MAP OF NEOTECTONIC (LATEST PLIOCENE-QUATERNARY) DEFORMATION IN ARIZONA

by

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ABG & MT OFR 83-22

EXPLANATORY TEXT

General Scheme

This map presents data and interpretations concerning the distribution, amounts and timing of neotectonic faulting in Arizona. It is one part of a larger study and analysis of the neotectonic framework of Arizona sponsored jointly by the U.S. Geological Survey (under contract 14-08-0001-19861) and the Arizona Bureau of Geology and Mineral Technology. This map is accompanied by the following items:

1. Two reports that discuss the information on the map, one by Phil Pearthree and others and one by Christopher Menges.
2. A 1:500,000 scale map with accompanying Legend entitled "Map of Basin and Range (post 15 m.y.a.) Exposed Faults, Grabens, and Basalt-Dominated Volcanism in Arizona" by Robert Scarborough, Christopher Menges, and Philip Pearthree.
3. References cited list, keyed to areas shown on a small accompanying map. References and map index are combined references for both 1:500,000 scale maps.
4. Two tables containing data and supportive documentation for neotectonic faults on this map. Table 1 lists known or suspected neotectonic faults in Arizona, and contains the names, identification procedures and references for all faults and mountain fronts labeled on the map. Table 2, listing displacement data for selected faults, is found as Table 1 in the Pearthree and others report.

In this study, we have restricted the term "neotectonic" to a latest Pliocene to Quaternary time interval (i.e., post 3-2 MA) in order to include

the youngest faulting and other deformation that we believe is distinct from earlier deformations, on the basis of distribution, displacement ages and amounts and/or association with Pliocene-Quaternary geomorphic surfaces, sediments and volcanic rocks. Although the neotectonic boundary is somewhat aribitrary in some areas, the approach to mapping has been applied as consistently as possible throughout this study.

The primary goal underlying the preparation of this map is the accurate portrayal and documentation of the locations and ages of known or probable neotectonic activity on faults throughout Arizona; thus we have not emphasized the identification and inclusion of the myriads of anomalous scarps and other geomorphic features of possible but uncertain fault origin (see below). To this end, we accurately plotted fault traces, with appropriate structural symbols; and secondly, we directly annotated the fault traces with available estimates on the age and amounts of the most recent, and where known, prior neotectonic displacements. Age estimates are based on offset relationships of geomorphic surfaces and rock units, fault scarp morphology, and tectonic landform analyses of mountain fronts and bedrock escarpments. Refer to the map explanation and accompanying report for further discussion.

Data sources. The primary data source for this map is an original study consisting of systematic statewide photointerpretation of black-and-white high-altitude (U2) aerial photography (nominal scale, 1:125,000), supported by ground and aerial reconnaissance concentrated on the major fault scarps in the state. We have additionally compiled data from relevant published and unpublished sources on neotectonic faulting in Arizona. These sources are included in the reference map for the accompanying Late Cenozoic Tectonic Map of Arizona. Table 1 lists the specific names, type of identification and references for individual faults on the map.

Resolution Limits of photointerpretive identification. The minimum

resolution limits on photointerpretative mapping of individual fault scarps vary widely, depending on the photo-image quality, illumination angle and direction, and such scarp characteristics as length, continuity, relief, slope angle, landscape position, and contrast with background. However, most features with lengths $\lesssim 0.1 - 0.5$ km, relief $\lesssim 1 - 5$ m, and/or slope angles $\lesssim 3^\circ - 5^\circ$ cannot consistently or reliably be identified on average-quality aerial photography without unusual contrast, lighting conditions, or additional aerial/ground reconnaissance. Fault identification is also more difficult in highly dissected or vegetated terrain (e.g. central Arizona).

The above identification limitations may affect detailed fault distribution patterns to some degree. However, we believe that most of the prominent scarps have been identified, and, as importantly, that the major regional distribution patterns are valid due to the generally good quality and uniform coverage of the aerial photography used in the study.

Identification Criteria and Interpretational Problems. Two main types of neotectonic fault identification uncertainties exist in Arizona: 1) determination of tectonic vs. nontectonic origins for certain geomorphic anomalies (e.g., linear scarps potentially derived from faulting and/or stream-downcutting); and 2) documentation of neotectonic displacements on faults that offset only rocks or surfaces of pre-neotectonic age.

We have focused more on the second problem by concentrating on the mapping of probable fault scarps that meet certain criteria. These criteria vary somewhat with local conditions, but usually include some combination of the following: 1) directly observable fault offsets or shearing associated with scarp; 2) a topographic scarp, not everywhere parallel or adjacent to local drainage; 3) the occurrence of approximately the same age geomorphic surfaces or rocks above and below some portion of the scarp; and 4) continuity and/or geometry consistent with other well-documented fault scarps in the area.

We have additionally included a limited number of very possible fault scarps marked by thinner line weights and queries. They meet the above criteria, but are inherently more ambiguous due either to possible non-tectonic origins (although faulting is of equal or greater probability) or the absence of field confirmation of photo-interpretated features that are near the resolution limits described above.

In contrast, we have included a category of known faults with possible, but undocumented, neotectonic displacements. Most of these faults occur on the Colorado Plateau, where they are interspersed among faults of similar geometry and orientation with documented neotectonic activity. There is a general similarity between the tectonic landforms associated with both groups of faults, based mostly on qualitative comparisons, although systematic quantitative analyses similar to those developed by W. B. Bull (see map explanation and accompanying report and appendices) might assist in establishing the probability of neotectonic activity on those faults lacking direct age control. We do not feel justified in totally excluding this latter set of faults simply because they lack directly observable offset of neotectonic-aged rocks or surfaces, given the available data suggesting young displacements.

In summary, where uncertainty exists about the presence and/or age of neotectonic faulting, we have consistently emphasized the inclusion of known or probable faults with ambiguous but suggestive evidence for neotectonic activity, and excluded scarps or geomorphic anomalies of uncertain tectonic origin. This approach was adopted because it focuses on those features with the greatest liklihood of true neotectonic significance, while minimizing those of more questionable origin. However, in so doing, we recognize that we may have somewhat inflated the number of faults the number of faults in the western margin of the Colorado Plateau and deflated the number in central and southern Arizona Basin and Range area. Still, we do not consider this a fundamental or significant bias that would affect order of magnitude variations in amounts of neotectonic faulting between the two regions. Further, we believe this interpretational philosophy to be the best accomodation to the existing data and techniques available within the time limitations of the project.

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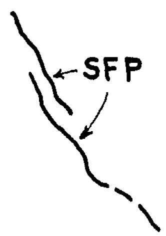
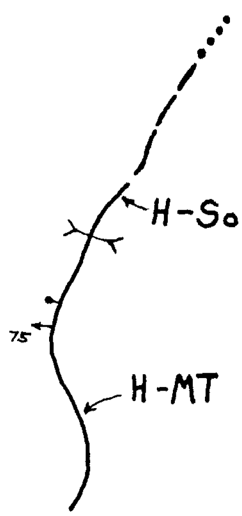
MAP EXPLANATION

STRUCTURAL SYMBOLS



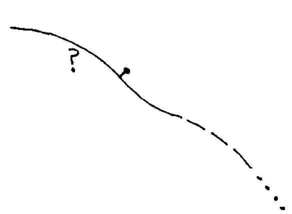
--letter abbreviations next to faults, fault segments, folds, or mountain fronts, refer to the names of individual features listed in the accompanying tables and reports.

Faults, Fault Scarps, and Folds

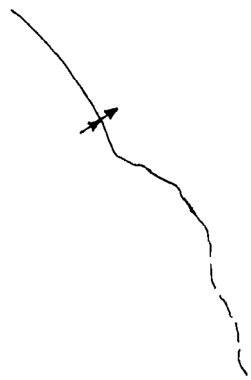


Known or probable fault or fault scarp; dashed where approximate or indefinite; dotted where concealed.

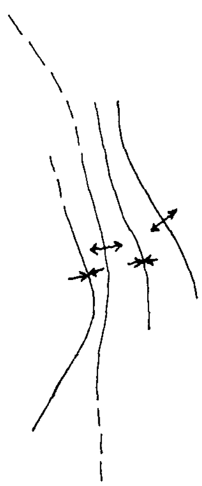
--bar and ball on downthrown side; dip of fault plane shown where known.
--bracket across the fault trace indicates subdivisions of the fault or scarp into segments, based on significant variations in either a) the amounts and/or timing of fault displacements, or b) the tectonic geomorphology of alluvial scarps or bedrock escarpments (see below).



Topographic scarp of very possible, although ambiguous, tectonic origin; other nontectonic mechanisms of formation (e.g., stream downcutting or lithologic control of erosion) may be present.

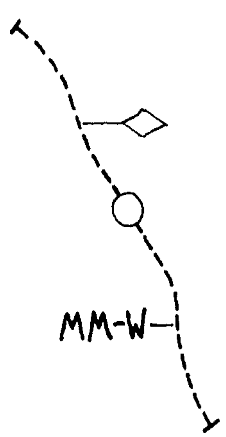


Monoclines; dashed where approximate or indefinite, arrow pointing in downdip direction of hinge. On the Colorado Plateau, only those bedrock monoclines have been included where data suggest possible neotectonic reactivation by either monoclinal flexure or surface faulting (although the sense of reactivated movement may follow or oppose the sense of older structural offset).



Anticlinal or synclinal folds, dashed where approximate. Arrow on axial trace indicates direction of plunge. All folds shown on the Colorado Plateau occur in bedrock. We have included only those folds with a reasonable liklihood of neotectonic activity, as inferred by spatial and/or geometric association with adjacent known or probable neotectonic faults. Direct age control for neotectonic fold formation does not now exist.

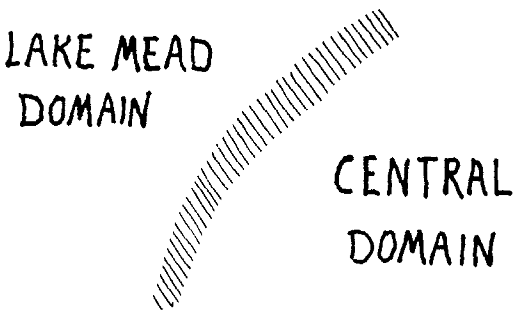
<u>Topographic Mountain Fronts or Escarpments</u>



Topographic bedrock mountain front and escarpments (approximately located) that have been quantatively analyzed for relative amounts neotectonic activity using the geomorphic landform analyses of W. B. Bull. (Refer below to age control section.)

--The location of individual mountain fronts have been defined solely on the basis of geomorphology. Usually no mountain-bounding faults are directly observable, although in many cases the presence of these structures may be inferred in the subsurface from residual local gravity anomalies (refer to accompanying Late Cenozoic Tectonic Map of Arizona by Scarborough, Menges and Pearthree).

Domain boundaries



Approximate boundaries and names of neotectonic domains that have been defined primarily on the basis of variations in the distribution, geometries, and displacement rates of surface faulting. Refer to accompanying report and tables for discussion of individual domains.

SYMBOLS FOR AGE CONTROL ON FAULT DISPLACEMENTS

The ages and amounts of neotectonic fault displacements have been estimated from one or more of the following data: 1) offset relationships of neotectonic-aged rocks and/or geomorphic surfaces; 2) morphology of alluvial faults scarps; and 3) quantitative tectonic landform analyses of bedrock escarpments and mountain fronts. We have emphasized the age of most recent surface rupture, where possible. Specific types of age control have been annotated to individual faults by means of symbols defined below. We have used only one set of age categories, indicated by the same letters or colors for all control symbols of this map. These basic age categories are:

Age Categories for Control Symbols

Qy late Quaternary undifferentiated (≈ ≲0.5 m.y.) — brackets h, H, L, M

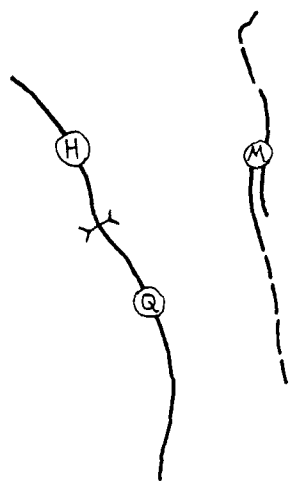
Q Quaternary undifferentiated (≲2 m.y.) — brackets h, H, L, M, E

		approximate age (m.y.B.P.)
h	late to mid Holocene	0.005
H	early Holocene to latest Pleistocene	0.005-0.02
L	late Pleistocene	0.02-0.15
M	mid Pleistocene	0.15-(0.5-0.7)
E	early Pleistocene	(0.5-0.7)-2
P	Known Pliocene	2-5
pQ	Pre Quaternary undifferentiated (mostly pre-Pliocene)	>2-3 (mostly >5)

L/M two age catagories separated by a slash indicates combined age range.

E? query by letter indicates possible but uncertain age assignment.

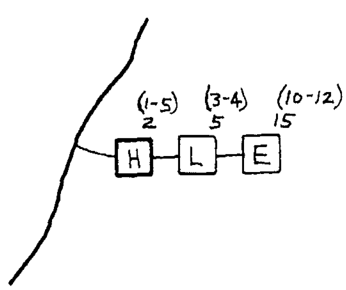
Composite Age of Most Recent Surface Displacement



Circle centered on fault trace indicates a composite estimate of the most recent surface rupture occurring anywhere along a given fault or fault trace, as inferred from offset relationships, scarp morphology, and/or tectonic geomorphology of mountain fronts or escarpments.

-- Age estimate indicated by inscribed symbols/colors as defined previously.

Offset Relationships of geomorphic surfaces and/or rock units.



Faulted Units

-- Boxes indicate units offset along the fault, queried where offset is less certain. Boxes are keyed to approximate location where displacement was measured.

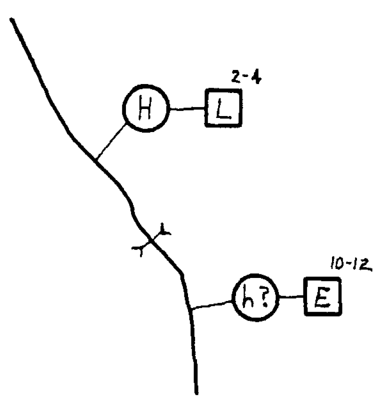
-- Age of offset unit indicated by inscribed letters/colors (defined previously).

-- Each box corresponds to one displaced unit of a specific age or age range (two letters/colors separated by slash); multiple boxes are used for successive offsets of different age units.

-- The box with heavier border corresponds to the youngest unit observed to be offset along that fault or fault segment (i.e., the maximum stratigraphic control on the age of most recent rupture).

-- Numbers at corners of box indicate the topographic scarp height and/or actual fault displacements (in parentheses) observed in that unit.

Unfaulted Units

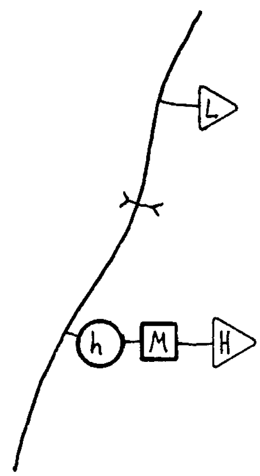


-- Heavier-bordered circles attached by leader to fault trace indicate surfaces or rocks not offset along the indicated fault, queried where offset is less certain. These circles are keyed to approximate location where lack of fault offset is observed.

-- Only the oldest unfaulted unit is shown (i.e., the minimum stratigraphic control on the age of most recent rupture).

Morphologic age estimates of fault scarps.

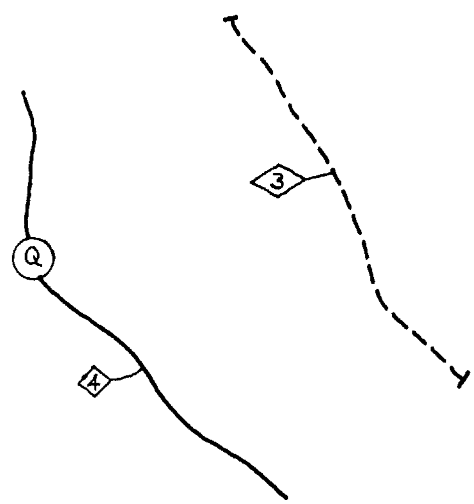
-- Triangles attached to fault scarp traces indicate the age of most recent surface rupture as estimated from fault scarp morphology. These estimates are



derived from quantitative analyses of topographic scarp profiles, using the methods derived by Mayer (1982b; in press) and Bucknam and Anderson (1979). These analytical techniques are described in the accompanying report and appendix. Morphologic age estimates were applied only to alluvial piedmont scarps.

-- The age estimates are indicated by the inscribed symbols/colors (defined previously).

<u>Tectonic landform analysis of faults, mountain fronts or bedrock escarpments</u>



-- Diamond attached by leader to a fault, fault segment, or topographic mountain front or escarpment indicates relative degree of Quaternary tectonic activity along the feature, queried where less certain. These estimates are based upon quantitative landform analyses developed by W. B. Bull. These techniques are described in accompanying report and appendices; (also refer to Bull and McFadden, 1977; Bull, 1978, 1979). We have adapted and applied these analyses to several of the larger bedrock escarpments of the Western Colorado Plateau margins.

-- The estimates of Quaternary tectonic activity are indicated by the following sets of inscribed symbols:

Numbers refer to the relative activity classes originally defined by Bull (1979) for topographic mountain fronts characteristic of the Basin and Range Province. The classes are:

1 --Highly active

2 --Moderately active

3 --Moderately active (but less active than class 2)

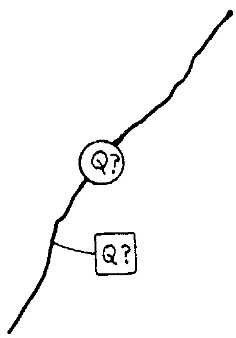
4 --Slightly active

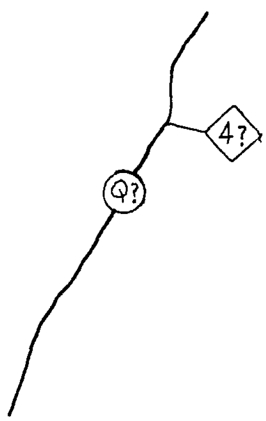
5 --Tectonically inactive

SYMBOLS FOR FAULTS WITH POSSIBLE NEOTECTONIC ACTIVITY WHICH LACK DIRECT AGE CONTROL OR HAVE NOT BEEN STUDIED USING ANY OF ABOVE QUANTITATIVE ANALYSES.

The following symbols indicate known or probable faults (commonly in bedrock) for which there is suggestive geologic and/or geomorphic evidence for neotectonic displacements. Refer to the explanatory text of this map and the accompanying report for discussions of the types of interpretational difficulties encountered and the minimum criteria applied to each feature included on this map.

Faults with very suggestive evidence for neotectonic activity



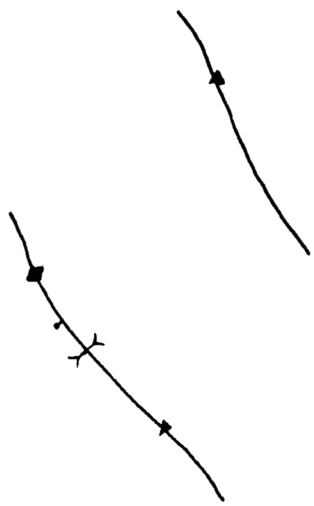


The presence of this symbol/color, within age control symbols indicate faults or escarpments which display at least one of the following criteria:

1. a segment of a fault lacking specific age control, but which is structurally or physiographically continuous with faults or segments with reliable age control on Quaternary displacements.
2. Offset of rocks and/or surfaces of known or probable latest Pliocene age ($\simeq$3 to 2 MA)
3. Geomorphic scarps or topographic benches developed within pre-Quaternary rocks but which morphologically resemble fault scarps in known Quaternary units. This criteria is not sufficient of itself, but must occur with other supportive evidence.
4. Quantitative tectonic landform analyses that strongly suggest, but are not diagnostic of, Quaternary activity along topographic mountain fronts or escarpments (see above). In most cases, further field

investigations are required to remove the analytical ambiguity.

Qualitative tectonic landform evaluation of faults



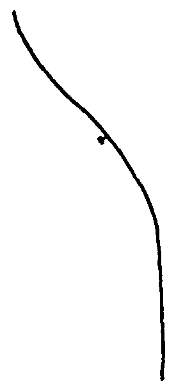
Small solid diamonds and triangles attached along a fault trace indicates the possibility of neotectonic activity along the structure, based on qualitative assessment of associated scarps or escarpments.

-- The diamonds and triangles refer to escarpments (≥50m in height) and fault scarps (≤50 m in height), respectively. These two types of features have been differentiated because of the contrasting types of tectonic geomorphic criteria applied to each use.

In most cases, this evaluation is based upon general comparisons with features with more reliable evidence for neotectonic activity (i.e., offset Quaternary units, quantitative scarp analysis, or mountain front landform analysis).

A special symbol has been used for these qualitative evaluations due to their inherent subjectivity and lack of precision.

Faults with possible, but poorly constrained, neotectonic activity.



The absence of any of the age control symbols defined above indicate those known or probable faults with possible neotectonic activity, based on general similarities and/or association with faults with reliable age control on neotectonic displacements. However, specific offset and/or geomorphic data substantiating activity of this age is either unavailable or very ambiguous for this unmarked class of faults, and no quantitative or qualitative tectonic landform evaluations have been conducted on these structures. These faults have been included in this map primarily to indicate structures and regions with possible neotectonic activity that require additional study.

to accompany MAP OF NEOTECTONIC (LATEST PLIOCENE-QUATERNARY) DEFORMATION IN ARIZONA by C.M. Menges and P.A. Pearthree

Footnotes - TABLE 1. KNOWN OR SUSPECTED QUATERNARY FAULTING IN ARIZONA

1 Fault symbols (in parens) are those used to label faults on accompanying map and appendices.

2 Reliability in identification of neotectonic (i.e., latest Pliocene-Quaternary) faults.

R - Reliable i.e., faulting proven or probable fault with good control on neotectonic displacements.

F? - Very possible neotectonic-age fault or fault scarp. Usually this feature is an anomalous topographic scarp of neotectonic age that is likely due to faulting, although other non-tectonic origins are possible. Only those features most suggestive of faulting have been included. (See Explanatory text of map for more complete discussion of minimum inclusion criteria.)

Q? - Known or probable fault with geomorphic characteristics and/or offset relationships, suggestive, but not diagnostic, of neotectonic displacements. Usually precise stratigraphic control on neotectonic movement is lacking.

3 Most photo-interpretation used high-altitude (U2) black and white aerial photography (nominal scale 1:125,000) with uniform statewide coverage and generally good, but variable, image quality. Refer to Explanatory text of map for discussion of resolution limits.

4 Field data refers to data on scarp morphology, geometry, age, or presence or absence of faulting along a given feature conducted as part of this study, unless otherwise specified. (✓) refers to a more reconnaissance field check, with collection of no or ambiguous data, in contrast to (X) that indicates a more thorough field study providing more usable and diagnostic data.

5 Topographic profiles refer to data on scarp morphology collected via topographic profiling transversely across scarps using Abney level and rod or tape.

6 Tectonic land form analyses refer to assessment of amount and rates of tectonic activity on a given structure or topographic feature based on either quantitative (X) or qualitative (✓) assessment of associated landforms. Quantitative estimates employ the methods and parameters developed by W. B. Bull (see Explanation for accompanying map).

7 References listed are those that either provide a basic source for feature listed and/or basic data that compliments this map. This is not an exhaustive reference list; instead we have included mainly those sources that provide mapping and/or data directly of use to this study, and especially for those features either not visited or checked cursorily during this study. Lack of reference indicates this map/study is the sole source.

TABLE 1. KNOWN OR SUSPECTED QUATERNARY FAULTING IN ARIZONA

Fault Name (Symbol)[1]	Reliability[2]	Photo[3] interpretation	Aerial Overflight	Field[4] Data	Topographic[5] Profiles (number)	Tectonic[6] Landform Analyses	References[7]
DOMAIN: SOUTHEASTERN NEVADA - LAKE MEAD							
Arrow Canyon Range SE (ACR-SE)	Q?	---	---	---	---	X	S. Reneau, written communication, 1982
Arrow Canyon Range W1 (ACR-W1)	R	---	---	---	---	X	" "
Arrow Canyon Range W2 (ACR-W2)	Q?	---	---	---	---	X	" "
Bitter Ridge Fault (BtR)	R	X	---	✓	---	✓	Mayer, 1982; Mayer, oral communication, 1982
Black Hills E1 (BH-E1)	Q?	---	---	---	---	X	S. Reneau, written communication, 1982
Black Hills E2 (BH-E2)	Q?	---	---	---	---	X	" "
Black Ridge NW2 (Br-NW2)	Q?	---	---	---	---	X	" "
Black Ridge SE (Br-SE)	Q?	---	---	---	---	X	" "
Boulder City faults (BCi)	Q?	---	---	---	---	X	Schell and Wilson, 1981
Bunkerville Ridge N (BuR-N)	Q?	---	---	---	---	X	S. Reneau, written communication, 1982
Detrital Valley scarps (DV)	F?	X	---	---	---	---	---
Frenchman Mtn. NW (FM-NW)	Q?	---	---	---	---	X	S. Reneau, written communication, 1982
Garnet Mtn. fault (Gn)	Q? F?	X	---	---	---	---	Blacet, 1975
Gold Basin fault (GBF)	Q?	X	---	---	---	---	Blacet, 1975; this map
Grand Wash fault scrarps-grabens (GW)	R, F?	X	X	X	14	---	---

(Note: this table contains abbreviations of faults used on the 1:500,000 scale map by Menges, et. al.)

Fault Name (Symbol)[1]	Reliability[2]	Photo[3] interpretation	Aerial Overflight	Field[4] Data	Topographic[5] Profiles (number)	Tectonic[6] Landform Analyses	References[7]
Grand Wash fault escarpment - Northern Basin segment (GWF)	R-Q?	X	X	---	---	X	---
Grand Wash fault - Pocum Wash segment (GWF-P)	Q?	X	X	---	---	---	Hamblin and Best, 1970; Hamblin, 1970
Grapevine Mesa scarps (GV)	R, F?	X	X	---	---	---	---
Littlefield Mesa scarps (Li)	F?	X	X	✓	---	---	---
Lower Granite Gorge scarps (LGG)	F?	X	---	---	---	---	---
Mead Slope fault scarp (MSl)	R, F?	X	X	---	---	---	Longwell, 1963
Meadow Valley Mtn. W1 (MVM-W1)	R	---	---	---	---	X	S. Reneau, written communication, 1982
Meadow Valley Mtn. W2 (MVM-W2)	R	---	---	---	---	X	" "
Mesquite fault scarp (M)	R	X	X	X; also Mayer, 1982b	85 Mayer, 1982b	X	Mayer, 1982b; Moore, 1982; this map
Muddy Mtn. W1 (MM-W1)	Q?	---	---	---	---	X	S. Reneau, written communication, 1982
North Muddy Mtn. fault scarp (NMM)	R	---	---	---	---	---	Nakata and others, 1982; Schell and Wilson, 1981
North Muddy Mtn. W1 (NMM-W1)	Q?	---	---	---	---	X	S. Reneau, written communication, 1982
North Muddy Mtn. W2 (NMM-W2)	Q?	---	---	---	---	X	" "
North Muddy Mtn. W3 (NMM-W3)	Q?	---	---	---	---	X	" "
Petroglyphs fault scarp (Pg)	R	X	---	(see reference)	3	X	Mayer, 1982b; S. Reneau, written communication, 1982
Pyramid Peak faults (PyP)	Q?	---	---	---	---	---	Schell and Wilson, 1981
Quail-Overton Arm grabens (QOG)	R	X	X	(see reference)	---	---	Mayer, 1982b

Fault Name (Symbol)[1]	Reliability[2]	Photo[3] interpretation	Aerial Overflight	Field[4] Data	Topographic[5] Profiles (number)	Tectonic[6] Landform Analyses	References[7]
River Mountain fault (RMF)	Q?	---	---	---	---	---	Schell and Wilson, 1981
River Mountain Interior (RM-I)	Q?	---	---	---	---	X	S. Reneau, written communication, 1982
River Mountain W1 (RM-W1)	Q?	---	---	---	---	X	" "
River Mountain W2 (RM-W2)	Q?	---	---	---	---	X	" "
Snap Canyon scarps (SnC)	F?	---	---	---	---	---	---
Sunrise Mtn. W (SrM-W)	Q?	---	---	---	---	X	S. Reneau, written communication, 1982
Tramp Ridge fault zone (TRF)	Q?, F?	X	---	---	---	---	---
Valley of Fire faults (VOF)	Q?	---	---	---	---	---	Schell and Wilson, 1981
Virgin Mtn. North (VM-N)	Q?	X	X	---	---	X	S. Reneau, written communication, 1982
Wheeler graben (WG)	R	X	X	X	5	---	---
Wheeler fault zone and mountain front-Hualapai Wash segment (WFZ-H)	Q?	X	X	---	---	X	S. Reneau, written communication, 1982; Blacet, 1975
-Northern segment (WFZ-N)	Q?	X	X	---	---	✓	---
DOMAIN: NORTHWESTERN ARIZONA							
Andrus Canyon fault (AnC)	Q?	X	X	---	---	✓	Huntoon, 1977
Aubrey fault							
North segment (Au-N)	Q?	X	X	---	---	---	---
Central (Au-C)	Q?	X	X	---	---	---	---
South segment and fault scarps (Au-S)	X	X	X	X	11	---	Huntoon, 1979
Aubrey Valley scarp (AuV)	F?	X	X	---	---	--	---

Fault Name (Symbol)[1]	Reliability[2]	Photo[3] interpretation	Aerial Overflight	Field[4] Data	Topographic[5] Profiles (number)	Tectonic[6] Landform Analyses	References[7]
Audley escarpment (Aud)	Q?	X	X	---	---	---	---
Big Chino fault scarp (BC)	R	X	X	X	41	X	Kreiger, 1965, 1967a, 1976b; Soule, 1978, 1979
Black Rock faults (BRF)	Q?	X	---	---	---	---	Hamblin and Best, j1970
Bright Angel fault							
Coconino segment (BA-C)	Q?	X	X	---	---	✓	Shoemaker and others, 1978; Huntoon, 1974
Grand Canyon sement (BA-G)	Q?	X	---	---	---	---	" "
Cataract Creek fault set (CCk)	Q?	X	(partial)	---	---	✓ (partial)	Shoemaker and others, 1978
Central Kaibab fault system							
Demotte Park set (CK-D)	Q?	X	---	✓ (partial)	---	✓	Huntoon, 1960, 1974; Babcock and others, 1976; Huntoon and others, 1976
Summit Valley Set (CK-S)	Q?	X	X		---	✓	Huntoon, 1969, 1974
Dutchman Draw graben (DDG)	Q?	X	X	✓	---	✓	Hamblin and Best, 1970
Eminance Break fault zone (EB)	Q?	X	X	---	---	✓	Shoemaker and others, 1978; Huntoon, 1974
Fence fault zone (FF)	Q?	X	---	---	---	✓	Huntoon, 1974
Frazier Well scarps (FzW)	F?	X	X	---	---	---	
Gyp Pocket graben and faults (GPG)	Q?	X	---	✓	---	✓	Hamblin and Best, 1970
Hidden Canyon graben (HCG)	Q?	X	---	✓	---	✓	" "
Hurricane fault zone							
Grandstand segment (H-Gs)	R	X	X	✓	---	X	Hamblin, 1970; Hamblin and Best, 1970
Hells Hollow segment (H-HH)	R	X	X	X	---	---	" "
Hurricane segment (H-Hu)	R	X	---	X	2	X	" "
Merchant Tank segment (H-MT)	R	X	X	X	---	X	" "

Fault Name (Symbol)[1]	Reliability[2]	Photo[3] interpretation	Aerial Overflight	Field[4] Data	Topographic[5] Profiles (number)	Tectonic[6] Landform Analyses	References[7]
Southern segment (H-So)	Q?	X	X	---	---	---	Hamblin, 1970; Humbin and Best, 1970
Temple Trail segment (H-TT)	R	X	---	✓	---	X	" "
Twin Butte segment (H-TB)	R	X	X	✓	---	X	" "
Whitmore Wash segment (H-WW)	R	X	X	X	23	---	" " Huntoon, 1977
Main Street fault zone							
Graben segment (MS-G)	Q?	X	X	✓	---	---	Hamblin, 1970; Hamblin and Best, 1970
Mt. Dellenbough segment (MS-D)	R	X	X	---	---	---	" "
Poverty Knoll segment (MS-P)	Q?	X	X	✓	---	---	" "
Seegmuller Mtn. segment (MS-S)	Q?	X	---	---	---	---	" "
Mohawk fault zone (MkF)	Q?	X	---	---	---	---	Hamblin and Best, 1970
Mt. Hope fault zone (MtH)	Q?	X	---	---	---	✓	---
Peach Springs graben (PeS)	Q?	X	---	---	---	✓	---
Robbers Roost fault set (RbF)	Q?	X	X	---	---	✓	Koons, 1964; Hualapai
Rose Well fault zone (RW)	Q?	X	X	---	---	✓	Shoemaker and others, 1978
Sand Creek fault zone (SCF)	Q?	X	---	---	---	✓	" "
Seligman fault and scarp (SeF)	R, Q?	X	---	X	3	✓	R. Whitney, 1981, oral and written communication
Seventy-four Plains fault and scarps (SFP)	Q?, F?	X	---	---	---	✓	---
Sinyala fault zone (Sy)	Q?	X	---	---	---	✓	Huntoon, 1974; Shoemaker and others, 1978
Sunshine Trail graben and faults (STG)	Q?	X	X	✓	---	---	Hamblin and Best, 1970

Fault Name (Symbol)[1]	Reliability[2]	Photo[3] interpretation	Aerial Overflight	Field[4] Data	Topographic[5] Profiles (number)	Tectonic[6] Landform Analyses	References[7]
Toroweap fault zone							
Antelope Valley segment (T-AV)	R	X	X	✓	---	✓	Hamblin, 1970; Haumblin and Best, 1970
Bulrush Wash segment (T-BW)	Q?	X	---	✓	---	---	" "
Heaton Knolls segment (T-HK)	R	X	X	X	---	---	" "
Losing Canyon segment (T-LC)	R	X	X	X	2	---	" "
Moccasin segment (T-Mo)	R-Q?	X	---	---	---	---	" "
Pipe Springs segment (T-PP)	R-F?	X	---	X	1	---	" "
Prospect Valley segment (T-PV)	R	X	X	---	---	---	Hamblin, 1970; Hamblin and Best, 1970; Huntoon, 1977
Ranger Station segment (T-RS)	R	X	X	X	5	---	Hamblin, 1970; Hamblin and Best, 1970
Southern segment (T-So)	R-Q?	X	X	---	---	✓	" "
Toroweap Cliffs segment (T-TC)	R	X	X	X	---	✓	" "
Vulcan's Throne segment (T-VT)	R	X	X	X	---	---	" "
Uinkaret Valcanic field faults (UKF)	Q?	X	---	---	---	---	Hamblin and Best, 1970
Washington fault zone							
Mokaac Wash segment (W-MW)	R	X	X	X	1	X	Hamblin, 1970; Hamblin and Best, 1970
Seegmuller Mtn. segment (W-SM)	Q?	X	X	✓	---	---	" "
Sullivan Draw segment (W-SD)	Q?	X	X	✓	---	✓	" "
West Kaibab fault zone							
Big Springs segment (WK-B)	Q?	X	---	✓	---	✓	Huntoon, 1969, 1974
Central escarpment (WK-C)	Q?	X	X	X	---	✓	" "
Grand Canyon (Muav) sement (WK-G)	Q?	X	---	---	---	---	Huntoon 1969, 1974; Babcock and others, 1976
Moquitch Canyon segment (WK-Mq)	Q?	X	---	✓	---	✓	Huntoon, 1969, 1974
Monocline segment (WK-M)	Q?	X	X	✓	---	---	" "
North segment (WK-N)	Q?	X	X	---	---	---	" "

Fault Name (Symbol)[1]	Reliability[2]	Photo interpretation[3]	Aerial Overflight	Field Data[4]	Topographic Profiles (number)[5]	Tectonic Landform Analyses[6]	References[7]
Yampai graben (YG)	Q?	X	X	✓	---	✓	---
Yellowhorse Flat fault zone	R	X	---	✓	---	---	Hamblin and Best, 1970
DOMAIN: SAN FRANCISCO VOLANIC FIELD							
Arrowhead fault scarps	R, Q?	X	---	X	1	✓	Moore and Wolfe, 1976; Ulrich and others, 1979
Bellemont fault scarp (Bl)	R	X	---	X	2	✓	Ulrich and others, 1979
Big Snake graben (BSG)	Q?	X	---	---	---	✓	Ulrich and others, 1979; Haynes and Hackman, 1978
Bill Williams fault zone (BWm)	R	X	---	---	---	---	Ulrich and Wolfe, written communication, 1981
Black Point fault set (BPt-E (15-16 individual faults)	Q?	X	---	---	---	✓	Ulrich and others, 1979
Black Point Monocline (BPt-M)	Q?	X	---	X	1	---	---
Cameron graben and faults (CmG)	R, Q?	X	X	---	---	✓	Akers and others, 1962; Reiche, 1937; Ulrich and others, 1979
Campbell Francis Wash fault set (30-40 individual faults, including CWF-Bl)	R, Q?	X	---	---	---	✓	Ulrich and others, 1979
Chavez Mtn. faults (CzM)	Q?	X	---	---	---	✓	---
Citadel Riuns fault set (CtR) (3 individual faults)	Q?	X	---	✓	---	✓	Moore and Wolfe, 1976; Ulrich and others, 1979
Doney Mtn. fault scarps (DnM) (3-4 individual faults)	R, Q?	X	---	✓	---	✓	" "

Fault Name (Symbol)[1]	Reliability[2]	Photo interpretation[3]	Aerial Overflight	Field Data[4]	Topographic Profiles (number)[5]	Tectonic Landform Analyses[6]	References[7]
Double Top fault set (DTp) (30 individual faults)	R, Q?	X	---	---	---	✓	Ulrich and others, 1979
Flagstaff fault set (Flg) (4-6 individual faults)	R, Q?	X	---	---	---	✓	" "
Garland Prairie fault scarps (GrP) (3 individual faults)	Q?	X	---	---	---	✓	" "
Gray Mtn. fault set (GrM) (60 individual faults)	Q?	X	X	---	---	✓	" "
Kendrick Peak fault (KnP)	R	X	---	X	---	✓	" "
Lake Mary fault zone (LkM)	Q?	X	---	X	---	✓	" "
Leupp fault set (LpF) (25 individual faults)	Q?	X	---	---	---	✓	" "
Marble Platform fault set (MPF)	Q?	X	---	---	---	✓	Haynes and Hackman, 1978; Ulrich and others, 1979
Mesa Butte fault zone and graben						✓	
North segment (MBt-N)	Q?	X	X	✓	---		Ulrich and others, 1979; Shoemaker and others, 1978
South segment (MBt-S)	R	X	X	✓	---	✓	" "
Mesa Butte fault set (MBF) (15-20 individual faults including)	R, Q?	X	---	some	some	✓	Ulrich and others, 1979
MBF-B1	R	X	---	X	✓	✓	" "
MBF-2	R	X	---	X	✓	✓	" "
MBF-B3	R	X	---	X	1	✓	" "
MBF-B4	R	X	---	X	✓	✓	" "
Mormon Lake fault zone (MLF)	Q?	X	---	✓	---	✓	---
Munds Park graben and faults (MPG)	Q?	X	---	---	---	✓	---
Oak Creek fault zone-north segment (OCK-N	R-Q?	X	---	---	---	✓	Ulrich and others, 1979

Fault Name (Symbol)[1]	Reliability[2]	Photo[3] interpretation	Aerial Overflight	Field[4] Data	Topographic[5] Profiles (number)	Tectonic[6] Landform Analyses	References[7]
Shadow Mtn. grabens (SMG)	R, Q?	X	X	---	---	✓	Akens and others, 1962; Condit, 1974; Ulrich and others, 1979
SP fault set (SP) (13-15 individual faults including	R, Q?	X	---	some	some	✓	Ulrich and others, 1979
SP-B1	R	X	---	X		✓	" "
SP-B2	R	X	---	✓	---	✓	" "
SP-B3	R	X	---	✓	---	✓	" "
Walnut Canyon fault set (WlC) (35-40 individual faults)	R?, Q?	X	---	---	---	✓	Ulrich and others, 1979
Wupatki fault set (WpF)	R	X	---	✓	---	✓	" "
DOMAIN: CENTRAL ARIZONA							
Alder Creek fault zone (AlC)	Q?, R	X	---	---	---	✓	---
Camp Verde scarp (CVS) (part of Verde fault zone)	R	X	---	X	9	---	R. Whitney, oral and written communication, 1981
Cottonwood fault scarp (CW)	R, F?	X	---	X	7	---	---
Deadman Creek fault zone (DmC)	Q?	X	---	---	---	✓	---
Hackberry Mtn. scarps (HkM)	F?	X	---	---	---	---	---
Horseshoe Dam fault (HsF)	R-Q?-F?	X	X	X	4	---	Fugro, 1981a,b
Orchard fault zone (OrF)	Q?	X	---	---	---	✓	Lehner, 1958
Paulden scarps (PaS)	F?	X	---	✓	---	---	---
Prescott Valley grabens (PVG)	R-Q?, F?	X	X	X	✓	---	---
Railroad fault zone (RRF)	Q?	X	---	---	---	✓	Lehner, 1958

Fault Name (Symbol)[1]	Reliability[2]	Photo[3] Interpretation	Aerial Overflight	Field[4] Data	Topographic[5] Profiles (number)	Tectonic[6] Landform Analyses	References[7]
Seven Springs fault (SSF)	Q?	X	---	---	---	✓	---
Sugarloaf Pk fault zone (Su)	R	X	---	X	1	✓	Fugro, 1981a, b
The Rolls (Rls)	F?	X	---	✓	---	---	---
Tonto Basin-Central (TnB-C)	Q-Q?	X	X	---	---	✓	---
Tonto Basin-SW (TnB-SW)	Q?	X	X	---	---	---	---
Tonto Basin-NW (TnB-NW)	Q?	X	X	✓	---	✓	---
Turret Peak fault zone (TuP)	Q?, F?	X	---	---	---	✓	---
Verde fault zone							
North segment (VdF-N)	Q?	---	---	✓	---	---	Twenter and Metzger, 1963; Anderson and Creasey, 1967
South segment (VdF-S)	Q?-F?	X	---	✓	---	✓	Twenter and Metzger, 1963; Wolfe, oral communication, 1981
Williamson Valley grabens (WVG)	R-F?	X	X	✓	---	---	---
DOMAIN: EAST-CENTRAL ARIZONA							
Big Lake faults and graben (BgL)	Q?	X	---	---	---	✓	---
Coyote Creek fault (CyC)	Q?	X	---	---	---	✓	Wilson and others, 1969
Ray fault/scarp (Ray)	F?	X	---	---	---	---	Keith and Scarborough, oral communication, 1979
St. Johns fault set (StJ) (6 individual faults)	Q?	X	---	---	---	✓	Crumpler, oral communication, 1982
San Carlos escarpment (SaC)	F?	X	---	✓	---	---	---
Sevenmile Mtn. fault and scarp (SmM)	Q?, F?	X	---	---	---	✓	---

Fault Name (Symbol)[1]	Reliability[2]	Photo[3] interpretation	Aerial Overflight	Field[4] Data	Topographic[5] Profiles (number)	Tectonic[6] Landform Analyses	References[7]
Sprucedale fault and escarpment (Spd)	Q?	X	---	---	---	✓	---
Whitlock Wash fault and escarpment (WtF)	Q?	X	---	---	---	---	Krieger,
DOMAIN: SOUTHEASTERN ARIZONA - SOUTHWESTERN NEW MEXICO							
Alma Mesa fault scarp (AlM)	R, Q?	X	---	---	---	---	---
Artesia Escarpment	F?	X	---	✓	---	---	---
Bunk Robinson Peak fault set (Brb) (4-5 individual faults)	Q?	X	---	---	---	---	Hayes, 1982
Cactus Flats faults and fractures	Q?	---	---	✓	---	---	---
California Wash Monocline and faults (CWM)	Q?	---	---	✓	---	---	Scarborough, 1975
China Camp scarp	Q?, F?	X	---	---	---	---	---
Chiricuhua fault scarp (C)	R, F?	X	---	X	7	✓	---
Chiriones fault scarp (Ch)	R	---	---	X	---	---	---
Clifton faults (Cl) (2 individual faults)	R	X	---	X	✓	---	Wahl, 1980; Cunningham, 1981; Witcher, 1980, 1981; Ratte and Hadlund, 1981
Cotton City fault scarp (CC)	R	X	---	X	9	---	Gillerman, 1958; Smith, 1978; Wynn, 1981; Machette, written communication, 1982.
Cowboy Pass scarps and faults	Q?, F?	X	---	✓	---	✓	Gillerman, 1958
Deep Creek Mesa scarps (DCM)	Q?, F?	X	---	---	---	---	Ratte, 1981
Duncan fault scarps (Du) (3-4 individual scarps)	R, F?	X	---	X	✓	---	Morrison, 1965; Machette, written communication, 1982

Fault Name (Symbol)[1]	Reliability[2]	Photo[3] interpretation	Aerial Overflight	Field[4] Data	Topographic[5] Profiles (number)	Tectonic[6] Landform Analyses	References[7]
Eastern Silver City scarps (ESC) (18-19 individual scarps)	R?	---	---	---	---	---	Machette and others, in prep.; Machette, written communication, 1982
Gillespie Mountain fault scarp (GM)	R	X	---	X (partial)	6	---	Zeller, 1962; Zeller and Alper, 1965; Seager and Morgan, 1979
Grays Ranch fault scarps (GR) (4-10 individual scarps)	R, F?, Q?	X	---	X (partial)	---	---	Wrucke and Bromfield, 1961; Seager and Morgan, 1979
Guadalupe Canyon fault (GdC)	R?	---	---	---	---	---	Hayes, 1982
Hereford fault (HFF)	Q?	---	---	✓	---	---	Haynes, oral and written communication, 1979
Huachuca fault scarp (H)	R, F?	X	---	X	4	---	---
Joe Glenn Ranch faults (JGR)	Q?	X	---	---	---	---	Lynch, 1972, 1978
Little Rincon Mts. fault (LRM)	Q?	X	---	---	---	✓	Lingrey, oral communication, 1980; Drewes, 1974
Mogollon fault zone (MgF)							
North segment (MgF-N)	Q?	X	---	---	---	---	---
South segment (MgF-S)	Q?	X	---	---	---	---	Leopoldt, 1981
Outlaw Mountain fault (OtM)	Q?	X	---	---	---	✓	---
Patagonia Mtn. fault zone (PgM)	Q?	X	X	---	---	---	Simons, 1974
Pedregosa Mountains fault scarp							
Main segment (Pd)	Q?	X	---	✓	---	✓	Lynch, 1972
Central scarp (Pd-C)	R	X	---	X	✓	---	---
Peloncillo fault scarp (Pe)	R	X	---	X	13	---	Gillerman, 1958; Seager and Morgan, 1979; Drewes and Thorman, 1980; Wynn, 1981; Machette, oral and written communication, 1981-1982

Fault Name (Symbol)[1]	Reliability[2]	Photo Interpretation[3]	Aerial Overflight	Field Data[4]	Topographic Profiles (number)[5]	Tectonic Landform Analyses[6]	References[7]
Pitaycachi fault scarp (Pi)	R	---	---	(see reference)	---	---	Mayer, 1982; Bull and Pearthree, oral and written communication, 1981-82; Bull and others, 1981; Herd and McMasters, 1982
Rice Mesa scarp (RMS)	F?	X	---	---	---	---	---
Rim Rock fault scarp (RR)	R, Q?	X	---	X	2	---	---
Safford-Pinaleno fault scarp (Sa/Pn)	R	X	---	X	44	---	Swan, 1976
Santa Rita fault scarps (SR)	R	X	X	X	61 (trenching)	X	Drewes, 1971; Calvo and Pearthree, 1981; Pearthree and Calvo,
Swisshelm Basin scarp (SwB)	F?	X	---	---	---	---	---
Swisshelm fault scarp (Sw)	R-Q?	X	---	X	6	✓	Druke, 1979
Swisshelm Mountain front (SwM)	Q?	X	---	X	---	✓	---
DOMAIN: WESTERN DESERTS							
Mohave Subdomain							
Big Sandy fault (Bsy)	Q?	X	✓	✓	---	✓	---
Dead Mtn. W (DM-W)	Q?	---	---	---	---	X	S. Reneau, written communication, 1982
Dead Mtn. El (Dm-El)	Q?	---	---	---	---	X	S. Reneau, written communication, 1982
Hualapai Mtns. scarp (HIM)	F?	X	X	✓	---	---	---
Needles "graben"/fault scarp (NGF)	R	X	X	X	14	X	Purcell and Miller, 1980; Schell and Wilson, 1981
Needles fault (NS)	F?	X	X	✓	---	---	---

Fault Name (Symbol)[1]	Reliability[2]	Photo[3] interpretation	Aerial Overflight	Field[4] Data	Topographic[5] Profiles (number)	Tectonic[6] Landform Analyses	References[7]
Sacramento Mts. El (SR-El)	Q?	---	---	---	---	X	S. Reneau, written communication, 1982
Sonoran Subdomain							
Blythe graben (BlG)	R	X	---	(see reference)	(trenching)	X	Purcell and Miller, 1980; Schell and Wilson, 1981
Date fault (DtF)	Q?	X	X	---	---	---	---
Lake Pleasant scarp (LPl)	F?	X	X		---	---	---
Lost Trigo fault (LTF)	Q?	X	---	(see reference)	---	---	Miller, written communication, 1980
Quitoquibito fault (Qtq)	Q?	X	X	---	---	---	---
Sand Tank fault scarp (ST)	R	X	X	X	12	---	Van Horn, oral and written communication, 1976, 1981
Sonoyta faults (SoF)	Q?-R	---	---	---	---	---	Merrill, 1972; Schell and Wilson, 1981
Wagoner fault (WgF)	Q?	X	X	---	---	✓	---
Yuma Subdomain							
Algodones fault scarp (AgF)	R	X	X	(see reference)	(trenching)	---	Bull, 1974b
Cargo Muchacho fault (CMF)	R	(see reference)	---	---	---	---	Bull, 1974b
Gila Mountains fault (GMt)	Q?	X	---	X	---	X	Bull, 1974a

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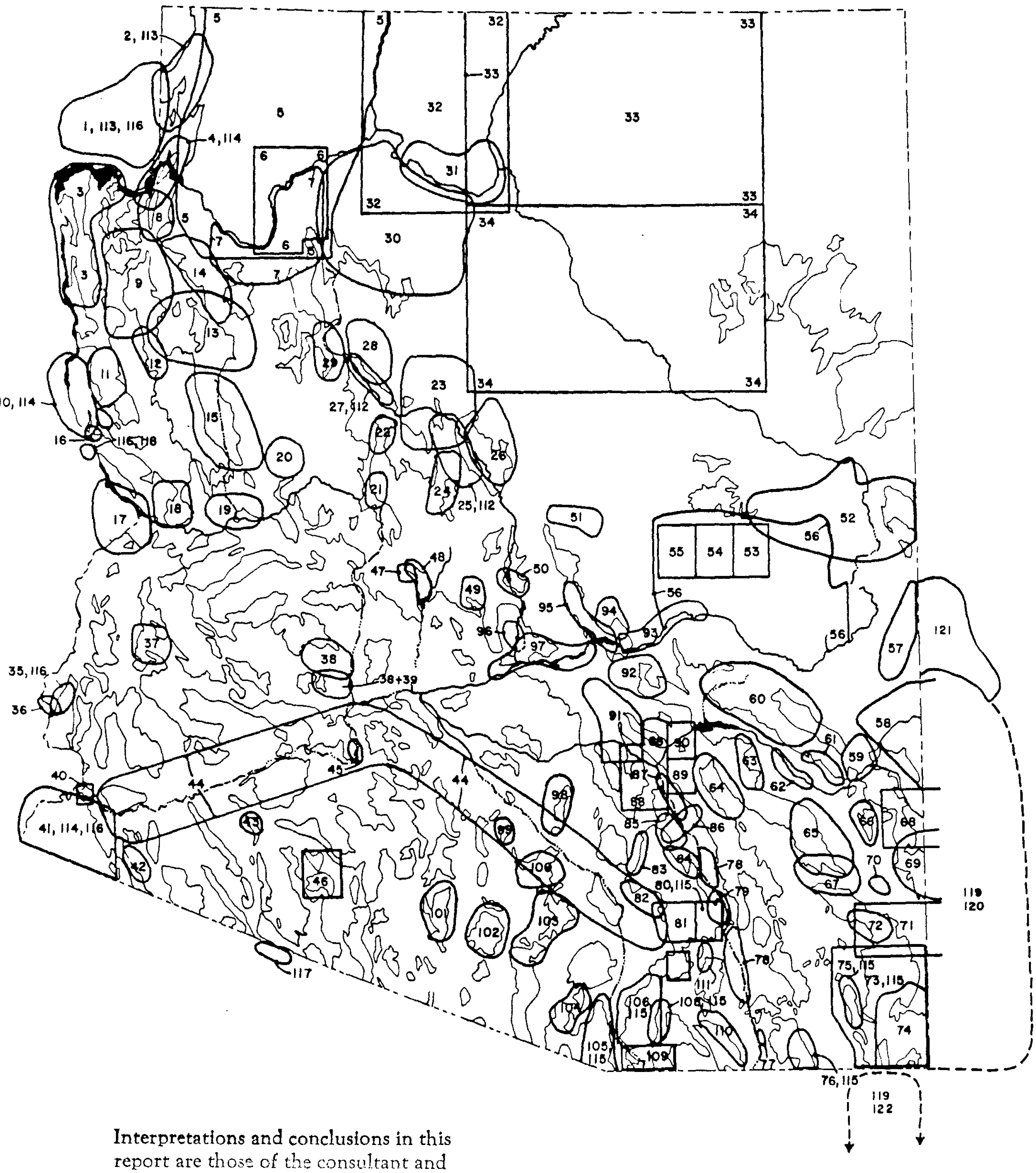
Index map for references cited in both 1:500,000 maps. Numbered areas on this map correspond to numbered entries on accompanying bibliography.



Interpretations and conclusions in this report are those of the consultant and do not necessarily coincide with those of the staff of the Bureau of Geology and Mineral Technology.

Combined references for both 1:500,000 scale maps, keyed to numbers within circled areas on small accompanying map.

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