Quaternary Fault Data and Map for Arizona

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In cooperation with the U.S. Geological Survey
International Lithospheric Program Task Group II-2
Major Active Faults of the World

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Technical Assistance from Richard Dart and Kathleen Haller

Introduction

This report is a compilation of available data on Quaternary faults in Arizona as of the summer of 1998. These data were compiled as part of a effort to compile data and map information on Quaternary faults throughout the world, which is being overseen by Michael Machette of the U.S. Geological Survey. Michael Machette, Richard Dart, and Kathleen Haller provided substantial technical assistance in the preparation of these data, and the fault data forms were reviewed and edited by Michael Machette. As part of this effort, fault traces were entered into a Geographic Information System (GIS) database by the USGS. Map traces were plotted on 1:250,000-scale topographic base maps, and were digitized by Richard Dart and Lee-Ann Bradley of the USGS. They generated the 1:750,000-scale fault map that accompanies this database.

Development of this database has depended heavily on several previous compilations of data on neotectonic structures in Arizona. The first and most comprehensive of these is the state-wide compilation of neotectonic faults by Menges and Pearthree (1983), which was done primarily by Chris Menges. I also utilized the later state-wide compilation of young faults by Euge and others (1992). Regional compilations of the Douglas and Silver City 1:250,000-scale quadrangles in southeastern Arizona by Machette and others (1986) and the Flagstaff area by Pearthree and others (1996) provided most of the data for these areas. I also utilized indexes of geologic mapping in Arizona (Scarborough and Coney, 1982; Harris and others, 1994) and the geologic bibliography for the state (Trapp, 1996) developed by the Arizona Geological Survey.

The data structure is set up to provide systematic information on each fault zone. Each fault has been assigned a number as part of the world-wide fault data set; faults are identified by number on the accompanying map. Fault names are based on published maps or reports. In cases where different names have been used for the fault, the alternative names are listed within the database. All of the faults are listed by name and number in the table on the following page. This table indicates where the data summary for each fault can be found, as well as the age of youngest activity and fault slip rate category. The individual fault data sheets include information on map and data sources, fault location, geologic setting of the fault, the geomorphic expression of the fault, recency of fault movement, fault slip rate(s), and fault zone length and orientation. Fault locations are rated good if they were originally mapped at 1:62,500 scale or larger, moderate if they were mapped at 1:130,000 scale or larger, or poor if there is substantial uncertainty in their location because of weak surface expression. Faults were grouped into slip rate categories of <0.02 mm/yr, < 0.2 mm/yr, and <1 mm/yr. Reported lengths are for the whole fault zone, not cumulative length of each individual fault in the zone, and orientations are averages for the fault zone. A composite list of references is at the end of this report. These fault data can be readily updated. Any feedback or any further data regarding individual faults is welcome, and more faults can be added as they are identified.

Fault Names and Numbers

Page	Fault Number	Fault Name	Age of Youngest Activity[1]	Slip Rate[2] mm/yr
6	926	Guadalupe Canyon fault	Q	<0.02
7	927	Bunk Robinson Peak fault zone	Q	<0.2
8	928	Pedrogosa fault	M	<0.02
9	929	Chiricahua fault zone	M	<0.02
10	930	South Swisshelm fault	Q	<0.02
11	931	North Swisshelm fault	Q	<0.02
12	932	Huachuca fault	M	<0.02
13	933	California Wash fold and faults	Q	<0.02
14	934	Santa Rita fault zone	L	<0.02
15	935	Little Rincon Mountains fault	Q	<0.02
16	936	Safford fault zone		
16	936A	Northern section	H	<0.02
17	936B	Southern section	H	<0.02
18	937	Cactus Flats faults	M	<0.2
19	938	Buena Vista fault	M	<0.02
20	939	Clifton faults	Q	<0.02
21	940	Whitlock Wash fault	Q	<0.02
22	941	Alma Mesa fault	Q	<0.02
23	942	Outlaw Mountain fault	Q	<0.02
24	943	Sand Tank fault	L	<0.2
25	944	Algodones fault zone	H	<1
27	945	Sugarloaf fault zone	L	<0.02
28	946	Horseshoe fault zone		
28	946A	Hell Canyon section	L	<0.2
29	946B	Horseshoe Reservoir section	H	<0.02
30	947	Carefree fault zone	M	<0.02
31	948	Verde fault zone	L	<0.02
33	949	Prescott Valley grabens	M	<0.2
34	950	Williamson Valley grabens	M	<0.2
35	951	Big Chino fault	H	<0.2
36	952	Seligman fault	H	<0.2
37	953	Arrowhead fault zone	L	<0.2
38	954	Babbitt Lake fault zone	M	<0.02

Page	Fault Number	Fault Name	Age of Youngest Activity[1]	Slip Rate[2] mm/yr
39	955	Bellemont fault	L	<0.2
41	956	Bill Williams fault	M	<0.02
42	957	Black Point/ Doney Mountain fault zone	M	<0.2
43	958	SP fault zone	L	<0.02
44	959	Campbell Francis fault zone	M	<0.02
45	960	Casner Cabin fault zone	M	<0.02
46	961	Cedar Ranch fault zone	M	<0.02
47	962	Cedar Wash fault zone	M	<0.02
48	963	Citadel Ruins fault zone	Q	<0.02
49	964	Deadman Wash faults	Q	<0.02
50	965	Double Top fault zone	Q	<0.02
51	966	Double Knobs fault	Q	<0.02
52	967	Ebert Tank fault zone	M	<0.02
53	968	Garland Prairie faults	Q	<0.02
54	969	Garland Prairie West faults	M	<0.02
55	970	Hidden Tank fault zone	M	<0.02
56	971	Lake Mary fault zone	L	<0.2
57	972	Large Whiskers fault zone	Q	<0.02
58	973	Lee Dam faults	Q	<0.02
59	974	Lockwood Canyon fault zone	Q	<0.02
60	975	Malpais Tank faults	M	<0.02
61	976	Maverick Butte faults	M	<0.2
62	977	Metz Tank fault zone	M	<0.02
63	978	Michelbach Tank faults	M	<0.02
64	979	Mormon Lake fault zone	Q	<0.2
65	980	Oak Creek North fault zone	Q	<0.2
66	981	Pearl Harbor fault zone	Q	<0.02
67	982	Phone Booth faults	Q	<0.02
68	983	Red House faults	M	<0.2
69	984	Rimmy Jim fault zone	Q	<0.02
70	985	Rock House fault	L	<0.2
71	986	Sinagua faults	L	<0.02
72	987	Mesa Butte North fault zone	Q	<0.02
73	988	Cameron graben and faults	M	<0.2
74	989	Shadow Mountain grabens	M	<0.2

Page	Fault Number	Fault Name	Age of Youngest Activity[1]	Slip Rate[2] mm/yr
75	990	Cataract Creek fault zone	Q	<0.2
76	991	Bright Angel fault zone	Q	<0.2
77	992	Eminence fault zone	Q	<0.2
78	993	Central Kaibab fault system	Q	<0.2
79	994	West Kaibab fault system	Q	<0.2
80	995	Aubrey fault zone	L	<0.2
81	996	Yampai graben	Q	<0.2
82	997	Toroweap fault zone		
82	997A	Northern Toroweap section	L	<0.2
83	997B	Central Toroweap section	H	<0.2
84	997C	Southern Toroweap section	M	<0.2
85	998	Hurricane fault zone		
86	998A	Anderson Junction section	H	<1
87	998B	Shivwitz section	L	<0.2
87	998C	Whitmore Canyon section	H	<0.2
88	998D	Southern Hurricane section	Q	<0.2
90	999	Sunshine Trail graben and faults	L	<0.2
91	1000	Sunshine faults	L	<0.2
92	1001	Gyp Pocket graben and faults	L	<0.2
93	1002	Main Street fault zone	L	<0.2
94	1003	Dutchman Draw fault	L	<0.2
95	1004	Washington fault zone		
95	1004A	Northern Washington section	L	<0.2
96	1004B	Mokaac section	L	<0.2
96	1004C	Sullivan Draw section	L	<0.2
97	1005	Grand Wash fault zone	L	<0.2
98	1006	Wheeler fault zone and graben	M	<0.02
100	1007	Mesquite fault	L	<0.2
101	1008	Littlefield Mesa faults	M	<0.2
102	1009	Mead Slope fault	H	<0.2
103	1010	Detrital Valley faults	M	<0.02
104	1011	Needles graben faults	L	<0.02
105	1012	Uinkaret Volcanic Field faults	Q	<0.2
106	1013	Andrus Canyon fault	Q	<0.2
107	1014	Concho fault	M	<0.2

[1] Age of youngest activity catetories are **H,** Holocene and post-glacial (<15 ka); **L,** late Pleistocene or younger (<130 ka); **M,** middle and late Quaternary (<750 ka); and **Q,** Quaternary (<1.6 Ma).

[2] Slip rate estimates are grouped into categories of <0.02 mm/yr; <0.2 mm/yr; and <1 mm/yr. If the range of slip-rate estimates for a fault is higher than the cutoff value, it is placed in the next higher category. For example, a slip-rate estimate of 0.01-0.03 mm/yr would be placed in the <0.2 mm/yr category.

926, GUADALUPE CANYON FAULT

Data Sources: Initially mapped by Hayes (1982) but not interpreted as cutting Quaternary alluvium. Menges and Pearthree (1983) and Machette and others (1986) recognized it as a possible Quaternary fault based on a fault scarp formed on a thin veneer of Pliocene to lower Quaternary alluvium.

Synopsis: This is a short, east-west-trending fault in the southeastern part of the Guadalupe Mountains, just north of the U.S.-Mexico border and just west of the Arizona-New Mexico border. The fault mainly cuts bedrock, but along about 3 km of its length, the fault forms a 10- to 20-m-high scarp on Pliocene to lower Quaternary alluvium. There are no useful minimum constraints on the age of youngest movement on this fault.

Date of compilation 1/05/95

County Cochise

1° x 2° sheet Douglas

Province Basin and Range

Reliability of location Good

Comments: Mapped by Hayes (1982) at 1:62,500 scale, field-checked on a reconnaissance basis and compiled at 1:250,000 scale by Machette and others (1986).

Geologic setting For most of its length, this is an intrabedrock fault within the Guadalupe Mountains, displacing mainly Cretaceous and Oligocene rocks. An upper Pliocene to lower Quaternary basalt is in contact with the fault and may be faulted. The east-west orientation of the fault is unusual among Quaternary faults of this region.

Sense of movement N

Comments: Normal fault as mapped in bedrock by Hayes (1982).

Dip Not reported

Dip direction S

Comments: Bedrock is displaced down-to-the-south across the fault, which is consistent with the inferred displacement of the veneer of Pliocene to Quaternary alluvium.

Geomorphic expression The fault forms 10- to 20-m-high scarps on the remnants of Pliocene to early Quaternary alluvial fans.

Age of faulted deposits Early Pleistocene to Pliocene

Comments: The estimated age of faulted alluvium is based on geomorphic surface characteristics and topographic position in the landscape.

Detailed studies None

Timing of most recent paleoevent Quaternary (<1.6 Ma)

Comments: Age of youngest faulted deposits is Pliocene to early Pleistocene. There is no meaningful minimum constraint on the age of youngest faulting event. Given the uncertainty in the age estimate of the faulted alluvial deposits, there may have been no Quaternary movement on this fault.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr

Comments: No more than 20 m of displacement has occurred during the past 1 m.y.

Length 5 km

Average strike N82E

927, BUNK ROBINSON PEAK FAULT ZONE

Data Sources: Mapped by Cooper (1959), Drewes (1980), and Hayes (1982); remapped and named by Machette and others (1986).

Synopsis: This is an approximately 15-km-long set of four north- to northwest-trending faults on the eastern side of the San Bernardino Valley in southeasternmost Arizona. Upper Pliocene basalt flows are displaced 20-150 m. Because there is no definitive evidence of middle to late Quaternary faulting, activity of these faults may have been associated with the basaltic eruptions in the late Pliocene or early Quaternary.

Date of compilation 01/03/96

County Cochise

1° x 2° sheet Douglas

Province Basin and Range

Reliability of location Good

Comments: Mapped at 1:62,500-scale by Hayes (1982); compiled at 1:250,000-scale by Machette and others (1986).

Geologic setting These four faults are located along the eastern margin of the San Bernardino Valley near the edge of and slightly within the southern Peloncillo Mountains. The longest fault, which also has the most displacement, is near or just west of the mountain front. The other three faults are on the western fringe of the mountains. The Pliocene-Quaternary San Bernardino volcanic field, with eruptions ranging in age from about 3 Ma to 270 ka, covers much of the valley.

Sense of movement N

Comments: Inferred from regional geology; fault movement may have been associated with extension and eruption of basalt flows.

Dip Not reported

Dip direction E, W, SW

Comments: The northern two faults have displacement down to the east, and the southern two faults have displacement down to the west or southwest.

Geomorphic expression Faulting is expressed as large (20-150 m high), embayed, rather gentle scarps formed on upper Pliocene (3 Ma) basalt flows.

Age of faulted deposits Late Pliocene

Detailed studies None

Timing of most recent paleoevent Quaternary (<1.6 Ma)

Comments: Faulting may have accompanied or closely followed eruption of upper Pliocene basalt flows (Machette and others, 1986).

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Comments: These faults may have been quite active in late Pliocene to early Quaternary time, but there is no definitive evidence of middle to late Quaternary activity. Thus, their slip rate is probably <0.2 mm/yr

Length 13 km

Average strike N6W

928, PEDROGOSA FAULT

Data Sources: Mapped and named by Menges and Pearthree (1983); further described by Machette and others (1986); corresponds to parts of the Buck Creek and Perilla faults as mapped by Drewes (1980).

Synopsis: A discontinuous, north to northeast-trending fault scarp is formed on Quaternary basalt flows and alluvium on the east side of the Pedrogosa Mountains, which lie at the western margin of the San Bernardino Valley in southeasternmost Arizona. There has been as much as 15 m of displacement of lower to middle Pleistocene alluvium, but a basalt flow of probable middle Pleistocene age is not faulted, implying that the fault was only active in the early to middle Pleistocene.

Date of compilation 1/03/96

County Cochise

1° x 2° sheet Douglas

Province Basin and Range

Reliability of location Moderate

Comments: Mapped at 1:130,000-scale on aerial photographs, field-checked on a reconnaissance basis, compiled at 1:250,000 on a topographic base by Machette and others (1986).

Geologic setting The fault is on the west side of the San Bernardino Valley, near the base of the Pedrogosa Mountains. The geometry of the structural basin associated with this valley is complex, but is deepest along the western side of the valley (Lynch, 1978). The Pliocene-Quaternary San Bernardino volcanic field, which has flows ranging from about 3 Ma to 270 ka in age, covers much of the valley.

Sense of movement N

Comments: Inferred from topography and regional geology and structure.

Dip Not reported

Dip direction E, SE

Comments: Surface displacement is down to the east or southeast.

Geomorphic expression Moderately high (5-15 m), gentle scarps are formed on lower to middle Pleistocene alluvial-fan remnants. No scarp is evident on an undated, middle Pleistocene (?) basalt flow that crosses the fault.

Age of faulted deposits Early to middle Pleistocene

Comments: The ages of deposit are estimated using geomorphic surface characteristics and the topographic position of the deposits in the landscape.

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Fault scarps on early to middle Pleistocene fans are about 5- to 15-m high. A fairly young basalt flow crosses the fault and is not displaced. This particular flow has not been dated, but dates for the San Bernardino volcanic field range from about 3 Ma to 270 ka. The unfaulted flow is low in the landscape and thus could be fairly young; it may be middle Pleistocene (130-750 ka). This evidence suggests that the Pedrogosa fault was active in the early to middle Quaternary, but has not been active for the past 130 k.y.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: This fault may not have been active in the past 130 k.y. and there has been less than 15 m of vertical displacement in the Quaternary. Thus, the slip rate is <0.02 mm/yr.

Length 26 km

Average strike N16E

929, CHIRICAHUA FAULT ZONE

Data Sources: Fault zone discussed by Lynch (1972). Mapped and named by Menges and Pearthree (1983); mapped and analyzed by Machette and others (1986).

Synopsis: This is a fault zone with probable Quaternary activity that extends for about 30 km along the east side of the Chiricahua Mountains in southeasternmost Arizona. The mountain front is steep and fairly linear, suggesting that this fault zone may have been fairly active in the Quaternary. However, fault scarps are poorly preserved, are not very high, and are formed only on lower to middle Pleistocene alluvial fans. These relations suggest that this fault has a fairly low middle and late Quaternary slip rate and has not ruptured in the latest Quaternary, contrary to previous published conclusions.

Date of compilation 1/02/96

County Cochise

1° x 2° sheet Douglas

Province Basin and Range

Reliability of location Moderate

Comments: Mapped at 1:250,000 scale by Machette and others (1986), based on interpretation of 1:130,000-scale aerial photographs.

Geologic setting The fault zone parallels the northerly trend of the east side of the Chiricahua Mountains, near the southern end of the San Simon Valley in southeastern Arizona. Scarps are close to the rugged, fairly linear mountain front that may reflect fault activity. The sharpness of the mountain front, however, is probably due at least in part to the resistant volcanic rocks of the mountains. The Cenozoic sedimentary basin in the San Simon Valley is up to 600 m deep, but the basin thickness decreases to the south (Lynch, 1978).

Sense of movement N

Comments: Movement inferred from regional geologic and structural relationships

Dip Not reported

Dip direction E

Comments: Inferred from surface displacement, which is down to the east.

Geomorphic expression Possible faulting is expressed as poorly preserved, discontinuous scarps formed on early to middle Pleistocene relict alluvial-fan surfaces. Late Pleistocene fans are probably not faulted, and Holocene fans clearly are not faulted. The steep, fairly linear mountain front on the east side of the Chiricahua Mountains suggests a moderately active fault zone (Lynch, 1972).

Age of faulted deposits Early to middle Pleistocene

Comments: Deposit ages are estimated using geomorphic surface characteristics and the topographic position of these deposits in the landscape.

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Previous studies (Menges and Pearthree, 1983; Pearthree and others, 1983; Machette and others, 1986) concluded that this fault zone ruptured during the latest Pleistocene or Holocene on the basis of morphologic scarp analysis. More recent field investigations by Pearthree (1988, unpublished data) indicate that scarps are very poorly preserved along this fault zone, and the scarps analyzed previously for morphometric analysis are likely fluvial terrace risers that trend parallel with the fault zone. The age of youngest rupture on this fault is probably middle to late Pleistocene.

Recurrence interval Not determined

Slip Rate <0.02 mm/yr

Comments: A slip rate of <0.01 mm/yr is estimated from < 5 m of vertical displacement in the past 500 ky.

Length 28 km

Average strike N0E

930, SOUTH SWISSHELM FAULT

Data Sources: Named by Machette and others (1986); previously called the Swisshelm Mountain fault by Menges and Pearthree (1983).

Synopsis: High, discontinuous, northwest-trending scarps formed on late Cenozoic alluvium parallel the east side of the Swisshelm Mountains in southeastern Arizona. Lower to middle Pleistocene deposits are probably displaced as much as about 15 m, but middle to upper Pleistocene terrace deposits are not faulted. The fault likely is Quaternary, but it has not been active since the middle Pleistocene.

Date of compilation 1/02/96

County Cochise

1° x 2° sheet Douglas

Province Basin and Range

Reliability of location Moderate

Comments: Mapped at 1:250,000 scale by Machette and others (1986), based on interpretation of 1:130,000-scale aerial photographs.

Geologic setting This northwest-trending fault parallels the east side of the southern Swisshelm Mountains. The fault is along the western margin of a narrow, shallow late Cenozoic sedimentary basin that lies between the Swisshelm and Chiricahua Mountains; to the south the basin pinches out. Late Cenozoic deposits, perhaps as young as middle Pleistocene in age, are displaced by the South Swisshelm fault.

Sense of movement N

Comments: Inferred from regional geologic relations.

Dip 60° to 70°

Comments: Faults are exposed at several locations.

Dip direction NE

Comments: Inferred from topography and regional geologic relations.

Geomorphic expression Faulting is expressed as high, discontinuous scarps formed on lower Pleistocene (>750 ka) to lower-middle Pleistocene (250?-750 ka) alluvial-fan deposits. Locally, upper to middle Pleistocene terrace deposits are not displaced.

Age of faulted deposits Early to middle Pleistocene

Detailed studies None

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

Comments: Early Quaternary faulting is likely and middle Quaternary faulting is possible, but there has been no late Quaternary (<130 ka) activity on this fault.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr

Comments: Low slip rate inferred from lack of late Quaternary activity.

Length 8 km

Average strike N23W

931, NORTH SWISSHELM FAULT

Data Sources: Studied and named the Swisshelm fault by Druke (1979); renamed the North Swisshelm fault by Machette and others (1986) in order to distinguish it from other faults farther south along the Swisshelm Mountains.

Synopsis: The North Swisshelm fault is marked by a fairly short, but high and prominent, northwest-trending scarp formed on late Cenozoic alluvium; the fault parallels the northeast side of the Swisshelm Mountains. The northwestern part of the scarp is steep (as much as 30°) suggesting recent activity, but it has almost certainly been trimmed and steepened by lateral stream erosion in Whitewater Draw. Away from the stream, the scarp is similarly high, but with a maximum slope of only 14°. It probably is a Quaternary fault, but likely has not been active since the early Pleistocene (Druke, 1979).

Date of compilation 1/02/96

County Cochise

1° x 2° sheet Douglas

Province Basin and Range

Reliability of location Good

Comments: Mapped at 1:250,000 scale by Machette and others (1986), based on large-scale mapping by Druke (1979)

Geologic setting This fault parallels the northeast side of the Swisshelm Mountains, near the southwestern margin of a narrow sedimentary basin between the Swisshelm and Chiricahua mountains. The fault displaces bedrock and upper Cenozoic basin-fill deposits.

Sense of movement N

Comments: Inferred from topography and regional geologic relationships.

Dip High-angle

Comments: The fault is naturally exposed at northwest end of scarp.

Dip direction NE

Comments: Inferred from regional geologic relationships

Geomorphic expression This fault is marked by a high, linear scarp formed on late Cenozoic alluvium. The scarp is much more impressive and steep to the northwest, where Whitewater Draw is not very far from the base of the scarp, implying that lateral stream erosion has steepened the scarp. Locally, late to middle Pleistocene terraces cross the fault and are not displaced.

Age of faulted deposits Late Miocene to possibly early Pleistocene

Detailed studies None

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

Comments: Early Quaternary faulting is likely, but there has been no late Quaternary activity and possibly no middle Quaternary activity on this fault.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr

Comments: No late Quaternary (<130 ka) activity has been documented on the fault.

Length 18 km

Average strike N41W

932, HUACHUCA FAULT ZONE

Data Sources: The fault zone was initially mapped and named by Menges and Pearthree (1983); geology of the fault zone was mapped in detail by Demsey and Pearthree (1994).

Synopsis: Low, subtle, discontinuous fault scarps trend north to northwest from near the U.S.-Mexico border to Arizona State Route 90. The faults displace lower and middle Pleistocene alluvial-fan deposits by a few meters or less; upper Pleistocene and Holocene deposits are not faulted. Detailed geologic mapping and morphologic fault scarp analysis indicate that the youngest fault rupture occurred 100 ka to 200 ka. It is possible that faulting occurred in the early Quaternary as well.

Date of compilation 1/03/96

County Cochise

1° x 2° sheet Nogales

Province Basin and Range

Reliability of location Good

Comments: Detailed mapping at 1:24,000-scale with field-checking (Demsey and Pearthree, 1994).

Geologic setting This fault zone parallels the general trend of the Huachuca Mountains, typically 3 to 8 km east of the embayed mountain front. The resultant scarps are near the western margin of a moderately deep (<1500 m) Cenozoic sedimentary basin in the upper San Pedro Valley.

Sense of movement N

Comments: No fault-plane exposures were observed; sense of movement and fault-dip direction inferred from regional geologic relations.

Dip Not reported

Dip direction E

Comments: No fault exposures observed; direction inferred from surface displacement and regional geology.

Geomorphic expression Faulting is expressed as low, subdued, east-facing piedmont fault scarps as much as 3 m high on middle Pleistocene and older alluvial fans and terraces. Analysis of scarp morphology indicates a middle to late Pleistocene scarp age (Demsey and Pearthree, 1994).

Age of faulted deposits Early Pleistocene, middle Pleistocene

Comments: Age of deposits estimated from soil development on deposits and from geomorphic characteristics of faulted surfaces.

Detailed studies None

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

Comments: Scarp morphology suggests an early late Quaternary age. Middle Pleistocene deposits are faulted, and upper Pleistocene and Holocene deposits are not faulted.

Recurrence interval Not reported

Comments: Evidence for more than one Quaternary fault movement is ambiguous.

Slip Rate < 0.02 mm/yr

Comments: A very low slip rate is inferred based on about 2 m of vertical displacement since the middle Pleistocene.

Length 25 km

Average strike N8W

933, CALIFORNIA WASH FOLD AND FAULTS

Data Sources: Although originally noted by Scarborough (1975), these structures were mapped and named by Menges and Pearthree (1983) and later discussed by Lindsay and others (1990).

Synopsis: These structures include an 8-km-long homoclinal fold and minor faults on the west side of the San Pedro Valley in southeastern Arizona. The faults offset uppermost Pliocene to lowermost Quaternary basin-fill deposits by as much as 15 m. There is little or no deformation of middle Pleistocene alluvial fan deposits by the homocline.

Date of compilation 1/03/96

County Cochise

1° x 2° sheet Nogales

Province Basin and Range

Reliability of location Poor

Comments: The structures were mapped using 1:130,000-scale aerial photos and transferred to a 1:250,000-scale topographic base; length of the structures is uncertain because their topographic expression is very subtle and stratigraphic exposures are limited.

Geologic setting These structures are located near the axis of, but toward west side of the San Pedro Valley. The sense of folding is down to the east. The San Pedro Valley is a strongly defined, N-S-trending topographic feature, but in the area of this structure it may contain less than 300 m of basin fill. The topographic front of the Whetstone Mountains is several kilometers west of the California Wash fold.

Sense of movement N

Comments: Homoclinal fold, down to the E; minor normal faults cut strata of the fold

Dip Not reported

Dip direction E

Comments: Displacement is down to the east. Dip direction is inferred from regional relations, but the actual dip of the inferred fault beneath the fold is uncertain.

Geomorphic expression These structures have weak surface expression. They may deform middle Pleistocene alluvial-fan remnants, but if so, it is very subtle. Fan remnants are not very well preserved, and detailed field surveys have not been conducted.

Age of faulted deposits Latest Pliocene sediment (2.0-1.6 Ma) (Lindsay and others, 1990)

Detailed studies None

Timing of most recent paleoevent Quaternary (<1.6 Ma)

Comments: Uppermost Pliocene sediments are deformed, but there is no clear evidence of middle or late Quaternary deformation.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: A low slip rate estimate is based on 15 m of offset since the late Pliocene, and no clear evidence of middle or late Quaternary deformation.

Length 6 km

Average strike N12W

934, SANTA RITA FAULT ZONE

Data Sources: Portions of the fault zone were mapped by Drewes (1971), whereas the entire fault zone was mapped and analyzed by Menges and Pearthree (1983), Pearthree and others (1983), and Pearthree and Calvo (1987).

Synopsis: Discontinuous faults scarps trend north to northeast along the western piedmont of the Santa Rita Mountains southeast of Tucson. The scarps are along the east side of a deep Cenozoic basin; seismic-reflection data suggests that the northern part of the fault zone dips about 20° to the west at depth. Detailed surficial geologic mapping, fault-scarp analysis, and trenching indicate that two fault rupture events have occurred in the past 200 to 300 k.y. The youngest rupture event likely occurred in the late Pleistocene (ca. 60 to 100 ka). There is no evidence of faulting in the early Pleistocene. A 7-km-long gap in fault scarps near the middle of the fault zone suggests the possibility of separate ruptures on the northern and southern parts of the fault. There is no clear difference in the age of youngest movement north and south of the gap, but the available timing data is crude.

Date of compilation 1/02/96

County Pima, Cochise

1° x 2° sheet Nogales

Province Basin and Range

Reliability of location Good

Comments: Trace based on detailed mapping at 1:48,000-scale with extensive field-checking by Pearthree and Calvo (1987); transferred to 1:250,000-scale topographic map.

Geologic setting Piedmont fault scarps parallel the general north to northeast trend of the Santa Rita Mountains. The fault zone is near east side of the deep (1500-3000 m) upper Cenozoic Santa Cruz sedimentary basin. This basin is fairly narrow (<10 km) along the southern part of the fault, but doubles in width to the north. Seismic-reflection data from the northern part of the fault suggests that the fault dips shallowly westward or northwestward beneath the Tucson basin. The fault displaces upper, middle, and lower Pleistocene deposits; total displacement of middle and lower deposits is the same, implying no significant early Pleistocene faulting.

Sense of movement N

Comments: Based on fault dip and stratigraphic displacements observed in trench (Pearthree and Calvo, 1987).

Dip 70° to 90° at surface; 20° at depth

Comments: Near surface dips are from trench exposure of faults in middle and upper Pleistocene alluvium; dips in the subsurface are based on interpretation of seismic-reflection data (Johnson and Loy, 1992)

Dip direction W to NW

Geomorphic expression Quaternary faulting is expressed as low, subdued, west- to northwest-facing piedmont scarps as much as 3 m high on late Pleistocene alluvial fans and terraces and as much as 5 m high on middle Pleistocene older alluvial fans. Scarp heights on middle and early Pleistocene alluvial fans are the same. The faults are located 3-5 km downslope from the fairly steep, but deeply embayed topographic front of the Santa Rita Mountains. Analysis of scarp morphology indicates a late Pleistocene (ca. 60 to 100 ka) age for the youngest surface rupture (Pearthree and Calvo, 1987).

Age of faulted deposits Early (ca. 1-2 Ma), middle (ca. 200-750 ka), and late (ca.100 ka) Pleistocene

Comments: Deposit age estimates are based on soil development and geomorphic surface characteristics (Pearthree and Calvo, 1987).

Detailed studies [934-1] One trench was excavated across the central part of the fault zone, near Madera Canyon (Pearthree and Calvo, 1987). No datable material was recovered from the trench, but soil-age estimates and offset relations indicate that late Pleistocene alluvium is displaced about 2 m and middle Pleistocene alluvium is displaced about 3.5 m. Latest Pleistocene deposits are not faulted.

Timing of most recent paleoevent Late Quaternary (<130 ka)

Comments: Trenching, surface-age estimates, and fault scarp morphology all indicate that the age of youngest movement is late Pleistocene (ca. 60 to 100 ka).

Recurrence interval ca. 100 k.y.

Comments: This estimate is based on evidence for two fault-rupture events in the past 200 to 300 ky.

Slip Rate <0.02 mm/yr

Comments: A low slip rate estimate is based on about 4 m of vertical displacement since the late middle Pleistocene (200 to 300 ka) and about 2 m of vertical displacement in the late Pleistocene (ca. 100 ka).

Length 52 km

Average strike N26E

935, LITTLE RINCON MOUNTAINS FAULT

Data Sources: Mapped by Drewes (1974), Lindgrey (1982), and Pearthree and others (1988), but named by Menges and Pearthree (1983).

Synopsis: The Little Rincon Mountains fault system defines the western margin of the San Pedro structural trough, east of the Rincon Mountains. Quaternary displacement is suspected on 2 short (< 5 km) parts of this fault system because of the well-defined topographic scarps on upper Cenozoic basin-fill deposits and deposition of early to middle Pleistocene alluvial fans immediately downslope from the scarps. However, no definitive displacement of Quaternary deposits has been recognized.

Date of compilation 01/03/96

County Cochise

1° x 2° sheet Tucson

Province Basin and Range

Reliability of location Good

Comments: Trace based on detailed field mapping at 1:24,000 scale (Lindgrey, 1982) and aerial photo interpretation at 1:130,000 scale; trace transferred to 1:250,000-scale topographic base map.

Geologic setting These faults are part of the western margin of the northern San Pedro Valley, which is a fairly shallow (<1000 m deep) Cenozoic sedimentary basin. The faults are located 3-5 km east of the prominent eastern front of the Little Rincon—Rincon mountain complex. Uppermost basin-fill deposits are definitely displaced across the fault.

Sense of movement N

Comments: Based on geologic mapping by Lindgrey (1982).

Dip 75° to 90°

Comments: Dip measurements from Lindgrey (1982)

Dip direction E

Geomorphic expression The fault zone is expressed as fairly sharp topographic scarps as much as 40 m high formed in basin-fill deposits. Small lower to middle Pleistocene alluvial fans have been deposited at the base of the scarp (Pearthree and others, 1988). These fans are only on the downthrown side, and do not cross the fault zone, so it is not clear whether they are faulted.

Age of faulted deposits Pliocene (?)

Detailed studies None

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

Comments: Quaternary fault activity is not certain, but is suspected because of the sharpness and size of the scarps.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr

Comments: No slip rate data is available, but the rate is probably low from the lack of proven Quaternary displacement.

Length 17 km

Average strike N8W

936, SAFFORD FAULT ZONE

Data Sources: Fault scarps were noted by Swan (1976) and J.C. Witcher (oral report); mapped by Menges and Pearthree (1983); remapped and analyzed by Machette and others (1986).

Synopsis: Discontinuous faults scarps trend north to northwest along the eastern front of the Pinaleno Mountains. Reconnaissance geologic mapping, soils studies, and analyses of scarp morphology indicate that several Quaternary faulting events have occurred along the Safford fault zone. The northern and southern sections of the fault zone each are about 15 km long; they are separated by a ~2-km-long gap that has no preserved scarps. There is evidence for recurrent, but infrequent Quaternary faulting event on each section. The youngest faulting event on both sections probably occurred during the latest Pleistocene, but timing data are not sufficiently precise to indicate whether this was one large event or two smaller events.

Date of compilation 01/02/96

County Graham

1° x 2° sheet Silver City

Province Basin and Range

Geologic setting Fault scarps parallel the north to northwest trend of the east side of the Pinaleno Mountains. Scarps are very close to the rugged, linear mountain front along the northern section of the fault. The sharpness of the mountain front suggests a fairly active normal fault, but it is probably due at in part to the resistant gneissic rocks of the mountains. Fault scarps are near the western margin of a middle and late Cenozoic sedimentary basin up to 3000 m deep. Faults associated with the scarps may merge downward into a major, moderate to low-angle, NE-dipping detachment fault (Kruger, 1991). Late Pleistocene, middle Pleistocene, and early middle Pleistocene surfaces are displaced by progressively greater amounts, indicating recurrent movement. Total middle Quaternary and younger displacement is 5 to 10 m.

936A, NORTHERN SAFFORD SECTION

Section Description: This name applies to the northern section part of the Safford fault zone. These faults are at or near the eastern front of the Pinaleno Mountains, from the mouth of Gillespie Canyon to the northeast corner of the mountain range at Deadman Ridge.

Reliability of location Good

Comments: Mapped at 1:250,000 scale by Machette and others (1986), based on 1:48,000-scale mapping by Pearthree and Calvo (unpublished, 1981).

Sense of movement N

Comments: Interpreted from topography and seismic reflection lines (Kruger, 1991)

Dip About 50° in the shallow subsurface, possibly decreasing to about 20° below 2-3 km

Comments: Interpreted from seismic reflection lines (Kruger, 1991).

Dip direction NE to E

Comments: Based on surface displacement that is down to the E or NE, and interpretations of seismic data

Geomorphic expression Low to moderately high scarps formed on Pleistocene relict alluvial-fan surfaces. Late Pleistocene fans are offset 1-2 m, whereas middle Pleistocene fans are offset 2-7 m. Morphologic analyses of fault scarps suggest a latest Pleistocene age of youngest rupture along the northern part of the fault.

Age of faulted deposits Early to middle Pleistocene, middle Pleistocene, and late Pleistocene

Comments: Deposit ages are estimated using geomorphic surface characteristics and their topographic position in the landscape, and soil development.

Detailed studies None

Timing of most recent paleoevent: Holocene to post glacial (<15 ka)

Comments: Analysis of fault scarp morphology suggests a latest Pleistocene age of youngest faulting. Deposits with an estimated age as young as late Pleistocene (based on soil development) are faulted, suggesting that the youngest faulting event occurred in the latest Pleistocene.

Recurrence interval ~100 k.y.

Comments: Late Pleistocene, middle Pleistocene, and early middle Pleistocene surfaces are displaced by progressively greater amounts, indicating recurrent movement. Total middle Quaternary and younger displacement is 5 to 10 m, implying that recurrence intervals between large surface ruptures are quite long.

Slip Rate <0.02 mm/yr

Comments: Fault slip rate is probably 0.01 to 0.02 mm/yr, based on < 10 m of vertical displacement in the middle and late Quaternary (the past 500 to 750 ky).

Length 15 km

Average strike N19W

936B, SOUTHERN SAFFORD SECTION

Section Description: This name applies to the southern section part of the Safford fault zone. These faults are 2 to 5 km east of the eastern front of the Pinaleno Mountains, from just northwest of the junction U.S. Highway 191 and State Route 266 southeastward to Willow Springs Wash.

Reliability of location Good

Comments: Mapped at 1:250,000 scale by Machette and others (1986), based on 1:48,000-scale mapping by Pearthree and Calvo (unpublished, 1981).

Sense of movement N

Comments: Interpreted from topography and seismic reflection lines (Kruger, 1991).

Dip Not reported

Comments: Fault dip information for the northern section of this fault zone is summarized above. No other information exists for the southern section of the fault.

Dip direction NE to E

Comments: Based on surface displacement that is down to the E or NE.

Geomorphic expression Low scarps formed on middle Pleistocene and latest Pleistocene alluvial-fan surfaces. These fault scarps are more gentle than along the northern part of the fault, suggesting a late Pleistocene age of youngest rupture, although they are formed in relatively fine gravelly alluvium.

Age of faulted deposits Middle Pleistocene, and late to latest Pleistocene

Comments: Deposit ages are estimated using geomorphic surface characteristics and their topographic position in the landscape, and soil development.

Detailed studies None

Timing of most recent paleoevent: Holocene to post glacial (<15 ka)

Comments: Analysis of fault scarp morphology suggests a late Pleistocene age of youngest faulting on this section. Deposits with an estimated age as young as latest Pleistocene (based on soil development) are faulted, suggesting that the youngest faulting event occurred in the latest Pleistocene to early Holocene.

Recurrence interval ~100 k.y.

Comments: Latest Pleistocene and middle Pleistocene surfaces are displaced by progressively greater amounts, indicating recurrent movement. Total middle Quaternary and younger displacement is about 5 m, implying that recurrence intervals between large surface ruptures are quite long.

Slip Rate <0.02 mm/yr

Comments: The fault slip rate is probably about 0.01 mm/yr, based on ca. 5 m of vertical displacement in the middle and late Quaternary (the past 500 ky)

Length 16 km

Average strike N45W

937, CACTUS FLATS FAULTS

Data Sources: Named by Menges and Pearthree (1983); mapped in more detail by Houser and others (1985).

Synopsis: A series of northwest-trending faults and fractures in basin-fill deposits and middle Pleistocene terrace gravels of the Gila River and possibly late Quaternary terraces of tributaries to the Gila River. Total Plio-Quaternary offset across these faults may be as much as 100 m, but surface scarps are low and subtle, and offset of Gila River terrace gravels is less than 0.5 m. Thus, there evidently has been little late Quaternary fault activity.

Date of compilation 12/11/95

County Graham

1° x 2° sheet Silver City

Province Basin and Range

Reliability of location Moderate

Comments: Mapped using 1:130,000-scale aerial photos, transferred to 1:250,000-scale topographic base for digitization; also, east end of fault zone was mapped at 1:48,000-scale by Houser and others (1985).

Geologic setting These northwest-trending faults and fractures are near the middle of the long, complex Safford basin. Total Plio-Quaternary displacement across these faults may be as much as 100 m (Houser and others, 1985), with displacement mainly down to the northeast toward the center of the basin.

Sense of movement N

Comments: Most exposed faults have normal displacement, but a few faults have reverse displacement.

Dip High angle

Dip direction NE, SW

Comments: The dominant dip is to the NE, but some faults dip to the SW.

Geomorphic expression Faulting is expressed as very subtle, low scarps on river terraces and tributary terraces. Displacement of middle Pleistocene alluvial surfaces is about 0.5 m.

Age of faulted deposits Pliocene, middle Pleistocene, and possibly late Pleistocene

Comments: Age estimates are based on geomorphic surface characteristics, landscape position, and regional correlation. Houser and others (1985) do not assign a specific age estimate to the tributary terrace deposits that are faulted. Based on their geomorphic position in the landscape, they are probably late Quaternary in age.

Detailed studies none

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

Comments: Machette and others (1986) concluded that middle Pleistocene terrace deposits are faulted, but that late Pleistocene fan deposits are not. Houser and others (1985) concluded that fairly young tributary terrace deposits are faulted; their age is uncertain.

Recurrence interval Not reported

Slip Rate <0.2 mm/yr

Comments: A long-term rate of 0.04 mm/yr is based on a maximum 100 m of offset of a 2.5-Ma volcanic tuff. The middle to late Quaternary slip rate is probably much less based on very modest middle and late Quaternary displacement of 0.5 m.

Length 9 km

Average strike N54W

938, BUENA VISTA FAULT

Data Sources: Initially mapped by Menges and Pearthree (1983); named and described by Machette and others (1986).

Synopsis: Low, gentle, northeast-trending scarps formed on middle Pleistocene piedmont alluvium are about 3 km long. The scarps are located about 3 km south of the modern Gila River and trend parallel to it, suggesting they could be old terrace scarps. No river gravels were found at the base of the scarps, however, so they may be fault scarps. If they are fault scarps, they are late to middle Pleistocene in age, and they may have formed in a single faulting event.

Date of compilation 12/11/95

County Graham

1° x 2° sheet Silver City

Province Basin and Range

Reliability of location Moderate

Comments: Located on 1:130,000-scale aerial photos, transferred to 1:250,000-scale topographic base map for digitization.

Geologic setting Low scarps are about 2 km west of several low bedrock hills, toward the east side of the long, complex Safford basin. Scarps trend northeast, which is different from most late Cenozoic faults in the area.

Sense of movement N

Comments: Inferred from regional relations.

Dip Not reported

Dip direction NW

Comments: Inferred from surface displacement, which is down to the northwest, and regional relations.

Geomorphic expression Possible faulting is expressed as low, gentle, northwest-facing scarps on middle Pleistocene lower piedmont alluvial fans. Scarps are about 2 m high and have 5° and 9° maximum slope angles, suggesting a late Pleistocene scarp age.

Age of faulted deposits Middle Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Timing estimate based on gentle scarps and no evidence of faulting of alluvium younger than middle Pleistocene in age.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: Rough slip rate estimate of < 0.01 mm/yr is based on 2 m of middle and late Quaternary slip.

Length 4 km

Average strike N45E

939, CLIFTON FAULTS

Data Sources: Mapped by several workers, but named and inferred to have Quaternary activity by Menges and Pearthree (1983). Also referred to as the Ward Canyon and Maverick Hill fault zones by Machette and others (1986).

Synopsis: These two NW-trending, en echelon normal faults clearly cut upper Cenozoic basin-fill deposits and alluvial-fan remnants of probable upper Pliocene to lower Quaternary age. The total length of the faults is about 40 km. Scarps on Pliocene-Quaternary fan remnants are as high as 10-15 m, but no evidence of late Quaternary fault activity has been discovered.

Date of compilation 12/13/95

County Greenlee

1° x 2° sheet Clifton

Province Basin and Range

Reliability of location Moderate

Comments: Faults mapped using 1:130,000-scale aerial photos, transferred to 1:250,000-scale topographic base.

Geologic setting These faults are at the northeastern margin of a northwest-trending structural basin and probably part of range-bounding fault system that has substantial total displacement. The sedimentary basin is probably quite shallow, however, with less than about 300 m of basin-fill sediment. Faults displace the highest-level basin-fill deposits, and poorly preserved relict alluvial-fan surfaces are displaced by about 10 to 15 m.

Sense of movement N

Comments: A steeply dipping normal fault is exposed near Clifton, in Ward Canyon.

Dip High-angle

Dip direction SW

Comments: Based on the fault exposure in Ward Canyon, and inferred from regional geologic relationships.

Geomorphic expression Faulting has generated high, fairly gentle scarps on upper Cenozoic basin-fill deposits and alluvial-fan deposits of probable upper Pliocene to lower Quaternary age. These scarps are as much as 15-20 m high and have maximum slope angles of 10° to 12°.

Age of faulted deposits Pliocene to early Quaternary

Detailed studies None

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

Comments: Quaternary fault activity is not certain, but early Quaternary activity is likely based on displacement of high fan remnants. No clear evidence of late Quaternary faulting has been documented.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: An estimate of 0.01 mm/yr is based on 10-15 m of offset of lower Pleistocene(?) fan deposits.

Length 14 km

Average strike N48W

940, WHITLOCK WASH FAULT

Data Sources: Mapped and named by Menges and Pearthree (1983); remapped by Pearthree and others (1988), but part of the fault was mapped in greater detail by Shenk (1990).

Synopsis: A series of north- to northwest-trending faults offset Pliocene basin-fill deposits on the east side of the northern San Pedro Valley, in southeastern Arizona. Quaternary fault activity is suspected based on the prominent escarpment formed on basin-fill deposits. However, a detailed map of the southern part of this fault zone shows no offset of lower to middle Quaternary deposits (Shenk, 1990), so Quaternary activity is uncertain.

Date of compilation 01/03/96

County Pinal

1° x 2° sheet Tucson

Province Basin and Range

Reliability of location Moderate

Comments: Trace mapped on 1:130,000-scale aerial photos; transferred to 1:250,000-scale topographic base map.

Geologic setting This structure is located toward the eastern side of the northern San Pedro Valley, which is a fairly deep (1000 m) Cenozoic sedimentary basin. The sense of faulting is down to the west. The San Pedro Valley is a strongly defined, north-trending topographic feature. Faults displace upper basin-fill deposits that are of Pliocene age (Shenk, 1990).

Sense of movement N

Comments: Based on natural fault exposures.

Dip 70° to 85°

Comments: Based on mapping by Shenk (1990).

Dip direction E

Comments: Based on natural fault exposures.

Geomorphic expression Faulting has generated a high, but not very steep, escarpment on basin-fill deposits along this fault. No certain offset of Quaternary deposits has been documented, and detailed geologic mapping along of part of the fault by Shenk (1990) found no evidence for displacement of fairly old Quaternary alluvium.

Age of faulted deposits Pliocene

Detailed studies None

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

Comments: There is a good chance that there has not been any Quaternary activity on this structure.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr.

Length 23 km

Average strike N12W

941, ALMA MESA FAULT

Data Sources: Mapped and named by Menges and Pearthree (1983); also mapped by Houser (1994); part of a group of several faults, most of which are in New Mexico and are only mentioned here.

Synopsis: The Alma Mesa fault is a short, NNE-trending fault in the Alma basin, very near the Arizona-New Mexico border. Based on photointerpretation, it is apparent that the fault displaces early Pleistocene to Pliocene relict alluvial fans. Houser (1994) inferred that some faults in the Alma basin have been active as recently as the late Pleistocene, but no clear evidence for or against younger movement has been documented for the Alma Mesa fault in Arizona.

Date of compilation 12/11/95

County Greenlee

1° x 2° sheet Clifton

Province Basin and Range

Reliability of location Moderate

Comments: Based on interpretation of 1:130,000-scale aerial photos; trace transferred to 1:250,000-scale topographic map.

Geologic setting This fault is near the northwestern margin of the deeply dissected late Cenozoic Alma basin, which extends eastward to the Mogollon Mountains in New Mexico. Based on regional correlations, the basin probably filled to its maximum level in the late Pliocene or early Quaternary. Modern streams are entrenched as much as 200 m below the highest level of Pliocene-early Pleistocene alluvial fan remnants.

Sense of movement N

Comments: Inferred from topography across the fault and from regional relationships.

Dip Not reported

Dip direction E, SE

Comments: Surface displacement is down to the east or southeast.

Geomorphic expression Faulting is expressed as large (estimated <20 m from topographic maps), but fairly gentle fault scarps on very high-level alluvial fan remnants.

Age of faulted deposits Pleistocene to Pliocene. Age estimates are based on geomorphic surface characteristics, topographic position of faulted units, and regional correlations.

Detailed studies None

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

Comments: Constraints on the age of youngest movement are weak. This fault cuts upper Pliocene to lower Quaternary alluvial-fan deposits. Younger deposits in this area are very limited in extent, and where present, it is not clear whether they are faulted.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: No more than 20 m of displacement has occurred during the past 1-2 m.y. Thus, the long-term slip rate must be 0.02 mm/yr or less.

Length 15 km

Average strike N22E

942, OUTLAW MOUNTAIN FAULT

Data Sources: Mapped by Hayes (1982); named by Machette and others (1986).

Synopsis: The Outlaw Mountain fault is a north-trending normal fault on the east side of the San Bernardino Valley that has displaced upper Pliocene basalt flows by about 150 m. Because there is no definitive evidence of middle to late Quaternary faulting, activity of this fault may have been associated with basaltic eruptions in the Pliocene-Quaternary San Bernardino volcanic field, and thus may have occurred primarily during late Pliocene or early Pleistocene time.

Date of compilation 1/03/96

County Cochise

1° x 2° sheet Douglas

Province Basin and Range

Reliability of location Good

Comments: Mapped at 1:62,500 scale by Hayes (1982); compiled at 1:250,000 scale by Machette and others (1986).

Geologic setting This fault is located along the eastern margin of the San Bernardino Valley, near the southern Peloncillo Mountains. The Pliocene-Quaternary San Bernardino volcanic field, which has flows ranging in age from about 3 Ma to 270 ka, covers much of the valley. The fault displaces upper Pliocene (3 Ma) basalt by about 150 m. Fault movement may have been associated with the eruption of basalt flows or may have closely post-dated the eruptions (Lynch, 1978).

Sense of movement N

Comments: Inferred from regional geology

Dip Not reported

Dip direction W

Comments: Displacement across the fault is down to the west, toward the valley.

Geomorphic expression Faulting is expressed as large scarps (as much as 150 m high) formed on upper Pliocene basalt flows. The fault escarpment is fairly sinuous and moderately steep and embayed; no definitive evidence of Quaternary faulting has been discovered.

Age of faulted deposits Late Pliocene

Detailed studies None

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

Comments: Faulting may have accompanied or closely followed eruption of upper Pliocene basalt flows (Machette and others, 1986).

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr

Comments: Fault probably was quite active in late Pliocene to early Quaternary time, but there is no definitive evidence of middle to late Quaternary faulting events. Thus, the fault is classified here as probably having a low slip rate.

Length 11 km

Average strike N1W

943, SAND TANK FAULT

Data Sources: Mapped and named by Schell and Wilson (1981); further studied by Pearthree and others (1983) and Demsey and Pearthree (1990). The fault trends northwest to north on the piedmont west of the Sand Tank Mountains, southeast of Gila Bend.

Synopsis: A low, but obvious fault scarp trends northwest to north on the western piedmont of the Sand Tank Mountains, southeast of Gila Bend, in the Sonoran Desert subprovince of the Basin and Range. The total length of the obvious fault scarp is about 3 km, but lineaments extend for about 5 km north and southwest of the fault scarp on Pleistocene alluvial surfaces with no discernible offset. Total late Quaternary displacement across the fault zone is less than 2 m. Detailed surficial geologic mapping, fault scarp analysis, and trenching strongly suggest that only one fault rupture has occurred since 70-200 ka, and that event occurred in the latest Pleistocene.

Date of compilation 1/04/95

County Maricopa

1° x 2° sheet Ajo

Province Basin and Range

Reliability of location Good

Comments: Trace based on detailed mapping at 1:24,000 scale with field-checking by Demsey and Pearthree (1990).

Geologic setting The Sand Tank fault is a down-to-west, normal fault on the east side of the broad Gila Valley in south-central Arizona. It is located in the heart of the Sonoran Desert subprovince of the Basin and Range, which is characterized by low, pedimented, deeply embayed mountain fronts indicative of long term tectonic stability. The fault vertically displaces middle to upper Pleistocene alluvium by less than 2 m, and latest Pleistocene and Holocene alluvium is not faulted (Demsey and Pearthree, 1990).

Sense of movement N

Comments: Sense based on fault dip and stratigraphic displacements observed in a trench; no slip indicators were observed.

Dip 45° to 90°

Comments: Fault planes were exposed in a trench in middle to late Pleistocene alluvium.

Dip direction NW

Geomorphic expression Faulting has generated low, fairly gentle, west- to northwest-facing piedmont fault scarps that parallel the general trend of the Sand Tank Mountains, and are 2 to 5 km downslope from a pedimented, embayed mountain front. These scarps are as high as 2 m on middle to upper Pleistocene alluvial fans. Analysis of scarp morphology, based on 13 scarp profiles, suggests a latest Pleistocene scarp age (ca. 10 to 20 ka).

Age of faulted deposits Middle to upper Pleistocene (ca. 70 to 200 ka)

Comments: Age estimate is based on soil development and regional correlation.

Detailed studies [943-1] Two trenches excavated across fault zone were interpreted by Demsey and Pearthree (1990). No datable material was found, but soil-age estimates and offset relationships indicate 1.5-2 m of vertical displacement of middle to late Pleistocene alluvium. No clear evidence for more than one faulting event was found. The short length of fault scarps relative to their maximum displacement is enigmatic, however, suggesting the possibility that the scarps may have formed in two events (D.B. Slemmons, oral communication, 1993). Holocene to latest Pleistocene alluvium (estimated age 8-12 ka) is unfaulted.

Timing of most recent paleoevent: Late Quaternary (<130 ka)

Comments: Trenching and surface-age estimates indicate that middle to late Pleistocene deposits (ca. 70 to 200 ka) are faulted, whereas early Holocene to latest Pleistocene deposits (8-12 ka) are not faulted. Analysis of fault scarp morphology indicates a latest Pleistocene age of youngest movement (ca. 10 to 20 ka).

Recurrence interval ca. 100 k.y.

Comments: The scarps probably record one, but no more than two faulting events in the past 70 to 200 k.y.

Slip Rate <0.02 mm/yr

Comments: Slip rates of 0.01-0.03 mm/yr are estimated from 1.5 to 2 m of vertical displacement in the past 70 to 200 k.y. These rates are probably a maximum, because there is no evidence of earlier Quaternary displacement on the fault zone.

Length 3 km

Average strike N27E

944, ALGODONES FAULT ZONE

Data Sources: The fault zone was mapped and named by Olmsted and others (1973). Geophysical studies of an area including the Algodones fault were done by Mattick and others (1973). The fault zone was mapped in more detail and its late Quaternary behavior was investigated by Woodward-McNeil & Associates (1974).

Synopsis: The Algodones fault zone consists of northwest-trending predominantly normal faults located within the Yuma Desert, southeast of Yuma, on the margin of the San Andreas fault system (California). The Yuma Desert, which is a broad plain between the Gila Mountains and the lowermost Colorado River, is covered with locally-derived alluvium, deposits of the Colorado River, and eolian deposits. The Algodones fault zone follows a basement high located between two deep late Cenozoic basins. Its faults displace probable upper Pleistocene Colorado River deposits on Upper Mesa by at least 15 m. Trenches revealed a broad zone of faults that dip northeast and have predominantly normal displacement. Multiple buried soil horizons and colluvial wedges are displaced by faulting, indicating that multiple events occurred in the late Pleistocene. The amount of vertical displacement per event is estimated at 0.5-1.5 m. Holocene eolian deposits blanket the faults and are not displaced. The age of youngest displacement was estimated to be latest Pleistocene (11-15 ka).

Date of compilation 2/03/98

County Yuma

1° x 2° sheet El Centro

Province Basin and Range

Reliability of location Good

Comments: Location based on mapping at 1:125,000-scale by Olmsted and others (1973) and at about 1:70,000-scale by Woodward-McNeil & Associates (1974); transferred to 1:250,000-scale topographic map for digitization.

Geologic setting The Algodones fault zone is composed of northwest-trending predominantly normal faults located northeast of the main San Andreas transform fault system. The Algodones fault zone is within the Yuma Desert, a broad plain between the Gila Mountains and the lowermost Colorado River. The Algodones fault zone follows a basement high between the deep (ca. 2000 m), fairly narrow late Cenozoic Fortuna basin to the northeast and the deep (> 2000 m), broader San Luis basin to the southwest (Mattick and others, 1973). The Algodones faults displace probable upper Pleistocene Colorado River deposits on Upper Mesa by at least 15 m (Woodward-McNeil & Associates, 1974).

Sense of movement N

Comments: Some workers have inferred right-lateral strike-slip displacement based primarily on fault orientation relative to the nearby faults of the San Andreas system. The Algodones fault zone was even considered as a possible continuation of the San Andreas fault (Mattick and others, 1973). However, the subsurface configuration of the top of the Pliocene Bouse Formation, which crosses the fault, precludes substantial lateral displacement. The Algodones faults bound deep, young sedimentary basins to the northeast and southwest, implying that the dip-slip component of displacement is the important. Faults recognized in trenches were interpreted as normal faults. Based on this collective evidence, it is likely that the Algodones fault zone is composed predominantly of normal faults that are not spatially linked to the San Andreas fault system (Woodward-McNeil & Associates, 1974).

Dip 50° to near vertical

Comments: Near surface estimates of dip are based on faults mapped in trenches (Woodward-McNeil & Associates, 1974).

Dip direction NE

Comments: Dip directions are based on faults mapped in trench logs trenches (Woodward-McNeil & Associates, 1974).

Geomorphic expression Faulting is expressed as 7- to 15-m-high, northeast-facing scarps formed on Upper Mesa, a Pleistocene terrace of the Colorado River. The scarp is well-defined on topographic maps and on aerial photographs. No morphologic data has been reported for this scarp.

Age of faulted deposits Latest Pleistocene (<15 ka)

Comments: The Algodones faults displace probable late Pleistocene Colorado River deposits on Upper Mesa by at least 15 m (Woodward-McNeil & Associates, 1974). This age estimate is based on soil development.

Detailed studies [944-1] Five trenches were excavated across the faults. The fault zone consists of multiple fractures with a width of about 70 m. The individual faults have variable, moderate to steep northeast dips, and predominantly normal displacement. Multiple buried soil horizons and colluvial wedges are displaced by faulting, indicating that multiple events occurred during the late Pleistocene. Vertical displacement per event is estimated at 0.5-1.5 m. Holocene eolian deposits blanket the faults and are not displaced. The age of youngest displacement was estimated at latest Pleistocene (11-15 ka; Woodward-McNeil, 1974).

Timing of most recent paleoevent: Holocene to post-glacial (<15 ka)

Comments: Trenching studies indicate a latest Pleistocene age for youngest movement (~11-15 ka).

Recurrence interval 5-10 k.y.

Comments: This rough estimate is based on 15 m of displacement of upper Pleistocene deposits (ca. 50-100 ka), with displacements of 0.5-1.5 m per event. Evidently, it has been at last 10 k.y. since the most recent paleoevent.

Slip Rate 0.2-1.0 mm/yr

Comments: The slip rate is estimated at 0.15-0.3 mm/yr based on 15 m of vertical displacement of Upper Mesa deposits, which are roughly estimated to be 50-100 ka.

Length 19 km

Average strike N39W

945, SUGARLOAF FAULT ZONE

Data Sources: Initially identified by Fugro (1981); named by Menges and Pearthree (1983); mapped and investigated by Anderson and others (1986); mapped and investigated by Pearthree and others (1995).

Synopsis: This low, fairly continuous fault scarp on bedrock trends north to northwest for about 10 km along the western margin of small sedimentary basin on the flank of the Mazatzal Mountains. The Sugarloaf fault zone continues for about 10 km further north, but minimal topographic relief across this part of the fault implies little or no Quaternary displacement. Detailed surficial geologic mapping shows almost no scarps on alluvium along the fault zone. However, interpretation of natural exposures and two fault trenches indicate that late to latest Pleistocene alluvium is faulted and Holocene alluvium is not faulted. The long-term slip rate is quite low, but there is insufficient evidence to estimate recurrence intervals.

Date of compilation 9/20/96

County Maricopa

1° x 2° sheet Mesa

Province Basin and Range

Reliability of location Good

Comments: Trace based on detailed mapping at 1:12,000 by Pearthree and others (1995) and Anderson and others (1986), and 1:24,000 scale by Skotnicki 1992a; 1992b).

Geologic setting The Sugarloaf fault is located in the Transition Zone between the Colorado Plateau and the Basin and Range provinces. This normal fault defines the western margin of a small basin that represents a shallow (< 200 m deep), asymmetric graben, just west of the Mazatzal Mountains.

Sense of movement N

Comments: Fault planes are exposed in trenches, stream cuts, and road cuts; the sense of movement is inferred from interpretation of drag deformation in fault sediment exposed in the hanging wall, and regional relationships (Pearthree and others, 1995).

Dip 70° to 80°

Comments: Fault dips have been measured in roadcut, gully, and trench exposures.

Dip direction E

Comments: East dip observed in numerous fault exposures.

Geomorphic expression Fault forms low but fairly sharply-defined, east-facing scarps as much as 5 m high at the boundary between weathered Precambrian granite and Tertiary basin-fill sediment. The bedrock escarpment associated with the fault is not high, but it is quite linear and fairly steep. Fault scarps formed on alluvium are rare and poorly preserved.

Age of faulted deposits Late to latest Pleistocene

Comments: Age based on soil development and regional correlations.

Detailed studies [945-1] Three trenches were excavated across the fault and a natural fault exposure was cleaned off and interpreted (Pearthree and others, 1995). Detailed study of these exposures indicates that upper and probably uppermost Pleistocene alluvium is faulted against granite; middle to upper Holocene deposits are not faulted. A small trench excavated across an apparent middle to late Holocene fault scarp reported by Pearthree and Scarborough (1984) and Anderson and others (1986) revealed no fault deformation of strata beneath the scarp, and archeological evidence that the undeformed strata below the scarp are 1 ka or less in age. Thus, this scarp is not a fault-related feature, and may be anthropogenic in origin (Pearthree and others, 1995).

Timing of most recent paleoevent Late Quaternary (<130 ka)

Comments: The estimated age of faulted deposits is upper to uppermost Pleistocene thereby indicating late Quaternary activity; however, middle Holocene and younger deposits are not faulted.

Recurrence interval Not reported

Comments: Evidence for more than one Quaternary fault movement is strong; but the timing of faulting events prior to the latest event is very poorly constrained.

Slip Rate <0.02 mm/yr

Comments: No more than 1 m of vertical displacement has occurred in the past 50-100 ka, based displacement of late Pleistocene (ca. 50-100 ka) deposits.

Length 8 km

Average strike N40W

946, HORSESHOE FAULT ZONE

Data Sources: Initially identified and called the Tangle Peak fault by Ertec (1981); renamed the Horseshoe Dam fault by Menges and Pearthree (1983). Also called the Horseshoe fault by Pearthree and Scarborough (1984) and Piety and Anderson (1990).

Synopsis: Fault consists of two sections, both of which have evidence of recurrent late Quaternary activity. The north-trending Hell Canyon section is about 12-km long and follows the boundary between a steep, linear mountain front to the west and a late Cenozoic sedimentary basin to the east. The west-northwest-trending Horseshoe Reservoir section is about 10-km long and roughly parallels the southern margin of the sedimentary basin. Part of this section is usually submerged beneath Horseshoe Reservoir. Detailed surficial geologic mapping and profiling of scarps along the Hell Canyon section indicate that upper to middle Pleistocene alluvium is faulted; the youngest event may be about 15-30 ka, but there probably was an earlier event post-150 ka. Trenches excavated across the Horseshoe Reservoir section indicate that middle Quaternary Verde River terrace gravels have been displaced a total of about 2 m in 2 or 3 events. The youngest event is about 10-20 ka (similar to that of the Hell Canyon section); one or two older events occurred between 100-300 ka (Piety and Anderson, 1990;1991).

Date of compilation 09/23/96

County Maricopa, Yavapai

1° x 2° sheet Mesa, Holbrook

Province Basin and Range

Geologic setting Located in the Transition Zone, the upland portion of the Basin and Range province in central Arizona. This normal fault defines the western and southern margins of the small, dissected Horseshoe basin between the Mazatzal Mountains and Humboldt Mountain. The basin is probably an asymmetric graben, with the Horseshoe fault being the master fault. The mountain front associated with the Horseshoe fault is fairly high and steep and quite linear; the basin has been deeply dissected in response to downcutting of the Verde River, which flows through it.

Number of sections 2

Comments: Sections are defined based on orientation and geomorphic expression (Piety and Anderson, 1990; 1991).

946A, HELL CANYON SECTION

Reliability of location Good

Comments: Location based on detailed mapping at 1:48,000 by Piety and Anderson (1990), transferred to 1:250,00-scale topographic base map.

Sense of movement N

Comments: Inferred from down-to-basin topographic expression of fault scarps, location of fault zone along bedrock-basin-fill contact, and regional relations.

Dip Not reported

Dip direction E

Comments: Inferred from regional relations and position of fault at western edge of sedimentary basin.

Geomorphic expression Fault scarps are formed on alluvial-fan deposits and at the bedrock-alluvium contact on this section. Alluvial scarps are well-preserved, ranging in height from 2 to 7.5 m and having maximum slopes of 11° to 27° degrees; morphologic analysis suggests the youngest rupture occurred 15 to 30 ka.

Age of faulted deposits Middle to Upper Pleistocene

Comments: Based on soil development and topographic relations.

Detailed studies None

Timing of most recent paleoevent: Late Quaternary (<130 ka)

Comments: Time of youngest movement is 15-30 ka based on morphologic fault-scarp analysis.

Recurrence interval About 100 ky

Comments: Based on inference of two events in last 150 ky

Slip Rate <0.2 mm/yr

Comments: A rate of <0.03 mm/yr is estimated from no more than 5 m of vertical displacement in past 150 k.y.

Length 12 km Determined from GIS data

Average strike N8W

946B, HORSESHOE RESERVOIR SECTION

Reliability of location Good

Comments: Location based on detailed mapping at 1:48,000 by Piety and Anderson (1990), transferred to 1:250,00-scale topographic base map.

Sense of movement N

Comments: Based on down-to-basin topographic expression of fault scarps and fault exposures on trenches.

Dip 70°-75°

Dip direction N, NNW,NNE

Comments: Faults are exposed in trenches; topographic expression is down-to-north across fault.

Geomorphic expression Low, subtle, partially buried NNE-facing fault scarps on a middle Pleistocene Verde River terrace along Horseshoe Reservoir section. Farther east this section the fault trace is near the base of a low basalt-capped escarpment.

Age of faulted deposits Middle and late Pleistocene

Comments: Based on soil development and the terrace height above the modern Verde River channel.

Detailed studies [946b-1] Two trenches were excavated across the Horseshoe Reservoir section. Middle Pleistocene Verde River alluvium is faulted down-to-the-northeast by 1.5 to 2 m. Two or three faulting events have occurred since about 300 ka; youngest faulting event is about 10 to 20 ka. Age estimates are based on soil development.

Timing of most recent paleoevent Holocene or post-glacial (<15 ka)

Comments: Age of youngest movement is 10-20 ka based on soil development on youngest faulted unit in trench.

Recurrence interval 85 to 140 k.y. (300 ka)

Comments: Based on estimate of 15±5 ka for youngest event and one or two other events since about 300 ka. If three events, penultimate event may be about 100 ka.

Slip Rate <0.02 mm/yr

Comments: A rate of 0.01 mm/yr is estimated from no more than 2 m of vertical displacement in past 200-300 k.y.

Length 9 km

Average strike N54W

947, CAREFREE FAULT ZONE

Data Sources: Pearthree and Scarborough (1984) initially identified and named this the Carefree fault; it was mapped and analyzed in more detail by Skotnicki and others (1997).

Synopsis: Forms a series of north- and northwest-trending normal faults within and along the western margin of an extensive bedrock pediment formed on Precambrian granite. Middle Pleistocene alluvium is probably displaced by the fault, but upper Pleistocene and younger alluvium is not. Topographic relief across the fault is less than a few meters, implying a very low slip rate.

Date of compilation 1/12/98

County Maricopa

1° x 2° sheet Mesa

Province Basin and Range

Reliability of location Good

Comments: Trace based on detailed mapping at 1:24,000 scale (Skotnicki and others, 1997).

Geologic setting The Carefree fault zone is located near the northeastern margin of the Phoenix Basin, a large, structurally complex physiographic basin near margin of the Sonoran Desert subprovince of the Basin and Range. The fault zone consists of a series of north- and northwest-trending normal faults within and along the western margin of an extensive bedrock pediment formed on Precambrian granite. West of the fault there are limited outcrops of tilted Tertiary volcanic rocks and sediment that filled a small, shallow late Cenozoic basin. The fault is within and extends north of the McDowell Mountains, which consist in this area of hills and a few inselbergs of resistant rock rising above the pediment.

Sense of movement N

Comments: The combination of a west dipping fault plane and down-to-west topographic relief indicates predominantly normal displacement.

Dip High angle

Dip direction W

Comments: Fault planes exposed locally along the fault dip steeply to the west.

Geomorphic expression Low, fairly well defined, west- to southwest-facing fault scarps as much as 3 m high formed on Precambrian granite and possibly on Quaternary deposits. Along much of the fault zone, the fault is a contact between bedrock on the upthrown (east) side and middle Pleistocene alluvium on the downthrown (west) side. There are no unequivocal fault scarps on alluvium, but probable alluvial fault scarps observed at a couple of localities are low and gentle. Recent detailed geologic mapping (Skotnicki and others, 1997) strongly suggests that middle Pleistocene deposits are faulted. Holocene and upper Pleistocene deposits cross the fault and are not displaced.

Age of faulted deposits Middle Pleistocene

Comments: Inferred from detailed geologic mapping, ages estimated from soil development on deposits, and from and regional stratigraphic relations.

Detailed studies None

Timing of most recent paleoevent Middle to late Quaternary (<750 ka)

Comments: Middle Pleistocene alluvium is probably faulted, where as late Pleistocene terraces and alluvial fans are not faulted.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr

Comments: A slip rate of <0.01 mm/yr is calculated from topographic relief across fault (<3m). Total Quaternary vertical displacement not well defined but probably on the order of a few meters.

Length 11 km

Average strike N30W

948, VERDE FAULT ZONE

Data Sources: The northern part of the fault zone was mapped by Anderson and Creasey (1958) whereas part of the southern portion of the fault zone was mapped by Wolfe and others (1983). The surficial geology along most of the fault zone was mapped by House and Pearthree (1993) and House (1994). Quaternary fault activity was investigated by Menges and Pearthree (1983) and Pearthree and others (1983), who called the section with evidence of Quaternary activity the "Camp Verde fault", and by Euge and others (1992), who called this same section the "Allen Canyon scarp".

Synopsis: The Verde fault zone is the main (master) fault on the southwestern margin of the Verde Valley, which is a large, asymmetric, southwest-tilted graben in the Basin and Range province near the margin of the Colorado Plateau. This steeply northeast-dipping fault zone follows the base of a high, relatively linear, steep, northeast-facing mountain front. The only documented evidence of Quaternary movement along the fault exists along a short section of the southern part of the fault zone, where fault scarps as much as about 7 m high are formed on high, dissected alluvial fans of probable early to middle Pleistocene age. Morphologic analysis of scarp profiles suggests an early to middle Holocene time of youngest movement (Pearthree and others, 1983); however, if the steep slope elements of these scarps are due to local erosion, then the youngest faulting may be late Pleistocene (Euge and others, 1992). No evidence of late Quaternary faulting has been documented along the mountain front either north or south of the alluvial scarps, implying that late Quaternary faulting has only occurred on a short portion of the Verde fault zone.

Date of compilation 02/23/98

County Yavapai

1° x 2° sheet Holbrook

Province Basin and Range

Reliability of location Good

Comments: Trace based on detailed mapping at 1:24,000 scale (House, 1994), transferred to 1:250,000-scale topographic base map.

Geologic setting The Verde fault is located in the Central Highlands portion of the Basin and Range province near the margin of the Colorado Plateau. The Verde fault zone is the main (master) fault on the southwestern margin of the Verde Valley, which is a large, asymmetric, southwest-tilted graben. Major subsidence of the Verde basin and displacement on the Verde fault occurred during the late Miocene and Pliocene (Bressler and Butler, 1978; Nations and others, 1981). During most of that time, the Verde Valley was a closed, undissected basin. However, during the Quaternary, the Verde River has downcut substantially and the Verde Valley has undergone dramatic dissection, leaving suites of dissected fan and terrace remnants that range from late Pliocene/early Pleistocene to early Holocene in age (House and Pearthree, 1993; House, 1994).

Sense of movement N

Comments: Inferred from fault exposures, topography, and regional relations.

Dip 62°-85°

Comments: A fault exposed in a 10-m-deep stream channel projects to the surface coincident with an alluvial fault scarp (Menges and Pearthree, unpublished field notes, 1982; Euge and others, 1992). The main fault zone dips about 70° to the northeast. Subsidiary shear zones dip from 62° to 85° to the northeast.

Dip direction NE

Geomorphic expression The Verde fault zone follows the base of a high, relatively linear, steep, northeast-facing mountain front. Along the northern half of the fault zone, however, middle and early Pleistocene alluvial fans and terraces cross the fault zone and are not displaced. The only clear evidence of Quaternary fault activity exists along a short portion of the southern part of the fault zone, where fault scarps as much as about 7 m high are formed on high, dissected, probable lower to middle Pleistocene alluvial fans. Nine topographic profiles of these scarps have been surveyed (Pearthree and others, 1983). The scarps are clearly segmented and formed in multiple rupture events, and maximum slopes range from 13° to 28°. Morphologic analyses of scarp data suggest an early to middle Holocene time of youngest movement (Pearthree and others, 1983). Euge and others (1992) argued that the steep slope segments represent a local erosional anomaly, and the time of youngest faulting is late or middle Pleistocene. No evidence of late Quaternary faulting has been documented along the mountain front either north or south of the alluvial scarps, implying that late Quaternary faulting has occurred along a short portion of the Verde fault zone.

Age of faulted deposits Early to middle Pleistocene, late Pleistocene(?)

Comments: Along a short portion of the southern part of the Verde fault, lower to middle Pleistocene alluvial fans (ca. 300 to 500 ka) are displaced about 5 m, and upper to uppermost Pleistocene terrace deposits are probably displaced as well (Pearthree and others, 1983). Detailed surficial geologic mapping by House (1994) and House and Pearthree (1993) confirms that there is no definitive evidence of Quaternary activity along the fault zone to the north or south of these alluvial scarps. These age estimates are based on rough examination of soil characteristics, the position of the alluvial surfaces in the landscape, and regional correlation.

Detailed studies None

Timing of most recent paleoevent Late Quaternary (<130 ka)

Comments: This estimate is based on morphologic scarp analysis and rough estimates for the age of faulted deposits. Pearthree and others (1983) inferred that the youngest faulting occurred in the latest Pleistocene to early Holocene. Based on the short length of the alluvial scarps and the absence of definitive evidence of young faulting along the mountain front to the north and south, Euge and others (1992) argued for a late to middle Pleistocene age of youngest faulting. Because of the dispute over the origin of the steep elements of the fault scarps, we conservatively choose late Quaternary as the probable time of the most recent event.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: An estimate of 0.01-0.02 mm/yr is based on about 5 m of vertical displacement of deposits estimated to be about 300 to 500 ka.

Length 8 km

Average strike N29W

949, PRESCOTT VALLEY GRABENS

Data Sources: Mapped and named by Menges and Pearthree (1983).

Synopsis: Evidence for young movement on the Prescott Valley grabens consists of a series of three N- to NW-trending, narrow, shallow physiographic troughs formed in upper Cenozoic deposits along the western margin of a broad structural and physiographic basin (Prescott Valley—Chino Valley). Alluvium of inferred upper Pleistocene age is displaced about 4 m, middle Pleistocene alluvium is displaced <11 m, and Holocene to uppermost Pleistocene alluvium is not faulted. From these relations, recurrent late Quaternary faulting is strongly suggested, but constraints on the age of the youngest rupture and the fault slip rate are poor.

Date of compilation 10/03/96

County Yavapai

1° x 2° sheet Prescott

Province Basin and Range

Reliability of location Moderate

Comments: Trace based on aerial photo interpretation at 1:130,000 scale; trace transferred to 1:250,000-scale topographic base map.

Geologic setting These faults are located in the Transition Zone in the upland portion of the Basin and Range province. The Prescott Valley grabens are along the western margin of a large, probably complex structural and physiographic basin. Faulting has occurred along or very near the contact between bedrock (Precambrian granite and middle Tertiary basalt) and upper Cenozoic basin-fill alluvium.

Sense of movement N

Comments: Inferred from regional relations.

Dip Not reported

Dip direction E, W

Comments: Dip directions are inferred from the graben's expression at the surface; given the position of the faults at the western margin of structural basin, east-dipping faults may be dominant.

Geomorphic expression Faulting is expressed as three relatively narrow and shallow physiographic troughs (grabens) in a left-stepping, en echelon pattern along basin margin. Fairly gentle scarps on eroded, upper Cenozoic basin-fill deposits are as much as about 15 m high, scarps on middle Pleistocene deposits are about 10 m high, and scarps on possible upper Pleistocene alluvium are 3-4 m high.

Age of faulted deposits Late Cenozoic, middle Pleistocene, possibly upper Pleistocene.

Comments: Age estimates are very rough, based on regional stratigraphic correlations.

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Upper Pleistocene alluvium may be faulted, but it is more certain that middle Pleistocene alluvium is faulted. Holocene to uppermost Pleistocene alluvium (ca. <30 ka) is not faulted.

Recurrence interval Not reported

Slip Rate <0.2 mm/yr

Comments: Possible upper Pleistocene (ca. 100-150 ka) alluvium is displaced 4 m; middle Pleistocene (ca. 150-750 ka) alluvium displaced <11 m. These data yield average long-term slip rates of 0.04 to 0.06 mm/yr (4 m in 70-110 k.y.) and 0.02 to <0.1 mm/yr (<11 m in 110 to ca. 700 k.y.)

Length 9 km

Average strike N16W

950, WILLIAMSON VALLEY GRABENS

Data Sources: Mapped and named by Menges and Pearthree (1983).

Synopsis: Evidence for young faulting consists of a series of north- to northeast-trending, narrow, shallow physiographic grabens formed on bedrock and upper Cenozoic deposits. Alluvium roughly estimated to be late to middle Pleistocene in age is displaced less than 15 m, whereas Holocene alluvium is not faulted (Menges and Pearthree, 1983).

Date of compilation 10/02/96

County Yavapai

1° x 2° sheet Prescott

Province Basin and Range

Reliability of location Moderate

Comments: Trace based on aerial photo interpretation at 1:130,000 scale; trace transferred to 1:250,000-scale topographic base map.

Geologic setting Located in the Transition Zone in the upland portion of the Basin and Range province. A series of narrow, shallow grabens displace Precambrian granite, Tertiary basalt, and upper Tertiary to Quaternary alluvial deposits. No large, well-defined late Cenozoic basins exist in this immediate area.

Sense of movement N

Comments: Inferred from regional relations.

Dip Not reported

Dip direction E and W

Comments: Inferred from the topographic expression of the grabens and regional relations.

Geomorphic expression A series of narrow, shallow troughs formed on bedrock and upper Cenozoic alluvium. Alluvial scarps are as much as 15 m high.

Age of faulted deposits Middle to late Pleistocene (<750 ka)

Comments: This age estimate is very rough and is inferred from surface characteristics and regional correlations.

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: The age estimate for the faulted alluvium is tentative, and not based on analytical data.

Recurrence interval Not reported

Slip Rate <0.2 mm/yr

Comments: About 15 m of displacement has occurred in the past few hundred thousand years (ca. 200 k.y.). These data yield minimum long-term slip rate of roughly 0.08 mm/yr.

Length 17 km

Average strike N12E

951, BIG CHINO FAULT

Data Sources: Partially mapped and named the "Big Chino fault or monocline" by Kreiger (1965; 1967a; 1967b). The fault was later studied and named the Big Chino fault by Soule (1978); additional studies have been conducted by Pearthree and others (1983) and Euge and others (1992).

Synopsis: The Big Chino fault is along the northeastern margin of Big Chino Valley, a northwest-trending basin that is essentially at the boundary between the Basin and Range and the Colorado Plateau. Along most of the fault it displaces middle to late Quaternary alluvium. Alluvial fan deposits estimated to be middle Pleistocene in age have been displaced vertically by as much as 20-25 m, whereas upper Pleistocene alluvial terrace deposits are displaced about 7 to 8 m by the fault. Lower to middle Holocene alluvium is not faulted, whereas morphologic analyses of fault scarps suggest an early Holocene time of youngest rupture. The fault has been fairly active in the late Quaternary, and the youngest rupture probably occurred 10-15 ka.

Date of compilation 02/17/98

County Yavapai

1° x 2° sheet Prescott; Williams

Province Basin and Range

Comments: The fault is near or at the base of the topographic escarpments that form the margin of the Colorado Plateau in this area.

Reliability of location Good

Comments: Trace based on interpretation of large-scale aerial photos by Chris Menges; trace transferred to 1:250,000-scale topographic base map.

Geologic setting The Big Chino fault is located along the northeastern margin of Big Chino Valley, a northwest-trending basin at the boundary between the Basin and Range and the Colorado Plateau provinces. Displaced bedrock is exposed at the northwestern end of the fault, but along most of the fault it displaces middle to late Quaternary alluvium.

Sense of movement N

Comments: The general sense of movement is inferred from topography, regional relations, and fault exposures. Some right-lateral oblique slip was suggested by Euge and others (1992).

Dip 60° to 70°

Comments: Based on fault-plane exposures in alluvium exposed in fault trenches (Euge and others, 1992).

Dip direction SW

Geomorphic expression Along most of its length, faulting is expressed as a fairly continuous set of medium-high to high alluvial scarps located about 0.5 to 1 km downslope from the main topographic escarpment associated with Black Mesa. The position of the Quaternary fault scarps in the landscape has been interpreted as evidence for a long period of tectonic quiescence, during which the main escarpment was eroded back from the fault, prior to fault reactivation during the middle and late Quaternary (Pearthree and others, 1983; Euge and others, 1992). Thirty-nine topographic scarp profiles have been surveyed across the fault (Pearthree and others, 1983). Scarp heights vary from a few meters to about 30 m, increasing with the age of the deformed surface. The largest scarps are obviously the result of recurrent fault movement; they typically have steep slope elements with maximum slopes of between 25° and 30°. Virtually all of the surveyed scarps have maximum slope angles greater than 10°. Morphologic fault-scarp analyses suggest an early Holocene age of youngest rupture. Much smaller, antithetic, northeast-facing scarps exist along much of the base of the main scarp.

Age of faulted deposits Middle Pleistocene, late Pleistocene

Detailed studies [951-1] Three trenches were excavated across the central part of the fault zone at a locality known as Sheep Camp (Euge and others, 1992). Two trenches were excavated in the mid-slope and the toe slope of a large scarp formed on a middle Pleistocene alluvial fan. They revealed multiple colluvial wedges interpreted as being from individual faulting events. A soil profile developed above the youngest colluvial wedge was considered to be of early Holocene age, implying that the youngest fault rupture is slightly pre-Holocene (*i.e.*, latest Pleistocene). A third trench excavated across a fault scarp formed on upper Pleistocene alluvium (ca. 80 to 100 ka) has about 8 m of surface displacement. Two or three colluvial wedges were interpreted from the stratigraphy, implying 2-3 faulting events that each had 2-4 m of displacement during the past ca. 100 ky.

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

Comments: Age estimates for faulted and unfaulted deposits exposed in fault trenches imply that the youngest faulting event is pre-Holocene, but may have occurred during the latest Pleistocene (10-15 ka). Analysis of fault-scarp morphology suggests an early Holocene time for the youngest faulting event).

Recurrence interval 25-50 k.y. (80-100 ka)

Comments: This estimate is based on 2 or 3 faulting events in the past 80 to 100 k.y. (from Euge and others, 1992).

Slip Rate <0.2 mm/yr

Comments: Estimates of 0.05-0.12 mm/yr are based on about 25 m of vertical displacement of middle Pleistocene alluvium (estimated age 200 to 400 ka; Euge and others, 1992). In addition, upper Pleistocene alluvium (estimated age 80-100 ka; Euge and others, 1992) is displaced about 8 m.

Length 46 km

Average strike N44W

952, SELIGMAN FAULT

Data Sources: Identified by Robert Whitney (oral commun., 1981); later mapped and named by Menges and Pearthree (1983).

Synopsis: The 10-km long Seligman fault has substantial Pliocene and Quaternary displacement, and evidently has also had recurrent late Quaternary movement. It forms the northern margin of a small structural horst that is bounded on the southwest by the Big Chino fault [951]. Upper Miocene to Pliocene basalts are displaced at least 60 m, whereas Quaternary alluvium is displaced as much as 20 m. Progressively younger Quaternary alluvial surfaces are displaced by decreasing amounts. The youngest faulting event may have occurred during the latest Pleistocene to early Holocene.

Date of compilation 10/07/96

County Yavapai

1° x 2° sheet Williams

Province Colorado Plateau

Reliability of location Moderate

Comments: Mapped on 1:130,000-scale aerial photos, transferred to 1:250,000-scale topographic base map. Fault location is obvious on most large-scale maps because of its substantial displacement.

Geologic setting The fault is located on the Colorado Plateau very near their southwestern margin. The fault displaces upper Miocene to Pliocene basalt flows in a down-to-north sense by at least 60 m, but is not associated with an obvious structural basin. The fault is about 5 km north of the western end of the Big Chino fault [951]. The Seligman and Big Chino faults appear to define the north and southwest sides, respectively, of a narrow structural horst that includes Picacho Butte.

Sense of movement N

Comments: Inferred from regional relations.

Dip Not reported

Dip direction N

Comments: Inferred from regional relations and topography.

Geomorphic expression The fault has formed an approximately 60-70 m high, sharply-defined scarp on upper Miocene to Pliocene basalt. This scarp on basalt becomes lower and less well defined to the east. Alluvial scarps as high as 20 m exist near the western end of fault. Three or four distinct alluvial surfaces are faulted there, with scarp heights decreasing incrementally from 20 m to about 5 m and 2 m on increasingly younger surfaces. Maximum scarp slope angles on the smaller (2 m) scarps are 17° to 19°. The morphometric age estimate (based on 3 scarp profiles) is early to middle Holocene (Pearthree and others, 1983).

Age of faulted deposits late Miocene to latest Pleistocene.

Comments: Basalts dated at 2.5 Ma (late Pliocene) to 9 Ma (late Miocene) (Reynolds and others, 1986) are clearly offset. Also, lower to upper Pleistocene and uppermost Pleistocene alluvium are offset progressively lesser amounts. Age estimates for alluvium are approximate, based on cursory examination of soils, geomorphic surface characteristics, and regional correlations.

Detailed studies None

Timing of most recent paleoevent: Holocene to post-glacial (<15 ka)

Comments: Limited scarp morphology data and crude surface-age estimates suggest a latest Pleistocene to middle Holocene age of youngest rupture. Upper Holocene terrace alluvium is not faulted.

Recurrence interval Not reported

Comments: Fault evidently has had recurrent late Quaternary displacements; age estimates for faulted alluvium are not sufficient to estimate recurrence interval.

Slip Rate <0.2 mm/yr

Comments: Long-term estimate of <0.03 mm/yr is based on 60 m of displacement of basalt flow that is at least 2 Ma. The late Quaternary slip rate is probably 0.03-0.07 mm/yr, based on about 15 m of displacement of a middle(?) Pleistocene alluvial fan (15 m in 200 to 500 k.y.), but constraints are poor because age estimates for faulted alluvial surfaces are cursory.

Length 16 km

Average strike N78E

953, ARROWHEAD FAULT ZONE

Data Sources: Mapped and named by Menges and Pearthree (1983). The geology of the area was mapped by Moore and Wolfe (1987).

Synopsis: The fault zone is expressed as a short, narrow, sharply defined graben formed on Paleozoic bedrock, and lower to middle Pleistocene basalt flows, and middle to upper Pleistocene alluvium. The surface of a lower Pleistocene flow is vertically displaced at least 8.5 m, and middle to upper Pleistocene alluvium has been displaced about 6 m. The long-term slip rate is fairly low, but the middle portion of the fault scarp formed on basalt is nearly vertical and has minimal rock varnish. This evidence suggests that this fault may have ruptured recently, but Holocene alluvium is not faulted.

Date of compilation 01/03/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting The fault is located near the northeastern edge of the Pliocene-Quaternary San Francisco volcanic field, on an erosion surface cut on Paleozoic rocks that slopes from the Colorado Plateau margin northeast to the Little Colorado River. The fault cuts Paleozoic rocks, lower and middle Pleistocene basalt flows, and middle to upper Pleistocene alluvium.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations, but slickenlines on an exposed fault plane suggest a minor right-oblique component of movement (Menges, 1981, unpublished field notes).

Dip 81°

Dip direction NE, SW

Comments: Dip directions are inferred from surface displacement and an exposed fault plane.

Geomorphic expression Faulting is expressed as a sharply defined, roughly symmetric, narrow (<300 m), shallow (< 15 m deep) physiographic trough. Scarps are formed on Paleozoic bedrock and Quaternary basalt. The scarp formed on lower Pleistocene basalt on the southwest margin of the trough has a nearly vertical 3-m-high mid-slope with minimal rock varnish, which suggests relatively recent fault rupture.

Age of faulted deposits Paleozoic, early Pleistocene, middle to late Pleistocene

Comments: A basalt flow mapped as lower Pleistocene (Moore and Wolfe, 1987) is clearly displaced by at least 8.5 m. A younger middle Pleistocene basalt may be faulted, but the evidence for faulting is ambiguous. An alluvial fan that is younger than either of the basalt flows is displaced about 6 m. Based on fairly strong soil development, this alluvial fan is probably of middle to late Pleistocene age (Pearthree, unpublished data, 1998).

Detailed studies None

Timing of most recent paleoevent: Late Quaternary (<130 ka)

Comments: A middle to late Pleistocene alluvial fan is faulted. However, the fresh appearance of the middle part of fault scarp suggests rupture could be as young as early Holocene to latest Pleistocene.

Recurrence interval Not reported

Slip Rate <0.2 mm/yr

Comments: An average long-term slip rate of 0.01-0.02 mm/yr is suggested by at least 8 m of displacement of a lower Pleistocene basalt flow (750 ka-1.6 Ma). Displacement of a middle to late Pleistocene alluvial fan surface (ca. 100 to 300 ka) by 6 m suggests a rate of 0.02-0.06 mm/yr.

Length 5 km

Average strike N34W

954, BABBITT LAKE FAULT ZONE

Data Sources: Mapped by Menges and Pearthree (1983) who included it with many other faults in their Double Top fault set; it was later named the Babbitt Lake fault zone by Pearthree and others (1996). The geologic map of the area was published by Wolfe and others (1987).

Synopsis: The Babbitt Lake fault zone is a short, narrow, shallow graben formed on Paleozoic bedrock and lower to middle Pleistocene basalt flows. The surface of a lower Pleistocene basalt flow is vertically displaced at least 4 m. The fault scarp formed on basalt is gentle, which suggests that this fault has not ruptured recently or during the late Quaternary.

Date of compilation 01/02/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting The fault zone is located in the northern part of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface between the Mogollon Rim and the Grand Canyon. The Babbitt Lake fault zone is one of several northwest-trending faults that cut Paleozoic bedrock and lower or middle Quaternary basalt flows near the northern limit of Quaternary volcanic rocks.

Sense of movement N

Comments: Inferred from surface displacement and regional relations.

Dip Not reported

Dip direction NE, SW

Comments: Dip directions are inferred from the topographic expression of the graben and regional relations.

Geomorphic expression The fault zone is expressed as a narrow (<300-m-wide), shallow (<10-m-deep) physiographic trough formed on Paleozoic bedrock and lower Quaternary basalt flows. The floor of the trough is partially covered by late Quaternary alluvium. The highest scarp is about 5 m high on an early Pleistocene basalt flow. The fault scarp on basalt is quite subdued, suggesting that the fault has not ruptured in the late Quaternary.

Age of faulted deposits Paleozoic, early to early middle Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Lower and lower to middle Pleistocene basalt flows are faulted. Holocene alluvium is not faulted.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: Lower to middle Pleistocene (~750 ka) basalt is displaced at least 4 m. These data suggest an extremely low slip rate of about 0.005 mm/yr.

Length 8 km

Average strike N50W

955, BELLEMONT FAULT

Data Sources: Mapped and named by Menges and Pearthree (1983), later mapped in more detail by Pearthree and others (1996). The geologic map of this area was published by Wolfe and others (1987).

Synopsis: The Bellemont fault forms a low to moderately high, west-facing escarpment on Paleozoic bedrock, and Quaternary basalt and alluvium. The fault has had recurrent movement at least through the Pliocene and Quaternary; it has had at least 45 m of late Cenozoic displacement and about 12 m of displacement since about 500 ka. Maximum surface rupture displacements are probably about 1.5-3 m for each event. The youngest fault rupture probably occurred during the late Pleistocene, because fault scarps formed on alluvium and basalt are gentle, and Holocene to uppermost Pleistocene alluvium is not faulted, which indicates that this fault has not ruptured in the Holocene, but it probably has ruptured during the late Pleistocene.

Date of compilation 01/02/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting The Bellemont fault is located in the southwestern part of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic rocks near the edge of the Colorado Plateau. This fault is part of a group of northeast- and west-northwest-trending faults that cut Paleozoic bedrock and Pliocene to middle Quaternary basalt flows just north of the Mogollon Rim, west and southwest of Flagstaff.

Sense of movement N

Comments: Inferred from surface displacement and fault trench exposures.

Dip 70°-75°

Comments: Dips were observed in a trench across the fault.

Dip direction WNW, NW

Comments: Displacements inferred in the trench are consistent with the down-to-northwest surface expression of fault.

Geomorphic expression The fault forms a low to moderately high (<20 m), west-northwest facing escarpment on Quaternary basalt flows and alluvium and Paleozoic bedrock. This escarpment forms the eastern margin of two small sedimentary basins, where faulting has periodically ponded the south- and east-flowing regional drainage system. Fault scarps are gentle; several-meter-high alluvial scarps have maximum slope angles of 8°.

Age of faulted deposits Paleozoic, Pliocene, early Pleistocene and middle Pleistocene basalt flows, and middle to late Pleistocene alluvium.

Detailed studies [955-1] Detailed geologic mapping, topographic surveying, evaluation of well logs, and interpretation of trench excavated across fault (Pearthree and others, 1996). These studies reveal at least 45 m of late Cenozoic normal displacement across the fault; 25-40 m of post 4-Ma displacement; and 12 m of middle and late Quaternary displacement. Trenching revealed evidence for several large surface ruptures, the youngest having about 2 m of vertical displacement, but no significant constraints on the time of youngest rupture were obtained.

Timing of most recent paleoevent: Late Quaternary (<130 ka)

Comments: Timing constraints on the youngest paleoevent are weak. A middle to late Pleistocene alluvial fan is faulted, but scarps formed on alluvium and on weathered basalt flows are not steep, suggesting that the youngest rupture occurred quite awhile ago. Holocene to latest Pleistocene deposits are not faulted.

Recurrence interval 40-130 k.y. (300 to 700 ka)

Comments: The estimate is based on 12 m of displacement in the past 300 to 700 k.y. and an estimated 1.5-3 m of displacement per event.

Slip Rate <0.2 mm/yr

Comments: An long-term (average) slip rate of 0.015 to 0.04 mm/yr is estimated from 12 m displacement of a middle Pleistocene (300 to 700 ka) basalt flow.

Length 11 km

Average strike N28E

956, BILL WILLIAMS FAULT

Data Sources: This fault is part of the regional Mesa Butte fault system as described by Shoemaker and others (1974; 1978). This southern part of the Mesa Butte fault zone was mapped and renamed by Menges and Pearthree (1983) to distinguish it from the spatially distinct, northern part of the Mesa Butte fault. Geologic map of the area is by Newhall and others (1987).

Synopsis: The Bill Williams fault is a major, northeast-trending structure that is approximately on trend with the Mesa Butte fault to the northeast. The Bill Williams fault displaces lower Pleistocene to Pliocene basalt flows by increasing amounts, indicating that it was active through this time interval. No middle to upper Pleistocene basalt flows exist along the fault, and no definitive evidence for late Quaternary activity has been found. The fault scarps formed on Pliocene basalt range are as much as about 50 m high and have gentle to moderately steep slopes. This fault likely has been active during the middle or late Quaternary, but the age of youngest activity is poorly constrained.

Date of compilation 01/03/97

County Coconino

1° x 2° sheet Williams

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting The Bill Williams fault is located on the Colorado Plateau in the western part of the Pliocene-Quaternary San Francisco volcanic field, which rests on the erosion surface cut on Paleozoic rocks between the Mogollon Rim and the Grand Canyon. The fault cuts Paleozoic bedrock and Pliocene and lower Quaternary basalt flows. It is one of several large, NE-trending faults in the vicinity of the Grand Canyon that have long and complex histories of movement (Shoemaker and others, 1978). Much of the downthrown side of the fault is covered by late Quaternary alluvium that has accumulated in small basins along the escarpment; reconnaissance studies have not revealed any faulted late Quaternary alluvium.

Sense of movement N

Comments: Inferred from surface displacement and regional relations.

Dip None reported

Dip direction SE

Comments: Dip directions inferred from surface displacement and regional relations.

Geomorphic expression Low (5 m) to fairly high (50 m), southeast-facing scarps are formed on Pliocene and lower Quaternary basalt flows. The larger fault scarps are moderately steep (as much as 23°), but a 5-m-high scarp on lower Pleistocene basalt near the northern end of the fault is quite subdued, suggesting that the fault may not have ruptured in the late Quaternary.

Age of faulted deposits Paleozoic, Pliocene, early Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: A lower Pleistocene (ca. 1 Ma) basalt flow is displaced about 4-10 m near northern end of fault. Fault scarps formed on basalt flows range from gentle to moderately steep, and Holocene alluvium is not faulted. The youngest rupture likely occurred in the middle or possibly late Pleistocene, but this estimate is poorly constrained.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: An upper Pliocene to lowermost Pleistocene (~1.5 to 3.5 Ma) basalt flow is displaced at least 32 m in the central part of the fault zone. These data yield long-term slip rates of 0.01-0.02 mm/yr. However, more recent displacement might have been at even slower rates as indicated about 4-10 m of displacement since about 1 Ma (0.004-0.01 mm/yr).

Length 21 km

Average strike N44E

957, BLACK POINT/DONEY MOUNTAIN FAULT ZONE

Data Sources: Mapped and named the Black Point monocline and the Doney Mountain fault scarps by Menges and Pearthree (1983). The fault zone and monocline were grouped together by Pearthree and others (1996), and the name is simplified herein as the Black Point/Doney Mountain fault zone. The geology of this area was mapped by Moore and Wolfe (1987) and Ulrich and others (1984).

Synopsis: This is a complex fault zone that deforms Paleozoic bedrock and late Pliocene and middle Pleistocene basalt flows. The southern part of the zone appears to be comprised of a normal fault having down-to-the-east displacement. The central part of the zone includes several minor, down-to-the-northeast normal faults; these faults are superimposed on a larger down-to-the-northeast monocline (Black Point) that probably formed during the late Cretaceous-early Tertiary Laramide orogeny. On the northern part of the zone, Pliocene-Quaternary displacement is down-to-the-southwest, which may represent normal reactivation of a Laramide reverse fault. The timing of youngest rupture is probably middle Pleistocene, because an upper Pleistocene basalt flow apparently is not faulted.

Date of compilation 01/03/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting The fault zone is located along the northeastern margin of the Pliocene-Quaternary San Francisco volcanic field, on the bedrock erosion surface that slopes from the Mogollon Rim northeast to the Little Colorado River. The Black Point / Doney mountain fault zone is the northeasternmost fault that cuts Quaternary basalt flows. Young displacement on the northern part of the fault zone may represent normal reactivation of an older reverse fault and monocline of Laramide age.

Sense of movement N

Comments: Normal movement is inferred from regional geologic and topographic relations. However this fault zone has complicated geometry because the southern part is apparently an east-side-down normal fault, the central part is a northeast-side-down series of small faults and a monocline, and the northern part is a southwest-side-down monocline.

Dip Not reported

Dip direction E (southern section), NE (central section), SW (northern section)

Comments: Dip directions are inferred from surface displacements and aspects of scarps.

Geomorphic expression The southernmost part of the fault forms a low, east-facing scarp on middle Pleistocene basalt. The remainder of the southern and central part of the fault is expressed as a moderately high (<50 m), east-facing escarpment formed on Paleozoic bedrock. A late Quaternary basalt flow (and its cinder cones) was erupted along and appears to bury the fault. The northern part of the fault is expressed as a gentle, several-meter-high, west-facing scarp on a late Pliocene basalt flow.

Age of faulted deposits Paleozoic, Pliocene, middle Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: A middle Pleistocene basalt flow is faulted, whereas an upper Pleistocene basalt flow and associated cinder cones apparently are not faulted.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Length 26 km

Average strike N1W

958, SP FAULT ZONE

Data Sources: Mapped, named and grouped with several other faults by Menges and Pearthree (1983); separated from this larger group of faults by Pearthree and others (1996) because of evidence of younger fault rupture. The geology of the area was mapped by Ulrich and Bailey (1987).

Synopsis: This series of faults cut Paleozoic bedrock and lower to upper Pleistocene basalt flows. A middle Pleistocene flow surface is displaced at least 5 m vertically. One of these faults probably cuts a upper Pleistocene basalt flow (the SP flow), and the mid-section of a fault scarp formed on middle Pleistocene basalt is nearly vertical and has minimal rock varnish. This fault may have ruptured recently, perhaps during the Holocene or latest Pleistocene (<15 ka).

Date of compilation 01/06/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting These faults are located in the northern part of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic rocks that slopes from the Colorado Plateau margin northeast to the Little Colorado River. Faults cut Paleozoic rocks, lower, middle and probably upper Pleistocene (70 ka) basalt flows.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic and regional relations.

Dip Not reported

Dip direction W, E

Comments: Dip directions are inferred from surface displacement. Faults on the east side of zone (most of the faults) probably dip west, and the fault on the west side of the zone probably dips east.

Geomorphic expression A series of several-meter-high, sharply defined fault scarps with the west side down are formed on middle Pleistocene basalt flows. The middle part (about 2 m) of a 4-m-high scarp is vertical and has minimal rock varnish, suggesting a young rupture event. A photo lineament on trend with these scarps continues south across the upper Pleistocene SP basalt flow; the flow surface is extremely rough and irregular, so scarps are not obvious. The central part of the fault zone, north of SP flow, is a roughly symmetric, 750 m-wide, shallow (about 5 m deep) physiographic trough (graben) with fault scarps on east and west sides.

Age of faulted deposits Paleozoic, early Pleistocene, middle Pleistocene, late Pleistocene(?)

Detailed studies None

Timing of most recent paleoevent: Late Quaternary (<130 ka)

Comments: A middle Pleistocene basalt flow is faulted, and an upper Pleistocene basalt flow is most likely faulted. The fresh appearance of the middle part of one of the fault scarps suggests Holocene to latest Pleistocene (<15 ka) rupture.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: A middle Pleistocene basalt flow is displaced at least 5 m, suggesting a long-term slip rate of 0.01 - 0.02 mm/yr.

Length 13 km

Average strike N3W

959, CAMPBELL FRANCIS FAULT ZONE

Data Sources: Mapped and included with a number of other fault zones as the Campbell Francis faults by Menges and Pearthree (1983), but separated from other Campbell Francis faults by Pearthree and others (1996). The geology of the area was mapped by Ulrich and Bailey (1987).

Synopsis: A series of north-trending faults with both down to the east and west displacement cut Paleozoic and Mesozoic bedrock and lower and middle Pleistocene basalt flows. A middle Pleistocene basalt flow surface is vertically displaced about 5 m. Although there has been little field examination of these faults, the sharp expression of some of the fault scarps on aerial photos suggests that this fault ruptured fairly recently, perhaps during the late Pleistocene.

Date of compilation 01/06/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting Located near the northern margin of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut across Paleozoic and Mesozoic rocks that slopes from the Mogollon Rim northeast to the Little Colorado River. The faults cut Mesozoic and Paleozoic rocks, and lower and middle Pleistocene basalt flows.

Sense of movement N

Comments: Predominantly normal movement inferred from topographic relations.

Dip Not reported

Dip direction W, E

Comments: Dip directions are inferred from surface displacement. Faults on the east side of the zone probably dip W; faults on the west side of zone probably dip E.

Geomorphic expression The faults form a series of several-m-high scarps on middle and lower Pleistocene basalt flows; scarps on Paleozoic bedrock are as much as about 15 m high. Scarps bound several weakly defined, shallow physiographic troughs. Little field data has been collected on these scarps, but some of them appear quite sharp on aerial photos, suggesting a fairly recent rupture event.

Age of faulted deposits Paleozoic, early Pleistocene, middle Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: A middle Pleistocene basalt flow is faulted. The sharp appearance of some scarps on aerial photos suggests possible late Pleistocene or younger rupture, but no field evidence has been collected to substantiate this inference.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: Middle Pleistocene basalt flow is displaced about 5 m, which yields a long-term slip rate of 0.01-0.02 mm/yr.

Length 10 km

Average strike N8E

960, CASNER CABIN FAULT ZONE

Data Sources: Mapped but not named by Menges and Pearthree (1983), later investigated and named by Pearthree and others (1996). The geology of the area was mapped by Ulrich and others (1984).

Synopsis: The Casner Cabin fault zone forms two fairly sharply defined, narrow grabens on Paleozoic bedrock and Pliocene volcanic rocks. Total vertical displacement is at least 40 m. Middle to late Quaternary faulting is likely because a middle Pleistocene alluvial fan in one of the grabens is probably displaced at least 3 m.

Date of compilation 01/06/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:100,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting This is one of several fault zones located near the Mogollon Rim (Colorado Plateau margin) southwest of the Quaternary volcanic rocks of the San Francisco field, but in an area covered by extensive Pliocene and upper Miocene volcanic rocks. The faults cut Paleozoic rocks, Pliocene volcanic rocks, and probably middle Pleistocene alluvium.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations.

Dip Not reported

Dip direction NNE, SSW

Comments: Dip directions are inferred from surface displacement. Faults on the north side of the zone probably dip S; faults on the south side of the zone probably dip N.

Geomorphic expression The faults form two narrow (<300-m-wide), moderately deep (ca. 40 m) physiographic troughs on Paleozoic bedrock and Pliocene volcanic rocks. Escarpments bounding the troughs are moderately steep; at one locality, a possible fault scarp on a middle Pleistocene(?) alluvial fan has been identified (Pearthree and others, 1996).

Age of faulted deposits Paleozoic, Pliocene, middle Pleistocene (?)

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Middle Pleistocene(?) alluvium is probably faulted at least 3 m. The relatively sharp geomorphic expression of the bedrock escarpments is consistent with Quaternary fault activity.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: A possible long-term slip rate of 0.006-0.02 mm/yr is suggested by at least 3 m of displacement of middle(?) Pleistocene alluvium (130-500 ka).

Length 16 km

Average strike N62W

961, CEDAR RANCH FAULT ZONE

Data Sources: Mapped and called the "Mesa Butte South" fault by Menges and Pearthree (1983). The geology was mapped and fault named "Cedar Ranch" by Ulrich and other (1987); Pearthree and others (1996) also called it the Cedar Ranch fault.

Synopsis: Normal faulting has generated a fairly large (ca. 50 m) escarpment on Paleozoic bedrock and lower Pleistocene basalt flows; the displacement is down to the east. The surface of a middle Pleistocene basalt flow is displaced about 3 m. This low fault scarp is subtle and gentle, suggesting that the fault may not have ruptured during the late Quaternary.

Date of compilation 01/06/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting The fault is located in the northern part of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic rocks that slopes from the Colorado Plateau margin northeast to the Little Colorado River. This fault may be a branch or splay of the Mesa Butte fault [987]; there is no definitive evidence that the main trace of the Mesa Butte fault in this area has been active during the Quaternary. The Cedar Ranch fault cuts Paleozoic rocks and lower and middle Pleistocene basalt flows. Paleozoic rocks are vertically displaced as much as 50 m and lower Pleistocene basalt may be displaced by a similar amount, however, a middle Pleistocene (500-600 ka) basalt flow is displaced only about 3 m.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations.

Dip Not reported

Dip direction E

Comments: Dip directions are inferred from surface displacement.

Geomorphic expression The fault forms a fairly high (ca. 50 m), curvilinear, east-facing escarpment on Paleozoic bedrock and lower Pleistocene basalt flows. The lower Pleistocene flows may have cascaded over an existing escarpment, making displacement estimates problematic. There is a 3-m-high fault scarp formed on a middle Pleistocene basalt that flowed down a valley and across the fault zone. This low fault scarp is gentle, suggesting pre-late Quaternary activity.

Age of faulted deposits Paleozoic, early Pleistocene, middle Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: A middle Pleistocene basalt flow is faulted, but the scarp is gentle. suggesting possibility pre-late Quaternary activity

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: A middle Pleistocene basalt flow (500-600 ka) is displaced about 3 m whereas a lower Pleistocene flow (750 ka-1.6 Ma) may be displaced as much as 50 m. However, older flow may have cascaded over a bedrock escarpment, so the net Quaternary fault displacement is likely much less than 50 m. Using the 3-m offset of the 500-600 ka basalt yields a long-term slip rate of about 0.005 mm/yr.

Length 10 km

Average strike N17E

962, CEDAR WASH FAULT ZONE

Data Sources: Mapped and grouped with the "SP" faults by Menges and Pearthree (1983); remapped and renamed "Cedar Wash fault zone" by Pearthree and others (1996). The geology of the area was mapped by Ulrich and Bailey (1987).

Synopsis: Normal faulting has generated a fairly low, west-facing scarp and localized graben on Paleozoic bedrock and lower and middle Pleistocene basalt flows. The primary sense of displacement is down to the east. A lower Pleistocene basalt flow is displaced about 6 m, and a middle Pleistocene basalt flow is displaced about 2 m. This low fault scarp is very gentle, suggesting that the fault may not have ruptured during the late Quaternary.

Date of compilation 01/07/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting This is one of several fault zones located in the northern part of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic rocks that slopes from the Mogollon Rim northeast to the Little Colorado River. The Cedar Wash fault cuts Paleozoic rocks and lower and middle Pleistocene basalt flows. A lower Pleistocene basalt flow is displaced at least 6 m and a middle Pleistocene basalt flow is displaced about 2 m.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations.

Dip Not reported

Dip direction W, SW, NE

Comments: Dip directions are inferred from surface displacement. The main fault zone probably dips west and southwest; a secondary fault bounding the west side of the graben in the northern part of the fault zone probably dips northeast.

Geomorphic expression The fault zone forms a fairly low (generally less than 10 m high), west-facing scarp and a localized graben on Paleozoic bedrock and lower and middle Pleistocene basalt flows. The low (2-m-high) scarp formed on middle Pleistocene basalt is very gentle.

Age of faulted deposits Paleozoic, early Pleistocene, middle Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Middle Pleistocene basalt flow is faulted, but the scarp is gentle; this relation suggests that the fault may not have ruptured during the late Quaternary.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: A middle Pleistocene basalt flow (500-600 ka) is displaced about 2 m; a lower Pleistocene flow (1.4 Ma) is displaced about 6 m near north end of fault zone. The displacement/age limits yield long-term slip rates of about 0.004 mm/yr.

Length 12 km

Average strike N9W

963, CITADEL RUINS FAULT ZONE

Data Sources: Mapped and named by Menges and Pearthree (1983). The geology of the area was mapped by Moore and Wolfe (1987).

Synopsis: Normal faulting has generated a fairly shallow and narrow, northeast-trending graben and a subsidiary, northwest-trending graben on Paleozoic and Mesozoic bedrock and an upper Pliocene basalt flow. Vertical displacement of the upper Pliocene basalt flow surface is less than 20 m. There is no documented evidence that this fault zone has ruptured during the middle or late Quaternary.

Date of compilation 01/07/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting This is one of several fault zones located near the northeastern margin of the Pliocene-Quaternary San Francisco volcanic field on the erosion surface cut on bedrock that slopes from the Mogollon Rim northeast to the Little Colorado River. The Citadel Ruins fault zone displaces Paleozoic rocks by less than 20 m vertically and an upper Pliocene (2.4 Ma) basalt flow is displaced by about 7 m (Holm and Ulrich, 1987).

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic and regional relations.

Dip Not reported

Dip direction NW, SE, NE, SW

Comments: The main fault zone forms a NE-trending graben that has inferred dips to the NW and SE. Also, several NW-trending fault splays probably dip to the NE and SW.

Geomorphic expression Faulting has generated a fairly sharply defined, shallow (<20 m deep), narrow (700 m wide), NE-trending physiographic trough and NW-trending subsidiary trough. The floor of the trough is covered by late Quaternary deposits that apparently are not faulted; scarps on he trough margin are moderately steep on bedrock and upper Pliocene basalt.

Age of faulted deposits Paleozoic, Mesozoic, late Pliocene

Detailed studies None

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

Comments: Displacement of an upper Pliocene basalt flow implies that Quaternary activity is likely, although there is no documented evidence of middle or late Quaternary surface ruptures.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: An upper Pliocene basalt flow (2.4 Ma) is displaced about 7 m; the net long-term slip rate is roughly 0.003 mm/yr. However, slip in the middle to late Quaternary may be even slower.

Length 5 km

Average strike N10E

964, DEADMAN WASH FAULTS

Data Sources: Mapped by Menges and Pearthree (1983), who grouped these faults with others in the area as the Wupatki faults; the Deadman Wash faults were later separated from the larger group of faults and named by Pearthree and others (1996) because they evidently have not been active as recently as other faults of the group. The geology of the area was mapped by Moore and Wolfe (1987).

Synopsis: Three short, north-trending normal faults displace a lower Pleistocene basalt flow by less than 6 m. Two scarps are down-to-the-west, the other is down-to-the-east. These faults do not cut uppermost lower Pleistocene (800 ka) tephra deposits, so evidently they have not been active in the middle or late Quaternary.

Date of compilation 01/07/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting The Deadman Wash faults are one of several fault zones located near the northeastern margin of the Plio-Quaternary San Francisco volcanic field, on the bedrock erosion surface that slopes from the Mogollon Rim northeast to the Little Colorado River. The Deadman Wash faults displace a lower Pleistocene basalt flow but do not cut uppermost lower Pleistocene (800 ka) tephra deposits derived from the San Francisco Mountains stratovolcano.

Sense of movement N

Comments: Predominantly normal movement inferred from topographic and regional relations.

Dip Not reported

Dip direction WSW, ENE

Comments: Surface displacement across two of the faults implies WSW-dipping faults; the other fault probably dips to the ENE.

Geomorphic expression Three weakly expressed, low (<6-m-high) fault scarps formed on a lower Pleistocene basalt flow.

Age of faulted deposits Early Pleistocene basalt flow

Detailed studies None

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

Comments: Displacement of a lower Pleistocene basalt flow indicates early Quaternary activity, but absence of displacement of 800 ka tephra deposits indicates no activity in the middle to late Quaternary (<750 ka).

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: No evidence of middle or late Quaternary activity, so slip rate for past 750 ka is very low or zero.

Length 2 km

Average strike N37W

965, DOUBLE TOP FAULT ZONE

Data Sources: Mapped by Menges and Pearthree (1983), who grouped this fault zone with others in the area as the Double Top fault set. This particular fault zone was named by Pearthree and others (1996) and differentiated from other faults in the region, which were given other names. The geology of the area was mapped by Wolfe and others (1987).

Synopsis: Two short, northwest-trending normal faults form a shallow, narrow graben on upper Pliocene to lower Pleistocene volcanic rocks near the northwestern margin of the Pliocene-Quaternary San Francisco volcanic field. The graben floor and small tributary valleys are covered by late Quaternary alluvium, which is not faulted. No evidence of middle or late Quaternary fault activity has been documented.

Date of compilation 01/07/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting This is one of several fault zones located near the northwestern margin of the Plio-Quaternary San Francisco volcanic field, on the erosion surface cut onto Paleozoic rocks between the Mogollon Rim and the Grand Canyon. The Double Top faults displace upper Pliocene to lower Pleistocene volcanic rocks by about 20 m.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations.

Dip Not reported

Dip direction NE, SW

Comments: Inferred from topographic and regional relations.

Geomorphic expression Northwest-trending scarps formed on Pliocene-Quaternary volcanic rock define a gentle, fairly narrow physiographic trough. The trough bottom and several tributary valleys that enter the trough perpendicular to the graben trend are covered by late Quaternary alluvium, which is not faulted. Both scarps are quite gentle (<10° slopes), but the southwestern scarp is much higher (as much as 20 m) and more continuous.

Age of faulted deposits Late Pliocene to early Pleistocene

Detailed studies None

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

Comments: Displacement of upper Pliocene to lower Pleistocene basalt flow indicates Quaternary activity, but no evidence of middle to late Quaternary activity has been documented.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: An estimate of 0.01 mm/yr or less is based on about 20 m of displacement of upper Pliocene to lower Pleistocene volcanic rocks.

Length 6 km

Average strike N34W

966, DOUBLE KNOBS FAULT

Data Sources: Mapped by Menges and Pearthree (1983), who grouped this fault zone with others in the area as the Double Top fault set; differentiated and named by Pearthree and others (1996). The geology of the area was mapped by Wolfe and others (1987).

Synopsis: Northwest-trending normal faults form two shallow, narrow, fairly symmetric grabens and another low, southwest-facing scarp on upper Pliocene to lower Pleistocene volcanic rocks at the northwestern margin of the Pliocene-Quaternary San Francisco volcanic field. Total displacement of these basalts is about 5 m. No definitive evidence of middle or late Quaternary fault activity has been documented.

Date of compilation 02/04/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting This is one of several fault zones located near the northwestern margin of the Pliocene-Quaternary surface cut onto Paleozoic rocks between the Mogollon Rim and the Grand Canyon. Vertical displacement of upper Pliocene to lower Pleistocene volcanic rocks is as much as 5 m.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations.

Dip Not reported

Dip direction NE, SW

Comments: Inferred from topography and regional relations.

Geomorphic expression Northwest-trending scarps formed on Pliocene-Quaternary volcanic rock define two gentle, fairly narrow physiographic troughs and another low, southwest-facing scarp. The bottoms of the troughs are partially covered by late Quaternary alluvium, which is not faulted. Scarps are low (<5 m) and quite gentle.

Age of faulted deposits Early Pleistocene to late Pliocene

Detailed studies None

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

Comments: Displacement of upper Pliocene to lower Pleistocene basalt flow indicates Quaternary fault activity, but there no evidence of middle to late Quaternary activity has been documented.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: An estimate of 0.01 mm/yr or less is based on about 5 m of displacement of upper Pliocene to lower Pleistocene volcanic rocks.

Length 6 km

Average strike N38W

967, EBERT TANK FAULT ZONE

Data Sources: Mapped by Menges and Pearthree (1983), who grouped this fault zone with others in the area as the Double Top fault set; this particular fault zone was named and differentiated from other faults in the area by Pearthree and others (1996). The geology of the areas was mapped by Wolfe and others (1987).

Synopsis: Two short, northwest-trending normal faults form a shallow, narrow graben on lower Pleistocene volcanic rocks and Paleozoic bedrock near the northwestern margin of the Pliocene-Quaternary San Francisco volcanic field. Middle Pleistocene(?) alluvium probably is displaced about 1 m near the southern end of the fault zone, but the alluvial fault scarp is very gentle. Middle Quaternary faulting is implied, and late Quaternary faulting is possible. The graben floor is covered by Holocene alluvium, which is not faulted.

Date of compilation 01/07/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting This is one of several fault zones located near the northwestern margin of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic rocks between the Colorado Plateau margin and the Grand Canyon. The Ebert Tank faults displace lower Pleistocene volcanic rocks and middle Pleistocene(?) alluvium is displaced vertically about 1 m.

Sense of movement N

Comments: Predominantly normal movement is inferred from relations.

Dip Not reported

Dip direction NE, SW

Comments: Inferred from topographic and regional relations.

Geomorphic expression Northwest-trending scarps formed on Quaternary volcanic rock define a gentle, fairly narrow, symmetric physiographic trough (graben). The southwest-margin scarp is much higher and steeper than the northeast-margin scarp. The bottom of the trough and several tributary valleys that enter the trough perpendicular to it are covered by late Quaternary alluvium, which is not faulted. However, a very gentle (4°), 2-m-high fault scarp is formed on middle Pleistocene(?) alluvium near the southern end of the fault. Both the bedrock and alluvial scarps are quite gentle, implying no recent fault ruptures.

Age of faulted deposits Early Pleistocene, middle Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: A lower Pleistocene basalt flow and middle Pleistocene(?) alluvium are displaced, but there is no evidence of late Quaternary activity.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: An estimate of <0.01 mm/yr is based on about 1 m of displacement of middle Pleistocene alluvium.

Length 3 km

Average strike N32W

968, GARLAND PRAIRIE FAULTS

Data Sources: Faults mapped by Ulrich and others (1984); they were remapped and named by Pearthree and others (1996). The geology of this area was mapped by Wolfe and others (1987), but these faults were not depicted.

Synopsis: Two short, northwest-trending normal faults form a shallow, symmetric, narrow graben on lower Pleistocene volcanic rocks and Paleozoic bedrock in the southwestern part of the Pliocene-Quaternary San Francisco volcanic field. The margins and floor of the graben are covered primarily by Pliocene-Pleistocene basalt flows, which partially filled the existing trough, and probably are faulted.

Date of compilation 01/29/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:100,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting One of several fault zones located in the southwestern part of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic rocks near the Colorado Plateau margin. The Garland Prairie faults cut Paleozoic bedrock and probably uppermost Pliocene to lower Pleistocene volcanic rocks.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations.

Dip Not reported

Dip direction NE, SW

Comments: Inferred from topography and regional relationships

Geomorphic expression Northwest-trending scarps formed on Paleozoic bedrock and Pliocene-Pleistocene basalt define a gentle, fairly narrow, symmetric physiographic trough. The trough bottom is covered by basalt and late Quaternary alluvium. The alluvium is not faulted, and scarps on the trough margins are quite gentle, implying that have been no late Quaternary fault ruptures.

Age of faulted deposits Paleozoic, latest Pliocene to early Pleistocene(?)

Detailed studies None

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

Comments: Uppermost Pliocene to lower Pleistocene basalt flow is probably faulted, but there is no definitive evidence of middle to late Quaternary activity.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr

Length 5 km

Average strike N49W

969, GARLAND PRAIRIE WEST FAULTS

Data Sources: Mapped and named the Garland Prairie faults by Menges and Pearthree (1983); remapped and renamed by Pearthree and others (1996) to differentiate them from the Garland Prairie fault zone [968] in the middle of Garland Prairie. The geology of the area was mapped by Wolfe and others (1987).

Synopsis: Two short, northwest- to north-trending normal faults form a shallow, narrow graben on uppermost Pliocene to middle Pleistocene volcanic rocks in the southwestern part of the Pliocene-Quaternary San Francisco volcanic field. Graben margins are formed primarily by Pliocene-Pleistocene basalt flows; a middle Pleistocene basalt flowed into the graben and is most likely displaced less than 2 m. The trough floor is covered with late Quaternary alluvium, which is evidently not faulted.

Date of compilation 01/29/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting One of several fault zones located in the southwestern part of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic rocks near the Mogollon Rim. The Garland Prairie West faults cut uppermost Pliocene to lower Pleistocene volcanic rocks and probably cut a middle Pleistocene (340±210 ka) basalt flow.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations.

Dip Not reported

Dip direction NE, SW

Comments: Inferred from topographic and regional relations

Geomorphic expression Northwest- to north-trending scarps formed on Pliocene-Pleistocene basalt define a fairly narrow, symmetric physiographic trough. The trough bottom is covered by late Quaternary alluvium that is not faulted and locally by a middle Pleistocene basalt flow that is probably faulted. Scarps on the trough margins are moderately steep, especially on the southwest side, but the probable scarp formed on the middle Pleistocene basalt flow is very gentle.

Age of faulted deposits Latest Pliocene to early Pleistocene, middle Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle to late Quaternary (<750 ka)

Comments: Middle Pleistocene basalt flow (ca. 300 ka) is probably faulted, but there is no definitive evidence of late Quaternary activity.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: A long-term slip rate of <0.01 mm/yr is estimated from about 2 m of displacement in approximately the past 300 k.y.

Length 3 km

Average strike N18W

970, HIDDEN TANK FAULT ZONE

Data Sources: Mapped by Menges and Pearthree (1983), who grouped this fault zone with others in the area as the Double Top fault set. This particular fault zone was named and differentiated from other faults in the area by Pearthree and others (1996); the geology of this area was mapped by Wolfe and others (1987).

Synopsis: This northwest-trending normal fault zone is located near the northwestern margin of the Pliocene-Quaternary San Francisco volcanic field. Faulting is expressed as a fairly low, southwest-facing fault scarp and shallow grabens formed on lower and middle Pleistocene volcanic rocks and Paleozoic bedrock. The fault may not have been active during the late Quaternary, because fault scarps are quite gentle and late Quaternary alluvium on graben floors and valleys of drainages that intersect the fault zone is not faulted.

Date of compilation 01/07/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting This is one of several fault zones located near the northwestern margin of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut onto Paleozoic rocks between the Colorado Plateau margin and the Grand Canyon. The Hidden Tank faults displace Paleozoic bedrock and lower Pleistocene basalt by about 10 m, and middle Pleistocene basalt by about 2 m.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic and regional relations.

Dip Not reported

Dip direction SW, NE

Comments: Dip inferred from topographic and regional relations. The main fault probably dips southwest; subsidiary faults that define grabens along the fault zone probably dip to the northeast.

Geomorphic expression The principal fault scarp formed on Paleozoic bedrock and lower Pleistocene basalt is moderately high (about 10 m), moderately steep (15° to 20°), and southwest-facing. Along the southern one-third of the fault zone, a scarp of similar size and morphology exists on the southwestern margin of a 750-m-wide trough. Near the southern end of the principal fault scarp, a gentle (about 10°), 2.5-m-high fault scarp is formed on a middle Pleistocene basalt flow. Farther north, a much narrower (ca. 50 m-wide) trough exists on lower Quaternary volcanic rock along the main fault zone.

Age of faulted deposits Paleozoic, early and middle Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Lower and middle Pleistocene basalt flows are displaced, but there is no definitive evidence of late Quaternary activity.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: An estimate of 0.005 mm/yr is based on about 2.5 m of displacement of a middle Pleistocene (500 ka) basalt flow.

Length 10 km

Average strike N41W

971, LAKE MARY FAULT ZONE

Data Sources: These faults were mapped and named the Anderson Mesa fault by Akers (1962), but later renamed the Lake Mary fault zone by Menges and Pearthree (1983) and Pearthree and others (1996). The general geology of the area was mapped by Ulrich and others (1984).

Synopsis: Substantial displacement across the northwest- and north-trending normal faults of the relatively long Lake Mary fault zone has formed a lhigh, southwest-facing escarpment on Paleozoic bedrock and uppermost Miocene volcanic rocks. The fault zone is located near the Colorado Plateau margin, southeast of the Pliocene-Quaternary San Francisco volcanic field. The main fault zone bounds the northeast side of a narrow trough that contains upper and lower Lake Mary; there are several north-trending splays off of the main fault zone. Uppermost Miocene volcanic rocks are displaced about 130 m; upper Pliocene volcanic rocks are also faulted, but the amount of displacement has not been documented. Upper Quaternary hillslope colluvium exposed in a roadcut across the middle section of the fault zone is most likely faulted as well, but no detailed investigations have been conducted there.

Date of compilation 01/29/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: mapped at 1:100,000 scale, transferred to 1:250,000 map

Geologic setting The Lake Mary fault zone is the longest of several faults located southeast of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut onto Paleozoic rocks near the Colorado Plateau margin. The Lake Mary fault system displaces uppermost Miocene (5.9±0.3 Ma) volcanic rocks about 130 m, which is the largest amount of late Cenozoic displacement documented across any fault in and around the San Francisco volcanic field. Upper Pliocene volcanic rocks are also faulted, but the total displacement is not known. A roadcut exposure strongly suggests that upper Quaternary colluvial deposits also have been faulted.

Sense of movement N

Comments: Predominantly normal movement inferred from topographic relations.

Dip 75° to 80°

Dip direction SW, W

Comments: Fault planes are exposed in roadcuts.

Geomorphic expression A northwest- to north-trending escarpment formed on Paleozoic bedrock and uppermost Miocene basalt defines the east side of a fairly narrow, asymmetric graben. The trough bottom is covered by late Quaternary alluvium deposited in lakes or marshes, and locally, upper Pliocene basalt. Escarpment slopes are moderately steep suggesting Quaternary fault activity.

Age of faulted deposits Paleozoic, latest Miocene, late Pliocene, late Quaternary

Detailed studies None

Timing of most recent paleoevent: Late Quaternary (<130 ka)

Comments: This age estimate is based on probable faulting of upper to uppermost Quaternary hillslope colluvium as exposed in a roadcut on the Lake Marshall road.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Comments: An estimate of 0.02 mm/yr is based on about 130 m of displacement in since 6 Ma This long-term rate may or may not be applicable to the Quaternary.

Length 25 km

Average strike N24W

972, LARGE WHISKERS FAULT ZONE

Data Sources: Mapped and included with the Campbell Francis faults by Menges and Pearthree (1983); separated from other Campbell Francis faults by Pearthree and others (1996). The geology of the area was mapped by Ulrich and Bailey (1987);

Synopsis: This is a series of faults with displacement down to the east and west that displace Paleozoic bedrock and lower Pleistocene basalt flows. There is as much as 10 m of vertical displacement of lower Pleistocene basalt flows, but evidently no displacement of middle Pleistocene basalt flows.

Date of compilation 01/09/97

County Coconino

1° x 2° sheet Flagstaff

Reliability of location Good

Comments: Traces mapped at 1:50,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting These faults are located near the northern margin of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic and Mesozoic rocks that slopes from the Mogollon Rim northeast to the Little Colorado River. Faults cut Paleozoic rocks and lower middle Pleistocene (1.1 Ma) basalt flows, whereas middle Pleistocene basalt flows (dated at 460 ka and 530 ka) are mapped as unfaulted.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations.

Dip Not reported

Dip direction W, E

Comments: Dip directions are inferred from surface displacement and regional relations.

Geomorphic expression Several 10-m-high fault scarps are formed on lower Pleistocene basalt flows; scarps bound several weakly defined, shallow grabens.

Age of faulted deposits Paleozoic, early Pleistocene

Detailed studies None

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

Comments: Lower Pleistocene basalt flows (about 1 Ma) are faulted as much as 10 m. Middle Pleistocene (about 500 ka) basalt flows are not faulted.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: Low slip rate inferred from 10 of displacement post 1.1 Ma and the lack of post-530 ka displacement.

Length 12 km

Average strike N7W

973, LEE DAM FAULTS

Data Sources: Mapped by Menges and Pearthree (1983), who grouped this fault zone with many others in the area in the SP fault set; this particular fault zone was named and differentiated from other faults in the area by Pearthree and others (1996). The geology of this area was mapped by Ulrich and Bailey (1987).

Synopsis: This is a north-trending series of east- and west-dipping normal faults and a narrow graben in the northern part of the Pliocene-Quaternary San Francisco volcanic field. Faults cut Paleozoic bedrock and lower Pleistocene volcanic rocks. A middle Pleistocene basalt flow near the southern end of the fault zone is probably not faulted, so the fault zone has likely been inctive in the middle or late Quaternary.

Date of compilation 01/07/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting One of many fault zones in the northern part of the Plio-Quaternary San Francisco volcanic field, on the erosion surface cut onto Paleozoic rocks between the Mogollon Rim and the Grand Canyon. The Lee Dam faults cut Paleozoic bedrock and lower Pleistocene basalt.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic and regional relations.

Dip Not reported

Dip direction W, E

Comments: Several faults with displacement down to the east and west; also includes a symmetric graben.

Geomorphic expression Faulting is expressed as a series of fairly low, east- and west-facing scarps formed on Paleozoic rocks and lower Pleistocene basalt, and a moderately deep (40 m), narrow (<300 m), linear trough bounded by scarps formed on Paleozoic bedrock. Scarp slopes are fairly gentle along most of the fault.

Age of faulted deposits Paleozoic, early Pleistocene

Detailed studies None

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

Comments: Lower Pleistocene volcanic rocks are faulted, but no displacement of a middle Pleistocene basalt flow or late Quaternary deposits has been documented.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr

Comments: No data exist to determine a slip rate, but the <0.02 mm/yr category is inferred on the basis of the lack of fault activity in the middle and late Quaternary.

Length 8 km

Average strike N4W

974, LOCKWOOD CANYON FAULT ZONE

Data Sources: Mapped by Menges and Pearthree (1983), who grouped this fault zone with many others in the area of the Gray Mountain fault set; this particular fault zone was named and differentiated from other faults in the area by Pearthree and others (1996). The geology of this area was mapped by Ulrich and others (1984).

Synopsis: Northwest- and north-trending normal faults form narrow, symmetric grabens and shallow valleys, northwest of the Pliocene-Quaternary San Francisco volcanic field. Quaternary fault activity is likely but not certain. Faults displace Paleozoic bedrock as much as 50 m and the fault escarpment is moderately steep to steep, but there are no Quaternary volcanic rocks along the fault and no displacement of Quaternary alluvium has been documented. Faults with similar surface expression and characteristics to the south have been shown to be active during the Quaternary.

Date of compilation 01/31/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:250,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting This is one of several fault zones that extend northwest of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic rocks between the Colorado Plateau margin and the Grand Canyon. The Lockwood Canyon fault zone displaces Paleozoic bedrock by as much as 50 m, but has not been shown to definitively cut Quaternary units.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic and regional relations.

Dip Not reported

Dip direction SW, NE, W

Comments: Grabens are bounded by faults with down to the northeast and southwest throw; two other faults not associated with grabens probably dip to the southwest and west.

Geomorphic expression Faulting is expressed as two northwest-trending grabens and two other southwest- to west-facing scarps are formed on Paleozoic rocks; late Quaternary alluvium covers the bottoms of each depression. The northeasternmost trough is linear, moderately deep (as much as 50 m), and quite narrow (<300 m). The escarpment of the northeastern flank is moderate to steep; downcutting of the stream that drains to the southeast across the Mesa Butte fault [987] may have steepened the scarp slopes; the southwestern flank is less steep.

Age of faulted deposits Paleozoic

Detailed studies None

Timing of most recent paleoevent: Quaternary (1.6 Ma)

Comments: Quaternary fault activity is likely based on the strong, linear expression of the faults and the relative steep slopes of fault escarpments. No Quaternary volcanic rocks cross the fault, and no displacement of Quaternary deposits has been documented.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr

Comments: No data exist to determine a slip rate, but the <0.02 mm/yr category is inferred on the basis of lack of documented Quaternary displacement and slip rates on other Quaternary faults in the region.

Length 21 km

Average strike N27W

975, MALPAIS TANK FAULTS

Data Sources: Mapped by Menges and Pearthree (1983), who grouped this fault zone with many others in the area in the SP fault set; this particular fault zone was named and differentiated from other faults in the area by Pearthree and others (1996). The geology of the area was mapped by Ulrich and Bailey (1987).

Synopsis: Northwest- and NNW-trending normal faults form a shallow, fairly narrow, symmetric graben on Paleozoic bedrock and lower Pleistocene basalt in the northwestern part of the the Pliocene-Quaternary San Francisco volcanic field. Faults displace lower Pleistocene (750-900 ka) basalt by less than 10 m. Fault scarps are not steep, and no displacement of upper Quaternary alluvium has been documented.

Date of compilation 01/31/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting This is one of many fault zones in the northern part of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic rocks between the Mogollon Rim and the Little Colorado River. The Malpais Tank faults displace Paleozoic bedrock by about 15 m and a lower Pleistocene basalt (830±80 ka; Conway and others, 1997) by less than 10 m.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic and regional relations.

Dip Not reported

Dip direction SW, NE

Comments: Graben-bounding faults have down to the northeast and southwest displacement.

Geomorphic expression Faulting is expressed as a northwest-trending graben formed on Paleozoic rocks and a lower Pleistocene basalt flow. Upper Quaternary alluvium partially covers the bottom of the trough. Graben-margin scarps on basalt are fairly gentle; scarps on bedrock are steeper, but may have been enhanced by stream erosion.

Age of faulted deposits Paleozoic, early Pleistocene

Detailed studies None

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

Comments: Uppermost lower Pleistocene basalt flow (about 800 ka) is displaced by as much as 10 m, thus, middle Quaternary or younger fault activity is likely. No definitive evidence of late Quaternary fault activity has been documented.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: An estimate of 0.01 mm/yr is based on about 10 m of displacement of a basalt flow dated at about 800 ka.

Length 5 km

Average strike N19W

976, MAVERICK BUTTE FAULTS

Data Sources: Mapped and named the Kendrick Peak fault by Menges and Pearthree (1983); investigated and renamed the Maverick Butte faults by Pearthree and others (1996). The geology of the area was geologic mapped by Wolfe and others (1987).

Synopsis: The Maverick Butte faults form a moderately high, west-facing escarpment and a shorter, lower, east-facing escarpment on Pliocene and middle Pleistocene basalt along the northwestern flank of San Francisco Mountain. The fault has had recurrent movement since at least the early Quaternary, with at least 18 m of total displacement since about 750 ka. This amount of displacement indicates that the Maverick Butte faults are among the most active middle and late Quaternary faults in north-central Arizona. However, the fault scarp formed on basalt is only moderately steep, which suggests that this fault has not ruptured recently. The age of youngest fault activity is poorly constrained.

Date of compilation 02/04/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting The faults are located in the northwestern part of the Pliocene-Quaternary San Francisco volcanic field, on the lower flank of San Francisco Mountain. There are no other Quaternary faults in the immediate vicinity. These northeast- and north-trending faults cut Pliocene volcanic rocks and two lowermost middle Pleistocene basalt flows; the younger of these flows has been dated at 660±110 ka (Wolfe and others, 1987).

Sense of movement N

Comments: Inferred from surface displacement and regional relations.

Dip Not reported

Dip direction NW, E

Comments: Fault dips are inferred from down-to-northwest and down-to-the-east surface expression of fault and regional relations.

Geomorphic expression The fault forms a moderately high (<20-m-high), northwest-facing escarpment and a shorter, lower, east-facing scarp on Quaternary and Pliocene basalt flows. The scarps join to form a low promontory at the north end of the fault zone. Scarp slopes are moderate and have maximum slopes of about 17°.

Age of faulted deposits Pliocene, early to middle Pleistocene basalt flows

Detailed studies None

Timing of most recent paleoevent: Middle to late Quaternary (<750 ka)

Comments: Substantial displacement of lowermost middle Pleistocene basalt (660±110 ka) indicates that this fault has been active during or since the middle Pleistocene. Scarp slopes are only moderately steep and no displacement of late Quaternary alluvium has been documented, so it is not clear that the fault has ruptured during the late Quaternary.

Recurrence interval Not reported

Slip Rate <0.2 mm/yr

Comments: A long-term estimate of 0.02-0.03 mm/yr is based on at least 18 m of displacement of a lowermost middle Pleistocene (660±110 ka) basalt flow.

Length 4 km

Average strike N26E

977, METZ TANK FAULT ZONE

Data Sources: Parts of the fault zone and the geology of the area were mapped by Wolfe and others (1987); the fault zone was remapped, investigated, and named by Pearthree and others (1996).

Synopsis: A northeast-trending, down-to-the-west normal fault displaces upper Miocene to lowermost Pleistocene volcanic rocks in the southwestern part of the San Francisco volcanic field. Upper Miocene rocks are displaced 10 m or less, and lowermost Pleistocene volcanic rocks are displaced 3 m or less. No definitive evidence of middle or late Quaternary displacement has been discovered, but moderately steep scarp slopes and the sharp expression of the scarps on aerial photos suggests that the fault ruptured during this period.

Date of compilation 01/31/97

Compiler and affiliation Philip A. Pearthree, Arizona Geological Survey

State Arizona

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location good

Comments: Most of the trace was mapped at 1:50,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting The Metz Tank fault zone is in the southwestern part of the Pliocene-Quaternary San Francisco volcanic field. The fault cuts upper Miocene and uppermost Pliocene to lowermost Pleistocene volcanic rocks. The fault displaces Miocene volcanic rocks about 10 m, and Pliocene-Pleistocene volcanic rocks 2-3 m.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations.

Dip Not reported

Dip direction NW

Comments: Dip direction is inferred from surface displacement.

Geomorphic expression Fault displacement has generated a low, northeast-facing scarp on Miocene to lowermost Quaternary volcanic rocks. Fault scarp slopes range from gentle to moderately steep. However, the strong expression of fault scarps on aerial photos and their moderately steep scarp slopes suggest possible middle to late Quaternary fault activity.

Age of faulted deposits Late Miocene, latest Pliocene to early Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle or late Quaternary (<750 ka)

Comments: Uppermost Pliocene to lowermost Pleistocene rocks are displaced. The moderately sharp geomorphic expression of the scarp is consistent with middle to late Quaternary fault activity.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: An estimate of <0.01 mm/yr is based on about 3 m of displacement of 1.5-2 Ma basalt.

Length 8 km

Average strike N48E

978, MICHELBACH TANK FAULTS

Data Sources: Mapped by Menges and Pearthree (1983), who grouped this fault zone with many others in the area in the SP fault set; this particular fault zone was named and differentiated from other faults in the area by Pearthree and others (1996). The geology of the area was mapped by Ulrich and Bailey (1987).

Synopsis: This north-trending system of faults and a narrow graben is in the northern part of the Pliocene-Quaternary San Francisco volcanic field. Faults cut Paleozoic bedrock and lower Pleistocene volcanic rocks, and a middle Pleistocene basalt flow is probably displaced by some faults of the system. There is no definitive evidence that the fault zone has been active in the late Quaternary.

Date of compilation 01/07/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location (good)

Comments: Trace mapped at 1:50,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting This fault zone is one of many in the northern part of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic rocks between the Mogollon Rim and the Little Colorado River. The Michelbach Tank faults cut Paleozoic bedrock and lower Pleistocene basalt; some of the faults in the zone do not offset a middle Pleistocene (480 ka) basalt flow, but other fault strands are mapped as cutting this flow.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic and regional relations.

Dip Not reported

Dip direction E, W

Comments: Most faults in this system are down-to-the-east, but several faults are down-to-the-west, and the northern part of fault is symmetric graben with probable east and west dips.

Geomorphic expression Faulting is expressed as a fairly high, east-facing escarpment formed on Paleozoic rocks and lower Pleistocene basalt. In the northern part of the system, faulting is expressed as a shallow (<15 m), narrow (500 m), linear trough bounded by scarps formed on Paleozoic bedrock. Middle Pleistocene basalt flowed down valleys that cross the fault system and partially filled the trough along central and southern part of the fault system.

Age of faulted deposits Paleozoic, early Pleistocene, middle Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Lower Pleistocene volcanic rocks are faulted, and a middle Pleistocene basalt flow is probably displaced by some of the faults of the system.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr

Comments: Low slip rate inferred from minimal or no offset of a middle Pleistocene (480 ka) basalt flow.

Length 13 km

Average strike N3E

979, MORMON LAKE FAULT ZONE

Data Sources: Mapped and named by Menges and Pearthree (1983). The general geology of the area was mapped by Weir and others (1989) and detailed geologic mapping was published by Holm (1994).

Synopsis: Substantial displacement across NNW-trending normal faults of the Mormon Lake fault zone has generated a west-facing escarpment on upper Miocene volcanic rocks southeast of the Pliocene-Quaternary San Francisco volcanic field. The main fault zone bounds the east side of a trough that contains Mormon Lake; several subsidiary faults follow the trend of the main fault zone. Upper Miocene rocks are displaced at least 60 m. The fault escarpment is fairly steep and linear, but no definitive displacement of Quaternary units has been documented.

Date of compilation 01/29/97

County Coconino

1° x 2° sheet Holbrook

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:24,000 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting This fault zone is one of several northwest- to north-trending fault zones located southeast of the Pliocene-Quaternary San Francisco volcanic field. The fault zone displaces an erosion surface cut onto Paleozoic rocks near the Mogollon Rim. The Mormon Lake fault zone displaces upper Miocene volcanic rocks at least 60 m, but most of this displacement may have occurred during the Pliocene (Holm, 1994). Along the southern part of the fault zone, late Pliocene basalt is not faulted.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations.

Dip Not reported

Dip direction W

Comments: Inferred from topography and regional relations.

Geomorphic expression Faulting has generated a fairly high, NNW-trending escarpment on upper Miocene basalt that defines the east side of a broad, asymmetric physiographic trough. The trough is floored by late Quaternary alluvium deposited in lakes or marshes. The slopes of the escarpment are moderately steep.

Age of faulted deposits Late Miocene

Detailed studies None

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

Comments: Quaternary activity is likely based on the relatively steep, linear fault escarpment, but there is no documented displacement of Quaternary alluvium.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Comments: A long-term slip rate of <0.01 mm/yr is estimated from 60 m of displacement since 6-10 Ma. However, the slip rate during the Quaternary cannot be estimated because there is no documented displacement of Quaternary alluvium.

Length 15 km

Average strike N17W

980, OAK CREEK NORTH FAULT ZONE

Data Sources: Originally mapped and named by Menges and Pearthree (1983); later misnamed the Oak Creek *Canyon* North fault zone by Pearthree and others (1996). The general geology of the area was mapped by Ulrich and others (1984).

Synopsis: A major north- to northeast-trending, down-to-the-east normal fault bounds the west side of Oak Creek Canyon and continues north to the southern flank of the San Francisco Mountains. There evidently has been no Quaternary activity along the southern two-thirds of this fault, because Miocene basalt is displaced about 120 m, but Pliocene volcanic rocks are not displaced. However, along the northernmost 5 km of the fault, lower Pleistocene volcanic rocks are displaced by less than 25 m. There is no definitive evidence of middle or late Quaternary displacement.

Date of compilation 01/31/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:100,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting The Oak Creek North fault zone extends from an area of extensive upper Miocene volcanic rocks on the south into the southern part of the Pliocene-Quaternary San Francisco volcanic field. Upper Pliocene volcanic rocks are not displaced along the southern and central parts of the fault. Along the northern part of the fault, which is within the San Francisco volcanic field, upper Miocene and lower Pleistocene volcanic rocks are displaced about 25 m.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations.

Dip Not reported

Dip direction E, SE

Comments: Dip directions are inferred from surface displacement and regional relations.

Geomorphic expression A moderately high, east-facing escarpment is formed on Miocene and lower Pleistocene volcanic rocks. The escarpment has a moderate slope angle.

Age of faulted deposits Late Miocene, early Pleistocene

Detailed studies None

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

Comments: Upper Miocene rocks are displaced, but Pliocene rocks are not displaced along the southern two-thirds of the fault zone. Lower Pleistocene volcanic rocks are displaced along the northernmost 5 km of the fault zone. The moderately sharp geomorphic expression of the fault escarpment is consistent with Quaternary fault activity, but no definitive evidence of middle or late Quaternary faulting has been documented.

Recurrence interval Not reported

Slip Rate <0.2 mm/yr

Comments: An estimate of 0.01-0.02 mm/yr is based on about 25 m of displacement of 1.0-1.6 Ma basalt.

Length 7 km

Average strike N21E

981, PEARL HARBOR FAULT ZONE

Data Sources: Mapped by Menges and Pearthree (1983), who grouped this fault zone with others in the area as the Double Top fault set. This particular fault zone was differentiated from other faults in the area and named after the Pearl Harbor Tank by Pearthree and others (1996). The geology or the area was mapped by Wolfe and others (1987).

Synopsis: This is a northwest-trending normal fault zone at the northwestern margin of the Pliocene-Quaternary San Francisco volcanic field. Faulting is expressed as a fairly low, southwest-facing fault scarp along the northern half of the fault; the southern half of the fault is expressed as a narrow, shallow, symmetric graben formed on Paleozoic bedrock and lower Pleistocene volcanic rock. This fault may not have been active during the late Quaternary, because fault scarps are quite gentle and late Quaternary alluvium that occupies graben floors and stream valleys that intersect the fault zone is not displaced.

Date of compilation 01/07/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting This is one of several fault zones located near the northwestern margin of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic rocks between the Mogollon Rim and the Grand Canyon. The Pearl Harbor faults cut Paleozoic bedrock and lower Pleistocene volcanic rocks.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic and regional relations.

Dip Not reported

Dip direction SW, NE

Comments: The main fault trends northwest and the southwest side is downdropped. The fault that defines the southwestern margin of the graben along the fault zone probably dips to the northeast.

Geomorphic expression The principal fault scarp formed on Paleozoic bedrock along much of the fault zone is moderately high (about 10 m), fairly gentle, and southwest-facing. Lower Pleistocene basalt on the downthrown side of the scarp is faulted. Along the southern half of the fault zone, a scarp of similar size and shape is formed on Paleozoic rock on the southwestern margin of a 500-m-wide graben. Bedrock scarps have quite gentle slopes, implying that the most recent fault rupture is not very recent.

Age of faulted deposits Paleozoic, early Pleistocene

Detailed studies None

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

Comments: A lower Pleistocene basalt flow is displaced, but there is no definitive evidence of middle or late Quaternary activity.

Slip Rate Unknown, probably <0.02 mm/yr

Comments: No data exist to determine a slip rate, but the <0.02 mm/yr category is inferred on the basis of slip rates on other Quaternary faults in the region.

Length 15 km

Average strike N46W

982, PHONE BOOTH FAULTS

Data Sources: Mapped but not named by Menges and Pearthree (1983); investigated and named by Pearthree and others (1996). The general geology of this area mapped by Ulrich and others (1984).

Synopsis: A moderately sharply defined, narrow graben and a narrow horst on trend with and northwest of the graben are formed on upper Miocene and Pliocene volcanic rock. Total surface displacement is about 30 m. No definitive evidence of Quaternary fault activity has been discovered, but the moderately sharp geomorphic expression of the graben and horst suggest possible Quaternary activity.

Date of compilation 01/30/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:100,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting This fault zone is one of several WNW-trending fault zones located near the Colorado Plateau margin, southwest of Quaternary volcanic rocks of the Pliocene-Pleistocene San Francisco field. Faults displace upper Miocene volcanic rocks about 30 m, and also displace Pliocene volcanic rocks.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations.

Dip no data

Dip direction NNE, SSW

Comments: Dip directions are inferred from surface displacements. Faults on the north side of the zone probably dip south; faults on the south side of the zone probably dip north.

Geomorphic expression A narrow (<500-m-wide), moderately deep (<30 m) graben is formed in Pliocene volcanic rocks, and a narrow horst bounded by small valleys is approximately on trend with the trough. Scarps bounding the graben and horst are moderately steep.

Age of faulted deposits Late Miocene, Pliocene

Dip Not reported

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

Comments: No definitive evidence of Quaternary activity has been documented, but Pliocene volcanic rocks are displaced by a substantial amount. In addition, the moderately sharp geomorphic expression of the fault scarps suggests possible Quaternary fault activity.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr

Comments: The long-term slip rate may be less than 0.01 mm/yr, based on 30 m of displacement of upper Miocene (ca. 6 Ma) basalt. The Quaternary slip rate is almost certainly very low.

Length 11 km

Average strike N63W

983, RED HOUSE FAULTS

Data Sources: Mapped by Menges and Pearthree (1983), who grouped this fault zone and the Deadman Wash faults in the Wupatki fault set. This fault set was named and differentiated from the Deadman Wash faults by Pearthree and others (1996) because it appears to have ruptured more recently. The geology of the area was mapped by Ulrich and Bailey (1987) and Moore and Wolfe (1987).

Synopsis: A northwest-trending system of faults form a series of small horsts and narrow grabens in the northeastern part of the Pliocene-Quaternary San Francisco volcanic field. Faults cut Paleozoic bedrock and lower and middle Pleistocene volcanic rocks. Holocene alluvium is not faulted, but fault scarps are linear and fairly steep, suggesting that the fault zone has been active in the late Quaternary.

Date of compilation 01/07/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting This is one of several fault zones in the northeastern part of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic rocks that slopes northeast from the Mogollon Rim to the Little Colorado River. The Red House faults cut Paleozoic bedrock and lower and middle Pleistocene basalt flows. A middle Pleistocene basalt flow is displaced about 12 m.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic and regional relations.

Dip Not reported

Dip direction NE, SW

Comments: Sense of displacement is about evenly divided between down-to-the-northeast and down-to-the-southwest.

Geomorphic expression Faulting is expressed as fairly low (<15 m), moderately steep scarps (15°-20°) formed on Paleozoic rocks and lower and middle Pleistocene basalt flows. Scarps bound narrow troughs that are partially filled with late Quaternary deposits; displacement of these deposits has not been documented.

Age of faulted deposits Paleozoic, early Pleistocene, middle Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Lower and middle Pleistocene volcanic rocks are faulted; scarps and grabens are quite linear and well-defined, suggesting possible late Quaternary activity.

Recurrence interval Not reported

Slip Rate <0.2 mm/yr

Comments: An estimate of 0.024 mm/yr is based on as much as 12 m displacement of a middle Pleistocene (about 500 ka) basalt flow.

Length 3 km

Average strike N43W

984, RIMMY JIM FAULT ZONE

Data Sources: Mapped and grouped with many other faults in the Campbell Francis fault set by Menges and Pearthree (1983); separated and named by Pearthree and others (1996) because these faults have apparently not ruptured as recently as other "Campbell Francis" faults [959]. The geology of the area was mapped by Ulrich and Bailey (1987).

Synopsis: Two short, NNE-trending, subdued grabens are formed on Mesozoic bedrock and lower Pleistocene basalt flows. The lower Pleistocene basalt flow is displaced less than 10 m. The gentle geomorphic expression of the scarps suggests that the fault has not ruptured during the late Quaternary.

Date of compilation 01/09/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting These faults are located near the northern margin of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic and Mesozoic rocks that slopes from the Colorado Plateau margin northeast to the Little Colorado River. The faults cut Mesozoic rocks and lower Pleistocene basalt flows.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations.

Dip Not reported

Dip direction W, E

Comments: Dip directions are inferred from surface displacement. Faults on the east side of the zone probably dip west, whereas faults on the west side of the zone probably dip east.

Geomorphic expression Subdued, less than 10-m-high scarps bound two grabens on a lower Pleistocene basalt flow surface. No alluvium is mapped in the bottoms of the troughs.

Age of faulted deposits Mesozoic, early Pleistocene

Detailed studies None

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

Comments: A lower Pleistocene basalt flow is faulted. Subtle scarps suggest that the faults have not ruptured during the late Quaternary, and they may not have ruptured during the middle Quaternary either.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: An estimate of 0.01 mm/yr is based on about 10 m of displacement of a lower Pleistocene basalt flow.

Length 8 km

Average strike N34E

985, ROCK HOUSE FAULT

Data Sources: Mapped by Menges and Pearthree (1983), who grouped this fault zone in the Walnut Canyon fault set; this fault set was named and differentiated from other Walnut Canyon faults by Pearthree and others (1996) because the clear evidence of Quaternary activity on the Rock House fault. The geology of the area was mapped by Moore and Wolfe (1987).

Synopsis: This is a northwest-trending normal fault with down-to-the-northeast displacement in the easternmost part of the Pliocene-Quaternary San Francisco volcanic field. The fault cuts Paleozoic bedrock, middle Pleistocene volcanic rocks and middle to late Pleistocene alluvium. The fault zone has probably been active in the late Quaternary, but alluvial fault scarps are very subtle, and Holocene alluvium is not faulted.

Date of compilation 01/08/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting The Rock House fault is the easternmost documented Quaternary fault within the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic rocks that slopes northeast from the Colorado Plateau margin to the Little Colorado River. This fault cuts Paleozoic bedrock, middle Pleistocene basalt, and middle to late Pleistocene alluvium.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic and regional relations.

Dip Not reported

Dip direction NE

Comments: Inferred from surface displacement

Geomorphic expression Faulting is expressed as low (<5 m) scarps formed on Paleozoic rocks and middle Pleistocene basalt flows. Alluvial fault scarps, which are low and very subdued, are more evident on aerial photographs than on the ground.

Age of faulted deposits Paleozoic, middle Pleistocene, middle to late(?) Pleistocene

Detailed studies None

Timing of most recent paleoevent: Late Quaternary (<130 ka)

Comments: Middle Pleistocene volcanic rocks and middle to upper(?) Pleistocene alluvium are faulted, suggesting late Quaternary fault activity. The resultant alluvial scarps are very subtle, and Holocene alluvium is not faulted, implying a late Pleistocene age of youngest movement.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Comments: No data exist to determine a slip rate, but the <0.2 mm/yr category is inferred on the basis of slip rates on other Quaternary faults in the region.

Length 7 km

Average strike N53W

986, SINAGUA FAULTS

Data Sources: Mapped by Wolfe and others (1987), later described and named by Holm (1987), and further analyzed by Pearthree and others (1996).

Synopsis: Three NNW-trending faults form a fairly narrow and shallow graben and a low horst across a middle Pleistocene alluvial fan. Alluvial fault scarps are as much as about 7 m in height. Their scarp morphology suggests a late to latest Pleistocene age of youngest rupture. Holocene alluvium along drainages that cross the fault scarps is not faulted.

Date of compilation 01/09/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting These faults are located in the northeastern part of the Pliocene-Quaternary San Francisco volcanic field, near the northeastern base of the San Francisco Mountain, which is a relict stratovolcano. Faults displace middle Pleistocene alluvial fan deposits as much as about 5 m.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic and regional relations.

Dip Not reported

Dip direction E, W

Comments: Dip directions are inferred from surface displacements.

Geomorphic expression Two fault scarps face ENE; the third fault scarp is between them and faces west. T he landforms associated with this set of faults include a sharply defined, roughly symmetric, shallow (<10 m deep) physiographic trough (graben) of variable width (300 m to 1 km), and a weakly defined horst. Surveyed alluvial scarps range from about 2 to 7 m in height and have maximum slope angles ranging from 9° to 20°. They are similar to, but slightly less steep than the 15-ka Bonneville shoreline scarps (Bucknam and Anderson, 1979).

Age of faulted deposits Middle Pleistocene

Detailed studies None

Timing of most recent paleoevent: Late Quaternary (<130 ka)

Comments: Middle Pleistocene alluvium is faulted. The morphology of the scarps suggest a late to latest Pleistocene rupture. Holocene alluvium along drainages that cross the fault scarps is not faulted.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: An estimate of 0.01-0.02 mm/yr is based on about 5 m of displacement of middle Pleistocene alluvium (~250-400 ka).

Length 5 km

Average strike N27W

987, MESA BUTTE NORTH FAULT ZONE

Data Sources: This collection of faults is part of the regional northeast-trending Mesa Butte fault system described by Shoemaker and others (1974; 1978); it was named the "Mesa Butte North" fault by Menges and Pearthree (1983). The geology of the area was mapped by Ulrich and Bailey (1987).

Synopsis: Folding and normal faulting have generated a large (as much as 100-m-high) escarpment on Paleozoic bedrock with displacement down to the southeast. Lower Pleistocene basalt flows and a basaltic cinder cone (Mesa Butte) are not displaced along the southern part of the fault. North of the junction of the Mesa Butte North and Cedar Ranch [961] faults, Quaternary activity is suggested by a sharply defined graben at the base of the high escarpment. There is no documented evidence of displacement of late Quaternary alluvium.

Date of compilation 01/09/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:50,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting This structure extends beyond the northern margin of the Pliocene-Quaternary San Francisco volcanic field, on the erosion surface cut on Paleozoic rocks south of the Little Colorado River. This fault is part of a larger fault system that has a long and complex movement history (Shoemaker and others, 1978). The Mesa Butte North fault cuts Paleozoic rock, but no definite faulting Quaternary volcanic rock or other deposits has been documented.

Sense of movement **N**

Comments: Predominantly normal movement is inferred from topographic relations.

Dip Not reported

Dip direction SE

Comments: Dip directions are inferred from surface displacement.

Geomorphic expression This structure has formed a high (as much as 100 m), linear, southeast-facing escarpment on Paleozoic bedrock with a fairly narrow, fairly sharply defined graben along its base. This major escarpment is the eastern margin of the Coconino Plateau. The sharp expression of the graben along the central and northern sections of the fault zone suggests possible Quaternary activity.

Age of faulted deposits Paleozoic

Detailed studies None

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

Comments: Most, and possibly all, displacement on the fault occurred prior to 500 ka (Shoemaker and others, 1974). No definitive displacement of Quaternary deposits or volcanic rocks has been reported, but fairly sharp geomorphic expression of the graben at the base of the escarpment suggests Quaternary activity.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr

Comments: No data exist to determine a slip rate, but the <0.02 mm/yr category is inferred on the basis a lack of post 500 ka displacement (Shoemaker and others, 1974).

Length 23 km

Average strike N40E

988, CAMERON GRABEN AND FAULTS

Data Sources: First mapped and discussed by Reiche (1937), the faults and geology were later mapped by Akers and others (1962) and Ulrich and others (1984). The faults were grouped together and named the Cameron graben by Menges and Pearthree (1983).

Synopsis: Several northwest- to northeast-trending normal faults cut the erosion surface formed on Mesozoic rocks near the Little Colorado River. The faults are north of the main part of the Pliocene-Quaternary San Francisco volcanic field, but an outlying middle Pleistocene basalt that flowed down the Little Colorado River Gorge is vertically displaced by as much as 25 m. The trends of these faults range from north to northeast; they form a narrow graben and other linear depressions. Fault scarps and escarpments away from the Little Colorado River Gorge are quite gentle, suggesting that there has been little or no late Quaternary activity on these faults.

Date of compilation 02/06/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:62,500 scale, transferred to 1:250,000-scale topographic base map.

Geologic setting These faults are located on the erosion surface cut on Mesozoic rocks in the Little Colorado River Valley. The faults cut Mesozoic bedrock, the middle Pleistocene Tappan basalt (510±70 ka), and possibly a high-level terrace gravel of the Little Colorado River. The Tappan basalt flow along the Little Colorado River may be downfaulted as much as 25 m in a narrow graben (Reiche, 1937).

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic and regional relations.

Dip Not reported

Dip direction E, W

Comments: Dip directions are inferred from surface displacement.

Geomorphic expression Graben escarpments near the Little Colorado River are quite high and fairly steep, but they may have been enhanced by stream erosion. Elsewhere, scarps on Mesozoic bedrock are fairly gentle.

Age of faulted deposits Mesozoic, middle Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Substantial middle to late Quaternary activity is indicated by substantial reported displacement of middle Pleistocene basalt flow. The fault scarps do not have a sharp geomorphic expression, which suggests that most or all of the fault activity occurred during the middle Quaternary.

Recurrence interval Not reported

Slip Rate <0.2 mm/yr

Comments: An average long-term slip rate of <0.05 mm/yr is suggested by about as much as 25 m of displacement of the middle Pleistocene Tappan basalt flow (510±70 ka).

Length 16 km

Average strike N26E

989, SHADOW MOUNTAIN GRABENS

Data Sources: Faults and geology mapped by Akers and others (1962), Haynes and Hackman (1978), and Ulrich and others (1984); whereas the geology of the Shadow Mountain area was studied in detail by Condit (1974). The faults were termed the Shadow Mountain grabens by Menges and Pearthree (1983)

Synopsis: Several northeast- to north-trending normal faults cut the erosion surface formed on Mesozoic rocks north of the Little Colorado River. The faults are north of the main part of the Pliocene-Quaternary San Francisco volcanic field, but they displace an outlying upper middle Pleistocene (about 300 ka) basalt flow by at least 13 m. Faulting has formed a narrow graben and other linear depressions.

Date of compilation 02/06/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:62,500 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting These faults are located on the erosion surface cut on Mesozoic rocks in the Little Colorado River Valley. The faults cut Mesozoic bedrock and a middle Pleistocene basalt flow. The flow was K/Ar dated at 620±230 ka (Condit, 1974), but more recently was Ar/Ar dated at 300±100 ka (Conway and others, 1997). The flow surface is displaced at least 13 m in the southeast graben floor (Condit, 1974).

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic and regional relations.

Dip Not reported

Dip direction SE, NW, E, W

Comments: Dip directions are inferred from surface displacement.

Geomorphic expression Graben scarps are low to moderately high and are fairly gentle.

Age of faulted deposits Mesozoic, middle Quaternary

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Substantial middle to late Quaternary activity is indicated by 13 m of displacement of an upper middle Pleistocene (300±100 ka) basalt flow. The geomorphic expression of fault scarps is not strong, which suggests that much of the fault activity occurred before the late Quaternary.

Recurrence interval Not reported

Slip Rate <0.2 mm/yr

Comments: An estimate of 0.03 to 0.06 mm/yr is based on about 13 m of displacement of a 200-400 ka basalt flow.

Length 10 km

Average strike N29E

990, CATARACT CREEK FAULT ZONE

Data Sources: Mapped by Shoemaker and others (1974; 1978), faults grouped and named by Menges and Pearthree (1983). Following the grouping used by Menges and Pearthree, this fault zone includes some north- and northeast-trending faults that Shoemaker and others considered as part of the northeast-trending Bright Angel regional fault system; the term Cataract Creek fault system has been used to encompass a fairly broad, northwest-trending zone of faults and historical seismicity that extends from the Grand Canyon southeast to the Winslow, Arizona area (Bausch and Brumbaugh, 1997).

Synopsis: Numerous normal faults cut an erosion surface formed on Paleozoic rocks between the southern margin of the Colorado Plateau and the Grand Canyon. The faults are west of the Pliocene-Quaternary San Francisco volcanic field, and Quaternary deposits are very sparse. The Cataract Creek faults trend mainly northwest, but several faults trend north and northeast. The northeast-trending faults in this zone share the same trend and have been considered as part of the regional Bright Angel fault system (Shoemaker, 1974, 1978). Cataract Creek faults form grabens and other linear depressions; the fault scarps and escarpments are formed on Paleozoic bedrock have quite gentle to fairly steep slopes. On the basis of their strong geomorphic expression, Quaternary activity is fairly likely on at least some of these faults, but this age movement has not been conclusively demonstrated. Some historical seismic activity has occurred in this area including a M 5.4 event in 1993 (Lay and others, 1994; Sanders, 1997) and a M 6.2 event in 1906 (Bausch and Brumbaugh, 1997).

Date of compilation 01/14/98

County Coconino

1° x 2° sheet Williams

Province Colorado Plateau

Reliability of location Moderate

Comments: Traces based on aerial photo interpretation at 1:130,000 scale; traces transferred to 1:250,000-scale topographic base map.

Geologic setting These faults are located on an erosion surface cut on Paleozoic rocks between the Mogollon Rim and the Grand Canyon. Extensive unpublished mapping has been conducted in this area (Shoemaker and others, 1974), but no intermediate or large-scale published maps exist for most of this area. Cataract Creek faults displace Paleozoic bedrock; Quaternary alluvium is sparse in this area. The geology of the southeasternmost faults of the Cataract Creek system has been mapped in detail (Newhall and others, 1987). These few faults apparently do not offset Pliocene volcanic rocks.

Sense of movement N

Comments: Predominantly normal movement is inferred from topography and regional relations.

Dip Not reported

Dip direction SE, NW

Comments: Dip directions are inferred from surface displacement.

Geomorphic expression Graben scarps are low to moderately high and slopes range from gentle to quite steep.

Age of faulted deposits Paleozoic

Comments: Quaternary deposits are very sparse in this area.

Detailed studies None

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

Comments: This time estimate is very poorly constrained, but the strong geomorphic expression of some fault scarps suggests that there has been Quaternary activity on this fault system.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr.

Length 51 km

Average strike N23W

991, BRIGHT ANGEL FAULT ZONE

Data Sources: The regionally extensive Bright Angel fault zone was mapped by Shoemaker and others (1974; 1978). In the Grand Canyon area, the Bright Angel fault has been mapped in detail (Huntoon and Sears, 1975; Huntoon and others, 1976).

Synopsis: The northeast-trending normal faults of the Bright Angel zone cut an erosion surface formed on Paleozoic rocks between the Mogollon Rim and the Grand Canyon. The faults are northwest of the Pliocene-Quaternary San Francisco volcanic field, and Quaternary deposits are very sparse in the area. Faults have vertically displaced Paleozoic strata by as much as 60 m, forming southeast-facing escarpments and narrow grabens. The fault zone continues into the Grand Canyon, where it evidently has controlled the development of Bright Angel Canyon, a deep tributary canyon north of the Colorado River. Away from the Grand Canyon, escarpments formed on Paleozoic bedrock vary from quite gentle to fairly steep in slope. Based on their strong geomorphic expression, Quaternary activity is possible on some of these faults, but such movement has not been conclusively demonstrated. Moderate historical seismic activity has occurred in this general area.

Date of compilation 02/07/97

County Coconino

1° x 2° sheet Williams, Grand Canyon, Marble Canyon

Province Colorado Plateau

Reliability of location Moderate

Comments: Traces based on aerial photo interpretation at 1:130,000 scale; traces transferred to 1:250,000-scale topographic base map.

Geologic setting These faults are located on the erosion surface cut on Paleozoic rocks between the Mogollon Rim and the Grand Canyon and continue into the Grand Canyon. A detailed geologic map exists for the Grand Canyon area (Huntoon and others, 1976), but not for areas south of the Grand Canyon. Faults of the Bright Angel zone cut Paleozoic bedrock; displacement of Paleozoic rocks near the Grand Canyon is about 60 m. Quaternary alluvium is sparse in this area, and no displacement of Quaternary alluvium has been documented.

Sense of movement N

Comments: Predominantly normal movement inferred from topography and exposed stratigraphic relations.

Dip 76°-87° and 45°-80°

Comments: Steeper dips were measured in Paleozoic strata; shallower dips were measured in Precambrian rocks lower in section within the Grand Canyon (Huntoon and Sears, 1975).

Dip direction SE, NW

Comments: The main strand of the Bright Angel fault system is a southeast-dipping normal fault. Other strands to the south are expressed as grabens, so individual faults probably dip either to the southeast or northwest.

Geomorphic expression Fault scarps formed on bedrock are low to moderately high and their slopes range from fairly gentle to quite steep.

Age of faulted deposits Paleozoic

Detailed studies None

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

Comments: This timing estimate is very poorly constrained, but the strong geomorphic expression of some fault scarps suggests that there has been some Quaternary activity on this fault system.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Length 66 km

Average strike N36E

992, EMINENCE FAULT ZONE

Data Sources: The Eminence fault zone is part of the regional Bright Angel fault system as mapped by Shoemaker and others (1974; 1978) and described by Huntoon and Sears (1975). It was called the "Eminence Break" fault zone by Menges and Pearthree (1983). The southern strands of the Eminence fault in the Grand Canyon area were mapped in detail by Huntoon and others (1976).

Synopsis: These northeast-trending normal faults cut across the the eastern Grand Canyon and the Marble Platform, an erosion surface formed on Paleozoic rocks east of the Grand Canyon. The faults are north of the Plio-Quaternary San Francisco volcanic field where Quaternary deposits are very sparse. The faults form a sharply defined, northwest-facing escarpment (Eminence Break) with a narrow graben along much of its base. Away from the Grand Canyon, the fault escarpment formed on Paleozoic bedrock is steep. On the basis of its strong geomorphic expression, Quaternary activity is likely along the Eminence fault, but it has not been conclusively demonstrated.

Date of compilation 2/10/97

County Coconino

1° x 2° sheet Marble Canyon

Province Colorado Plateau

Reliability of location Good

Comments: Trace mapped at 1:62,500 and 1:130,000 scales, and compiled on 1:250,000-scale topographic base map.

Geologic setting The Eminence fault zone is located in the eastern Grand Canyon and on the Marble Platform, an erosion surface cut onto Paleozoic rocks east of the Grand Canyon. A detailed geologic map exists for the Grand Canyon area (Huntoon and others, 1976), and less detailed mapping exists farther to the northeast (Haynes and Hackman, 1978). The Eminence faults cut Paleozoic and older bedrock but displacement of Paleozoic rocks near the Grand Canyon is less than 90 m. Although not shown on the published geologic maps, from inspection of aerial photos it appears that Quaternary alluvium has been deposited along much of the base of Eminence Break. No displacement of Quaternary alluvium has been documented.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic and exposed stratigraphic relations.

Dip Not reported

Dip direction NW, SE

Comments: The main strand of the Eminence fault system is a northwest-dipping normal fault. Fault strands to the northwest of the main fault probably dip to the southeast.

Geomorphic expression The primary fault escarpment, Eminence Break, is formed on the resistant Kaibab Formation. The escarpment is moderately high (<100 m), quite steep (average escarpment slopes are as much as 40°), and linear, suggesting that Quaternary activity is likely. The escarpment decreases in height rather abruptly at the northeastern end of the fault. Several scarps that define the northwestern margin of grabens along the base of Eminence Break are much lower and have moderate to gentle slopes.

Age of faulted deposits Paleozoic

Detailed studies None

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

Comments: The timing estimate is weakly constrained, but Quaternary activity on this fault system is very likely based on the strong geomorphic expression of the primary fault escarpment, Eminence Break.

Recurrence interval Not reported

Slip Rate Unknown, probably < 0.2 mm/yr

Length 36 km

Average strike N34E

993, CENTRAL KAIBAB FAULT SYSTEM

Data Sources: Mapped and named by Huntoon (1974); some of the faults were mapped and described previously by Strahler (1948). The fault system includes the Central Kaibab—Demotte Park and Central Kaibab—Summit Valley fault sets of Menges and Pearthree (1983).

Synopsis: Several normal faults cut the erosion surface formed on Paleozoic rocks along the highest part of the Kaibab Plateau, north of the Grand Canyon. Quaternary deposits are sparse in this area, but local deposition has occurred in shallow valleys along some of the faults. The overall trend of the Central Kaibab fault system is north, but individual faults trend north, northwest, northeast, and approximately east-west. Along the southern half of the fault system, faulting is expressed as fairly high, gentle, west-facing scarps formed on Paleozoic bedrock, with Quaternary deposits in linear valleys along their bases. Quaternary activity is possible on at least some of these faults based on their geomorphic expression, but it has not been conclusively demonstrated.

Date of compilation 02/11/97

County Coconino

1° x 2° sheet Grand Canyon

Province Colorado Plateau

Reliability of location Moderate

Comments: Mapped on 1:130,000-scale aerial photos, transferred to 1:250,000-scale topographic base for digitization.

Geologic setting These faults cut an erosion surface developed on Paleozoic rocks of the Kaibab Plateau, north of the Grand Canyon. Published, fairly detailed geologic mapping covers the southern part of this fault zone (Huntoon and others, 1976); the geology of the northern faults has not been mapped in detail. Down-to-the-west normal faulting may represent reactivation of west-dipping reverse faults at the cores of Laramide folds (Huntoon, 1974). The Central Kaibab faults cut Paleozoic bedrock; Quaternary alluvium has been deposited on the downthrown side of many of the faults, but no displacement of Quaternary alluvium has been documented.

Sense of movement N

Comments: Predominantly normal movement inferred from topography and regional geolgoic relations.

Dip Not reported

Dip direction W, SW, NW

Comments: Dip directions are inferred from surface displacements.

Geomorphic expression Predominantly west-facing graben escarpments are moderately high with fairly gentle slopes. Linear troughs covered by Quaternary alluvium are common on the western, downthrown sides of these faults.

Age of faulted deposits Paleozoic

Detailed studies none

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

Comments: This timing estimate is very poorly constrained. The moderately strong geomorphic expression of the fault escarpments suggests that there may have been some Quaternary activity on this fault system.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Length 71 km

Average strike N2E

994, WEST KAIBAB FAULT SYSTEM

Data Sources: Faults mapped and described by Strahler (1948); faults grouped and included in larger named system by Huntoon (1974); includes the Muav Canyon, Big Springs, North Road, and Lefevre graben fault sets of Strahler; the geology of most of these faults has not been mapped in detail, but detailed mapping exists for parts of the Big Springs and Muav faults (Billingsley, 1992).

Synopsis: Several large, down-to-the-west normal faults cut the erosion surface formed on Paleozoic rocks along the western flank of the Kaibab Plateau, north of the Grand Canyon. Quaternary deposits are fairly sparse in this area, but deposition has occurred in valleys along the faults. The overall trend of the West Kaibab fault system is north, but individual faults trend north, northwest, and northeast. Along the central and northern parts of the fault system, faulting is expressed as fairly high and steep, west-facing scarps formed in Paleozoic bedrock, with Quaternary deposits in linear valleys along their bases. Quaternary activity is likely on at least some of these faults based on their strong geomorphic expression and possible displacement of Pleistocene colluvium, but these relations have not been conclusively demonstrated.

Date of compilation 02/11/97

County Coconino

1° x 2° sheet Grand Canyon

Province Colorado Plateau

Reliability of location Good

Comments: Faults mapped at 1:24,000 scale and on 1:130,000-scale aerial photos; the traces were transferred to 1:250,000-scale topographic base map for digitization.

Geologic setting Major faults cut the erosion surface developed on Paleozoic rocks on the western flank of the Kaibab Plateau, north of the Grand Canyon. Total normal displacement of Paleozoic rocks across the Muav fault is as much as 165 m; across the Big Springs fault, displacement is as much as 350 m (Billingsley, 1992). Down-to-the-west normal faulting probably represents reactivation of west-dipping reverse faults at the cores of Laramide folds (Huntoon, 1974).

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations and fault exposures.

Dip 86°

Comments: This dip was measured on the Muav fault in the Grand Canyon (Billingsley, 1992).

Dip direction W, SW, NW

Comments: Dip directions are inferred from exposed stratigraphic relations, and surface displacement.

Geomorphic expression Graben escarpments are high and steep. Alluvial fans and stream valleys containing Quaternary alluvium are common on the western, downthrown sides of these faults, but no displacement of these deposits has been documented.

Age of faulted deposits Paleozoic, Pleistocene(?) colluvium

Detailed studies None

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

Comments: This timing estimate is not well constrained, but possible faulting of some Quaternary deposits along the Big Springs fault (Billingsley, 1992) and the strong geomorphic expression of the fault escarpments indicates that Quaternary activity is likely on this fault system, and middle and late Quaternary activity is possible.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Length 83 km

Average strike N4W

995, AUBREY FAULT ZONE

Data Sources: Mapped on a reconnaissance basis by Koons (1948) and Blissenbach (1952); remapped and studied by Pearthree and others (1983) and Jackson (1990). The geology of the northern part of the fault was mapped in detail by Billingsley and others (1986) and the southern part of the fault zone was trenched by Euge and others (1992).

Synopsis: This large, generally north-trending fault zone has generated a high, steep, linear, west-facing bedrock escarpment and formed a small, closed alluvial basin near the southwestern margin of the Colorado Plateau. Fault trends generally vary from northwest to northeast; the northernmost part of the fault trends approximately west. The northern part of the Aubrey fault zone merges with the southern part of the Toroweap fault zone [997], and they could be considered part of one fault zone. There has been at least 240 m of Cenozoic normal displacement in the central part of the Aubrey fault zone. Reconnaissance and detailed field studies have focused on the southern part of the fault zone, south of a major convex fault bend. On this part of the fault, middle and upper Quaternary alluvium has been displaced as much as 5 m. Trenching investigations suggest two rupture events in the past 200 k.y. Displacement of Quaternary alluvium has not been documented north of the bend, but this part of the fault zone has not been studied in detail. The southern part of the fault probably ruptured between about 10 and 30 ka.

Date of compilation 02/12/97

County Coconino

1° x 2° sheet Williams

Province Colorado Plateau

Geologic setting The Aubrey fault zone is located near the southwestern margin of the Colorado Plateau. It forms the eastern side of a relatively shallow, asymmetric Cenozoic basin. Paleozoic rocks are displaced at least 240 m across the fault zone. Faults also cut early to middle Tertiary sediment.

Reliability of location Good

Comments: The northern part of the fault zone was mapped at 1:24,000 scale (Billingsley and others, 1986); the southern part of the fault zone was mapped on 1:130,000-scale aerial photos. Fault traces were transferred to a 1:250,000-scale topographic base map.

Sense of movement N

Comments: Inferred from topography and regional relations and exposures in a fault trench.

Dip Not reported

Comments: Faults interpreted in trench exposures dip very steeply, but angles are not reported.

Dip direction W, SW

Comments: Faults interpreted in trench exposures dip very steeply to the west or southwest.

Geomorphic expression Faulting has generated a high, steep, linear, west-facing escarpment on Paleozoic bedrock. Low, moderately sloping alluvial scarps exist downslope from the bedrock escarpment. The alluvial scarps range in height from about 2 to 5 m and have maximum slope angles of 10° to 17°, respectively. Morphologic analysis of 11 scarp profiles suggests an age of about 10 ka to 20 ka (Pearthree and others, 1983) for the most recent surface rupturing event.

Age of faulted deposits Paleozoic, middle to late Pleistocene, late Pleistocene

Detailed studies [995-1] Two trenches were excavated across the southern part of the fault zone by Euge and others (1992). One trench revealed no clear faults and no datable organic material, but upper to middle Pleistocene (at least 100 ka) deposits with strongly developed soil were interpreted to be downwarped about 2 m across a buried fault zone. The second trench revealed faults but no datable material. Euge and others (1992) found evidence for at least 2 displacement events with about 2 m of total displacement since deposition of an upper middle Pleistocene deposit (soil age estimate about 200 ka). A scarp-derived deposit that post-dates the youngest rupture is estimated to be latest Pleistocene (soil age estimate ≥15 ka) in age.

Timing of most recent paleoevent Late Quaternary (<130 ka)

Comments: The time of youngest rupture was estimated to be latest Pleistocene (10-20 ka) by Pearthree and others (1983) based on scarp morphology, whereas Euge and others (1992) estimated a time of about 30 ka based on an estimated age of >15 ka for the youngest colluvium.

Recurrence interval ca. 100 k.y. (200 ka)

Comments: This recurrence interval was estimated by Euge and others (1992) on the basis of 2 fault ruptures since about 200 ka.

Slip Rate <0.2 mm/yr

Comments: A estimate of 0.01 to 0.03 mm/yr is based on roughly 2 m of displacement in the last 100-200 k.y. on southern part of fault (Euge and others, 1992), and about 5 m of displacement of an upper to middle Pleistocene alluvial fan farther north (Menges and Pearthree, 1983).

Length 53 km

Average strike N18W

996, YAMPAI GRABEN

Data Sources: Mapped and named by Menges and Pearthree (1983).

Synopsis: The Yampai graben is a narrow, shallow, symmetric graben located on the west side of the Aubrey Valley near the southwestern margin of the Colorado Plateau. Paleozoic rocks are displaced at least 30 m from the graben shoulders to the valley bottom. The escarpments are fairly steep and quite linear which suggests Quaternary fault activity, but there is no documented displacement of the scarce Quaternary deposits along the fault.

Date of compilation 04/15/97

County Coconino

1° x 2° sheet Williams

Province Colorado Plateau

Geologic setting The Yampai graben is a narrow, shallow, symmetric graben located near the southwestern margin of the Colorado Plateau province. It is on the west side of the Aubrey Valley, which is a relatively shallow, asymmetric Cenozoic basin bounded on its east side by the much larger Aubrey fault [995]. Paleozoic rocks are displaced at least 30 m from the graben shoulders to the valley bottom.

Reliability of location Moderate

Comments: Trace based on aerial photo interpretation at 1:130,000 scale; trace transferred to 1:250,000-scale topographic base map.

Sense of movement N

Comments: Inferred from topography and regional relations.

Dip Not reported

Dip direction NE, SW

Comments: Inferred from topography and regional relations.

Geomorphic expression Faulting has generated two steep, linear escarpments on Paleozoic bedrock; these escarpments form the sides of a narrow trough that is filled with young fan deposits that are not faulted.

Age of faulted deposits Paleozoic

Comments: Surficial Quaternary deposits are scarce and there is no evidence that they are faulted.

Detailed studies None

Timing of most recent paleoevent Quaternary (<1.6 Ma)

Comments: No Quaternary faulting has been documented, but Quaternary deposits are scarce along the fault and thus definitive evidence may not be present. The steepness and linearity of the graben escarpments suggest Quaternary activity, and late Quaternary movement is possible.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr.

Length 7 km

Average strike N22W

997, TOROWEAP FAULT ZONE

Data Sources: Quaternary activity on the Toroweap fault has been studied by Koons (1945), Hamblin (1970), Huntoon (1977), Menges and Pearthree (1983), Pearthree and others (1983), and Jackson (1990). Geologic maps by Billingsley and Huntoon (1983), Billingsley and others (1986) and Jackson (1990) cover much of the fault zone.

Synopsis: The Toroweap fault is a long, north- to northeast-trending fault zone near the western margin of the Colorado Plateau that has had substantial Cenozoic normal displacement. It extends from south of the Grand Canyon northward into Utah, where it is called the Sevier fault zone [xxxx]. The fault has generated a west-facing bedrock escarpment north and south of the Colorado River, in Toroweap and Prospect Valleys, respectively. There has been as much as 300 m of Cenozoic normal displacement across the Toroweap fault zone near the Grand Canyon. To the south, displacement remains similar as the Toroweap fault merges with the northern part of the Aubrey fault zone [995]. Total normal displacement decreases to less than 100 m on the Kanab Plateau north of Toroweap Valley, but then increases dramatically to about 500 m near the Utah border. There is very little topographic relief across the Toroweap fault where it crosses the Kanab Plateau, and near the Utah border resistant rocks in the hanging wall have caused it to remain topographically higher than the footwall. Detailed field mapping, and soils and geomorphologic analyses of the fault zone indicate that about 50 km of the fault, centered approximately on the Colorado River, ruptured during the middle to late Holocene (Jackson, 1990). There is clear evidence for recurrent late Quaternary displacement events on this section of the fault, which has a late Quaternary slip rate of about 0.05 to 0.075 mm/yr. The high, relatively linear fault escarpment continues about 10 km south of the young rupture, suggesting that the southern section of the fault zone has also been quite active during the Quaternary. The northern section of the fault zone on the Kanab Plateau has probably been less active during the Quaternary because there is minimal topographic relief across the fault, but there may have been late Quaternary displacement this section as well.

Date of compilation 04/03/97

Compiler and affiliation Philip A. Pearthree

State Arizona, Utah

County Mohave, Coconino

1° x 2° sheet Grand Canyon, Williams

Province Colorado Plateau

Geologic setting The Toroweap fault zone is located near the western margin of the Colorado Plateau province. Paleozoic rocks are displaced vertically by at least 300 m across the fault zone near the Grand Canyon; vertical displacement remains similar to the southern end of the fault, but is less than 100 m north of Toroweap Valley. A middle Pleistocene (600 ka) basalt in northern Toroweap Valley is displaced 36 m, whereas an upper middle Pleistocene (200 ka) basalt in southern Toroweap Valley is displaced 15 m (Jackson, 1990).

Number of sections 3

Comments: The Toroweap fault is divided into northern, central, and southern sections based on the geomorphic expression and recent rupture history of the fault. The northern section [997a] corresponds with "segment A" of Jackson (1990). Total vertical displacement across this section is quite variable, but topographic relief is modest to minimal and the youngest rupture occurred in the late Pleistocene. Topographic relief and vertical displacement are much higher across the central section [997b], which corresponds with "segment B" of Jackson (1990); this section has ruptured during the Holocene and it has had recurrent late Quaternary movement. Topographic relief and vertical displacement in the southern section [997c] are similar to the central section. This southern section, which corresponds with "segment C" of Jackson (1990), evidently has not ruptured during the Holocene.

997A, NORTHERN TOROWEAP SECTION

Comments: This name applies to the part of the Toroweap fault from the northern end of Toroweap Valley north to the Utah border. North of the border in Utah, the fault is called the Sevier fault zone.

Reliability of location Good

Comments: Mapped on large-scale aerial photos (Hamblin, 1970), transferred to 1:250,000-scale topographic base map for digitization.

Sense of movement N

Comments: Based on regional relations and normal displacement of Mesozoic and Paleozoic bedrock across the fault zone.

Dip Not reported

Dip direction NW, W

Comments: Based on topographic expression of fault and structural relations.

Geomorphic expression Faulting is expressed as low to moderately high, west-facing escarpments on Paleozoic bedrock, low fault scarps on undated but probable Pleistocene basalts, and low, gentle fault scarps on upper(?) Pleistocene alluvium. North of Cedar Knoll on the Kanab Plateau, where less resistant Mesozoic rocks are at the surface of the footwall, there is very little relief across the fault. An alluvial fault scarp profiled south of Pipe Springs is about 3.5 m high and has a maximum slope angle of 7.5°, suggesting a late Pleistocene time of youngest rupture.

Age of faulted deposits Paleozoic, Mesozoic, late(?) Pleistocene

Detailed studies None

Timing of most recent paleoevent: Late Quaternary (<130 ka)

Comments: Based on the estimated age of faulted alluvium and single fault scarp profile.

Recurrence interval Not reported

Slip Rate <0.2 mm/yr

Comments: A rough long-term slip rate estimate of 0.01 to 0.04 mm/yr is based on 2 m of vertical displacement of late Pleistocene (~50-150 ka) alluvium.

Length 60 km

Average strike N16E

997B, CENTRAL TOROWEAP SECTION

Comments: This name applies to the part of the Toroweap fault from the northern end of Toroweap Valley to the southern end of Holocene rupture in Prospect Valley.

Reliability of location Good

Comments: Mapped at 1:24,000 scale, transferred to 1:250,000-scale topographic base map for digitization.

Sense of movement N

Comments: Based on regional relations and normal displacement of Paleozoic bedrock, Quaternary basalt and alluvium across the fault zone.

Dip Not reported

Dip direction W

Comments: Based on the topographic expression of the fault and fault exposures in the Grand Canyon.

Geomorphic expression Faulting has generated a high, moderately steep, fairly linear, west-facing escarpment on Paleozoic bedrock in Prospect Valley and northern Toroweap Valley. The escarpment is sinuous in southern Toroweap Valley, probably due in part to damming of the valley by Pleistocene basalt flows. Alluvial fault scarps exist downslope from the bedrock escarpment in Prospect and Toroweap Valleys. Alluvial scarps formed on Holocene coarse gravel deposits in Prospect Valley range in height from about 2 to 4.5 m and have maximum slope angles of 14° to 24°, respectively. Diffusion-based morphologic analysis of 39 scarp profiles suggested an age of about 2-5 ka (Jackson, 1990). Alluvial scarps formed on fine-grained Holocene deposits in Toroweap Valley range in height from about 1 to 3.5 m and have maximum slope angles of 7° to 16°, respectively. Diffusion-based age estimate based on 8 scarp profiles suggests a scarp age of 15 ka (Jackson, 1990). However, Jackson (1990) argued that the fault ruptured in Toroweap and Prospect Valleys during the middle Holocene.

Age of faulted deposits Paleozoic, Mesozoic, middle Pleistocene, late Pleistocene, early to middle Holocene.

Detailed studies None. Interpretations supported by detailed mapping, and geomorphologic and soils analyses by Jackson (1990); no trenching studies have been performed.

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

Comments: Based on the estimated age of young alluvial fans that are faulted, and from morphologic analyses of fault scarps profiled in Prospect Valley.

Recurrence interval 10 to 30 k.y. (25 to 100 ka)

Comments: This estimate is based on about 2 m of vertical displacement during the youngest faulting event and about 6.5 m of displacement recorded by a late Pleistocene alluvial fan, estimated to be 25 to 100 ka (Jackson, 1990).

Slip Rate <0.2 mm/yr

Comments: A rough long-term slip rate estimate of 0.05 to 0.075 mm/yr is based on 6.5 m of vertical displacement of late Pleistocene (~25-100 ka) alluvium, 15 m of displacement of a 200 ka basalt flow, and 36 m of displacement of a 600 ka basalt flow (Jackson, 1990).

Length 60 km

Average strike N11E

997C, SOUTHERN TOROWEAP SECTION

Comments: This name applies to the section of the Toroweap fault in Prospect Valley south of the southern end of Holocene rupture. This section corresponds with "segment C" of Jackson (1990) and includes the Prospect Point graben, which diverges SSE-ward from the main fault zone at the northern end of this section. The southern end of this section bends to the east and merges with the Aubrey fault zone [995].

Reliability of location Good

Comments: Mapped at 1:48,000 scale, transferred to 1:250,000-scale topographic base map for digitization.

Sense of movement N

Comments: Based on regional relations and normal displacement of Paleozoic bedrock across the fault zone.

Dip Not reported

Dip direction W

Comments: Based on topographic expression of the fault and structural relations.

Geomorphic expression Faulting is expressed as a high, moderately steep, linear, west- to southwest-facing escarpment formed on Paleozoic bedrock in southern Prospect Valley. No alluvial fault scarps have been mapped along the base of the bedrock escarpment in this section.

Age of faulted deposits Paleozoic

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: No definitive displacement of Quaternary deposits has been documented, but the strong geomorphic expression of the fault escarpment implies substantial middle and late Quaternary fault activity.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Length 19 km

Average strike N12E

998, HURRICANE FAULT ZONE

Data Sources: Quaternary activity on the Hurricane fault in Arizona has been studied by Gardner (1941), Hamblin (1970), Huntoon (1977), Holmes and others (1978), Hamblin and others (1981), Menges and Pearthree (1983), Pearthree and others (1983), Jackson (1990), and Stenner and others (1998). Geologic maps by Billingsley and Huntoon (1983), and Billingsley (1992f, 1992d, 1993a, 1993c, 1994a, 1994b) cover most of the fault zone in Arizona. The fault continues north into Utah.

Synopsis: The Hurricane fault is a long, generally north-trending fault zone with substantial Quaternary normal displacement near the western margin of the Colorado Plateau province in Arizona and Utah. The fault has generated a steep, curvilinear, west-facing bedrock escarpment several hundred meters high. There has been 200-400 m of Cenozoic normal displacement across the fault zone along most of its length in Arizona. Near the Utah border, displacement increases to at least 450 m and probably continues to increase into Utah. In this summary, the Hurricane fault in Arizona is divided into four sections based on gross geomorphic and structural characteristics. Although parts of the Hurricane escarpment south of the Colorado River is fairly linear and steep, no definitive evidence of Quaternary activity on this southern section of the fault has been reported. The Whitmore Wash section, between the Colorado River and the Mt. Trumbull area, last ruptured in the latest Pleistocene to early Holocene and has had recurrent late Quaternary activity. The escarpment associated with the fault in this section is steep, but is sinuous and erosionally embayed. The Mt. Trumbull area is probably a section boundary, because there is very little topographic relief across the Hurricane fault and Pliocene volcanic rocks have only been displaced a moderate amount. Northward along the Shivwitz section, the curvilinear fault escarpment (the Hurricane Cliffs) increases to several hundred meters in height. Low fault scarps on colluvium, alluvium, and bedrock are fairly common along the base of the Cliffs in this section, and record late Quaternary fault activity. The northern end of the Shivwitz section is defined by a major convex bend in the fault zone, across which total fault displacement increases by at least 50 percent. The Anderson Junction section begins at this convex bend and continues north into Utah. The fault escarpment is very steep and curvilinear, and scarps along the base of the Cliffs record at least 20 m of late Quaternary displacement. The youngest rupture on this section was probably in the early Holocene, but the northern extent of this rupture is uncertain.

Date of compilation 01/27/98

Compiler and affiliation Philip A. Pearthree

State Arizona, Utah

County Mohave, Coconino, Washington, Iron (Utah)

1° x 2° sheet Grand Canyon, Williams, Cedar City (Utah)

Province Colorado Plateau

Geologic setting The Hurricane fault zone is one of several long normal faults located near the western margin of the Colorado Plateau, in what is effectively a transition zone between the Colorado Plateau and Basin and Range. Substantial late Cenozoic, down-to-the-west displacement on the Grand Wash, Washington, Hurricane, and Toroweap faults has resulted in the formation of a series of broad plateaus and escarpments that step down to the west. Along most of its length, the Hurricane fault is marked by a high, steep bedrock escarpment with relatively thin Quaternary deposits along its base. Paleozoic strata have been vertically displaced by hundreds of meters across the Hurricane fault. Pliocene and Quaternary basalt flows have been displaced by substantial amounts, and upper Quaternary alluvium and colluvium have been faulted as well.

Number of sections 4 (in Arizona)

Comments: Previous workers (Menges and Pearthree, 1983) subdivided the Hurricane fault in Arizona into eight “segments” based on structural and geomorphic characteristics. Detailed studies have not been conducted to justify this level of detail, however. In this summary, the fault is divided into four sections in Arizona (Anderson Junction, Shivwitz, Whitmore Wash, and Southern) based on the gross geomorphic expression, structural characteristics, and what is known about the recent rupture history of the fault. The major section boundaries are zone of structural complexity in a left fault step at the north end of the Anderson Junction section in Utah (Stewart and Taylor, 1996), a convex fault bend about 10 km south of the Utah border that separates the Anderson Junction section to the north from the Shivwitz section to the south. The southern part of the Anderson Junction section corresponds with the “Hurricane segment” of Menges and Pearthree (1983), and the Shivwitz section corresponds with the “Temple Trail”, “Grandstand”, “Merchant Tank”, and “Twin Buttes” segments of Menges and Pearthree (1983). The Mt. Trumbull area, where topographic relief and Quaternary displacement across the Hurricane fault are relatively small, separates the Shivwitz section from the Whitmore Canyon section to the south. The Whitmore Canyon section corresponds with the “Whitmore Wash” and most of the “Hells Hollow” segments of Menges and Pearthree (1983). The Colorado River is the boundary between the Whitmore Canyon and Southern sections of the Hurricane fault.

998A, ANDERSON JUNCTION SECTION

Comments: This name applies to the part of the Hurricane fault north of the major convex bend in the fault, which is located about 10 km south of the Utah border. The features described below are in Arizona. This section continues to the Anderson Junction area, north of the town of Hurricane, Utah.

Reliability of location Good

Comments: Mapped at 1:24,000 scale (Billingsley, 1992b), transferred to 1:250,000-scale topographic map for digitization.

Sense of movement N

Comments: Mesozoic and Paleozoic bedrock, and Quaternary volcanic rocks, alluvium, and colluvium are displaced vertically across the fault zone. Also, slickenlines reported from the fault near the Utah border indicate dip-slip movement (Hamblin, 1970).

Dip 75° to 80°

Comments: Reported by Hamblin (1970).

Dip direction NW, W

Comments: Based on the topographic expression of fault, stratigraphic relations, and fault exposures.

Geomorphic expression Faulting has generated a high, northwest- to west-facing escarpment on Paleozoic bedrock. The escarpment is very steep and curvilinear, and closely follows the fault zone's trace. Low to moderately high (<30-m-high), steep (up to 35°) fault scarps formed on probable late Pleistocene colluvium and alluvium exist along much of the base of the escarpment. Vertical surface displacement across the larger scarps is about 20 m. Smaller fault scarps have been documented at several locations along the fault. A scarp studied by Pearthree and others (1983) is about 2-2.5 m high and has a maximum slope of 22°-24°, which suggests an Holocene time for the youngest rupture. A plot of maximum scarp slope vs. log of scarp height for scarps ranging in height from 2 m to 20 m also implies a Holocene age of youngest rupture (Stenner and others, 1998).

Age of faulted deposits Paleozoic and Mesozoic bedrock; middle to late Pleistocene, latest Pleistocene to early Holocene sediments.

Detailed studies **[**988-1] Two trenches have recently been excavated across the fault at Cottonwood Canyon (Stenner and others, 1998). Preliminary analyses of these trenches indicate that deposits as young as early Holocene (based on soil development), are displaced about 60 cm. Probable upper Pleistocene deposits have been displaced more than 5 m as a result of multiple fault ruptures.

Timing of most recent paleoevent: Holocene to post-glacial (<15 ka)

Comments: This timing is based on the estimated age of faulted alluvium exposed in a trench and from morphometric analysis of several fault scarp profiles. The most recent paleoevent might well be of early Holocene age.

Recurrence interval Not reported

Slip Rate 0.2 to 1 mm/yr (100-200 k.y.)

Comments: An estimate 0.15-0.4 mm/yr is based on about 20 m of vertical displacement of a late Pleistocene (~50-130 ka) alluvial fan surface (Stenner and others, 1998). In addition, a middle Pleistocene (200-400 ka) basalt flow is displaced about 90 m at the town of Hurricane, Utah (Hamblin and others, 1981), 15 km north of the Arizona border. This older faulted datum results in a slightly higher long-term average slip rate of about 0.23-0.45 mm/yr.

Length 12 km (continues north into Utah)

Average strike N25E

998B, SHIVWITZ SECTION

Comments: This name applies to the part of the Hurricane fault from the major convex fault bend about 10 km south of the Utah border, south to the Mt. Trumbull area. The Hurricane Cliffs form the eastern margin of the Shivwits Plateau along this section. This relatively long section of the fault was further subdivided by Menges and Pearthree (1983) into the “Temple Trail”, “Grandstand”, “Merchant Tank”, and “Twin Buttes” segments, but detailed studies to support this finer differentiation have not been conducted.

Reliability of location Good

Comments: Most of the fault is mapped at 1:24,000 scale (Billingsley, 1992a, 1993a, 1993b, 1994a, 1994b); this information was transferred to 1:250,000-scale topographic map for digitization.

Sense of movement N

Comments: Based on regional relations and normal displacement of Paleozoic bedrock and Quaternary basalt and alluvium across the fault zone.

Dip Near vertical

Comments: As reported by Hamblin (1965)

Dip direction W, NW

Comments: Based on the topographic expression of the fault and stratigraphic relations.

Geomorphic expression Faulting has generated a high, WSW- to northwest-facing escarpment on Paleozoic bedrock. The escarpment closely follows the fault zone and is very steep and curvilinear except in the Navajo Trail—Grandstand area, where the fault zone is obviously composed of several major strands. Fault scarps formed on probable late Pleistocene colluvium and alluvium exist along much of the base of the escarpment north of Twin Butte. Scarps range in height from about 4 to 25 m, with maximum slope angles of 15° to 30°. Estimated vertical displacement across these scarps is 10 m or less. Preliminary morphologic analysis based on 10 scarp profiles suggests a latest Pleistocene age of youngest rupture (Menges and Pearthree, 1983).

Age of faulted deposits Paleozoic bedrock; early to middle Pleistocene basalt and late Pleistocene sediment.

Detailed studies None

Timing of most recent paleoevent: Late Quaternary (<130 ka)

Comments: This timing is based on estimated age of faulted alluvium and from analysis of fault scarp profiles; the youngest paleoevent might well be have occurred in the latest Pleistocene.

Recurrence interval Insufficient data

Slip Rate <0.2 mm/yr (50-150 k.y.)

Comments: A rough estimate of 0.08 to 0.2 mm/yr is based on 10 m or less of vertical displacement of late Pleistocene (~50-130 ka) alluvium and colluvium.

Length 57 km

Average strike N5W

998C, WHITMORE CANYON SECTION

Comments: This name applies to the part of the Hurricane fault from the Mt. Trumbull area south to the Colorado River. This section corresponds with the “Whitmore Wash segment” and part of the “Hells Hole segment” of Menges and Pearthree (1983). It is separated from the section of the fault south of the Colorado River because of the definitive evidence of late Quaternary on the Whitmore Canyon section.

Reliability of location Good

Comments: Mapped at 1:48,000 scale, transferred to 1:250,000-scale topographic map for digitization.

Sense of movement N

Comments: Based on regional relations and normal displacement of Paleozoic bedrock and Quaternary alluvium and basalt across the fault zone

Dip Near vertical to 55°

Comments: Dip angles were reported by Hamblin (1965). Relatively steep dips exist at higher stratigraphic levels and at higher altitudes. Shallowest dips were measured near the bottom of the Grand Canyon.

Dip direction W

Comments: Based on topographic expression of fault, stratigraphic relations, and fault exposures in the Grand Canyon (Hamblin, 1965).

Geomorphic expression Faulting has generated a moderately high, steeply embayed, west-facing escarpment on Paleozoic bedrock in Whitmore Canyon. Alluvial fault scarps that have been mapped downslope from the base of the bedrock escarpment along most of this section record recurrent late Quaternary faulting events. These scarps range in height from about 4 to 20 m, with vertical displacements of 2 to 8.5 m. Scarps that may record the youngest paleoevent only have heights of 4 to 6 m, with estimated vertical displacements of 2 to 3.5 m and maximum slope angles of 21° to 31°. Morphologic analyses based on about 13 scarp profiles suggest a latest Pleistocene to early Holocene time for the youngest fault rupture (Pearthree and others, 1983; Jackson, 1990). Older alluvial scarps have vertical displacements of 3.5 to 5 m, and the oldest alluvial scarps have displacements of 5 to 8.5 m. Older Pleistocene basalts exposed at the mouth of Whitmore Canyon are displaced 23 m (Huntoon, 1977), whereas younger basalt flows (ca. 100 to 200 ka; Holmes and others, 1978) are displaced by 10 to 20 m (Pearthree, unpublished data, 1998).

Age of faulted deposits Paleozoic bedrock; middle to late Pleistocene alluvium and basalt flows, and latest Pleistocene to early Holocene alluvium.

Detailed studies None

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

Comments: This timing estimate (ca. 5-15 ka) is based on morphologic fault-scarp analyses and a rough age estimate of the age of the youngest faulted alluvial deposits based on soil development (Pearthree and others, 1983).

Recurrence interval Not reported

Slip Rate <0.2 mm/yr (50-200 k.y.)

Comments: An estimate of 0.05 to 0.2 mm/yr is based on 5 to 8.5 m of vertical displacement of late Pleistocene (~50-100 ka) alluvium, and 10 to 19 m of vertical displacement of 100-200 ka basalt flows (Pearthree, unpublished data, 1998). Holmes and others (1978) estimated larger vertical displacements for the basalt flows, and obtained vertical strain estimates (equivalent to slip rates as used in this data base) of 0.14 to 0.25 mm/yr.

Length 29 km

Average strike N2W

998D, SOUTHERN HURRICANE SECTION

Comments: This name applies to the most southern part of the Hurricane fault, which extends from the Colorado River to the southern end of the fault near Peach Springs. This section corresponds with the “southern segment” of Menges and Pearthree (1983). It is separated from the Whitmore Canyon section of the fault, which is north of the Colorado River, because of the lack of definitive evidence of late Quaternary faulting on the Southern section.

Reliability of location Good

Comments: Most of this section was mapped at 1:48,000 scale (Wenrich and others, 1986; Billingsley and others, 1986; Billingsley and others, 1990); the trace was transferred to 1:250,000-scale topographic map for digitization.

Sense of movement N

Comments: Based on regional relations and normal displacement of Paleozoic bedrock across the fault zone.

Dip 70° to 55°

Comments: Based on fault exposures in the Grand Canyon and south along the fault as far as the Peach Springs area (Hamblin, 1965).

Dip direction W

Comments: Based on the topographic expression of the fault, stratigraphic relations, and fault exposures in the Grand Canyon (Hamblin, 1965).

Geomorphic expression Faulting has generated a moderately high, steep, embayed, west-facing escarpment on Paleozoic bedrock. Paleozoic units are vertically displaced by as much as 700 m, but the total displacement decreases to the south along the fault. The fault zone has complex geometry, with multiple fault strands along much of this section. The faults typically are located in valleys or canyons along most of this section, and young deposition along the fault is very limited. Available detailed mapping indicates that young surficial deposits are not faulted, although some very dissected, Pliocene-Quaternary deposits near the southern end of the fault may be displaced by a few meters (Billingsley and others, 1990).

Age of faulted deposits Paleozoic, Pliocene-Quaternary

Detailed studies None

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

Comments: Quaternary fault activity is based primarily on the fault's fairly linear escarpment. There is no documented evidence of displacement of Quaternary deposits, but Pliocene-Quaternary deposits may be displaced near the southern end of this section.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Comments: No slip rate estimates have been made for this section. However, on the basis of its distal location and slip rate of the presumedly more active Whitmore Canyon section [999c] to the north, we infer a long-term average slip rate of <0.2 mm/yr.

Length 71 km

Average strike N23E

999, SUNSHINE TRAIL GRABEN AND FAULTS

Data Sources: These faults were mapped by Hamblin and Best (1970); remapped and named by Menges and Pearthree (1983). The geology in the area of the faults was mapped by Billingsley (1992d, 1993a).

Synopsis: The Sunshine Trail graben is a narrow, shallow graben with related normal faults. It is located west of the Hurricane fault [998] on the Shivwitz Plateau, and is one of several fault zones that appear to be subsidiary to the Hurricane fault. Paleozoic rocks are displaced as much as 50 m from the graben shoulders to the valley bottom. The fault escarpments formed on Paleozoic bedrock are linear and moderately steep, with extensive young fan deposition at the bases of the escarpments. Pleistocene terrace gravels and Holocene to upper Pleistocene fan deposits are faulted, but no displacements have been estimated. Younger Holocene fan deposits are not faulted.

Date of compilation 04/16/97

County Mohave

1° x 2° sheet Grand Canyon

Province Colorado Plateau

Geologic setting These fault set consists of a narrow, shallow graben with related normal faults located west of the Hurricane fault on the Shivwitz Plateau. It is one of several fault sets that appear to be subsidiary to the Hurricane fault zone. Paleozoic rocks are displaced about 50 m or less from the graben shoulders to the valley bottom. Pleistocene terrace gravels and Holocene to Upper Pleistocene fan deposits are faulted, but no displacements have been estimated. Younger Holocene fan deposits are not faulted (Billingsley, 1992, 1993).

Reliability of location Good

Comments: Mapped at 1:24,000-scale, transferred to 1:250,000-scale topographic base map for digitization.

Sense of movement N

Comments: Inferred from topography and regional relations.

Dip Not reported

Dip direction NE, SW, W

Comments: Inferred from topography and regional relations.

Geomorphic expression The faulting is expressed as moderately steep, linear escarpments formed in Paleozoic bedrock, with extensive young fan deposition at the bases of the escarpments. Mapping indicates that alluvium is faulted, but no alluvial fault scarps have been documented.

Age of faulted deposits Paleozoic, Pleistocene, late Pleistocene to Holocene.

Detailed studies None

Timing of most recent paleoevent Late Quaternary (<130 ka)

Comments: Quaternary deposits estimated to be Pleistocene and upper Pleistocene to Holocene in age are faulted, but these age estimates are very rough. Linear, moderately steep graben escarpments also suggest late Quaternary activity. Younger Holocene fan deposits are not faulted.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Length 17 km

Average strike N22W

1000, SUNSHINE FAULTS

Data Sources: Mapped by Hamblin and Best (1970) but mapped and named the "Dutchman Draw graben" by Menges and Pearthree (1983). The geology along the faults was mapped by Billingsley (1992c, 1992e, 1993a). The fault nomenclature used here follows Billingsley, who called the westernmost fault of this set the Sunshine fault.

Synopsis: The Sunshine faults form a narrow, shallow, asymmetric graben with related normal faults located west of the Hurricane fault [998] on the Shivwitz Plateau. These faults are part of a series of fault zones that appear to be subsidiary to the Hurricane fault zone. Paleozoic rocks are displaced as much as 120 m across the western (Sunshine) fault. Linear fault escarpments formed on Paleozoic bedrock range from fairly gentle to moderately steep, with extensive young fan deposition at the bases of the escarpments. Upper Pleistocene to Holocene fan deposits are evidently faulted in a few places; 7.5 m of displacement of these deposits has been estimated at one locality by Billingsley (1993). Younger Holocene fan deposits are not faulted.

Date of compilation 04/16/97

County Mohave

1° x 2° sheet Grand Canyon

Province Colorado Plateau

Geologic setting The Sunshine faults form a narrow, shallow, asymmetric graben with related normal faults on the Shivwitz Plateau west of the Hurricane fault. These faults are part of a series of fault zones that appear to be subsidiary to the Hurricane fault. Paleozoic rocks are displaced up to 120 m across the western (Sunshine) fault. Upper Pleistocene to Holocene fan deposits are evidently faulted in a few places; vertical displacement of 7.5 m has been estimated at one locality (Billingsley, 1993). Younger Holocene fan deposits are not faulted.

Reliability of location Good

Comments: Mapped at 1:24,000-scale; the traces were transferred to 1:250,000-scale topographic base map for digitizaiton.

Sense of movement N

Comments: Inferred from topography and regional relations.

Dip Not reported

Dip direction NE, SW, E, W

Comments: Inferred from topography and regional relations.

Geomorphic expression Faulting has generated gentle to moderately steep, linear escarpments on Paleozoic bedrock, with extensive young fan deposition in the linear trough at the bases of the escarpments; the western escarpment generally is larger and steeper. Alluvial fault scarps exist locally along these faults, but none have been studied in detail.

Age of faulted deposits Paleozoic, Pleistocene, late Pleistocene to Holocene.

Detailed studies None

Timing of most recent paleoevent Late Quaternary (<130 ka)

Comments: Surficial deposits estimated to be Pleistocene and upper Pleistocene to Holocene in age are evidently faulted in a few places, but age estimates are very rough. The steepness and linearity of the graben escarpments also suggest late Quaternary activity. Younger Holocene fan deposits are not faulted.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Length 29 km

Average strike N20W

1001, GYP POCKET GRABEN AND FAULTS

Data Sources: Mapped by Hamblin and Best (1970); remapped and named by Menges and Pearthree (1983). The geology in the area of the faults was mapped by Billingsley (1992a, 1992d).

Synopsis: The Gyp Pocket faults form narrow, shallow, symmetric grabens southwest of a major convex bend of the Hurricane fault zone [998] on the Shivwitz Plateau. They are part of a group of fault zones on the Shivwitz Plateau that appear to be subsidiary to the Hurricane fault zone. Paleozoic rocks are displaced between 25 and 50 m along most of the grabens, but displacement increases to about 110 m near the northern end of these structures. The margins of the grabens are moderately steep, linear escarpments formed on Paleozoic bedrock, and there is extensive young fan deposition at the base of these escarpments. Upper Pleistocene to Holocene fan deposits are evidently faulted in a few places, whereas younger Holocene fan deposits are not faulted.

Date of compilation 04/16/97

County Mohave

1° x 2° sheet Grand Canyon

Province Colorado Plateau

Geologic setting The Gyp Pocket grabens are narrow, shallow, symmetric grabens located southwest of a major convex bend of the Hurricane fault zone [998] on the Shivwitz Plateau. The graben faults and other fault zones in this area appear to be subsidiary to the Hurricane fault zone. Paleozoic rocks are displaced 120 m or less, as measured from the graben shoulders to the valley bottoms

Reliability of location Good

Comments: Faults are mapped at 1:24,000 scale, transferred to 1:250,000-scale topographic map for digitization.

Sense of movement N

Comments: Inferred from topography and regional geologic relations.

Dip Not reported

Dip direction NE, SW, E, W

Comments: Dip directions are inferred from fault trends, topography, and regional relations.

Geomorphic expression The faults are expressed as moderately steep, linear escarpments on Paleozoic bedrock, with extensive young fan deposition at the base of the escarpment. Scarps on alluvium exist locally along these faults, but none have been studied in detail.

Age of faulted deposits Paleozoic, late Pleistocene to Holocene

Comments: Upper Pleistocene to Holocene fan deposits are evidently faulted in a few places (Billingsley, 1992a; 1992b). Younger Holocene fan deposits are not faulted.

Detailed studies None

Timing of most recent paleoevent Late Quaternary (<130 ka)

Comments: Quaternary deposits estimated to be Pleistocene and upper Pleistocene to Holocene in age are evidently faulted in a few places, but these age estimates are very rough. The steepness and linearity of the graben escarpments are consistent with late Quaternary activity. However, younger Holocene fan deposits are not faulted. Holocene and post glacial activity is possible, but has not been demonstrated conclusively.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Comments: No slip rate values have been determined. However, the faults probably have a low rate owing to the lack of large (10 m or bigger) noticeable scarps on deposits of upper Pleistocene age.

Length 12 km

Average strike N20E

1002, MAIN STREET FAULT ZONE

Data Sources: Mapped and named the "Main Street fault" by Hamblin and Best (1970), but later remapped and subdivided into the "Main Street graben" (central part), "Mt. Dellenbaugh" (southernmost part), "Poverty Knoll" (southern part), and "Seegmuller Mtn." (northern part) segments by Menges and Pearthree (1983). No detailed work has been done to justify this level of differentiation, so these "segments" are regrouped in this summary. The geology of most of the fault zone was mapped by Billingsley (1990b, 1992a, 1992e, 1993b).

Synopsis: The Main Street fault zone, located west of the Hurricane fault [998] on the Shivwitz Plateau, includes a narrow, shallow graben, a long, down-to-the-west normal fault, and other related faults. Paleozoic rocks are displaced between 25 and 50 m on the western graben fault, and 50 to 110 m on the eastern graben fault. The eastern fault continues north of the graben, where a Tertiary basalt is displaced 50 to 75 m, and south of the graben, where displacement of Paleozoic rock is about 60 to 80 m and displacement of Pliocene-Quaternary basalt is 6 to 12 m. Fault escarpments formed on Paleozoic bedrock are moderately steep and linear, with extensive young fan deposition at the base of the escarpment. Upper Pleistocene to Holocene fan deposits are faulted in a few places, but the amount of displacement is unknown. Younger Holocene fan deposits are not faulted.

Date of compilation 04/18/97

Compiler and affiliation Philip A. Pearthree, Arizona Geological Survey

State Arizona

County Mohave

1° x 2° sheet Grand Canyon

Province Colorado Plateau

Geologic setting The Main Street fault zone includes a narrow, shallow graben and a down-to-the-west normal fault located west of the Hurricane fault on the Shivwitz Plateau. Paleozoic rocks are displaced between 25 and 50 m on the western graben fault, and 50 to 110 m on the eastern graben fault. The eastern fault continues north of the graben, where a Tertiary basalt is displaced 50 to 75 m, and south of the graben, where displacement of Paleozoic rocks is about 60 to 80 m. Along the southernmost part of the fault zone, Pliocene-Quaternary basalt flows are displaced 6 to 12 m, and upper Pleistocene to Holocene fan deposits are faulted in a few places along the central part of the fault zone.

Reliability of location Good

Comments: Most of the fault zone is mapped 1:24,000; the traces were transferred to 1:250,000-scale topographic base map for digitization.

Sense of movement N

Comments: Inferred from topography and regional relations.

Dip Not reported

Dip direction W, E

Comments: Inferred from topography and regional relations.

Geomorphic expression Faults of the zone form moderately steep, linear escarpments on Paleozoic bedrock, with extensive late Pleistocene and Holocene fan deposition at the base of the escarpments. Upper Pleistocene to Holocene deposits are faulted in a few localities, but no alluvial fault scarps have been investigated in detail along these faults.

Age of faulted deposits Paleozoic, late Pleistocene to Holocene

Detailed studies None

Timing of most recent paleoevent Late Quaternary (<130 ka).

Comments: Quaternary deposits estimated to be Pleistocene and upper Pleistocene to Holocene in age are faulted in a few places, but these age estimates are very rough. The steepness and linearity of the fault escarpments suggest late Quaternary activity. Younger Holocene fan deposits are not faulted.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Length 87 km

Average strike N4E

1003, DUTCHMAN DRAW FAULT

Data Sources: Mapped by Hamblin and Best (1970); remapped and named by Menges and Pearthree (1983). The geology in the area of the faults was mapped by Billingsley (1992c, 1992f).

Synopsis: The Dutchman Draw fault zone is a northeast-trending fault zone in the southernmost St. George basin, in northern Arizona and southern Utah. Bedrock is displaced from 15 to 120 m vertically across the fault; displacement decreases to the northeast. Quaternary basalt (undated, but probably quite old) has been displaced about 100 m. Late Pleistocene alluvial-fan and terrace deposits are faulted in a few places, but displacements have not been estimated. Holocene deposits are not faulted.

Date of compilation 05/06/97

County Mohave

1° x 2° sheet Grand Canyon

Province Basin and Range

Geologic setting The Dutchman Draw is a northeast-trending normal fault near the southern margin of St. George basin. At its southwestern end, it merges with the Washington fault zone [1004]; its northeastern termination is near the Hurricane fault zone [998] in Utah. Paleozoic and Mesozoic bedrock is vertically displaced as much as 120 m across the fault, with displacement decreasing to less than 20 m near the northeastern end of the fault; undated but probably lower Quaternary basalt is displaced as much as 100 m (Billingsley, 1992a,b). Upper Pleistocene fan and terrace deposits are faulted in a few places, but displacements have not been estimated. Younger Holocene fan and stream deposits are not faulted.

Reliability of location Good

Comments: Mapped 1:24,000, transferred to 1:250,000-scale topographic map for digitization.

Sense of movement N

Comments: Inferred from topography and regional geologic relations.

Dip Not reported

Dip direction NW

Comments: inferred from topography and regional relationships

Geomorphic expression Faulting has generated a moderately steep, fairly linear escarpment on Paleozoic bedrock along the southwestern part of the fault. Topographic relief decreases to the northeast, so that near the Hurricane fault [998] the Dutchman Draw fault scarp is low and subdued. Alluvial fault scarps may exist locally along the fault because late Quaternary deposits are mapped as being faulted, but none of the scarps have been studied in detail.

Age of faulted deposits Paleozoic, Mesozoic, early Pleistocene, late Pleistocene.

Detailed studies None

Timing of most recent paleoevent Late Quaternary (<130 ka)

Comments: Quaternary deposits estimated to be late Pleistocene in age are evidently faulted in a few places, but these age estimates are very rough. Younger Holocene fan deposits are not faulted.

Recurrence interval Not reported

Slip Rate < 0.2 mm/yr

Comments: This estimate is based on about 100 m of displacement of lower Quaternary (1 to 2 Ma?) basalt, which yields an average long-term slip rate of 0.05-0.1 mm/yr.

Length 16 km

Average strike N41E

1004, WASHINGTON FAULT ZONE

Data Sources: The Washington fault in Arizona has been studied by Peterson (1983) and Menges and Pearthree (1983). The geology of the fault zone was mapped by Billingsley (1990a; 1990b; 1991a; 1991b; 1992c).

Synopsis: The Washington fault is a long, north- to northeast-trending fault zone with substantial Cenozoic normal displacement that straddles the western margin of the Colorado Plateau province. It extends from the Shivwitz Plateau into the St. George basin in southern Utah. The fault zone has generated two prominent, west-facing bedrock escarpments in the southern St. George basin as a result of several hundred meters of normal displacement. The high, linear escarpments is formed by the two faults and its morphology suggests that this part of the fault zone has been fairly active during the Quaternary. Pleistocene deposits are faulted in a few places, but no definitive evidence of Holocene faulting has been discovered. Farther south, the Washington fault zone forms the westernmost of several grabens that cut the Shivwitz Plateau. The fault zone has a moderately high, west-facing escarpment and a narrow, shallow graben on the plateau; vertical displacement across the fault zone is less than 100 m. Along this part of the fault zone, upper Pleistocene deposits are displaced by a few meters, and Holocene deposits are not faulted.

Date of compilation 04/26/97

County Mohave

1° x 2° sheet Grand Canyon

Province Colorado Plateau, Basin and Range

Geologic setting The north- to northeast-trending Washington fault zone straddles the margin of the Colorado Plateau province in northwestern Arizona. Paleozoic rocks are displaced vertically by several hundred meters across each of the two major fault strands in the southern St. George basin. Tertiary basalt is also displaced by substantial amounts across these fault strands, and upper Quaternary alluvium is displaced several meters (Billingsley, 1990a; 1992). Vertical displacement of Paleozoic rocks is less than about 100 m across the southern section of the fault on the Shivwitz Plateau; upper Pleistocene to Holocene(?) alluvial deposits are displaced by as much as 3 m along this section of the fault.

Number of sections 3

Comments: The Washington fault is divided into 3 sections (northern, Mokaac, and Sullivan Draw) on the basis of structural geometry and geomorphic expression of the fault zone. The northern section encompasses the main Washington fault zone from the pass between Seegmiller and Wolf Hole Mountains north to the Utah border; this section was called the Washington fault by Billingsley. The Mokaac section is subparallel with and northwest of the Washington section in the southern St. George basin. It was called the Mokaac Wash segment by Menges and Pearthree (1983) and the Mokaac fault by Billingsley. It merges with the Washington section about 5 km south of the Utah border. The Sullivan Draw section is farther south on the Shivwitz Plateau, and total displacement across the fault is much less. Along much of this section, there is a companion, east-dipping fault to the west of the Washington fault. Together, they form the Sullivan graben of Billingsley (1991a; 1991b).

1004A, NORTHERN WASHINGTON SECTION

Comments: This section name applies to the main Washington fault from the pass between Seegmiller and Wolf Hole Mountains north to the Utah border. The fault continues several kilometers north of the border in Utah, through the town of Washington, Utah.

Reliability of location Good

Comments: Mapped at 1:24,000 scale; the traces were transferred to 1:250,000-scale topographic base map for digitization.

Sense of movement N

Comments: Based on regional relations and normal displacement of bedrock and alluvium across the fault zone.

Dip Not reported

Dip direction NW, W

Comments: Based on topographic expression of the fault and structural relations.

Geomorphic expression Faulting has generated moderately high, steep, west- to northwest-facing escarpments on resistant Paleozoic bedrock. Escarpment height decreases dramatically toward the Utah border, where less resistant Mesozoic bedrock is exposed in the footwall. Upper Quaternary alluvium is displaced several meters (Billingsley, 1990a; 1992), but no detailed analysis of fault-scarp morphology has been made. Upper Quaternary talus and landslide deposits are probably faulted near the northern end of this section.

Age of faulted deposits Paleozoic, Mesozoic, Tertiary, late Pleistocene

Detailed studies None

Timing of most recent paleoevent: Late Quaternary (<130 ka)

Comments: This timing is based on the estimated age of faulted alluvium.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Length 21 km

Average strike N27E

1004B, MOKAAC SECTION

Comments: This name applies to the northwestern strand of the Washington fault zone in the southern St. George basin. This strand was called the Mokaac fault by Billingsley and the Mokaac Wash fault by Menges and Pearthree. It merges with the main Washington fault [1004a] about 5 km south of the Utah border.

Reliability of location Good

Comments: Mapped at 1:24,000 scale; the traces were transferred to 1:250,000-scale topographic base map for digitization.

Sense of movement N

Comments: Based on regional relations and normal displacement of bedrock and alluvium across the fault zone.

Dip Not reported

Dip direction NW

Comments: Based on topographic expression of the fault and structural relations.

Geomorphic expression Faulting has generated a moderately high, steep, linear, northwest-facing escarpment on Paleozoic bedrock in the southern St. George basin. Upper Quaternary talus and landslide deposits are probably faulted near the northern end of this section. Alluvial scarps have been documented along the southern part of this section; a late Pleistocene age of youngest rupture is suggested (Pearthree and others, 1983) on the basis of morphologic analysis of a single scarp profile.

Age of faulted deposits Paleozoic, Mesozoic, late Pleistocene

Detailed studies None

Timing of most recent paleoevent: Late Quaternary (<130 ka)

Comments: Based on the estimated age of faulted alluvium and one scarp profile.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr.

Length 11 km

Average strike N39E

1004C, SULLIVAN DRAW SECTION

Comments: This section name applies to the part of the Washington fault on the Shivwitz Plateau south of the pass between Seegmiller and Wolf Hole Mountains. This section includes the main Washington fault zone and east-dipping faults that form the western margin of the Sullivan graben.

Reliability of location Good

Comments: Mapped at 1:24,000 scale; the traces were transferred to 1:250,000-scale topographic base map for digitization.

Sense of movement N

Comments: Based on regional relations and normal displacement of bedrock and alluvium across the fault zone.

Dip Not reported

Dip direction W, E

Comments: Based on the topographic expression of faulting and structural relations; the main fault zone dips west and antithetic faults dip east

Geomorphic expression Faulting is expressed as a moderately high, fairly steep, curvilinear, west-facing escarpment and a lower, east-facing scarp formed in Paleozoic bedrock on the Shivwitz Plateau. Low alluvial fault scarps (displacements of 3 m or less) have been mapped in several places along this segment, but their morphologies have not been documented.

Age of faulted deposits Paleozoic, late Pleistocene

Detailed studies None

Timing of most recent paleoevent: Late Quaternary (<130 ka)

Comments: Based on the estimated age of displaced deposits.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr.

Length 35 km

Average strike N3W

1005, GRAND WASH FAULT ZONE

Data Sources: Mapped by Lucchitta (1966); also mapped and investigated by Pearthree (unpublished data, 1991) and Menges and Pearthree (1983).

Synopsis: The Grand Wash fault zone is a major normal fault that forms the boundary between the Colorado Plateau and Basin and Range provinces at this latitude. Thousands of meters of down-to-the-west Cenozoic displacement across this fault zone has formed a deep structural trough, but nearly all of this displacement occurred during the Miocene. Quaternary displacement is restricted to the part of the fault zone that is north of the Colorado River and is on the order of a few meters to perhaps a few tens of meters. Along this part of the fault zone, lower to upper(?) Pleistocene fan deposits and alluvial surfaces are displaced, whereas Holocene deposits are unfaulted. Morphologic analyses of fault scarp based on 14 scarp profiles suggest a late Pleistocene age of youngest movement.

Date of compilation 04/25/97

County Mohave

1° x 2° sheet Grand Canyon

Province Basin and Range

Comments: The Grand Wash fault is just west of the base of the Grand Wash Cliffs, which are the boundary between the Colorado Plateau and Basin and Range provinces at this latitude.

Geologic setting The Grand Wash fault is a major a down-to-the-west normal fault located in the Grand Wash trough, along the western edge of the Shivwitz Plateau. Paleozoic rocks are displaced between 3000 and 5000 m across the fault zone near the Colorado River. A substantial thickness of basin-fill deposits (Muddy Creek Formation, at least 600 m thick) accumulated in the Grand Wash trough as a result of faulting during the middle to late Miocene (Lucchitta, 1966; 1987).

Reliability of location Moderate

Comments: Mapped on 1:130,000-scale aerial photos, transferred to 1:250,000-scale topographic map for digitization.

Sense of movement N

Comments: Inferred from topography and stratigraphic displacement.

Dip Not reported

Dip direction W

Comments: Inferred from topography and stratigraphic displacement.

Geomorphic expression Faulting has generated the high (500 m), steep, embayed Lower Grand Wash Cliffs, which are formed on Paleozoic bedrock. The sinuosity of the cliffs indicates that substantial erosional retreat from the more linear trace of the fault zone has occurred, which in turn implies that the Pliocene-Quaternary fault slip has been low. Fault scarps have been documented in lower to upper(?) Pleistocene alluvial-fan deposits. These scarps range in height from about 1 to 15 m and they have maximum slope angles of 4°-27°. The estimated time of the youngest surface rupturing is late Pleistocene (Pearthree and others, 1983) and is based on 14 scarp profiles.

Age of faulted deposits Paleozoic, early Pleistocene, and middle to late Pleistocene

Comments: Lower to upper(?) Pleistocene deposits are displaced by as much as 10-15 m along the the fault zone well north of the Colorado River. No evidence of Quaternary activity on the fault zone near the Colorado River and farther south has been reported.

Detailed studies None

Timing of most recent paleoevent Late Quaternary (<130 ka)

Comments: Quaternary deposits ranging in age from early to late(?) Pleistocene are faulted. Scarp morphologies suggest a late Pleistocene time of youngest rupture. Holocene alluvial-fan deposits are not faulted.

Recurrence interval Not reported

Slip Rate <0.2 mm/yr

Comments: Lower to middle Quaternary alluvial surfaces are displaced by less than 15 m, which yields an average long term slip rate of 0.01-0.03 mm/yr. (15 m in 0.5 to 1.5 m.y.)

Length 35 km

Average strike N9E

1006, WHEELER FAULT ZONE AND GRABEN

Data Sources: Fault zone mapped and investigated by Lucchitta (1966; 1987); the subsidiary Wheeler graben was investigated by Menges and Pearthree (1983). The reconnaissance fault mapping by Dohrenwend and others (1991) covers the southwestern end of the fault.

Synopsis: The Wheeler fault zone, located west of the Grand Wash fault [1005] in the Grand Wash trough, includes a major NNE-trending, down-to-the-west normal fault, and a related north-trending graben. Plio-Quaternary alluvium is displaced about 10-15 m in the Wheeler graben, suggesting that some Quaternary activity has occurred, but the resultant scarps are quite gentle implying that they are fairly old. The fault zone as described by Lucchitta (1966) continues south of Wheeler Ridge along the west side of Grapevine Mesa. The mountain front along this section of the fault is quite linear, but no evidence of Quaternary activity has been reported.

Date of compilation 04/23/97

County Mohave

1° x 2° sheet Grand Canyon, Las Vegas

Province Basin and Range

Comments: The fault zone is in the Great Basin subprovince (north of the Colorado River) and the Sonoran Desert subprovince (south of the Colorado River). It is also very close to the Basin and Range/Colorado Plateau boundary as shown by Thelin and Pike (1991).

Geologic setting The Wheeler fault zone is a NNE-trending, down-to-the-west normal fault with a subsidiary, north-trending graben near its northern end. The fault zone is located west of the Grand Wash fault. The northern part of the fault zone bounds the west side of Wheeler Ridge, which is composed of Paleozoic rocks. Paleozoic rocks are displaced between 1500 and 3500 m in the Wheeler Ridge area, and late Miocene deposits are displaced about 300 m (Lucchitta, 1966). Plio-Quaternary alluvium is displaced about 10-15 m in the Wheeler graben, which appears to be subsidiary to the northern Wheeler fault zone. Displacement decreases to the north, where the fault becomes a monocline and dies out in the Grand Wash trough. No evidence of Quaternary activity has been reported for the southern part of the fault zone, which bounds the west side of Grapevine Mesa.

Reliability of location Moderate

Comments: The fault zone was mapped on 1:130,000-scale aerial photos, transferred to 1:250,000-scale topographic base map for digitization.

Sense of movement N

Comments: Inferred from topography and structural relations.

Dip 60°

Comments: Dip measurement from Lucchitta (1987).

Dip direction W

Comments: As determined from several exposures of fault planes.

Geomorphic expression The Wheeler fault is associated with a steep, linear bedrock escarpment on the west side of Wheeler Ridge. The Wheeler graben is expressed as relatively low alluvial fault scarps on upper Pliocene to middle Pleistocene alluvium. These scarps range in height from about 4 to 12 m and have maximum slope angles of 7° to 16° respectively. Morphologic analyses of these scarps suggest a middle to late Pleistocene age of youngest faulting (Pearthree and others, 1983).

Age of faulted deposits Paleozoic, Miocene, late Pliocene to middle Pleistocene

Detailed studies None

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

Comments: Deposits roughly estimated to be Pliocene-Pleistocene in age are displaced along the main fault zone. The steepness and linearity of the fault escarpment along Wheeler Ridge is consistent with Quaternary activity. Alluvial scarps associated with the Wheeler graben are readily recognizable but are subdued, so the fault zone likely has been active since 750 ka but may not have been active during the late Quaternary.

Recurrence interval Not reported

Slip Rate <0.02 mm/yr

Comments: Plio-Pleistocene deposits are displaced by about 10 to 15 m across the Wheeler graben. This implies a long-term slip rate of <0.01 mm/yr.

Length 46 km

Average strike N22E

1007, MESQUITE FAULT

Data Sources: Mapped and named the "Piedmont fault" by Moore (1972). The tectonic geomorphology of the fault zone was investigated by Mayer (1982) who named it the Mesquite fault scarp. The geology of most of the fault zone was mapped by Billingsley (1995) and Billingsley and Bohannon (1995); and Dohrenwend and others (1991) conducted reconnaissance mapping of the western end of the fault.

Synopsis: The Mesquite fault displaces middle and upper(?) Pleistocene alluvial-fan deposits on the piedmont west of the Virgin Mountains along the southeastern margin of the Virgin River depression. Early to middle Pleistocene alluvial-fan surfaces are displaced as much as 18 m, and late Pleistocene fan surfaces are displaced as much as 4 m. However, Holocene and some upper Pleistocene fan deposits are not faulted. Morphologic analyses of the fault scarps indicate a late Pleistocene time for the youngest fault rupture.

Date of compilation 05/07/97

County Mohave

1° x 2° sheet Grand Canyon

Province Basin and Range

Geologic setting The Mesquite fault displaces middle and upper(?) Pleistocene alluvial-fan deposits on the piedmont west of the Virgin Mountains along the southeastern margin of the Virgin River depression.

Reliability of location Good

Comments: The fault zone is mapped at 1:24,000-scale; the trace was transferred to 1:250,000-scale map

Sense of movement N

Comments: Inferred from topography and regional relationships

Dip Not reported

Dip direction NW, W

Comments: inferred from topography and regional relationships

Geomorphic expression Quaternary faulting has generated low to moderately high, moderately steep fault scarps in alluvial fan deposits on the western piedmont of the Virgin Mountains. Scarps are up to 1 km downslope from the topographic mountain front. Scarps range in height from about 4 to 30 m, with maximum slopes of 15° to 30°. Morphologic analyses of the fault scarps indicate a late Pleistocene age of youngest fault rupture (Mayer, 1982).

Age of faulted deposits Early to middle Pleistocene, late Pleistocene.

Comments: Lower to middle Pleistocene alluvial-fan surfaces are vertically displaced by as much as 18 m (Billingsley and Bohannon, 1995), whereas upper(?) Pleistocene fan surfaces are displaced by about 2-4 m (estimate of Mayer, 1982). Holocene and some upper Pleistocene fan deposits are not faulted.

Detailed studies None

Timing of most recent paleoevent Late Quaternary (<130 ka)

Comments: Morphologic analyses of fault scarps by Mayer (1982) imply a late Pleistocene time for the youngest rupture. Quaternary deposits estimated to be upper Pleistocene are faulted. Some upper Pleistocene and all Holocene deposits are not faulted.

Recurrence interval Not reported

Slip Rate <0.2 mm/yr

Comments: Average slip rates of 0.01 to 0.05 mm/yr are estimated from 2-4 m of displacement of upper(?) Pleistocene deposits (~100 to 200 ka) and 18 m of displacement of lower to middle Pleistocene deposits (~500 ka to 1.0 Ma).

Length 36 km

Average strike N28E

1008, LITTLEFIELD MESA FAULTS

Data Sources: Mapped and named by Menges and Pearthree (1983); geology of most of the fault zone mapped by Billingsley (1995) and Billingsley and Bohannon (1995). Reconnaissance fault mapping of the western part of the zone is by Dohrenwend and others (1991) modified by unpublished field data from Pearthree (1997).

Synopsis: The numerous, short, generally north-trending intrabasin faults cut high, old basin-floor sediments and high, old river deposits in the Virgin River depression west and north of the town of Littlefield, Arizona. This set of faults vary from northwest to northeast in strike. Upper Pliocene to middle Pleistocene basin-floor deposits and river gravels are displaced less than 10 m across most of the faults, but a few faults have displacements as large as 36 m. The maximum slope angles on the scarps are quite gentle. Conversely, upper Pleistocene and Holocene fan and terrace deposits are not faulted. As a whole, these faults have been active during the middle to late Quaternary, but how individual faults might interact in large earthquakes is unknown.

Date of compilation 05/07/97

County Mohave

1° x 2° sheet Grand Canyon

Province Basin and Range

Geologic setting The generally north-trending Littlefield Mesa faults cut high, old basin-floor sediments and old river gravels west and north of the town of Littlefield, Arizona. This set of faults includes many short faults whose trends vary from northwest to northeast. The Pliocene to middle Pleistocene basin-floor deposits are displaced less than 10 m across most of the faults, but a few faults have displacements as large as 36 m (Billingsley, 1995). Upper Pleistocene and Holocene fan and terrace deposits are not faulted.

Reliability of location Good

Comments: Most of the fault zone is mapped 1:24,000; the traces were transferred to a 1:250,000-scale topographic base map for digitization.

Sense of movement N

Comments: Inferred from topography and regional relations.

Dip Not reported

Dip direction W, E

Comments: Dip directions are inferred from topography, regional relations, and a few stratigraphic exposures.

Geomorphic expression Faulting has generated low to moderately high fault scarps on the carbonate-cemented relict basin-floor deposits. These intrabasin scarps are located in the axial part of the Virgin River depression, well away from the nearest mountain ranges. Limited field observations indicate maximum scarp slopes of about 7° on roughly 2-m-high scarps, and as much as 10° on larger scarps (Pearthree, unpublished field data, 1997).

Age of faulted deposits Pliocene-Pleistocene, early to middle Pleistocene.

Detailed studies None

Timing of most recent paleoevent Middle to late Quaternary (<750 ka)

Comments: Pliocene-Pleistocene to middle Pleistocene deposits and alluvial surfaces are displaced by substantial amounts along some of these faults, so early to middle Quaternary faulting is highly probable. Younger deposits are not extensive along these faults, but locally Holocene to upper Pleistocene deposits are not faulted. Scarps are readily recognizable in the field; limited morphologic observations indicate that late Quaternary fault activity is possible and middle to late Quaternary activity is very likely.

Recurrence interval Not reported

Slip Rate <0.2 mm/yr (1 m.y.)

Comments: A rough long-term estimate of 0.04 mm/yr or less is based on as much as 36 m of vertical displacement of Plio-Pleistocene deposits and alluvial surfaces across individual faults during the past million years. Most faults have substantially less Quaternary displacement. Slip rate for the whole fault zone is undetermined, and how individual faults might interact in large earthquakes is unknown.

Length 21 km

Average strike N1W

1009, MEAD SLOPE FAULT

Data Sources: Mapped and named the Mead Slope fault by Longwell (1936; 1963); detailed mapping and investigations were conducted by Anderson and O'Connell (1993).

Synopsis: The Mead Slope fault is a very high angle fault with reverse and probably left-lateral strike-slip components of movement. It cuts lower and uppermost Quaternary deposits on the piedmont below Fortication Hill on the eastern side of Lake Mead, and evidently continues some distance to the northeast beneath Lake Mead. Oblique slip on the fault is suggested by the surface expression of faulting on the Quaternary fan surfaces, which is primarily linear troughs with minimal net vertical displacement. In addition, several other northeast-trending faults in the Lake Mead region have substantial late Cenozoic left-lateral displacement. Late Cenozoic basin deposits are displaced at least 70 m vertically across the Mead Slope fault, but there is no basis for estimating the long-term slip rate or recurrence intervals. The youngest faulting event occurred in the late Pleistocene to early Holocene.

Date of compilation 05/09/97

County Mohave

1° x 2° sheet Las Vegas

Province Basin and Range

Comments: The fault is very close to the boundary between subprovinces of the Basin and Range province.

Geologic setting The Mead Slope fault is a very high angle fault with reverse and probably left-lateral strike-slip components of movement. It is located on the piedmont slope below Fortification Hill, a basalt capped mesa on the eastern side of Lake Mead. The fault evidently continues some distance to the northeast beneath Lake Mead. Oblique slip on the fault is likely, because several other northeast-trending faults in the Lake Mead region have substantial late Cenozoic left-lateral displacement. Late Cenozoic basin deposits are displaced at least 70 m vertically across the Mead Slope fault (Anderson and O'Connell, 1993), and deformation of Pleistocene deposits is well documented.

Reliability of location Good to poor

Comments: The on-land portion of the fault zone is mapped at 1:24,000-scale; extension of the fault zone to the northeast is inferred from Longwell (1936); transferred to 1:250,000-scale topographic map.

Sense of movement R, S

Comments: Very high-angle reverse movement is inferred from stratigraphic exposures and the near vertical dip of the fault (Longwell, 1963). Possible left-lateral movement is inferred from the near vertical fault dip, the linearity of the fault trace, variable geomorphic expression of the fault along strike, and regional relationships.

Dip Near vertical

Comments: Determined from fault exposure (Longwell, 1963).

Dip direction SE to vertical

Comments: Inferred from fault exposure (Longwell, 1963) and detailed mapping (Anderson and O'Connell, 1993).

Geomorphic expression Linear troughs and down-to-the-northwest scarps are formed on all Pleistocene to early Holocene alluvial-fan deposits on the piedmont. However, no profiles of alluvial fault scarps have been surveyed.

Age of faulted deposits Miocene, early to middle Pleistocene, late Pleistocene to early Holocene

Comments: Age estimates for Quaternary deposits are based on soil development and regional correlations.

Detailed studies Detailed studies included surficial geologic mapping of the fault zone and soil descriptions and analyses (Anderson and O'Connell, 1993); no trenching was done.

Timing of most recent paleoevent Holocene to post-glacial (<15 ka)

Comments: Quaternary deposits estimated to be late Pleistocene to early Holocene in age are faulted, so the youngest event is likely to be <15 ka. Late Holocene deposits in channels and low overbank areas are not faulted.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Comments: Lower Pleistocene and uppermost Pleistocene to early Holocene deposits are faulted, but the amount of vertical displacement of these deposits generally is minimal and no quantitative estimates of strike-slip offset have been made (Anderson and O'Connell, 1993). Nevertheless, the fault is probably in the <0.2 mm/yr category on the basis of slip rates on other Quaternary faults in the region. Further study of offset features is needed to calculate slip rates

Length 7 km

Average strike N43E

1010, DETRITAL VALLEY FAULTS

Data Sources: Mapped and named by Menges and Pearthree (1983); additional information from reconnaissance investigation by Anderson and O'Connell (1994) and unpublished field studies of Pearthree (1997)

Synopsis: The Detrital Valley faults likely displace lower to middle Pleistocene alluvium along the west side of Detrital Valley, 1-2 km downslope from the topographic front of the Black Mountains. The east-facing fault scarps are discontinuous, mature, and poorly preserved; field measurements indicate they are several meters high or less and have maximum slopes of 5° or less. Middle to upper Pleistocene deposits are not faulted, implying no late Quaternary faulting.

Date of compilation 5/10/97

County Mohave

1° x 2° sheet Las Vegas

Province Basin and Range

Geologic setting The Detrital Valley faults are along the northwest side of Detrital Valley, east of the Black Mountains. Northern Detrital Valley is a relatively shallow structural basin, with several hundred meters of late Cenozoic basin fill.

Reliability of location Good

Comments: Trace mapped on 1:60,000-scale aerial photographs; transferred to 1:250,000-scale topogaphic map.

Sense of movement N

Comments: Sense inferred from topographic expression and regional relationships

Dip Not reported

Dip direction E

Comments: Dip direction inferred from regional relationships

Geomorphic expression Fault forms low, gentle (mature), east-facing scarps on lower to middle Pleistocene alluvial fan deposits. These scarps are sinuous, discontinuous, and poorly preserved. They are several meters high or less, and have maximum slopes of 5° or less. The piedmont fault scarps are about 1-2 km downslope from the topographic front of the Black Mountains. No profiles of alluvial fault scarps have been surveyed. Quaternary deposits that are probably faulted have strong petrocalcic horizons developed in them; the oldest unfaulted deposits have strong, darkly varnished desert pavements suggestive of middle to upper Pleistocene age.

Age of faulted deposits Early to middle Pleistocene.

Detailed studies None

Timing of most recent paleoevent Middle or late Quaternary (<750 ka)

Comments: Quaternary deposits estimated to be early to middle Pleistocene in age are faulted, whereas probable middle to late Pleistocene deposits are not faulted. Anderson and O'Connell (1993) concluded that there was no evidence for late Quaternary faulting.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr

Comments: A slip rate of < 0.01 mm/yr is estimated on the basis of about 2 m of vertical displacement in the past 750 k.y.

Length 10 km

Average strike N7E

1011, NEEDLES GRABEN FAULTS

Data Sources: Originally identified by Metzger and Loeltz (1973); also reported by Bechtold and others (1973). Mapped, named, and investigated further by Purcell and Miller (1980); investigated by Menges and Pearthree (1983), Pearthree and others (1983), and Anderson and O'Connell (1993).

Synopsis: The Needles graben faults are located along the west side of the Black Mountains, which are on the east side of the Mohave Valley along the Colorado River in the Basin and Range province of west-central Arizona. The small, shallow, short, asymmetric graben is formed on Quaternary alluvium. Maximum surface displacement of lower to middle Pleistocene alluvium across the main eastern fault is about 4 m. Middle to upper Pleistocene alluvium is displaced less than 2 m, and upper Pleistocene alluvium is not faulted. Analysis of fault scarp morphology suggests a late Pleistocene age for the youngest faulting event.

Date of compilation 2/03/98

County Mohave

1° x 2° sheet Needles

Province Basin and Range

Reliability of location Moderate

Comments: Trace mapped on 1:130,000-scale aerial photographs, transferred to 1:250,000-scale topographic base.

Geologic setting The Needles Graben is located in the Basin and Range province of west-central Arizona. It is west of the Black Mountains, on the east side of the Mohave Valley along the Colorado River. The graben faults displace Quaternary alluvium that probably ranges in age from early Pleistocene to middle to late Pleistocene.

Sense of movement N

Comments: Inferred from surface displacement and regional geologic relations.

Dip Not reported

Dip direction SE, NW

Geomorphic expression Faulting has generated a fairly low, gentle southwest-facing piedmont fault scarp, and smaller northeast-facing scarps. A shallow, narrow trough has formed between the scarps. Fault scarps on early Pleistocene alluvial fans on the east side of the graben are as much as 6 m high, whereas they are less than 2 m high on an adjacent middle to late Pleistocene alluvial fan.

Age of faulted deposits Early Pleistocene, middle to late Pleistocene

Comments: Age estimates are based on soil development and surficial characteristics of the deposits.

Detailed studies None

Timing of most recent paleoevent: Late Quaternary (<130 ka)

Comments: Middle to upper Pleistocene deposits are faulted but Holocene to some upper Pleistocene deposits are not faulted. Analysis of scarp morphology (based on 14 scarp profiles) suggested a late Pleistocene age of youngest faulting (Pearthree and others, 1983).

Recurrence interval Not reported

Slip Rate < 0.02 mm/yr

Comments: A slip rate of < 0.01 mm/yr is estimated on the basis of about 4 m of vertical displacement in the middle and late Quaternary (about the past 500 k.y.).

Length 4 km

Average strike N27W

1012, UINKARET VOLCANIC FIELD FAULTS

Data Sources: Mapped by Hamblin and Best (1970); remapped and named by Menges and Pearthree (1983). The geology of the northern part of the fault zone was mapped by Billingsley (1994).

Synopsis: The Uinkaret volcanic field faults are a series of northwest- to NNW-trending normal faults that diverge eastward from the Hurricane fault on the Uinkaret Plateau. Vertical displacements of Paleozoic rocks across individual faults range from a few meters to as much as 40 m, and undated but probable Pleistocene age basalt flows of the Uinkaret volcanic field are displaced about 20 m (Menges and Pearthree, 1983). Fault escarpments are moderately steep and linear. Quaternary deposits are scarce along the fault zone, and Holocene deposits are not faulted.

Date of compilation 01/28/98

County Mohave

1° x 2° sheet Grand Canyon

Province Colorado Plateau

Geologic setting This series of NNW-trending normal faults east of the Hurricane fault on the Uinkaret Plateau. At the northern end of this fault zone, it diverges from the SSW-trending Hurricane fault zone [998], so these faults may be subsidiary to the Hurricane fault. Vertical displacements of Paleozoic rocks across individual faults range from a few meters to as much as 40 m. These faults also displace undated, but probably Pleistocene basalt flows of the Uinkaret volcanic field by about 20 m (Menges and Pearthree, 1983). Quaternary deposits are scarce along the fault zone, but Holocene deposits are not faulted.

Reliability of location Good to moderate

Comments: The northern part of the fault zone is mapped at 1:24,000 scale, the southern part of the fault zone was mapped on 1:130,000-scale aerial photos; these traces were transferred to a 1:250,000-scale topographic base map for digitization.

Sense of movement N

Comments: Inferred from topography and regional relations.

Dip Not reported

Dip direction NE, SW

Comments: Dip directions are inferred from fault trends, topography, and regional relations.

Geomorphic expression Moderately steep, linear escarpments are formed on Paleozoic bedrock and Pleistocene basalt. There has been little young deposition along the faults, and no alluvial fault scarps have been recognized.

Age of faulted deposits Paleozoic, Pleistocene

Detailed studies None

Timing of most recent paleoevent Quaternary (<1.6 Ma)

Comments: Basalt flows of probable Pleistocene age are displaced, but they have not been dated. Fault escarpments are moderately steep and linear, which is consistent Quaternary activity. Holocene deposits are not faulted.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Length 19 km

Average strike N21W

1013, ANDRUS CANYON FAULT

Data Sources: Mapped, described, and named the "subsidiary fault" by Huntoon (1977); geology mapped by Huntoon and others (1981); renamed the Andrus Canyon fault by Menges and Pearthree (1983) for its proximity to Andrus Canyon.

Synopsis: The Andrus Canyon fault is a short, north-trending, down-to-the-west normal fault on the western Colorado Plateau, just north of the Grand Canyon. There is substantial vertical displacement of Paleozoic rocks across the fault and late Quaternary sediments have been deposited locally along the fault. Although Holocene or late Quaternary activity has been inferred for this fault by some workers, no definitive evidence of faulting of Quaternary deposits has been documented.

Date of compilation 01/28/98

County Mohave

1° x 2° sheet Grand Canyon

Province Colorado Plateau

Geologic setting The Andrus Canyon fault is a short, north-trending, down-to-the-west normal fault near the southern end of the Shivwits Plateau, just north of the Grand Canyon. There is substantial vertical displacement of Paleozoic rocks across the fault.

Reliability of location Good

Comments: Mapped at 1:48,000 scale by Billingsley and others (1981), transferred to 1:250,000-scale map for digitization.

Sense of movement N

Comments: Inferred from topography and regional geologic relations.

Dip Not reported

Dip direction W

Comments: Dip direction is inferred from topography and stratigraphic relations.

Geomorphic expression A moderately steep, linear escarpment is formed on Paleozoic bedrock. Locally, young deposition has occurred along the fault, but no alluvial fault scarps have been documented.

Age of faulted deposits Paleozoic (bedrock); no reported deformation of Quaternary deposits.

Detailed studies None

Timing of most recent paleoevent Quaternary (<1.6 Ma)

Comments: Holocene activity on this fault was implied by Huntoon (1977). This implication was disputed by Anderson and this difference in opinion was acknowledged by Huntoon (in Anderson and Huntoon, 1979). The fault escarpment is moderately steep and linear, and local young deposition at the base of the escarpment is consistent with Quaternary fault activity, but there is no definitive evidence of late Quaternary activity.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Comments: No slip rate has been reported owing to a lack of clear Quaternary offset.

Length 6 km

Average strike N1W

1014, CONCHO FAULT

Data Sources: Mapped and named by Crumpler and others (1994). A subsidiary fault along the northern part of the fault zone was mapped and grouped with a few faults of the Vernon [1016] and Coyote Wash [1015] faults; this group was called the "St. Johns fault set" by Menges and Pearthree (1983).

Synopsis: The Concho fault is a generally northwest-trending, discontinuous system of probable sinistral and oblique-normal slip faults that cuts the northeastern part of the Pliocene-Pleistocene Springerville volcanic field in east-central Arizona. The faults are on the erosion surface cut on Mesozoic rocks that slopes northeast from the Colorado Plateau margin to the Little Colorado River. Faults displace Mesozoic bedrock and upper Pliocene to lower Pleistocene basalt flows in a down-to-the-northeast sense. Sinistral slip is inferred for the central part of the fault where there is minimal topographic relief; conversely, oblique normal and sinistral slip is inferred for the southern part of the fault. An early Pleistocene cinder cone has been displaced vertically about 30 m by the fault; along the northern part of the fault, there is a graben with fairly steep sides. The faults have probably been active in the middle or late Quaternary, but the age of youngest movement is not well constrained.

Date of compilation 02/13/98

County Apache

1° x 2° sheet Saint Johns

Province Colorado Plateau

Reliability of location Moderate

Comments: Mapped at 1:250,000-scale on topographic base map.

Geologic setting The Concho fault zone trends generally northwest along the northeastern margin of the Pliocene-Pleistocene Springerville volcanic field in east-central Arizona. The faults are on the Mogollon Slope, an erosion surface cut on Mesozoic rocks that slopes north from the Colorado Plateau margin to the Little Colorado River. Faults cut Pliocene to lower Pleistocene (0.9-1.3 Ma) volcanic rocks and Mesozoic bedrock. Along the northern part of the fault, an early Pleistocene cinder cone is vertically displaced about 30 m in a graben.

Sense of movement N, S

Comments: Oblique normal and left-lateral movement is inferred for this fault on the basis of fault geometry, the narrowness of the zone of deformation, orientations of subsidiary structures, and regional relations. Oblique movement with a strong normal component is inferred for the southern part of the fault, and mainly sinistral slip is inferred for the central part of the fault. The northern end of the fault merges with a east-facing monocline, suggesting local compression there (Crumpler and others, 1994).

Dip Not reported

Dip direction NE

Comments: Inferred from surface displacement; fault trends vary from north to WNW.

Geomorphic expression Faulting is expressed as low to moderately high, fairly subdued, northeast-facing scarps formed Pliocene-Pleistocene basalt flows along the main fault. Throughout the fault zone, the pattern of surface faulting is complex; multiple short fault scarps are common. The slopes of a graben along the northern part of the fault are affected very little by erosion, implying that the fault has been active during the middle or late Quaternary (Crumpler and others, 1994); no morphologic scarp data has been reported. In addition, Pleistocene basalt flows have been tilted and deformed adjacent to the main fault zone and by several subsidiary folds.

Age of faulted deposits Mesozoic, Pliocene, early Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Lower Pleistocene volcanic rocks are displaced; no faulting of alluvium has been documented.

Recurrence interval Not reported

Slip Rate <0.2 mm/yr

Comments: A lower Pleistocene cinder cone (750 ka to 1.6 Ma) has been vertically displaced 30 m. These data yield a minimum long-term slip rate of about 0.02 to 0.04 mm/yr.

Length 39 km

Average strike N37W

1015, COYOTE WASH FAULT

Data Sources: Mapped and named by Crumpler and others (1994). Faults in the northern part of the zone were mapped and grouped with other faults in the "St. Johns fault set" by Menges and Pearthree (1983); part of the southern Coyote Wash fault zone was called the "Coyote Creek fault" by Menges and Pearthree (1983).

Synopsis: The Coyote Wash fault zone is a generally northwest-trending, discontinuous system of probable sinistral and oblique-slip faults that are at the northeastern margin of the Pliocene-Pleistocene Springerville volcanic field in east-central Arizona. The faults are on the erosion surface cut on Mesozoic rocks that slopes northeast from the Colorado Plateau margin to the Little Colorado River. Faults displace Mesozoic bedrock and upper Pliocene to lower Pleistocene basalt flows in a down-to-the-southwest sense. Sinistral slip and sinistral/normal slip are inferred for the fault on the basis of structural characteristics and regional relations. The topographic scarp associated with this fault zone evidently is not sharply defined. The faults have probably been active in the middle or late Quaternary, but the age of youngest movement is not well constrained.

Date of compilation 02/13/98

County Apache

1° x 2° sheet St. Johns

Province Colorado Plateau

Reliability of location Moderate

Comments: Mapped at 1:250,000-scale on topographic base map.

Geologic setting The Coyote Wash fault is a generally northwest-trending, discontinuous system of probable left-lateral and oblique-slip faults that are at the northeastern margin of the Pliocene-Pleistocene Springerville volcanic field in east-central Arizona. The faults are on the Mogollon Slope, an erosion surface cut onto Mesozoic rocks and mantled with Pliocene-Pleistocene volcanic rocks and Miocene to Pliocene sediment. The surface slopes north from the Colorado Plateau margin to the Little Colorado River. Faults cut Pliocene to lower Pleistocene volcanic rocks and Mesozoic bedrock. Amounts of displacement have not been reported. The Coyote Wash fault and the Concho fault zone to the southwest define a ~20-km-wide, northwest-trending structural depression. Small anticlines and synclines in the depression suggest that it has undergone contractional strain.

Sense of movement N, S

Comments: Oblique (sinistral) normal and left-lateral (sinistral) movement is inferred for this fault on the basis of on fault geometry, orientations of subsidiary structures, and regional relations (Crumpler and others, 1994).

Dip Not reported

Dip direction SW

Comments: Inferred from surface displacement; fault trends vary from NNW to northwest.

Geomorphic expression Faulting is expressed as low to moderately high, fairly subdued, southwest-facing scarps formed on Pliocene-Pleistocene basalt flows. The slopes of this scarp have been affected by stream erosion, but no morphologic scarp data has been reported.

Age of faulted deposits Mesozoic, Pliocene, early Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Lower Pleistocene volcanic rocks are displaced by these faults.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Comments: No slip rate data have been reported, but the fault zone likely has a low slip rate owing to the subdued scarps associated with it and the lack of clear late Quaternary offset.

Length 42 km

Average strike N42W

1016, VERNON FAULT ZONE

Data Sources: Mapped and named by Crumpler and others (1994). Some faults at the northern end of the fault zone were mapped but grouped with some other faults of the Concho [1014] and Coyote Wash [1015] fault zones, and labeled the “St. Johns fault set” by Menges and Pearthree (1983). This name is not used herein because of its collective nature. The general geology was mapped by Crumpler and others (1994) and Condit (1991)

Synopsis: The Vernon fault zone is a generally northwest-trending, probable sinistral and oblique-slip system of faults that cuts through the middle of the Pliocene-Pleistocene Springerville volcanic field in east-central Arizona. The faults are on an erosion surface cut on Mesozoic rocks that slopes from the Colorado Plateau margin north to the Little Colorado River. Faults cut Mesozoic bedrock, uppermost Miocene volcanic rocks, and upper Pliocene to lower Pleistocene basalt. Displacement is primarily down to the northeast, and Miocene rocks are displaced substantially more than the lower Pleistocene volcanic rocks. Sinistral slip is inferred for the central part of the fault; this area has a small pull-apart basin and minimal topographic relief across the fault. The faults of the zone have probably been active in the middle or late Quaternary, but the age of youngest movement is not well constrained.

Date of compilation 02/13/98

County Apache

1° x 2° sheet Saint Johns

Province Colorado Plateau

Reliability of location Moderate

Comments: Mapped at 1:250,000-scale on a topographic base map.

Geologic setting The Vernon fault zone trends through the middle of the Pliocene-Quaternary Springerville volcanic field in east-central Arizona. The faults are on the Mogollon Slope, an erosion surface cut on Mesozoic rocks that slopes north from the Colorado Plateau margin to the Little Colorado River. Faults cut uppermost Miocene (~6 Ma) to lower Pleistocene (0.9 to 1.3 Ma) volcanic rocks and Mesozoic bedrock. Amounts of displacement have not been reported.

Sense of movement S, N

Comments: Left-lateral movement is inferred for the central, NNW-trending part of the fault on the basis of fault geometry, the presence of a pull-apart basin at a prominent left-step in the fault, orientations of subsidiary structures, and regional relations. Normal and left-lateral movement is inferred for the northern and southern parts of the fault on the basis of topography across the fault and orientations of subsidiary structures (Crumpler and others, 1994).

Dip Not reported

Dip direction NE

Comments: Inferred from surface displacement; fault trends vary from NNW to WNW.

Geomorphic expression Faulting is expressed as low to moderately high, fairly subdued, northeast-facing scarps formed on Pleistocene to uppermost Miocene basalt flows along the main fault. No morphologic scarp data has been reported. In addition, Pleistocene basalt flows have been tilted and deformed adjacent to the main fault zone and by several subsidiary folds, indicating Quaternary deformation has occurred.

Age of faulted deposits Mesozoic, late Miocene, Pliocene, early Pleistocene.

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Lower Pleistocene volcanic rocks are displaced by these faults. No faulting of alluvium has been documented and the age of youngest movement is not well constrained.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Comments: No slip rate data have been reported, but the fault zone likely has a low slip rate owing to a lack of clear late Quaternary offset.

Length 57 km

Average strike N46W

1017, LUEPP FAULTS

Data Sources: These faults are part of a group that were named by Menges and Pearthree (1983); faults included in this data base are mapped as cutting Quaternary deposits or volcanic rocks, whereas other faults in the Leupp set of Menges and Pearthree (1983) are not included. The geology of the area was mapped by Ulrich and others (1984);

Synopsis: These predominantly northwest-trending normal faults are at the easternmost edge of and beyond the Pliocene-Quaternary San Francisco volcanic field in north-central Arizona. They are on the erosion surface cut on Paleozoic rocks that slopes north from the Colorado Plateau margin to the Little Colorado River. The faults cut Paleozoic and Mesozoic bedrock, locally middle Pleistocene basalt, and Quaternary alluvium. Displacement is primarily down-to-the-northeast or east. The faults have been active in the middle or late Quaternary, but the age of youngest movement is not well constrained.

Date of compilation 02/12/98

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Moderate

Comments: Trace mapped at 1:250,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting The Leupp faults are at the easternmost edge of and beyond the Pliocene-Quaternary San Francisco volcanic field in north-central Arizona. The faults deform the erosion surface cut on Paleozoic rocks that slopes north from the Colorado Plateau margin to the Little Colorado River. These faults cut Paleozoic and Mesozoic bedrock, locally middle Pleistocene basalt, and Quaternary alluvium.

Sense of movement N

Comments: Predominantly normal movement is inferred from topographic relations.

Dip Not reported

Dip direction E, NE, SW

Comments: Dip directions are inferred from surface displacement; fault trends vary from N to WNW.

Geomorphic expression Faulting is expressed as low, fairly subdued scarps formed on Paleozoic and Mesozoic rocks and middle Pleistocene basalt flows. No alluvial fault scarps have been documented.

Age of faulted deposits Paleozoic, middle Pleistocene

Detailed studies None

Timing of most recent paleoevent: Middle and late Quaternary (<750 ka)

Comments: Middle Pleistocene volcanic rocks are displaced by several of the faults of this set. Quaternary alluvium of unspecified age is also mapped as being faulted in several locations.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Comments: No data exist to determine a slip rate, but the <0.2 mm/yr category is inferred on the basis of slip rates on other Quaternary faults in the region.

Length 32 km

Average strike N35W

1018, GRAY MOUNTAIN FAULTS

Data Sources: The name applies to a large number (about 50) generally north- or northwest-trending possible Quaternary faults on Gray Mountain. Some of the faults were mapped and described in general by Barnes (1974). Menges and Pearthree (1983) mapped, grouped together and called them the Gray Mountain fault set. Faults and general geology were mapped by Ulrich and others (1984). This group of faults includes the Burro Canyon graben of Barnes (1974).

Synopsis: Numerous normal faults cut the erosion surface formed on Paleozoic rocks on Gray Mountain, which is on the northeasternmost part of the Coconino Plateau, south of the Grand Canyon. The faults are north of the Pliocene-Quaternary San Francisco volcanic field. Fault trends range from north to west-northwest and they form numerous narrow grabens and other linear depressions. This large set of faults has been grouped together because field investigations of them have been minimal and little is known about their behavior or recency of movement. Pleistocene activity has been inferred for at least some of these faults. Quaternary faulting is suggested by fairly sharply defined scarps associated with some of these faults.

Date of compilation 02/05/97

County Coconino

1° x 2° sheet Flagstaff

Province Colorado Plateau

Reliability of location Moderate

Comments: Trace mapped at 1:250,000 scale; transferred to 1:250,000-scale topographic base map.

Geologic setting These faults are located on an erosion surface cut onto Paleozoic rocks of the Coconino Plateau between the Pliocene-Quaternary San Francisco volcanic field and the Grand Canyon. These faults are on top of Gray Mountain, a topographic prominence that forms the easternmost part of the Coconino Plateau. This relatively high area evidently was uplifted by monoclinal folding during regional compression of the late Cretaceous-early Tertiary Laramide orogeny. Several folds with different orientations come together in this area, creating a complex pattern that may have affected later normal faulting as well (Barnes, 1974). The Gray Mountain faults cut Paleozoic rocks and possibly some Quaternary alluvium, although Quaternary faulting has not been conclusively demonstrated.

Sense of movement N

Comments: Predominantly normal movement inferred from topographic relations.

Dip Not reported

Dip direction E, W, NE, SW

Comments: Dip directions are inferred from surface displacements and regional relationships.

Geomorphic expression Low to fairly high escarpments bound grabens formed on Paleozoic bedrock along the highest part of the Coconino Plateau. Some troughs are quite sharp with fairly steep scarps; others are subtle and weakly defined. The sharp geomorphic expression of some of the grabens and scarps suggests possible Quaternary activity.

Age of faulted deposits Paleozoic, Quaternary(?)

Detailed studies None

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

Comments: Pleistocene activity has been inferred for at least some of these faults (Barnes, 1974). Displacement of Quaternary deposits has not been conclusively demonstrated, but the fairly sharp geomorphic expression of Burro Canyon graben and some of the other faults in this set suggests Quaternary activity.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.2 mm/yr

Comments: No data exist to determine a slip rate, but the <0.2 mm/yr category is inferred on the basis of slip rates on other Quaternary faults in the region.

Length 24 km

Average strike N10W

1019, TINAJAS ALTAS FAULT ZONE

Data Sources: Tucker (1980) refered to the fault as the Tinajas Altas W2 mountain front. The general geology of this area was mapped by Olmsted and others (1973), whereas Biggs and Demsey (unpublished map and report, Arizona Geological Survey, 1998) have conducted detailed surficial geologic mapping along the structure. The fault zone continues from Arizona for several kilometers into northwestern Sonora, Mexico.

Synopsis: The Tinajas Altas fault zone consists of two northwest-trending faults located on the eastern margin of the Yuma Desert, southeast of Yuma in southwesternmost Arizona and Sonora, Mexico. The Tinajas Altas and Gila Mountains form the eastern margin of the northwest-trending Fortuna basin. The Tinajas Altas fault zone bounds parts of the west side of the Tinajas Altas Mountains, and locally the fault zone is within the mountain range. Faulting has produced two very linear, short (<5 km) mountain fronts on the southwest side of the Tinajas Altas Mountains. No scarps or other evidence of deformation of latest Quaternary or younger deposits have been documented. Low bedrock ridges and inselbergs lie between the two fault strands. The presence of knobs of bedrock having similar lithology as the main mountain mass on the west side of the Tinajas Altas fault zone implies that the fault zone may be a very narrow graben. Alternatively, the subparallel orientation of the Tinajas Altas fault zone and San Andreas system suggests that the Tinajas Altas may have accommodated primarily dextral displacement.

Date of compilation 03/04/98

County Yuma

1° x 2° sheet El Centro

Province Basin and Range

Reliability of location Good

Comments: Trace based on detailed unpublished mapping at 1:24,000 scale (Biggs and Demsey, 1998)

Geologic setting The Tinajas Altas fault zone is composed of two northwest-trending faults located southeast of the Algodones fault [944] on the margin of the Yuma Desert. The Tinajas Altas fault zone bounds parts of the west side of the Tinajas Altas Mountains, and locally the fault zone is within the range. The Yuma Desert is a broad plain between the Gila Mountains and the lowermost Colorado River; it is covered with locally-derived alluvium, deposits of the Colorado River, and eolian deposits. In the subsurface, the Yuma Desert consists of two separate, deep sedimentary basins. The Tinajas Altas and Gila Mountains form the eastern margin of the approximately 2000-m-deep Fortuna basin, the easternmost of the two basins (Olmsted and others, 1973).

Sense of movement N, D(?)

Comments: The presence of bedrock of similar lithology as the main mountain mass on the west side of the Tinajas Altas fault zone implies that normal displacement across the fault is not great, or that the fault zone is a very narrow graben (Tucker, 1980). Alternatively, the orientation of the Tinajas Altas fault zone subparallel with the San Andreas system suggests that it may have accommodated primarily dextral displacement (P.K. Knuepfer, oral commun., 1981).

Dip Not reported

Dip direction Not reported

Geomorphic expression Faulting is expressed as two very linear, steep, fairly low and short (< 5 km) mountain fronts on the southwest side of the Tinajas Altas Mountains. The mountain front becomes more embayed and sinuous to the northwest, suggesting less fault activity. Low bedrock ridges and inselbergs lie between the two fault strands. Based on the striking linearity of the mountain fronts, Tucker (1980) inferred possible Holocene faulting. However, recent detailed surficial geologic mapping of the area by Biggs and Demsey (1998) indicates that uppermost Pleistocene and younger deposits are not faulted. No scarps or other evidence of deformation of Quaternary deposits has been documented.

Age of faulted deposits Early Tertiary to late Cretaceous

Comments: Estimated age of deformed bedrock, which consists of granitic rocks of the Tinajas Altas Mountain. No evidence of deformation of Quaternary deposits has been documented.

Detailed studies None

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

Comments: No definitive evidence of faulting of Quaternary deposits has been found. All of the alluvium along the fault zone is quite young, probably uppermost Pleistocene and younger and thus stratigraphic evidence of Quaternary movement may be obscured by sedimentation. The fault has not ruptured during the latest Pleistocene or Holocene, but the striking linearity of the mountain fronts suggests that Quaternary fault activity is fairly likely.

Recurrence interval Not reported

Slip Rate No data

Length 7 km

Average strike N38W

1020, COTTONWOOD BASIN FAULT

Data Sources: Part of the fault was mapped by Twenter and Metzger (1963); detailed surficial geology was mapped by House (1994). The name Cottonwood Basin fault is applied herein.

Synopsis: The Cottonwood Basin fault is a fairly minor fault located in the Verde Valley in the Central Highlands portion of the Basin and Range province. It is on the northwest side of the southernmost Verde Valley, opposite the Verde fault zone [948]. Most of the displacement on the Verde fault zone and subsidence of the Verde Valley occurred during the late Miocene and Pliocene (Bressler and Butler, 1978; Nations and others, 1981). The Cottonwood Basin fault displaces Tertiary volcanic rocks. Lower Pleistocene terrace deposits are displaced several meters vertically. Faulting is expressed as low, subdued, southwest-facing scarps on Tertiary volcanic rocks and on an early Pleistocene terrace remnant. Middle to late Pleistocene alluvial fans may be faulted by a small amount as well, but there are no clear alluvial scarps formed on these surfaces.

Date of compilation 03/05/98

Compiler and affiliation Philip A. Pearthree, Arizona Geological Survey

State Arizona

County Yavapai

1° x 2° sheet Holbrook

Province Basin and Range

Reliability of location Good

Comments: Trace based on 1:24,000-scale mapping by House (1994), transferred to 1:250,000-scale topographic map.

Geologic setting The Cottonwood Basin fault is located in the Verde Valley in the Central Highlands portion of the Basin and Range province. The Cottonwood Basin fault is a fairly minor fault on the northwest side of the southernmost Verde Valley, a large, asymmetric, southwest-tilted graben. Most of the displacement on the Verde fault [948] and subsidence of Verde Valley occurred during the late Miocene and Pliocene (Bressler and Butler, 1978; Nations and others, 1981) as recorded by displacement of Tertiary volcanic rocks and accumulation of the Verde Formation sediments in Verde Valley. During most of that time, the Verde Valley was a closed, undissected basin. During the Quaternary, the Verde River downcut substantially and the Verde Valley has undergone dramatic dissection, leaving suites of dissected fan and terrace remnants ranging from late Pliocene/early Pleistocene to early Holocene in age (House, 1994).

Sense of movement N

Comments: Inferred from topography and regional relations.

Dip Not reported

Dip direction SW

Comments: Inferred from topography and regional relations.

Geomorphic expression Faulting is expressed as low, subdued, southwest-facing scarps on Tertiary volcanic rocks and on an early Pleistocene terrace remnant. Middle to late Pleistocene alluvial fans may be faulted a small amount, but there are no clear alluvial scarps formed on these surfaces.

Age of faulted deposits Early Pleistocene, middle to late Pleistocene(?)

Comments: Age estimates are based on examination of soil characteristics, the position of alluvial surfaces in the landscape, and regional correlations.

Detailed studies None

Timing of most recent paleoevent Middle or late Quaternary (<750 ka)

Comments: This estimate is based on displacement of lower Pleistocene terrace deposits and possible displacement of middle to upper Pleistocene alluvial-fan deposits.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr

Comments: An estimate of < 0.01 mm/yr is based on 2-3 m of vertical displacement of deposits estimated to be about 1 Ma.

Length 5 km

Average strike N43W

1021, JOE GLENN RANCH FAULTS

Data Sources: Mapped by Lynch (1972). Further described by Menges and Pearthree (1983) and Machette and others (1986). The geology of this area was mapped by Drewes and Brooks (1988).

Synopsis: Two north to northwest-trending faults displace late Pliocene basalt flows and and Pliocene-Quaternary alluvium in the northeastern Pedrogosa Mountains, which lie at the western margin of the San Bernardino Valley in southeasternmost Arizona. There has been as much as 15 to 30 m of displacement of Pliocene-Pleistocene alluvium, but no the age of most recent fault .

Date of compilation 07/27/98

County Cochise

1° x 2° sheet Douglas

Province Basin and Range

Reliability of location Moderate

Comments: Mapped at 1:130,000-scale on aerial photographs, field-checked on a reconnaissance basis, compiled at 1:250,000 on a topographic base by Machette and others (1986).

Geologic setting The fault is on the west side of the San Bernardino Valley, in the northeastern part of the Pedrogosa Mountains. The geometry of the structural basin associated with this valley is complex, but is deepest along the western side of the valley (Lynch, 1978). The Pliocene-Quaternary San Bernardino volcanic field, which has flows ranging from about 3 Ma to 270 ka in age, covers much of the valley. A basalt flow that is displaced by these faults has been dated at 3.3 Ma (Lynch, 1978).

Sense of movement N

Comments: Inferred from topography and displacement of basalt flows.

Dip Not reported

Dip direction E

Comments: Surface displacement is down to the east.

Geomorphic expression Moderately high (15-30 m), gentle scarps are formed on Pliocene-Pleistocene alluvium and Pliocene basalt.

Age of faulted deposits Late Pliocene to early (?) Pleistocene

Comments: A faulted basalt flow has been dated at 3.3 Ma. Ages of deposits are estimated using geomorphic surface characteristics and the topographic position of the deposits in the landscape.

Detailed studies None

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

Comments: Faults displace upper Pliocene basalt and Pliocene-Pleistocene alluvium by 15-30 m. There are no meaningful constraints on the age of youngest fault activity.

Recurrence interval Not reported

Slip Rate Unknown, probably <0.02 mm/yr

Comments: This fault may not have been active in the past 130 k.y. and there has been less than 30 m of vertical displacement in the Quaternary. Thus, the slip rate is probably <0.02 mm/yr.

Length 7 km

Average strike N7W

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