COMPILATION OF KNOWN OR SUSPECTED QUATERNARY FAULTS WITHIN 100 KM OF YUCCA MOUNTAIN, NEVADA AND CALIFORNIA

U.S. GEOLOGICAL SURVEY

Open-File Report 94-112

Prepared in cooperation with the Dept.

NEVADA OPERATIONS OFFICE, U.S. DEPARTMENT OF ENERGY,

under Interagency Agreement DE-AI08-92NV10874

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COMPILATION OF KNOWN AND SUSPECTED QUATERNARY FAULTS WITHIN 100 KM OF YUCCA MOUNTAIN, NEVADA AND CALIFORNIA

By L.A. Piety, U.S. BUREAU OF RECLAMATION

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215

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CONVERSION FACTORS AND ACRONYMS

Multiply	By	To obtain
centimeter (cm)	0.394	inch
kilometer (km)	0. 621	mile
meter (m)	3.28	foot
millimeter (mm)	0.0394	inch

The following terms and abbreviations also are used in this compilation.

ka thousands of years old

mm/yr millimeters per year

myr millions of year ago

Ma millions of years old

CONTENTS

ILLUSTRATIONS

TABLES

Compilation of Known and Suspected Quaternary Faults within 100 km of Yucca Mountain

By L.A. Piety

Abstract

Geologic data have been compiled for known and suspected Quaternary faults in southern Nevada and southeastern California within about 100 km of the potential repository site at Yucca Mountain. This compilation is based on published and readily available literature, including theses and dissertations. The data set includes regional studies that attempt to identify and evaluate lineaments, scarps, and other possible tectonic landforms of possible Quaternary age, detailed studies that focus on a single fault, and geologic studies that were completed for purposes other than evaluation of Quaternary fault activity. Studies included in this compilation are those that were available as of December 1993. Faults that have known or suspected Quaternary activity are presented on a topographic base map at a scale of 1:250,000. Data for each fault that are pertinent to the assessment of future faulting and earthquake events are assembled on description sheets and summarized on tables.

Faults that have known evidence for or are suspected of Holocene (≤10 ka) or late Pleistocene (>10 ka and <130 ka) surface rupture are highlighted on the map because these faults may be the most likely to produce ground motions that could impact the potential repository. This compilation identifies ten faults within 50 km of the site but outside the site area and an additional fourteen faults between 50 km and 100 km of the site for which evidence for Holocene or late Pleistocene surface rupture has been reported in the literature. The longest and most continuous of these faults is the northwest–striking, 250–km–long Furnace Creek fault (including its possible extension into Fish Lake Valley), which is located about 50 km west of the site. In addition to identifying known or suspected Quaternary faults within about 100 km of the site, this compilation demonstrates the lack of information for most of these faults. Future work will undoubtedly change the portrayal of Quaternary faults presented in this report and on the accompanying map by eliminating some faults shown here, by adding other faults for which Quaternary rupture has not yet been recognized, and by revising and refining the age designations and other data for many of the faults.

INTRODUCTION

This report and accompanying map present the results of a compilation of published literature and readily available data on known and suspected Quaternary faults within about 100 km of Yucca Mountain. The report and map were prepared as part of Activity 8.3.1.17.4.3.2, "Evaluate Quaternary Faults Within 100 km of Yucca Mountain", which is an activity within Study 8.3.1.17.4.3, "Quaternary Faulting within 100 km of Yucca Mountain, including the Walker Lane" (Department of Energy, 1988). The objective of Study 8.3.1.17.4.3 is to collect and synthesize "information pertaining to the abundance, distribution, geographic orientation, displacement rate, and recurrence interval of movement" for faults within about 100 km of Yucca Mountain (Department of Energy, 1988). An important purpose of the work summarized in this report and on the accompanying map is to provide a basis and direction for future investigations under Activity 8.3.1.17.4.3.2. Specifically, this report shows in detail what data are presently available for known and suspected Quaternary faults in the study area.

Data from Study 8.3.1.17.4.3 will be used to "assist in predicting the likely locations, timing, and magnitudes of future faulting and earthquake events that could have an impact on the design or performance of the waste facility" (Department of Energy, 1988). Data presented in this report may be used in preliminary analyses of future faulting and earthquake events. The actual identification of earthquake sources will be performed under Study 8.3.1.17.3.1, "Relevant Earthquake Sources" (Department of Energy, 1988). Data will also support Activity 8.3.1.17.4.12, "Tectonic Models and Synthesis".

A preliminary draft of this report without the map was submitted as an interim report to the U.S. Geological Survey in March 1993 (Piety and others, 1993). This report supersedes the interim report.

This work was supported by the U.S. Department of Energy under a Memorandum of Understanding (MOU) between the U.S. Geological Survey and the U.S. Bureau of Reclamation dated January 13, 1986.

Regional Geologic and Tectonic Setting

Yucca Mountain is located in the central portion of the southern Basin and Range (fig. 1). Rocks of nearly all geologic ages are present within the region, but volcanic rocks of Miocene age are especially common and voluminous. Geologic structures in this region are characterized in part by the elongate mountain blocks and alluvial basins typical of other parts of the Basin and Range. The mountain ranges and intervening basins are the result of late Cenozoic extensional faulting. Wernicke and others (1988) believed that, at the latitude of Yucca Mountain, both normal and strike–slip faults have accommodated nearly 250 km of extension between the Colorado Plateau and the Sierra Nevada during the last 20 m.y. It is clear from available data that dip–slip, oblique–slip, and strike–slip Quaternary faults are all present in the region surrounding Yucca Mountain.

Figure 1. Major known or suspected Quaternary faults in southern Nevada and southeastern California in the region surrounding Yucca Mountain.

For this assessment of Quaternary faulting within about 100 km of Yucca Mountain, Data on specific known or suspected Quaternary faults within the study area are presented. However, discussion of possible relationships between these faults and proposed regional geologic structures has been omitted. A synthesis of various tectonic models for the site and region will be conducted as part of Study 8.3.1.17.4.12, "Tectonic Models and Synthesis" (Department of Energy, 1988).

Definitions

All tectonic features described in this report are called faults even if they have been labeled fault zones, fault systems, or lineaments by previous workers. This was done for consistency. Some tectonic features have enough data that differences in terminology could be distinguished on the basis of the following definitions; some of these features may be more correctly called fault sets or fault systems. However, most of the tectonic features described in this report have limited data available from only a single locality or, at most, a few localities so that the criteria used to distinguish between the terms have not been determined. The following definitions have been used in preparing this report.

Quaternary fault: Fault with displacement since approximately 1.6 Ma. In general, evidence for such activity is displacement of deposits or surfaces of latest Tertiary or Quaternary age or geomorphic features or characteristics indicative of Quaternary activity.

Known Quaternary fault: Fault with documented evidence of displacement during the Quaternary (since approximately 1.6 Ma) presented on published geologic maps or in other literature. Documented evidence may include descriptions of displaced Quaternary deposits or landforms, fault scarps on Quaternary surfaces, faults or shears that displace Quaternary deposits as displayed in natural or man–made exposures, or faults with historical surface rupture.

Suspected Quaternary fault: A fault or lineament that, based on presently available data (usually published geologic maps or other literature), is suspected of having or representing Quaternary tectonic displacement. Quaternary activity is suspected because the fault may have an apparent association (e.g., proximity, orientation, tectonic or structural setting) with a known Quaternary fault, or it may be in deposits of uncertain but possibly Quaternary age. In this report, the category of suspected Quaternary faults also includes lineaments that have characteristics similar to those of lineaments associated with known Quaternary faults and that are on surfaces of known Quaternary age or of uncertain but possibly Quaternary age.

Fault: "A fracture or a zone of fractures along which there has been displacement of the sides relative to one another parallel to the fracture" (Bates and Jackson, 1987, p. 235).

Fault zone: "A fault that is expressed as a zone of numerous small fractures or of breccia or fault gouge. A fault zone may be as wide as hundreds of meters" (Bates and Jackson, 1987, p. 237).

Fault set: "A group of faults that are parallel or nearly so, and that are related to a particular deformational episode" (Bates and Jackson, 1987, p. 236).
Fault system: "Two or more interconnecting fault sets", which are "a group of faults that are parallel or nearly so, and that are related to a particular deformational episode" (Bates and Jackson, 1987, p. 236-237).

Lineament: "A mappable, simple or composite linear feature of a surface, whose parts are aligned in a rectilinear or slightly curvilinear relationship and which differs distinctly from the patterns of adjacent features and presumably reflects a subsurface phenomenon" (O'Leary and others, 1976, p. 1467).

Scarp or fault scarp: A relatively linear break in slope formed directly by movement along a fault and separating surfaces at different topographic levels (Bates and Jackson, 1987, p. 236, 590).

Holocene: The time period that includes about the last 10,000 years.

Late Pleistocene: The time period between about 10,000 years ago and about 130,000 years ago.

Acknowledgments

I thank John W. Whitney (U.S. Geological Survey) for his suggestions and comments throughout the study, Dennis W. O'Leary (U.S. Geological Survey) for his helpful technical review of the interim and present reports, Larry W. Anderson and Ralph E. Klinger (U.S. Bureau of Reclamation) for their reviews of this report and several earlier drafts, Nancy Urquhart (U.S. Bureau of Reclamation) for her dedication in obtaining references, and R. A. Westphal and T. J.Horner (U.S. Bureau of Reclamation) for drafting the plates and figures in this report.

COMPILATION OF KNOWN AND SUSPECTED QUATERNARY FAULTS WITHIN 100 KM OF YUCCA MOUNTAIN

Methods

The primary purposes of this report and accompanying map were to systematically identify all potential Quaternary faults that are within about 100 km of the potential nuclear waste repository at Yucca Mountain and to assemble available data about their Quaternary activity into a consistent and usable format. Principal references used in this compilation are regional studies that have examined small–scale (1:124,000 to 1:58,000) aerial photographs for geomorphic features that might indicate Quaternary surface rupture (Schell, 1981; Dohrenwend and others, 1991, 1992; Reheis, 1991a, 1992; Reheis and Noller, 1991; fig. 2). Faults that underwent Quaternary surface rupture are assumed to exhibit one or more geomorphic features that are preserved on surfaces of known or suspected Quaternary (primarily) or latest Tertiary age and that are visible on aerial photographs or on the ground. These features include scarps; disrupted drainages; alignments of vegetation, drainages, topographic saddles, hills, tonal or color differences, springs, spring deposits, and depressions; and range fronts that are linear, steep, and faceted. These references include reconnaissance–level field examination of some of these geomorphic features.

Figure 2. Extent of previous studies that evaluated Quaternary displacement along faults in the area covered by plates 1 and 2.

Three additional primary references for this compilation are products of regional studies in which data on faults with possible Quaternary displacement in California have been collected and evaluated (Hart and others, 1989; Jennings, 1985, 1992) (fig. 2). These three studies were principally undertaken as part of a fault evaluation program designed to carry out the objectives of the Alquist–Priola Special Studies Zones Act. Because the part of California that is near Yucca Mountain is sparsely populated, faults in this area were given less attention in these studies than were similar faults in other parts of the state.

All of these regional studies, which cover the study area except for the portion south of latitude 36°N. and a small area northeast of Yucca Mountain north of latitude 37°N. (fig. 2), have probably identified most of the features that could be attributable to Quaternary surface rupture. They have also inferred type of displacement on associated faults on the basis of the geomorphic features visible on the aerial photographs. From characteristics of surfaces affected by or overlying the faults, these studies also provide an estimate of the age of youngest surface rupture (e.g., Dohrenwend and others, 1991, 1992). However, only rough estimates of the ages of the surfaces can be inferred from aerial photographs, and these studies yield no information about the lengths of ruptures, the amount of displacement caused by individual ruptures, the amount of total displacement, slip rate, and recurrence, because these parameters cannot be estimated from aerial photographs. Consequently, more detailed studies of individual faults were used as supplemental sources of information if such studies are available. These more detailed studies include field mapping, measurement of topographic scarp profiles, interpretation of trench exposures, and radiometric dating of displaced and undisplaced deposits and surfaces. These studies can directly address the amounts of displacement, the number of displacements, slip rates, and recurrence, as well as provide better age estimates. However, these studies are primarily limited to one or, at most, a few localities along a fault that may be several tens of kilometers long and may consist of several strands. Thus, the representativeness of this information for an entire fault is not known. With exception of some faults within about 5 km of the potential waste repository (site faults), no fault within 100 km has yet been studied in enough detail at enough localities to estimate values for all of the above parameters or to understand their variation along the entire fault.

Additional faults that were not shown by either the regional studies that specifically evaluated possible Quaternary tectonic features or the more detailed studies of Quaternary displacement on individual faults were taken from geologic maps completed with the primary objective of portraying the distribution and structure of pre–Quaternary rocks (e.g., Albers and Stewart, 1972; Cornwall, 1972; Frizzell and Shulters, 1990). Possible Quaternary surface rupture was inferred for faults that are shown on these maps as displacing Quaternary (or Quaternary/Tertiary) deposits or as faulted contacts between Quaternary deposits and older units. Because associated geomorphic features that would indicate Quaternary surface rupture are not usually noted by the authors of these maps, the presence of such features is not known unless they are shown by one of the studies specifically evaluating possible Quaternary tectonic features. In general, the only information about Quaternary surface rupture obtainable from the geologic maps are crude estimates of both Quaternary rupture length and age of the youngest ruptured units.

All mapped faults that are portrayed by previous workers as disrupting deposits or surfaces of known or suspected Quaternary age are included in this compilation even if the reported geologic interpretations or age estimates are inconsistent. This was done because (1) the objectives, evaluation methods, and scales differed among the numerous references used to compile this report, (2) preparation of this report included no independent evaluation of the mapped faults, scarps, lineaments, or range fronts either on aerial photographs or in the field, and (3) this compilation is supposed to provide a basis for additional study of known and suspected Quaternary faults. Geomorphic features (e.g., scarps, lineaments, linear range fronts, etc.) that are interpreted as possibly indicating Quaternary surface rupture by at least one worker are also included in this compilation and are called faults even though no associated fault has yet been documented. Additional study may eliminate some of these geomorphic features as being tectonic in origin.

Known and suspected Quaternary faults identified from the literature were compiled onto a base map at a scale of 1:250,000 (pls. 1 and 2). This scale was chosen because the faults could be readily shown relative to the potential waste site and topographic features, and the entire area could be included on a map of manageable size. Faults were transferred from maps in the cited references by visual inspection. Accuracy of the locations of the faults is dependent upon the scale of the original maps. Previously mapped faults are labeled using fault names employed by previous authors as indicated in appendix 2. If no name was reported in the literature, faults were assigned names taken from nearby physiographic features. Geomorphic features that have not yet been related to a known and previously named fault have been included with or combined into faults, if possible, on the basis of similarities in (1) relationship to physiographic features (e.g., along a range front, within a valley), (2) strike or trend, and (3) type of displacement and were assigned names taken from nearby physiographic features. It is unknown if these geomorphic features are structurally related. Occasionally, several relatively short faults in one area are discussed together even though they have variable strikes, relationships to physiographic features, or types of displacement (e.g., Central Spring Mountains faults, Saline Valley faults). This was done for ease of discussion and is not meant to imply a geologic relationship among the faults.

During the initial stages of this compilation, an attempt was made to collect and examine all published and unpublished data. However, this compilation is primarily limited to published literature and other readily available data that were available as of December 1993. The compilation concentrates on major faults in the region, especially those within 50 km of the potential waste repository. Although faults at distances greater than 100 km are also included in this compilation, less effort was made to identify all the potential Quaternary faults (and the associated references) at this distance than for faults within 100 km of the site. References were organized into a data base and assigned an accession number beginning with "Y-". This was done to provide a unique identifier for each reference and to indicate that the reference is part of the data base for Yucca Mountain. References were initially examined in a cursory manner. Those directly addressing geomorphic features that might be related to Quaternary fault displacement, those showing the distribution of Quaternary deposits and surfaces, and those presenting age estimates for Quaternary deposits and surfaces were examined in the most detail. Relatively little time was spent reviewing articles discussing regional tectonic models and pre–Quaternary geology.

Although Activity 8.3.1.17.4.3.2 indicates that faults within 100 km of Yucca Mountain will be evaluated for possible Quaternary displacement, the study plan suggests concentration on faults within approximately 45 km of the site (the distance stated there as the distance to the Furnace Creek fault), "because faults in this area are considered to have the greatest potential for producing ground motions that may affect repository design and performance" (Department of Energy, 1988). Consequently, this compilation, while including known and suspected Quaternary faults within about 100 km of the site, has focused on faults within about 50 km of Yucca Mountain, the measured distance to the Furnace Creek fault from the site using an arbitrary location near the center of the potential repository site as the site location (pl. 2). Radius circles at distances of 50 km and 100 km from the potential nuclear waste repository site at Yucca Mountain are denoted on plates 1 and 2. Faults within about 5 km of the potential repository site are shown on figure 3 and are included on the description sheets and in the summary tables, although Quaternary activity on these faults is being examined under separate studies (8.3.1.17.4.2, "Location and Recency of Faulting Near Prospective Surface Facilities", and 8.3.1.17.4.6, "Quaternary Faulting Within the Site Area"). These faults are included in this compilation so that their characteristics could be compared to those of faults farther from the site. Faults that are greater than 100 km from Yucca Mountain are also included in our assessment because (1) the Quaternary displacement histories of these faults may be used to infer Quaternary displacement histories along faults closer to the site, (2) some of these faults may merge with or be part of faults within 100 km of the site, or (3) these faults may impact the interpretation of the regional tectonic setting for the site. Furthermore, a few faults at distances greater than 100 km from the site are specifically mentioned in the study plan, for example the Pahranagat fault (Department of Energy, 1988).

Figure 3. Known and suspected Quaternary faults near the potential repository at Yucca Mountain.

Of the faults shown on plates 1 and 2, those faults with known or suspected Historical, Holocene (≤10 ka), or late Pleistocene (10 ka to 130 ka) displacements at any locality along their length are emphasized on the plates by thicker lines because these faults are the most likely to produce ground motions that may adversely affect the potential repository site. Faults shown by the thinner lines on the plates have known or suspected Quaternary displacement that is either thought to be older than late Pleistocene (>130 ka) or whose age cannot be more specifically defined at this time. Thus, late Pleistocene and Holocene displacements cannot be ruled out on many faults shown by the thinner lines. In designating the faults primarily by age, relative significance of faults determined on the basis of rupture length or amount of displacement is not obvious. For example, faults that have experienced one Holocene or late Pleistocene surface rupture are combined with faults that have experienced several surface ruptures during this same time interval. For example, the Death Valley, Furnace Creek, and Panamint Valley faults, which have evidence for multiple Holocene surface ruptures, are portrayed in the same way as the Carpetbag fault, which is reported to have evidence for late Pleistocene fault rupture that is limited to fracturing.

Faults that are portrayed only in Tertiary deposits or on Tertiary surfaces are generally not included in this compilation even though they have been noted by previous workers to be potentially young faults (Dohrenwend and others, 1991, 1992; Reheis, 1991a, 1992; Reheis and Noller, 1991). Faults expressed solely in Tertiary deposits or on Tertiary surfaces were excluded in order to focus the compilation on those faults that have reported evidence for known or suspected Quaternary displacement. Faults in Tertiary deposits or on Tertiary surfaces are shown on the plates only if they align with (and thus may be related to) faults or fault–related geomorphic features of known or suspected Quaternary age. Thus, all faults in pre–Quaternary deposits or on pre–Quaternary surfaces are treated in a similar manner. Eventually many of these faults may need to be examined to determine if they could have experienced Quaternary displacement, but additional study should probably be focused initially on those faults with known or suspected Quaternary surface rupture.

In addition to compiling the faults on plates 1 and 2, description sheets were assembled for each fault shown on the plates, for some faults near the potential nuclear waste repository (fig. 3), and for two faults outside of the area covered by the plates (the Cedar Mountain fault and the State Line fault that are shown on fig. 1). The description sheets summarize available information about fault location, fault strike and length, estimated ages of displaced and undisplaced Quaternary deposits, scarp characteristics, total displacement, Quaternary displacement, single–event displacement, slip rate, and recurrence of Quaternary surface rupture (appen. 2). These criteria were chosen because they will likely be important in evaluating whether or not a fault should be considered an earthquake source. A more detailed discussion of the information included on the description sheets is given in appendix 2.

The data on the description sheets presented in appendix 2 are summarized in tables in appendix 1. These summary tables were put together so that the characteristics of the individual faults within a given radius from the potential waste repository could be readily compared and contrasted. The methods used to assemble the tables are described in appendix 1.

Limitations of the Data Presented in this Compilation

The faults depicted on plates 1 and 2 and the data reported on the description sheets (appen. 2) and summarized in the tables (appen. 1) are influenced by a number of factors. First, the distribution of the faults and their age assessments are strongly biased by the information that is available in published literature. Some of the faults and the information about them have been inferred from studies in which the primary objective was something other than evaluating young fault displacements. The detail of mapping for faults varies considerably throughout the region. For example, studies evaluating possible Quaternary fault displacements south of latitude 36°N. are limited to investigations done at scales of 1:250,000 or smaller (fig. 2). In contrast, some faults have been mapped at a scale of 1:24,000 or larger.

Second, the scale of the maps in the original references influences the accuracy of the location of faults shown on plates 1 and 2. Faults that were shown on 1:250,000–scale maps could be directly transferred onto the base map. Faults shown by Reheis (1991a, 1992) and Reheis and Noller (1991) are portrayed on 1:100,000–scale maps with metric contour intervals requiring that the location of the faults on plates 1 and 2 be approximated. In addition, faults shown on maps with scales significantly smaller than 1:250,000, especially where topographic features are lacking and those shown on maps with scales significantly larger than 1:250,000 are also difficult to portray accurately. The purpose of plates 1 and 2 is to show the regional pattern of known and suspected Quaternary faults. Cited references should be consulted for the accurate location of an individual fault.

Third, the delineation of faults with Historical, Holocene, and late Pleistocene displacement should be considered with caution. Whereas some of these faults have documented evidence for one or more surface ruptures over much of their length during these time intervals (e.g., Death Valley fault, Furnace Creek fault, Panamint Valley fault), such displacement may be recorded at only a single locality along faults several tens of kilometers in length (e.g., Rock Valley fault, Bare Mountain fault). Extrapolation of data from a single site to the entire fault may not be a valid method of assessing the characteristics of the entire fault. In addition, faults shown on plates 1 and 2 as not having Historical, Holocene, and late Pleistocene displacement are not necessarily older Quaternary faults. These faults may have experienced younger ruptures that have not yet been identified or documented.

Fourth, assembling short, individual fault traces (or tectonic–related geomorphic features) into one fault and implying a single seismotectonic source, when no such grouping has been previously described in the literature, is very subjective and the resulting fault shown and labeled on plates 1 and 2 may not bear any relationship to geologic reality. Relationship to physiographic features, strike, type of displacement, and the criteria used to group the faults, can all vary along a single known fault. The faults that result from these groupings not only influence the visual image presented on the plates, but also affect various fault characteristics, most notably fault length, reported on the description sheets and in the summary tables.

Fifth, the data shown on the description sheets and in the summary tables are influenced by all the factors that limit assessment of Quaternary displacement along faults and by the differences in interpretation that result from each worker's skills and biases. These include, but are not limited to, problems in accurately dating the ages of Quaternary deposits, problems with determining the exact relationship between Quaternary deposits and faults (e.g., is the deposit really displaced?), problems of finding Quaternary deposits of several appropriate ages in proximity to the fault, and factors (e.g., climate, location, degree of cementation, erosion, deposition) that influence the preservation of scarps and other geomorphic features indicative of Quaternary displacement.

Sixth, the compilation of the description sheets and, especially, the summary tables required putting the various types of age data found in individual references into a single time scale. The reported ages of the deposits and surfaces in relationship to the faults do not always allow this to be done easily. Terms such as late Pleistocene or late Quaternary are used in different ways by individual workers, sometimes without specifying the age range that is meant. Additionally, both relative and numerical age estimates often have large uncertainties. As a result, reported ages for displaced deposits sometimes overlap with or appear to be older than the ages for the undisplaced deposits. Also, ages noted by some authors cross the age categories used by other authors and in this compilation.

Seventh, a compilation such as this can never be complete, in part because work is ongoing. This report and accompanying map are a first attempt to compile the information available as of December 1993 into a usable format for future studies. As in any study, existing work may been unintentionally overlooked. Thus, original references should examined before beginning any detailed study of a particular fault.

PATTERN OF KNOWN AND SUSPECTED QUATERNARY FAULTS WITHIN ABOUT 100 KM OF YUCCA MOUNTAIN AND ACCOMPANYING DATA

Ten faults within 50 km of the potential waste repository have Holocene or late Pleistocene (≤130 ka) displacements. Of these ten faults, the longest and most continuous is the northwest–striking Furnace Creek fault about 50 km southwest and west of the potential repository site (pls. 1 and 2). This fault is reported to have evidence for recurrent surface displacement along most of its 250 km length (including its possible extension into Fish Lake Valley). This fault may be even longer if it connects with the north–striking Death Valley fault, which also exhibits evidence for recurrent Holocene displacements, immediately to its south. If these faults represent a single fault system, then the length of the entire system would be at least 325 km, by far the longest geologic structure in the region with reported recurrent Holocene displacements.

The other nine faults within 50 km of the potential repository site for which Holocene or late Pleistocene surface ruptures have been reported include the following (listed in order of increasing distance from the site): the north–striking Bare Mountain fault located 14 km west of the site, the north–northeast–striking faults along the east side of Oasis Valley located 24 km northwest of the site, the northeast–striking Rock Valley fault located 24 km south of the site, the north– to northwest–trending Beatty scarp located 26 km west of the site, the north–striking Ash Meadows fault located 34 km south of the site, the northeast–striking Eleana Range fault located 37 km northeast of the site, the northwest–striking Amargosa River fault located 40 km south of the site, the north–striking Yucca fault located 40 km northeast of the site, and the north–striking Carpetbag fault located 43 km northeast of the site (pls. 1 and 2). Of these faults, only the Rock Valley fault, the Ash Meadows fault, the Yucca fault, and the Carpetbag fault have suggested lengths of greater than 30 km. Displacements along these faults have been reported to be normal, lateral, or oblique.

Fifteen more faults that are reported to have Holocene or late Pleistocene displacements are located between >50 km and about 100 km from the potential waste repository. The longest of these faults is the north– to north–northwest–striking Panamint Valley fault, which is at least 80 km long, and the northwest–striking Hunter Mountain fault, which is also about 80 km long. These two faults may represent a continuous fault system similar to the Death Valley and Furnace Creek faults to the east. The closest approach of these faults to the site is about 95 km. Other relatively long faults on which Holocene or late Pleistocene displacements have been noted are the generally north–striking, 85–km–long Kawich Range fault located 57 km north of the site, the northwest–striking, 70–km–long Pahrump fault located 70 km south–southeast of the site, the north–striking, 60–km–long West Pintwater Range fault located 76 km east of the site, the north– to north–northeast–striking, 55–km–long Belted Range fault located 55 km northeast of the site, and the north–striking, 50–km–long Cactus Flat fault located 84 km north of the site (pls. 1 and 2). Except for the Hunter Mountain fault and the Pahrump fault, most of these faults generally strike north.

Thirty–three faults that are reported to have Holocene or late Pleistocene displacements are located at distances greater than 100 km of the potential waste repository but within the area covered by plates 1 and 2. These faults, some of which have received more extensive work than faults within 100 km of the site, are included because some may be related to closer faults and some of these are specifically noted in the study plan (Department of Energy, 1988).

Available data on the Quaternary activity on the known and suspected Quaternary faults within the study area are assembled on description sheets in appendix 2 and in summary tables in appendix 1. Data for selected characteristics that are needed to assess each fault's potential seismic hazard are listed in tables 1 through 3. These tables highlight the lack of data about known and suspected Quaternary faults within about 100 km of Yucca Mountain. Even for faults within 50 km of the site, data are generally based on only limited or reconnaissance studies. For only a few faults have the parameters been estimated that will be needed to assess the potential of these faults for future earthquake activity (e.g., potential rupture length, type of displacement, amount of displacement per event, slip rate, and recurrence of surface–rupturing events). Even for these few faults, examination of available maps and reports indicates that these values are often rough guesses, are based on limited field data, or are estimated for only a short section or at only a single locality along the fault. A primary obstacle in calculating slip rate and recurrence is the lack of reliable age estimates for deposits or surfaces displaced by or burying the faults. Although the dating of deposits and surfaces is a continual problem in Quaternary studies, for many faults within 100 km of Yucca Mountain, no attempt has yet been made to map the distribution of Quaternary deposits in relation to the faults and to evaluate the potential for obtaining numerical ages on these deposits. The possibility for correlating Quaternary deposits and surfaces with those that have been studied in detail in Midway Valley (e.g., Gibson and others, 1991; Wesling and others, 1992) has also not been evaluated. In addition, types of displacement and amounts of displacement have not yet been determined. The component of strike–slip displacement, in particular, needs to be addressed because some initial workers assumed that displacements along faults in the area were principally dip slip, an assumption that subsequent workers have suggested may not be correct for some faults. In addition, conclusions of some studies are contradictory and open to alternative interpretations.

Additional examination of faults in the region may eliminate some of the known and suspected Quaternary faults shown on plates 1 and 2, may add other faults that do have Quaternary displacements but are as yet unrecognized, or may change the age designations and other information shown on the plates and noted on the description sheets and in the summary tables. Hopefully, future studies will provide additional detailed information to expand our knowledge of these faults, so that those within about 100 km of the potential waste repository can be evaluated on the basis of more uniform and reliable data.

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APPENDIX 1. DATA TABLES FOR KNOWN AND SUSPECTED QUATERNARY FAULTS WITHIN ABOUT 100 KM OF YUCCA MOUNTAIN

INTRODUCTION

This appendix contains tables that summarize properties of known and suspected Quaternary faults located within the area covered by plates 1 and 2. It includes known and suspected Quaternary faults within 100 km of the potential waste repository at Yucca Mountain. Data shown on these tables have been extracted from the description sheets presented in appendix 2. The tabulated properties provide information about possible earthquake sources relevant to the potential waste repository. The properties shown in the tables in this appendix are listed below. The tables in which the properties appear are shown in parentheses.

- Strike of the fault (Tables 8, 13, 18)
- Type of displacement identified along the fault (Tables 8, 13, 18)
- Estimated length of the fault (Tables 4, 9, 14)
- Percent of the fault's total length that has experienced late Quaternary surface rupture (Tables 4, 9, 14)
- Closest approach of the fault to the potential waste repository at Yucca Mountain (Tables 4, 9, 4)
- Estimated age(s) of the youngest displaced deposit(s) (Tables 5, 10, 15)
- Estimated age(s) of the oldest undisplaced deposit(s) (Tables 5, 10, 15)
- Amount of displacement that occurred in the youngest surface–rupturing event (Tables 5, 10, 15)
- Amount of displacement that has occurred during the late Quaternary (Tables 5, 10, 15)
- Slip rates or apparent slip rates estimated for time intervals during the Quaternary (Tables 6, 11, 16)
- Estimated number of surface–rupturing events for time intervals during the Quaternary (Tables 7, 12, 17)
- Recurrence interval between surface–rupturing events during the late Quaternary or the Quaternary (Tables 8, 13, 18)

Two additional pieces of information are shown for the faults:

- Plate or figure number where the fault is shown (Tables 4, 9, 14)
- Reference(s) from which the data were taken (Tables 4, 5, 8, 9, 10, 13, 14, 15, 18). The numbers beginning with "Y-" have been arbitrarily assigned to the references. The references are listed by these numbers in appendix 4.

The faults shown in the tables in this appendix are grouped by distance from the potential waste repository at Yucca Mountain as follows: faults within 50 km of Yucca Mountain (tables 4 through 8, pages 18 through 35), faults between >50 and 100 km from Yucca Mountain (tables 9 through 13, pages 36 through 55), and faults at distances greater than 100 km from the site but within the area covered by plates 1 and 2 (tables 14 through 18, pages 56 through 75).

Previous workers have subdivided several faults into segments (although these are not necessarily rupture segments). These segments or sections are listed separately in the tables under the fault name. Some individual traces of a fault have received enough study that they are also listed separately under the fault name. In addition, some separate, short faults are listed together under one name on plates 1 and 2 and on the description sheets in appendix 2. These short faults are shown under the name for the group of faults, but properties are listed for each short fault.

Large uncertainties exist in the ages of the displaced and undisplaced deposits. These uncertainties partly reflect the problems in determining the ages of Quaternary deposits. In some cases, ages have been estimated at different localities along a fault, but studies are not detailed or extensive enough to determine if the differences in ages actually reflect differences in rupture histories. These uncertainties sometimes result in age estimates for the youngest displaced deposits that overlap with or are younger than the age estimates for the oldest undisplaced deposits.

DISCUSSION

The tables in this appendix demonstrate that, with but a few exceptions, little data about the properties listed above are available for known and suspected Quaternary faults within about 100 km of the potential waste repository at Yucca Mountain. The exceptions are the faults within about 5 km of the site (site faults) and a few other faults that have received relatively detailed study (e.g., the Carpetbag fault in Yucca Flat). Additional studies may eliminate some faults listed in the tables in this appendix by demonstrating that no Quaternary surface rupture has occurred. Additional studies may also change the way in which some faults are portrayed on plates 1 and 2. Previously mapped fault traces that have known or suspected Quaternary activity and geomorphic features (e.g., scarps, lineaments, and linear range fronts) that may indicate Quaternary surface rupture have been grouped together where these traces and geomorphic features have similar strikes or trends and similar relationships to topographic features (e.g., at or near the base of a mountain range), and a similar senses of displacement, if they are indicated. However, once an understanding of fault displacements and their ages becomes clearer, grouped fault traces as shown on plates 1 and 2 may change. This could be significant for some properties shown in the tables in this appendix. An example is fault length, a property used to assess potential hazard but one that is primarily dependent upon how individual fault traces have been grouped together.

Compilation of existing data is in constant revision because of the continuing study of the faults near and around Yucca Mountain. Because of this, a primary goal of this compilation is to provide an exhaustive bibliography of what was available as of December 1993. Additional studies will, hopefully, provide the data necessary to complete the tables in this appendix.

Table 4. Estimated length, total displacement, and distance from the site for known and suspected Quaternary faults within 50 km of Yucca Mountain

[Detailed data are on data sheets in appendix 2. References are listed by number in appendix 4. Queried entries indicate uncertainty in information. Entries separated by a comma (,) indicate data for individual faults or at different localities along a fault or faults; entries separated by a semicolon (;) indicate different interpretations by different authors; leaders (--), no information was noted during the literature review; YM, the proposed repository site at Yucca Mountain]

Fault or faults [Segment, individual fault]	Plate (P) or Figure (F) number	Estimated total fault length (km)	Percent of total length with late Quaternary displacement	Total vertical displacement (km)	Total lateral displacement (km)	Closest approach to YM (km)	References (Y-)
Amargosa River fault (AR)	P2	15	--	--	--	40	695
Area Three fault (AT)	P1	[1]5 to 7.5	--	--	--	44	181, 224, 526
Ash Meadows fault (AM)	P2	60	--	--	--	34	69, 695
[Northern section]	P2	7	--	[2]≥0.05	--	--	695
[Central section]	P2	5	--	[3] (0.002 to 0.003)	--	--	695
[Southern section]	P2	48	--	--	--	--	69, 695
Bare Mountain fault (BM)	P1, P2	15.5	--	≥2.6	--	14	3, 101
[Section #1]	F5	3.5	--	--	--	--	
[Section #2]	F5	3.3	--	--	--	--	
[Section #3]	F5	2.5	--	--	--	--	
[Section #4]	F5	3.8	--	--	--	--	
[Section #5]	F5	2.5	--	--	--	--	
Beatty scarp (BS)[4]	P1, P2	8; 10; 25?	--	--	--	26	6; 232, 1041
Bow Ridge fault (BR)	F3	≥6; 9 to10	--	[5]≥0.2	--	1	26, 46, 55, 217, 224, 298, 772, 1042
Bullfrog Hills faults (BUL)	P1	[6]4, 7	--	--	--	38	232
Cane Spring fault (CS)	P1, P2	14; 27	--	--	--	36	104, 210, 232
Carpetbag fault (CB)	P1	16.5; 30	--	[7]≥0.6; 1.2?	[8]≥0.6	43	181, 182, 224, 526
Checkpoint Pass fault (CP)	P2	8	--	--	--	44	813, 852
Crossgrain Valley faults (CGV)[9]	P2	--	--	--	--	48	

Table 4. Estimated length, total displacement, and distance from the site for known and suspected Quaternary faults within 50 km of Yucca Mountain — Continued

Fault or faults [Segment, individual fault]	Plate (P) or Figure (F) number	Estimated total fault length (km)	Percent of total length with late Quaternary displacement	Total vertical displacement (km)	Total lateral displacement (km)	Closest approach to YM (km)	References (Y-)
[North Ridge front fault]	P2	7; 8.5	--	--	--	--	813, 852
[Northeast valley faults]	P2	1.5; 2.5	--	--	--	--	813, 852
[Southwest valley fault]	P2	3	--	--	--	--	813
East Crater Flat faults (ECR)	F3	--	--	--	--	--	
Fault S	F3	12	--	--	--	4	26
Fault T	F3	7	--	--	--	5	26
Black Cone fault (BLK)	F3	3.5 to 6.5	--	--	--	7	1196, 1201
West lava fault (WL)	F3	8				7	1196, 1201, 1230
Fault U	F3	0.2; 0.5	--	--	--	16	26
Eleana Range fault (ER)	P1	6; 9; 13	--	--	--	37	526, 813, 853
Fatigue Wash fault (FW)	F3	4.5; 7.5	--	--	--	2	26, 1042
Furnace Creek fault (FC)	P1, P2	[10]105; 115; 160; 165; 175; >250; 400	[11]75 to 80	--	[12]10; ≥19; 24 to 48; 50; 68±4; 80; 80 to 128	50	216, 236, 262, 389, 468, 479, 596, 600, 651, 683, 1027
Ghost Dance fault (GD)	F3	9; 19 to 20	--	≥0.025	--	0	26, 55, 396, 1042
Keane Wonder fault (KW)	P2	25		--	[13]5	43	238, 1357
Mercury Ridge faults (MER)	P2	--	--	--	--	--	
[Northwest fault]	P2	9; 10	--	--	--	48	813, 852
[Southeast fault]	P2	3	--	--	--	51	852
Mine Mountain fault (MM)	P1	16; 22; 27	--	--	≥1	19	104, 182, 205, 232
Oasis Valley faults (OSV)	P1	--	--	--	--	--	
[Eastern faults]	P1	[14]16 to 20(?)	--	[15]≥0.004	--	24	10, 238, 813, 1223
[Western faults]	P1	[14]7 to 11(?)	--	--	--	30	238, 813
Pahute Mesa faults (PM)	P1	[16]9	--	--	--	48	813
Paintbrush Canyon fault (PBC)	F3	18; 25; 30	--	[15]0.3; ≥0.5	--	3	26, 46, 55, 217, 224, 575, 1042
Plutonium Valley–North Halfpint Range fault (PVNH)	P1	15; 26	--	--	--	46	232, 813

Table 4. Estimated length, total displacement, and distance from the site for known and suspected Quaternary faults within 50 km of Yucca Mountain — Continued

Fault or faults [Segment, individual fault]	Plate (P) or Figure (F) number	Estimated total fault length (km)	Percent of total length with late Quaternary displacement	Total vertical displacement (km)	Total lateral displacement (km)	Closest approach to YM (km)	References (Y-)
Ranger Mountains faults (RM)[16]	P2	--	--	--	--	--	
[North faults]		3; 5	--	--	--	--	813, 852
[South faults]		3; 4	--	--	--	--	813, 852
Rock Valley fault (RV)	P2	[19]19; 32; 65	--	--	([20])	[21]24; 27	20, 62, 68, 224, 238, 695
Rocket Wash–Beatty Wash fault (RWBW)	P1	[22]5; 17	--	--	--	19	238, 813, 853
Solitario Canyon fault (SC)	F3	≥12; 13	--	[23]≥0.4; 1	--	0.5	26, 396, 1201
Stagecoach Road fault (SCR)	F3	[24]≥9; 12; 13; 31	--	[25]≥10	[26]≥1	10	31, 46, 55, 189, 396
Tolicha Peak fault (TOL)	P1	22	--	--	--	42	813
Wahmonie fault (WAH)	P2	14; 15	--	--	--	22	104, 232
Windy Wash fault (WW)	F3	[27]14; 25	--	≥0.4	--	3	396, 701
Yucca fault (YC)	P1	[28]22; 25; 24 to 32; 34 to 40	--	[29]≥0.2; 0.31 to 0.61; >0.61	([30])	40	181, 526, 693, 813, 853
Yucca Lake fault (YCL)	P1	17	--	--	--	36	232

[1]The northern portion is about 2 km long. The southern section has two branches, a western one 3 or 4 km long and an eastern one 3.5 to 5.5 km long (Y-181; Y-224; Y-526).

[2]This displacement is for a 3.2-Ma tuff along the western branch of the northern section (Y-695).

[3]This is the minimum vertical displacement of a deposit with an estimated age of about 40 ka as interpreted from trenches (Y-695).

[4]Although a tectonic origin is not clear, a non–tectonic origin for the Beatty scarp has not been verified. Therefore, the feature is included in this compilation, which is based on published literature and other readily available data for known and suspected Quaternary faults.

[5]The is the apparent vertical separation reported by Y-217 and Y-298 for the Topopah Spring Member of the Paintbrush Tuff (13.1±0.8 Ma; K-Ar).

[6]BUL includes four faults. The eastern and western faults are each about 7 km long. The other two faults are each about 4 km long (Y-232).

[7]Y-181 (p. 27) reported an average vertical displacement in Tertiary volcanic tuff of 600 m. Y-182 (p. 21, 23-24) noted that alluvium adjacent to the southern end of CB is 600 to 1,200 m thick and interpreted this depression to be a structural feature formed in part by vertical displacement on CB.

[8]Y-181 (p. 27) noted that the amount of right-lateral displacement on CB since deposition of Tertiary volcanic tuff could be ≥600 m and that Paleozoic rocks could be displaced laterally "several thousand feet."

[9]CGV includes several faults: one along the front of North Ridge (North Ridge front fault), faults about 0.5 km north of North Ridge in Crossgrain Valley and faults at the northeastern end of the ridge (Northeast valley faults), and a fault at the southwestern end of North Ridge (Southwest valley fault).

[10]Variation in length estimates results from differences in the interpretation of the ends of FC, especially it southeastern extension along the Furnace Creek basin into the Amargosa Valley, and the relationships between FC and the Fish Lake Valley fault (FLV) to the northwest and the Death Valley fault (DV) to the south. (See data sheets in appendix 2.)

[11]Percent of length with late Quaternary displacement was estimated using a late Quaternary rupture length of 130 km (between the northern end of Death Valley and Navel Spring adjacent to Furnace Creek Wash) and a total length of 165 to 175 km (between the northern end of Death Valley and the Amargosa Valley).

[12]Y-683 (p. 128) thought that development of Furnace Creek basin requires no more than 10 km of right-lateral displacement on FC. Y-468 (p. 157) implied that right-lateral displacement on FC has been at least 19 km. Y-389 (p. 56) suggested that FC has experienced 24 to 48 km of right-lateral displacement. Y-596 estimated 50 km of right-lateral displacement on FC at the northern end of Death Valley. On the basis of correlations of Mesozoic thrust faults, Y-1027 suggested that 68±4 km of apparent right-lateral displacement has occurred on FC between the Cottonwood and Funeral mountains. Y-600 (p. 133, 135) estimated about 80 km of right-lateral displacement on FC on the basis of isopachs on Upper Precambrian and Lower Cambrian rocks. Y-262 (p. 1411) interpreted isopachs and facies of Devonian and Silurian rocks and the distribution of Mississippian rocks as indicating 80 to 128 km of right-lateral displacement on FC in northern Death Valley.

[13]Y-1357 reported about 5 km of right-lateral displacement on the southeastern end of KW. This amount was estimated from displaced, northeast-trending axes of folds in Proterozoic rocks.

Table 4. Estimated length, total displacement, and distance from the site for known and suspected Quaternary faults within 50 km of Yucca Mountain — Continued

[14]A graben shown by Y-813 in the northern part of Oasis Valley does not clearly align with the faults along either side of the valley. The larger, queried value is the length of the faults if this graben, which is about 3.5 km long, is included with the other faults.

[15]Y-10 (p. 58) reported that one fault along the eastern side of Oasis Valley displaces Quaternary and Tertiary alluvial-fan deposits about 4 m.

[16]Individual faults have lengths between 0.5 and 4 km (Y-813).

[17]Stratigraphic dip separation on PBC in the Topopah Spring Member of the Paintbrush Tuff (13.1±0.8 Ma) is 515±5 m at the northern end of Fran Ridge (Y-55; Y-217). Total displacement across the Fran Ridge fault, which Y-217 (p. 52) included as a splay of PBC, is about 300 m.

[18]RM includes two faults north of the Ranger Mountains (North faults) and four faults in the southern Ranger Mountains (South faults).

[19]RV as mapped by Y-224 extends from the Specter Range to Frenchman Flat for a length of about 32 km. The length of RV as portrayed by Y-20 is only 19 km because they do not show fault traces in Frenchman Flat to be part of RV. Y-68, Y-238, and Y-695 extend RV about 33 km southwest of the Specter Range into the Amargosa Desert for a total length for RV of about 65 km.

[20]Total lateral displacement on RV is estimated to be "a few kilometers" (Y-62).

[21]Distance is 27 km if RV is considered to extend from the Specter Range to Frenchman Flat. Distance is 24 km if the southwestern end of RV extends into the Amargosa Desert as suggested by Y-68, Y-238, and Y-695.

[22]The length of 5 km is from Y-853, who show only some of the fault traces that are shown by Y-238 and Y-813. Y-238 and Y-813 estimated RWBW to be 17 km long.

[23]Y-396 (p. 273) reported a dip-slip displacement of 0.4 km along the central portion of SC since 13.5 Ma. Y-396 (p. 259) noted a cumulative displacement of about 1 km at the southern end of the fault.

[24]The length of SCR is 12 km as estimated from Y-55 and about 9 km as estimated from Y-189, but SCR extends to the edge of their map areas. If concealed sections between Yucca Mountain and Jackass Flats, across Jackass Flats, and northeast of the flats are considered part of SCR, then the total length of SCR as portrayed by Y-46 is 31 km.

[25]On the basis of tectonic tilt of volcanic units (Paintbrush Tuff at 13 Ma to 13.5 Ma and Timber Mountain Tuff at 11.5 Ma), Y-396 (table 2, p. 275) suggested 6.7 km of vertical displacement on SCR between 13 Ma and 11.5 Ma, 3.3 km of vertical displacement since 11.5 Ma, and 4.5 m of vertical displacement since some time after 1.7 Ma. This is a total vertical displacement of at least 10 km.

[26]Y-31 (p. 332) identified as much as 1 km of left-lateral displacement of ridges composed of a 13-Ma tuff.

[27]Y-701 reported a length of 14 km for WW. The length of WW is about 25 km as estimated from the map by Y-396 (p. 256).

[28]The total length of YC is about 22 km as estimated from Y-813 (pl. 2) and Y-853, about 25 km as estimated from Y-526, at least 24 km and possibly 32 km as noted by Y-181 (p. 26), and about 34 km to 40 km as inferred by Y-693 (p. 209). The longest values include the Butte fault (BT) as part of YC.

[29]Y-181 (p. 27) reported a vertical displacement of ≥200 m in Tertiary volcanic tuff. Y-693 (p. 201) reported that alluvial and lacustrine deposits are 305 to 610 m thick on the downthrown side of YC; alluvium in the south-central part of the basin and east of YC (downthrown side) is >610 m thick (Y-688, p. 50). These thicknesses may represent the amount of vertical displacement on YC.

[30]Y-181 (p. 29) reported that Paleozoic rocks may be displaced laterally "several thousand feet" on YC. Y-181 (p. 27) also noted that the lateral component of displacement in Tertiary volcanic tuff may be equal to or greater than the amount of vertical displacement (≥200 m).

Table 5. Estimated ages of displaced and undisplaced deposits and amounts of youngest displacement for known and suspected Quaternary faults within 50 km of Yucca Mountain

[Detailed data are on description sheets in appendix 2. Ages are estimated primarily from photogeologic, geomorphic, and pedologic criteria. (See individual references and description sheets in appendix 2 for limitations.) References are listed by number in appendix 4. Overlap of ages reported in columns 2 and 3 reflects uncertainties in age estimates and in stratigraphic interpretations (appen. 2). Abbreviations for ages (used where age is not specified in years): Hist., Historical; Hol., Holocene; E.Hol., Early Holocene; Lt.Pleist., Latest Pleistocene; L.Pleist., Late Pleistocene; L-M Pleist., Late and Middle Pleistocene; M.Pliest., Middle Pleistocene; E.Pleist. Early Pleistocene; L.Plio., Latest Pliocene; L.Quat., Late Quaternary; Quat., Quaternary; Tert., Tertiary. Late Quaternary displacement is since 130 ka. Queried entries indicate uncertainty of information. Entries separated by a semicolon (;) indicate different interpretations by different authors; entries separated by a comma (,) indicate data for individual faults or at different localities along a fault or faults; leaders (--), no information was noted during the literature review]

Fault or faults [Segment or individual fault]	Age of youngest unit/surface displaced (10^3 yr)	Age of oldest unit/surface undisplaced (10^3 yr)	Displacement in youngest event (m)		Late Quaternary displacement (m)		References (Y-)
			Vertical	Lateral	Vertical	Lateral	
Amargosa River fault (AR)	≤10	--	--	--	--	--	695
Area Three fault (AT)	[1]Hist.; ≤10	--	--	--	--	--	181, 224, 526
Ash Meadows fault (AM)							
[Northern section]	[2]≤10	--	--	--	[2]≤50	--	695
[Central section]	>10; 40	--	1.6, >3	--	--	--	695
[Southern section]	E.Hol./Lt.Pleist.	≤10	--	--	--	--	69
Bare Mountain fault (BM)	Hol.	--	--	--	--	--	3, 1041
[Section #1]	L/M Pleist.?	--	--	--	--	--	3
[Section #2]	<350	--	--	--	--	--	3
[Section #3]	L/M Pleist.?	≤8.3±0.075	--	--	--	--	3, 64
[Section #4] locality 3	<(5 to 15)	--	--	--	--	--	3
locality 4	<9	--	1.75	--	--	--	3
locality 5	E.Hol.	--	--	--	--	--	
[Section #5]	L/M Pleist.?	--	--	--	--	--	3
Beatty scarp (BS)[3]	[4]<(10 to12)	[5]>(1 to 3?)	--	--	[6]≥2 to 30	--	6
Bow Ridge fault (BR)	[7]38±10 to 270±90; 270 and 1,200	[8]40; 38±10; 90±50	Fracturing; [9]0.05 to 0.2	[9]0.11 to 0.28	[10]0.45	[10]0.76 to 1.32	26, 87, 217, 1091
Bullfrog Hills faults (BUL)	Quat.	Quat.	--	--	--	--	43, 232
Cane Spring fault (CS)	Quat.?	Quat.	--	--	--	--	104, 210, 226, 232
Carpetbag fault (CB)	[11]Hist.; 30	[12]35±15; 125 to 130 (350?); 170	[13]Fracturing	[14]0.15	--	--	181, 224, 327, 1106

Table 5. Estimated ages of displaced and undisplaced deposits and amounts of youngest displacement for known and suspected Quaternary faults within 50 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Age of youngest unit/surface displaced (10^3 yr)	Age of oldest unit/surface undisplaced (10^3 yr)	Displacement in youngest event (m)		Late Quaternary displacement (m)		References (Y-)
			Vertical	Lateral	Vertical	Lateral	
[Southeast fault]	Quat.?	Quat./Tert.	--	--	--	--	62, 852
Mine Mountain fault (MM)	Quat.	Quat.	--	--	--	--	104, 205, 232, 238
Oasis Valley faults (OSV)							
[Eastern faults]	[21]>(27 to 35) to <730; 145 to 430; Quat.	--	--	--	≥4	--	10, 73, 264, 1223
[Western faults]	Quat.	--	--	--	--	--	813
Pahute Mesa faults (PM)	Quat.	--	--	--	--	--	813
Paintbrush Canyon fault (PBC)	[22]L.Quat.; 270 to 700; 270 to 800; 700 to 750; L.Pleist.	[23]160 to 250; 270 to 700; Quat.	[24]0.15	--	[25]≤4.1; ([26]); [27]≤(1.7 to 2.7)	--	26, 217, 575, 1098
Plutonium Valley–North Halfpint Range fault (PVNH)	Quat.	Quat.	--	--	--	--	232, 813
Ranger Mountains faults (RM)[28]							
[North faults]	Quat.	--	--	--	--	--	852
[South faults]	Quat.	--	--	--	--	--	852
Rock Valley fault (RV) [Central section]	[29]<(31 to 38); ≤10	([30])	0.1 to 0.32	--	[31]≤(2.5 to 3)	--	20, 70
[Northeast section]	[32]10 to130	--	--	--	--	--	852
[Possible southwest extension]	≤10	--	--	--	--	--	68, 90, 695
Rocket Wash–Beatty Wash fault (RWBW)	Quat.	--	--	--	--	--	238, 813
Solitario Canyon fault (SC)	6.6 to 11.1; ≤15	270 to 800	([33])	--	≤1	--	26, 396, 700, 1196, 1201, 1230
Stagecoach Road fault (SCR)	1100 to 2000; Quat.	700 to 750	--	--	--	[34]≤(10 to 30)	26, 31
Tolicha Peak fault (TOL)	Quat.	--	--	--	--	--	813
Wahmonie fault (WAH)	270 to 740; >740; Quat.	150 to 740	[35]<1 to 3?	--	--	--	226, 238
Windy Wash fault (WW)	3 to 6.5	--	<0.1	--	[36]≤(1.5 to 2)	--	12, 701

Table 5. Estimated ages of displaced and undisplaced deposits and amounts of youngest displacement for known and suspected Quaternary faults within 50 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Age of youngest unit/surface displaced (10^3 yr)	Age of oldest unit/surface undisplaced (10^3 yr)	Displacement in youngest event (m) Vertical	Displacement in youngest event (m) Lateral	Late Quaternary displacement (m) Vertical	Late Quaternary displacement (m) Lateral	References (Y-)
Yucca fault (YC)	[37]Hist.; 1 to 10; 10 to 130; ≥35	≤10	--	--	[38]1.5 to 6; >12; 15	--	181, 224, 526, 688, 693, 853, 1106
Yucca Lake fault (YCL)	Quat.[?]	--	--	--	--	--	181, 232

[1]Surficial expression of parts of the Area Three fault may be the result of underground nuclear explosions (Y-181; Y-224).

[2]Data are for the western branch of the northern section.

[3]Although a tectonic origin is not clear, a non–tectonic origin for the Beatty scarp has not been verified. Therefore, the feature is included in this compilation, which is based on published literature and other readily available data for known and suspected Quaternary faults.

[4]Age is uncertain. Radiocarbon dates suggest that faulted deposits are about 10 ka (10±0.3 ka and 9.8±0.3 ka), but uranium-trend analyses suggest that the age of these same deposits is about 500 ka (480±50 ka). Maximum scarp-slope angles suggest that displacement is younger than 12 ka, but older than a few thousand years (Y-6).

[5]Age is based on interpretation of maximum scarp-slope angles (Y-6; see note 4 above).

[6]These are the measurements of scarp heights (Y-6). Number of events is not known; ages for the scarps are not specified.

[7]These first two ages were estimated using uranium-trend methods (Y-26). Y-217 concluded that the dates are inconsistent. The last two numbers are from Y-87, who concluded that the most-recent event exposed in Trench 14 is represented by undated basaltic ash that they correlated with 1.2-Ma and 0.27-ka ashes from Crater Flat.

[8]Y-217 concluded that deposits with an estimated age of 40 ka overlie the fault. Y-87 interpreted an eolian unit that yielded dates (uranium-trend analyses) of 38±10 ka and 90±50 ka as undisplaced.

[9]Y-1091 inferred a per-event vertical displacement between 5 and 20 cm (average of about 10 cm) and an average net (left-oblique) displacement per event between 11 and 28 cm.

[10]Y-1091 inferred a cumulative vertical displacement of 45 cm since middle Quaternary and a cumulative net (left-oblique) displacement of 76 to 132 cm since middle Quaternary.

[11]The youngest fracturing occurred about 30 ka (Y-327). Y-181, Y-224, Y-327, and Y-1106 all reported that portions of CB were reactivated by an underground nuclear explosion in 1970.

[12]On the basis of a date (uranium-trend analyses) of 35±15 ka for an unfractured deposit, Y-327 (p. 231) and Y-1106 (p. 25, 30) concluded that no surface fracturing (or larger displacement) had occurred on at least part of CB since that time. Another unfractured deposit was estimated to have an age of about 170 ka by Y-1106 (p. 30) on the basis of development of both rock varnish and an argillic soil horizon. On the basis of an absence of prehistoric scarps and undisplaced stratigraphic units exposed in three trenches, Y-327 (p. 231) and Y-1106 (p. 14, 31) concluded that no significant vertical displacement had occurred at least since 10 ka, probably since 125 ka to 130 ka, and possibly since 350 ka.

[13]Youngest displacements have been interpreted by Y-327 to be fracturing only.

[14]An historical subsurface explosion resulting from nuclear testing produced 15 cm of right-lateral displacement across a 1.2-m-high scarp and left-stepping, *en echelon* cracks (Y-181).

[15]The Quaternary age is based on the faults juxtaposing Quaternary alluvium against bedrock along a range front or ridge that has morphologic features similar to those along major range-front faults (Y-852).

[16]A map by Y-1230 (fig. 5) portrays as "recently active" a fault that is probably correlative with Fault S.

[17]The youngest units displaced at several localities have estimated ages of late Holocene (0.2 ka to 2 ka; Y-216, table 3). The oldest undisplaced units noted by Y-216 (table 3, p. 20) along most of FC are latest Holocene (<200 yr). However, they recognized no displacement of late Holocene units (0.2 ka to 2 ka) northwest of Grapevine Canyon. Similarly, Y-66 portrayed FC northwest of Grapevine Canyon as displacing deposits no younger than Pleistocene. Y-421 (p. 8, pl. 1) shows an undisplaced surface with an estimated age of older Pleistocene across FC above Navel Spring about 15 km southeast of the Furnace Creek Inn in the Furnace Creek basin.

[18]Y-236 (p. 238) noted 0.6 to 1.5 m of east-side-down, vertical displacement in a gravel deposit with an estimated Holocene age in northern Death Valley.

[19]This is the range of right-lateral displacements noted by Y-216 (table 3) on late Holocene surfaces.

[20]The maximum right-lateral displacement noted by Y-216 (table 3) on a Pleistocene surface is 21 m near Grapevine Canyon. Y-236 (p. 238) reported right-lateral displacement of 46 m for an alluvial fan with well-developed desert varnish and pavement and an estimated Pleistocene age in the area northwest of Red Wall Canyon.

[21]These are the different age estimates that were given by Y-73 and Y-264 for the faulted deposits.

[22]Y-575 (p. A119) estimated that the youngest rupture at Busted Butte probably occurred during late Quaternary. On the basis of correlation of stratigraphic units, Y-26 (table 4, p.21) inferred an age of 270 ka to 700 ka for the youngest displacement on PBC. Y-26 (table 1, p. 5) noted that the youngest rupture that is recorded in two trenches near Yucca Wash near the northern end of PBC displaced units with an estimated age of 700 to 750 ka in one trench and an estimated age of 270 ka to 800 ka in the other trench. Y-26 (table 1, p. 5) concluded that the youngest rupture recorded in two trenches west of Fran Ridge displaces deposits with an estimated age of 700 ka to 750 ka. On the basis of faulted and unfaulted colluvial deposits exposed in a trench, Y-1098 (p. 153) inferred a late Pleistocene age for the most-recent displacement along a western splay of PBC.

[23]Y-26 (table 1, p. 5) noted that the youngest rupture that is recorded by two trenches near Yucca Wash near the northern end of PBC does not displace deposits with an estimated age of 160 ka to 250 ka. Y-26 (table 1, p. 5) concluded that the youngest rupture recorded in two trenches west of Fran Ridge does not displace deposits with an estimated age of 270 ka to 700 ka. PBC is shown by Y-224 as concealed over much of its length.

[24]Y-1098 (p. 153) estimated a vertical displacement of about 15 cm during the youngest rupture along a western splay of PBC. They estimated a vertical displacement per event of 40 to 85 cm for all but this youngest event.

[25]Y-575 (p. A119) reported an apparent maximum vertical displacement of 4.1 m at Busted Butte for the deepest of several buried soils (maximum age of 700 ka) developed in sand ramps. Assuming oblique displacement of 45°, Y-575 (p. A119) calculated a total oblique displacement of 5.8 m since the beginning of middle Pleistocene.

[26]Y-26 (p. 13) noted that displacement in middle and late Pleistocene deposits exposed in trenches near Yucca Wash have apparently been minor (less than a few centimeters).

[27]Y-1098 (p. 153) estimated a cumulative dip-slip displacement of about 170 to 270 cm in middle Pleistocene deposits along a western splay of PBC.

[28]RM includes two faults north of the Ranger Mountains (North faults) and four faults in the southern Ranger Mountains (South faults).

[29]Data are for the central part of RV at the trench sites of Y-20.

[30]Y-70 noted that younger Holocene units (their Q1b deposits) are deposited against fault scarps on older Pleistocene (160 ka to 740 ka) surfaces.

[31]Vertical displacement on the central part of RV is 2.5 to 3 m in deposits thought to be older than 740 ka (Y-20).

[32]Data are for scarps along Frenchman Flat at the northeastern end of the fault (Y-852).

Table 6. Slip rates (mm/yr) for known and suspected Quaternary faults within 50 km of Yucca Mountain

[Detailed data are on description sheets in appendix 2. References are listed on tables 4, 5, and 8 and in appendix 2. Rates in italics are for apparent lateral slip; rates in vertical type are for apparent vertical slip. F indicates fracturing has been recognized, but no significant displacement. Numbers in parentheses indicate the time interval for which the rate has been estimated. The pre–Quaternary rates are based on displacement of units that are older than 1.6 Ma, but the time interval over which the rates are estimated may continue into the Quaternary. Queried entries indicate uncertainty in information. Entries separated by a semicolon (;) indicate different interpretations by different authors; leaders (– –), no information was noted during the literature review]

Fault or faults	Holocene			Pleistocene		Late		Pre-Quaternary	
	Late	Middle	Early	Late	Middle	Quaternary	Quaternary		Interval
[Segment or individual fault]	0-4 ka	4-8 ka	8-10 ka	10-130 ka	130-790 ka	<130 ka	<1.6 Ma	Rate	(10^6 yr)
Amargosa River fault (AR)	– –	– –	– –	– –	– –	– –	– –	– –	– –
Area Three fault (AT)	– –	– –	– –	– –	– –	– –	– –	– –	– –
Ash Meadows fault (AM)									
[Northern section]	– –	– –	– –	– –	– –	– –	– –	[1]0.016	<3.2
[Central section]	---------- 0.04 ----------(<40 ka)				– –	– –	– –	– –	– –
[Southern section]	– –	– –	– –	– –	– –	– –	– –	– –	– –
Bare Mountain fault (BM)									
[Section #1]	– –	– –	– –	– –	– –	– –	– –	– –	– –
[Section #2]	– –	– –	– –	– –	– –	– –	– –	– –	– –
[Section #3]	– –	– –	– –	– –	– –	– –	– –	– –	– –
[Section #4]	---------- 0.19 ----------(<9 ka)				– –	– –	– –	– –	– –
[Section #5]	– –	– –	– –	– –	– –	– –	– –	– –	– –
Beatty scarp (BS)[2]	– –	– –	– –	– –	– –	– –	– –	– –	– –
Bow Ridge fault (BR)	---------- F ----------(<(38 to 270) ka)					[3]0.001	– –	0.016 to 0.018; 0.009 to 0.011	<(12.3 to 13.9); <(11.4 to 13.6)
Bullfrog Hills faults (BUL)	– –	– –	– –	– –	– –	– –	– –	– –	– –
Cane Spring fault (CS)	– –	– –	– –	– –	– –	– –	– –	([4])	11 to 14
Carpetbag fault (CB)				(>10; >39; >130; >850?)------[5]F --- ------(<(230 to 240) ka)		– –	– –	– –	– –
Checkpoint Pass fault (CP)	– –	– –	– –	– –	– –	– –	– –	– –	– –
Crossgrain Valley faults (CGV)									
[North Ridge front fault]	– –	– –	– –	– –	– –	– –	– –	– –	– –
[Northeast valley faults]	– –	– –	– –	– –	– –	– –	– –	– –	– –
[Southwest valley fault]	– –	– –	– –	– –	– –	– –	– –	– –	– –

Table 6. Slip rates (mm/yr) for known and suspected Quaternary faults within 50 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Holocene Late 0–4 ka	Holocene Middle 4–8 ka	Holocene Early 8–10 ka	Pleistocene Late 10–130 ka	Pleistocene Middle 130–790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma	Pre-Quaternary Rate	Pre-Quaternary Interval (10⁶ yr)
East Crater Flat faults (ECR)									
Fault S	--	--	--	--	--	--	--	--	--
Fault T	--	--	--	--	--	--	--	--	--
Black Cone fault (BLK)	----------	[6]0.03 to 0.06	----------	----------(<(17.3 to 30.3) ka)	--	--	--	--	--
West lava fault (WL)	--	--	--	--	--	--	--	--	--
Fault U	--	--	--	--	--	--	--	--	--
Eleana Range fault (ER)	--	--	--	--	--	--	--	--	--
Fatigue Wash fault (FW)	--	--	--	--	--	--	--	--	--
Furnace Creek fault (FC)	----------	2.3	----------	----------(<20 ka)	--	--	--	*4.1 to 4.4*	<(7.3 to 7.9)
Ghost Dance fault (GD)	--	--	--	--	--	--	--	--	--
Keane Wonder fault (KW)	--	--	--	--	--	--	--	--	--
Mercury Ridge faults (MER)									
[Northwest fault]	--	--	--	--	--	--	--	--	--
[Southeast fault]	--	--	--	--	--	--	--	--	--
Mine Mountain fault (MM)	--	--	--	--	--	--	--	0.07 to 0.09	<(11.5 to 13.5)
Oasis Valley faults (OSV)									
[Eastern faults]	--	--	--	--	--	--	[7]0.001 to 0.005	--	--
[Western faults]	--	--	--	--	--	--	--	--	--
Pahute Mesa faults (PM)	--	--	--	--	--	--	--	--	--
Paintbrush Canyon fault (PBC)	---------- ----------	---------- ----------	[8]0.0083 [9]≤0.01	---------- ----------	----------(<200 ka) ----------	--	--	0.035; 0.006	9 to 13; 0.7 to 9
Plutonium Valley–North Halfpint Range fault (PVNH)	--	--	--	--	--	--	--	--	--
Ranger Mountains faults (RM)[10]									
[North faults]	--	--	--	--	--	--	--	--	--
[South faults]	--	--	--	--	--	--	--	--	--
Rock Valley fault (RV)	----------	[11]0.003 to 0.01	----------	----------(<(31 to 38) ka)	--	--	--	--	--
Rocket Wash–Beatty Wash fault (RWBW)	--	--	--	--	--	--	--	--	--

Table 6. Slip rates (mm/yr) for known and suspected Quaternary faults within 50 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Holocene Late 0-4 ka	Holocene Middle 4-8 ka	Holocene Early 8-10 ka	Pleistocene Late 10-130 ka	Pleistocene Middle 130-790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma	Pre-Quaternary Rate	Pre-Quaternary Interval (10^6 yr)
Solitario Canyon fault (SC)	0.03 to 0.06 (<(17.3 to 30.3) ka)				--	--	--	0.19; 0.01	<(11.5 to 13); <11.5
Stagecoach Road fault (SCR)	--	--	--	--	--	--	>0.003	0.08; [12]0.45; [13]0.029	<13; 11.5 to 13; <11.5
	--	--	--	--	--	--	--	0.45	11.5-13
Tolicha Peak fault (TOL)	--	--	--	--	--	--	--	--	--
Wahmonie fault (WAH)	--	--	--	--	--	--	--	--	--
Windy Wash fault (WW)	[14]0.001 to 0.03 (<270 ka) [15]0.0015 (<270 ka)					--	--	[16]0.07; [17]0.026	11.5 to 13; <11.5
Yucca fault (YC)	--	--	--	--	--	--	--	--	--
Yucca Lake fault (YCL)	--	--	--	--	--	--	--	--	--

[1]Data are for the western branch of the northern section of the fault (Y-695; Y-996).

[2]Although a tectonic origin is not clear, a non-tectonic origin for the Beatty scarp has not been verified. Therefore, the feature is included in this compilation, which is based on published literature and other readily available data for known and suspected Quaternary faults.

[3]Y-1091 (p. 120) estimated that slip rates on BR during middle and late Quaternary have been very low (about 0.001 mm/yr).

[4]Y-181 and Y-210 noted that left-lateral displacement along CS becomes progressively less in tuffs that range between 14 Ma and 11 Ma, but no amounts are specified.

[5]See notes 11 and 12 on Table 5.

[6]This is a maximum vertical slip rate during the last 17,000 yr to 30,000 yr. The rate was estimated using the <1 m of displacement on a surface with an estimated age of 17.3 ka to 30.3 ka as reported by Y-1201 (p. 1-64).

[7]This slip rate was estimated using the 4 m of displacement noted by Y-10 (p. 58) in deposits with an estimated age of 730 ka to 3 Ma (Y-73, p. 2, 26) for one fault along the eastern side of Oasis Valley since early Quaternary or latest Tertiary.

[8]On the basis of an estimated 5.8 m of oblique displacement since about 700 ka, Y-575 (p. A119) estimated an oblique slip rate for PBC at Busted Butte of 0.0083 mm/yr since the beginning of middle Pleistocene.

[9]An apparent vertical slip rate of about 0.01 mm/yr or less during middle and late Quaternary was estimated by Y-1098 (p. 153) for a western splay of PBC.

[10]RM includes two faults north of the Ranger Mountains (the North faults) and four faults in the southern Ranger Mountains (the South faults).

[11]Data are for the central part of RV at the trench sites of Y-20.

[12]This rate assumes that 6.7 km of vertical displacement occurred during the 1.5-million-year interval between 11.5 Ma and 13 Ma (Y-396, table 2, p. 275).

[13]This rate assumes that 3.3 km of vertical displacement occurred since 11.5 Ma and that Cenozoic displacement rates occurred in a step-wise manner in which rates sharply decreased about 11.5 Ma (Y-396, p. 273).

[14]This is the average vertical slip rate estimated by Y-1201 (p. 1-67) for their southern WW (western splay of Y-1042) for the late Pleistocene and Holocene, using the interpretations of Y-12 (40 cm of vertical displacement in 270-ka deposits and 10 cm of vertical displacement in 3-to-6-ka deposits).

[15]This rate was calculated by Y-396 (table 2, p. 275) based on the 40 cm of vertical displacement since 270 ka that was interpreted by Y-12.

[16]This rate assumes that about 0.14 km of vertical displacement occurred during the 1.5-million-yr interval between 13 Ma and 11.5 Ma (Y-396, table 2, p. 275).

[17]This rate assumes that about 0.26 km of vertical displacement has occurred on WW since 11.5 Ma and that Cenozoic displacement rates have varied in a step-wise manner in which rates sharply decreased about 11.5 Ma (Y-396, table 2, p. 273, 275).

Table 7. Estimated number of events/time interval for known and suspected Quaternary faults within 50 km of Yucca Mountain

[Detailed data are on description sheets in appendix 2. Numbers with age units in parentheses indicate the estimated age of the faulting event(s). References listed on tables 4, 5, and 8 and in appendix 2. Queried entries indicate uncertainty in information. F, fracturing (no significant displacement). Entries separated by a semicolon (;) indicate different interpretations by different authors; leaders (– –), no information was noted during the literature review. Number of events are shown in the last two columns only if more specific information is unavailable]

Fault or faults [Segment or individual fault]	Holocene Late 0-4 ka	Holocene Middle 4-8 ka	Holocene Early 8-10 ka	Pleistocene Late 10-130 ka	Pleistocene Middle 130-790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma
Amargosa River fault (AR)		------ 1 ------(≤10 ka)		– –	– –	– –	– –
Area Three fault (AT)		------ 1 ------(≤10 ka)		– –	– –	– –	– –
Ash Meadows fault (AM)							
[Northern section]		------[1]≥1 ------(≤10 ka)		– –	– –	– –	– –
[Central section]		------ ≥1 ------(≤40 ka)			– –	– –	– –
[Southern section]		------ 1 ------([2])			– –	– –	– –
Bare Mountain fault (BM)							
[Section #1]	– –	– –	– –	------ ≥1? ------([3])		– –	– –
[Section #2]		------ ≥1 ------(<350 ka)			(>350 ka) ---- ≥1 ------	– –	– –
[Section #3]	– –	– –	– –	------ ≥1? ------([3])		– –	– –
[Section #4] locality 3		------ 1 ------(<(5 to 15) ka)			– –	– –	– –
locality 4		------ 1 ------(<9 ka)		------ 1 ------ (<(145 to 160) ka)		– –	– –
locality 5		------ [4]2 ------(<(40 to 50) ka)			– –	– –	– –
[Section #5]	– –	– –	– –	------ ≥1? ------([3])		– –	– –
Beatty scarp (BS)[5]	(>(1 to 32) ka) ------	1? ------(<(10 to 12) ka)			– –	– –	– –
Bow Ridge fault (BR)			------ 5 to 6 ------			– –	– –
Bullfrog Hills faults (BUL)	– –	– –	– –	– –	– –	– –	≥1
Cane Spring fault (CS)	– –	– –	– –	– –	– –	– –	1?
Carpetbag fault (CB)	– –	– –	– –	(>10, >30, >130, >350?) --- [6]F4 ---(<(230 to 240) ka)		[6]4	≥(5 to 6)
Checkpoint Pass fault (CP)	– –	– –	– –	– –	– –	– –	≥1?
Crossgrain Valley faults (CGV)							
[North Ridge front fault]	– –	– –	– –	– –	– –	– –	≥1?
[Northeast valley faults]	– –	– –	– –	– –	– –	– –	≥1?
[Southwest valley fault]	– –	– –	– –	– –	– –	– –	≥1?

Table 7. Estimated number of events/time interval for known and suspected Quaternary faults within 50 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Holocene Late 0–4 ka	Holocene Middle 4–8 ka	Holocene Early 8–10 ka	Pleistocene Late 10–130 ka	Pleistocene Middle 130–790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma
East Crater Flat faults (ECR)							
Fault S	--	--	--	--	--	--	≥1?
Fault T	--	--	--	--	--	--	≥1?
Black Cone fault (BLK)	----------	≥1 ----------	----------	(<(6.6 to 11.1) ka;<(270 to 800) ka)	--	--	--
West lava fault (WL)	--	--	--	----- ≥1 ------- (<(17.3 to 30.3) ka)	--	--	--
Fault U	--	--	--	--	--	--	≥1?
Eleana Range fault (ER)	----------	≥1 ----------	----------	(<(10 to 130) ka)	--	--	--
Fatigue Wash fault (FW)	--	--	--	--	--	--	--
Furnace Creek fault (FC)	(>0.2 ka) ----------	4 to 6	---------- (≤10 ka)	--	--	--	--
Ghost Dance fault (GD)	--	--	--	--	--	--	≥1?
Keane Wonder fault (KW)	--	--	--	--	--	--	≥1
Mercury Ridge faults (MER)							
[Northwest fault]	--	--	--	--	--	--	≥1?
[Southeast fault]	--	--	--	--	--	--	≥1?
Mine Mountain fault (MM)	--	--	--	--	--	--	≥1
Oasis Valley faults (OSV)							
[Eastern faults]	--	--	--	---------- ≥1	-------- (<(27 to 35) ka to 730 ka)	--	--
[Western faults]	--	--	--	--	--	--	≥1
Pahute Mesa faults (PM)	--	--	--	--	--	--	≥1
Paintbrush Canyon fault (PBC)	----------	----------	[7]5 ----------	----------	---------- (<700 ka)	--	--
				---------- [8]3 to 5	----------		
Plutonium Valley–North Halfpint Range fault (PVNH)	--	--	--	--	--	--	≥1
Ranger Mountains faults (RM)[9]							
[North faults]	--	--	--	--	--	--	≥1
[South faults]	--	--	--	--	--	--	≥1
Rock Valley fault (RV)							
[Central section]	----------	1 ----------	----------	(<(31 to 38) ka) ------- 1?	--- (<180 ka)	--	--

Table 7. Estimated number of events/time interval for known and suspected Quaternary faults within 50 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Holocene: Late 0-4 ka	Holocene: Middle 4-8 ka	Holocene: Early 8-10 ka	Pleistocene: Late 10-130 ka	Pleistocene: Middle 130-790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma
[Northeast section]	---------- ≥1 ---------- (<(10 to 30) ka) (spans 0-4 ka to 10-130 ka)				--	--	--
[Possible southwest extension]	---------- ≥1 ---------- (≤10 ka) (spans 0-4 ka to 8-10 ka)			--	--	--	--
Rocket Wash–Beatty Wash fault (RWBW)	--	--	--	--	--	--	≥1
Solitario Canyon fault (SC)	---------- ≥1 ---------- (<(6.6 to 11.1) ka; ≤15 ka) (spans 0-4 ka to 8-10 ka)				--	--	--
Stagecoach Road fault (SCR)	--	--	--	--	(>(700 to 750) ka) ------ ≥1 ------	--	--
Tolicha Peak fault (TOL)	--	--	--	--	--	--	≥1
Wahmonie fault (WAH)	---------- ≥1 ---------- (<(270-740) ka) (spans 0-4 ka to 10-130 ka)					--	--
Windy Wash fault (WW)	------ [10]1 ------ (<(3 to 6.5) ka) (spans 0-4 ka to 4-8 ka)		--	(>40 ka) ------ [10]6 ------ (>100 ka) (spans 10-130 ka to 130-790 ka)		--	[10]≥7
Yucca fault (YC)	(>1 ka) ------ 1 ------ (<10 ka) (>1 ka) ------ 1 ------ (<(10 to 130) ka) (spans 0-4 ka to 8-10 ka)			(≥35 ka) ------ ≥1 ------ (spans 10-130 ka to 130-790 ka)		--	--
Yucca Lake fault (YCL)	--	--	--	--	--	--	≥1

[1]Data are for the western branch of the northern section (Y-695).

[2]The age of the youngest faulted deposits are noted as early Holocene and (or) latest Pleistocene (no age specified; Y-69).

[3]Y-3 inferred a possible event during middle and late Pleistocene.

[4]Two events since 40 ka to 50 ka, one of which probably occurred during early Holocene (Y-3)

[5]Although a tectonic origin is not clear, a non–tectonic origin for the Beatty scarp has not been verified. Therefore, the feature is included in this compilation, which is based on published literature and other readily available data for known and suspected Quaternary faults.

[6]Fracturing is noted to have occurred at about 30 ka, 45 ka, 65 ka, 100 ka, and 230 ka, so that five fracturing events occurred in all during the late and middle Pleistocene; Four of these fracturing events occurred during the late Pleistocene. See notes 11 and 12 on Table 5.

[7]On the basis of buried soils in faulted sand ramps at Busted Butte, Y-575 (p. A119) interpreted five events since about 700 ka.

[8]Y-1098 (p. 55) estimated that three to five separate surface-faulting events had occurred during middle and late Pleistocene on a western splay of PBC.

[9]RM includes two faults north of the Ranger Mountains (the North faults) and four faults in the southern Ranger Mountains (the South faults).

[10]Y-12 (p. 787) interpreted trench exposures as indicating at least seven Quaternary faulting events on the southern portion of WW. Three of these events occurred before 300 ka; event 4 occurred around or just before 300 ka; event 5 occurred between 270 ka and 190 ka; event 6 occurred between 190 ka and 40 ka; and event 7 occurred after 3 ka to 6.5 ka.

Table 8. Recurrence interval, strike, and type displacement for known and suspected Quaternary faults within 50 km of Yucca Mountain

[Detailed data are on description sheets in appendix 2. References are listed in appendix 4. Abbreviations of trends: E, east; N, north; NE, northeast; NW, northwest; ENE, east–northeast; NNE, north–northeast; NNW, north–northwest. Abbreviations for displacement type: F, fracturing; LL, left lateral; LO, left oblique; N, normal; RL, right lateral; RO, right oblique. Queried entries indicate uncertainty in information. Number of events and time period are shown only when used to estimate recurrence interval; entries separated by a comma (,) indicate data for individual fault traces or for different localities along the fault or faults; entries separated by a semicolon (;) indicate different interpretations by different authors; leaders (– –), no information was noted during the literature review]

Fault or faults [Segment or individual fault]	Number of events	Time period (10^3 yr)	Recurrence interval (10^3 yr)	Strike	Type displacement	References (Y-)
Amargosa River fault (AR)	– –	– –	– –	N.48°W.	RL	238, 695
Area Three fault (AT)	– –	– –	– –	[1]N, NE, NE to NW	– –	181, 224, 526
Ash Meadows fault (AM)	– –	– –	– –	N	N	69, 695
[Northern section]	– –	– –		[2]N.18°W., N.28°E.	N	68, 695
[Central section]	– –	– –	– –	N.10°W.	N	695
[Southern section]	– –	– –	– –	N	N?	69, 695
Bare Mountain fault (BM)	– –	– –	– –	N	N, RL?	1, 1041
[Section #1]	– –	– –	– –	N to NNE	– –	3
[Section #2]	– –	– –	– –	NNW, NE	– –	3
[Section #3]	– –	– –	– –	NNW	– –	3
[Section #4] locality 3	– –	– –	– –	NNE	– –	3
locality 4	2; 1	<(145-160)	≥(73 to 80)	– –	– –	3
locality 5	2; 1	<(40-50)	20 to 25	– –	– –	3
[Section #5]	– –	– –	– –	NNW to NNE	– –	3
Beatty scarp (BS)[3]	– –	– –	– –	N.40°W. to N.10°E.	N?	6, 40, 43, 379
Bow Ridge fault (BR)	– –	– –	– –	N	N, LO	26, 55, 87, 1042, 1091
Bullfrog Hills faults (BUL)	– –	– –	– –	N-NW to NW	N?	232
Cane Spring fault (CS)	– –	– –	– –	NE	LO?, LL	104, 210, 226, 232
Carpetbag fault (CB)	[4]4	[4]125 to 130	[4]25	N to NNW	F, RL	60, 182, 224, 327, 1106
Checkpoint Pass fault (CP)	– –	– –	– –	[5]NNE to NE, E	[6]N, LL	813, 852
Crossgrain Valley faults (CGV)						
[North Ridge front fault]	– –	– –	– –	NE to ENE	LO; LL	52, 813
[Northeast valley faults]	– –	– –	– –	NE	LL, N	813
[Southwest valley fault]	– –	– –	– –	NE	LL, N	813

Table 8. Recurrence interval, strike, and type displacement for known and suspected Quaternary faults within 50 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Number of events	Time period (10^3 yr)	Recurrence interval (10^3 yr)	Strike	Type displacement	References (Y-)
East Crater Flat faults (ECR)						
Fault S	--	--	--	NNE	N	26
Fault T	--	--	--	NNE	N	26
Black Cone fault (BLK)	--	--	--	NNW, NW	N	26, 224, 1201, 1230
West lava fault (WL)	--	--	--	NNE	N	1196, 1201, 1230
Fault U	--	--	--	NE	N	26
Eleana Range fault (ER)	--	--	--	NE to NNE	N	181, 182, 526, 813, 853
Fatigue Wash fault (FW)	--	--	--	NNE to NNW	N, LL, L?O	26, 55, 506, 1042
Furnace Creek fault (FC)	4 to 6	≤10	1.7 to 2.5	NW	RL; RO	66, 216, 475, 479, 600, 683, 880
Ghost Dance fault (GD)	--	--	--	N, NNW, NNE	N	26, 55, 189, 1042, 1239
Keane Wonder fault (KW)	--	--	--	NW	[7]N, RL	238, 336, 390, 1357
Mercury Ridge faults (MER)						
[Northwest fault]	--	--	--	NE	LO; RO	62, 813
[Southeast fault]	--	--	--	NE	LO	62
Mine Mountain fault (MM)	--	--	--	NNE to NE	LO?	104, 205, 232
Oasis Valley faults (OSV)						
[Eastern faults]	--	--	--	NNE	N?	238, 813, 1223
[Western faults]	--	--	--	NNE	N?	813
Pahute Mesa faults (PM)	--	--	--	Variable	N, RO?	10, 813, 922
Paintbrush Canyon fault (PBC)	5 to 6	<700	[8]117 to 140; [9]10^3 to 10^4	NNE	N, LL, LO	26, 55, 217, 224, 396, 575, 1042, 1098
Plutonium Valley–North Halfpint Range fault (PVNH)	--	--	--	NNW	N	232, 813
Ranger Mountains faults (RM)						
[Northern faults]	--	--	--	NE, ENE	N?	813, 852
[Southern faults]	--	--	--	NE; NNE to NE	N?	813, 852
Rock Valley fault (RV)	--	--	--	NE	LL; LO	20, 238
Rocket Wash–Beatty Wash fault (RWBW)	--	--	--	[10]N; NNE	N	238, 813

Table 8. Recurrence interval, strike, and type displacement for known and suspected Quaternary faults within 50 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Number of events	Time period (10^3 yr)	Recurrence interval (10^3 yr)	Strike	Type displacement	References (Y-)
Solitario Canyon fault (SC)	--	--	--	NNE	N, LO, LL	26, 55, 700, 1042
Stagecoach Road fault (SCR)	--	--	--	NE to NNE	N, LL, LO	46, 55, 189, 575, 1042
Tolicha Peak fault (TOL)	--	--	--	NNW	[11]N; RO	813
Wahmonie fault (WAH)	--	--	--	[12]NE, N to NE	N	104, 226, 232, 238
Windy Wash fault (WW)	[13]4	[13]<300	[13]75	[14]N, NNW, N to NNW, NE	N, LL	12, 55, 224, 701, 1042
Yucca fault (YC)	--	--	--	N	[15]N; RL; RO	50, 60, 181, 182, 224, 526, 693, 813
Yucca Lake fault (YCL)	--	--	--	NNW	N	232

[1]The northern section strikes generally north. The southern section has two branches, a western one that strikes generally northeast and an eastern one that strikes between northeast and northwest (Y-181; Y-224; Y-526).

[2]The northern section consists of two branches, a western one striking N. 18° W. and an eastern one striking N. 28° E. (Y-68; Y-695).

[3]Although a tectonic origin is not clear, a non–tectonic origin for the Beatty scarp has not been verified. Therefore, the feature is included in this compilation, which is based on published literature and other readily available data for known and suspected Quaternary faults.

[4]Data are for fracturing, not for significant surface displacement (Y-327). Recurrence interval is for the last 125,000 to 130,000 years. See notes 11 and 12 on Table 5.

[5]The eastern half of CP has a curving, but general east, strike (Y-813). The northern trace of the western half strikes northeast; the southern trace of the western half strikes north-northeast.

[6]Displacement on the eastern half of CP is shown by Y-813 as left-lateral. Displacement on the two branches of the western half is shown as dip slip (normal).

[7]Y-238 showed displacement on KW as down to the southwest. Y-1357 concluded that displacement on KW has been right-lateral strike slip, which was accompanied by northeast tilting of the Funeral Mountains. Y-336 (p. 149) also mentioned right-lateral displacement on KW.

[8]Using the conclusion of Y-575 (p. A119) for five events since about 700 ka and adding one event for the present interval, the average recurrence interval for surface-faulting events on PBC at Busted Butte since the beginning of middle Pleistocene ranges between 117,000 to 140,000 yr.

[9]On the basis of weakly developed soils that are preserved on sediments deposited between surface faulting events, Y-1098 (p. 153) concluded that recurrence intervals of 10^3 to 10^4 yr separate three to five middle and late Pleistocene surface-faulting events on a western splay of PBC.

[10]RWBW strikes generally north (Y-813; Y-853). Traces at the southern end of RWBW strike north-northeast (Y-238).

[11]Displacement on one trace at the southern end of TOL is portrayed by Y-813 as down to the southwest. One trace of TOL that crosses Tolicha Peak is shown by Y-813 to have right-oblique displacement.

[12]WAH strikes generally northeast, but its trace curves so that the strike of WAH ranges between north and northeast (Y-232).

[13]On the basis of four faulting events since 300 ka, Y-12 (p. 787) and Y-701 estimated an average recurrence interval between surface-rupturing events of 75,000 yr.

[14]Displacement on WW is shown by Y-12 and Y-701 as dip slip (normal) with a left-lateral component of an undetermined amount. A left-lateral component of displacement was also interpreted by Y-1042 (p. 17, 20) from observed geomorphic features and slickensides that plunge 43° to 47°.

[15]Displacement on YC is shown by Y-50, Y-60, Y-224, and Y-526 to be dip slip (normal). Y-181 (p. 27-28) concluded that the left-stepping, *en echelon* pattern of scarps suggests right-lateral displacement. Y-182 suggested that YC belongs to a set of north-striking faults with right-oblique displacement.

Table 9. Estimated length, total displacement, and distance from the site for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain

[Detailed data are on description sheets in appendix 2. References are listed by number in appendix 4. Queried entries indicate uncertainty in information. Entries separated by a comma (,) indicate data for individual fault traces or for different localities along the fault or faults; entries separated by a semicolon (;) indicate different interpretations by different authors; leaders (—), no information was noted during the literature review; YM, the proposed repository site at Yucca Mountain]

Fault or faults [Segment or individual fault]	Plate (P) or Figure (F) number	Total fault length (km)	Percent of total length with late Quaternary displacement	Total vertical displacement (km)	Total lateral displacement (km)	Closest approach to YM (km)	References (Y-)
Belted Range fault (BLR)	P1	38; 51; 53; 54	--	>0.61	--	55	5, 232, 813, 853
Bonnie Claire fault (BC)	P1	27	--	--	--	74	238
Boundary fault (BD)	P1	3 to 6.5	--	--	--	51	224, 526, 813, 853
Buried Hills faults (BH)	P1, P2	[1]10, 26	--	--	--	53	813
Cactus Flat fault (CF)	P1	50	--	--	--	84	813
Cactus Flat–Mellan fault (CFML)	P1	35	--	--	--	80	813
Cactus Range–Wellington Hills fault (CRWH)	P1	25; 29	--	--	--	87	232, 813
Cactus Springs fault (CAC)	P2	12	--	--	--	59	813, 852
Central Pintwater Range faults (CPR)	P1	[2]4.5; 16	--	--	--	79	813
Central Spring Mountains faults (CSM)[3]	P2	--	--	--	--	76	
[Northwest fault]	P2	16	--	--	--	--	813
[Northeast fault]	P2	6 to 9	--	--	--	--	813, 852
[Southeast fault]	P2	5 to 12	--	--	--	--	813, 852
Chalk Mountain fault (CLK)	P1	[4]8; 20?	--	--	--	87	813
Chert Ridge faults (CHR)[5]	P1	--	--	--	--	65	
[Eastern faults]	P1	14	--	--	--	--	813
[Western faults]	P1	12	--	--	--	--	813
Chicago Valley fault (CHV)	P2	20	--	--	--	90	69, 238
Cockeyed Ridge–Papoose Lake fault (CRPL)	P1	21	--	--	--	53	813
Death Valley fault (DV)	P2	[6]51; 64 to 104; 68; 72; 79	--	[7]1.2 to 3; 2.3; 5; 10 to 20	--	55	216, 389, 429, 594, 976, 1048
East Belted Range fault (EBR)	P1	26	--	--	--	80	813, 853
East Nopah fault (EN)	P2	>(17 to 19)	--	[8]≥0.008	--	85	69, 238, 696

Table 9. Estimated length, total displacement, and distance from the site for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Plate (P) or Figure (F) number	Total fault length (km)	Percent of total length with late Quaternary displacement	Total vertical displacement (km)	Total lateral displacement (km)	Closest approach to YM (km)	References (Y-)
East Pintwater Range fault (EPR)	P1, P2	58	--	--	--	81	813, 852
Emigrant fault (EM)	P2	13	--	--	--	73	239
Emigrant Valley North fault (EVN)	P1	28	--	--	--	60	813
Emigrant Valley South fault (EVS)	P1	20	--	--	--	66	813
Fallout Hills faults (FH)	P1	4 to 8	--	--	--	70	813
Gold Flat fault (GOL)	P1	16	--	--	--	65	813
Gold Mountain fault (GOM)	P1	17; 18	--	--	--	90	238, 853
Grapevine fault (GV)	P1, P2	20; 30	--	4.3	0.002	58	236, 239, 755, 917
Grapevine Mountains fault (GM)	P1	--	--	--	--	--	
[Southern trace]	P1	9; 23	--	--	--	67	238, 239, 853
[Northern trace]	P1	13; 21	--	--	--	70	238, 853
Groom Range Central fault (GRC)	P1	31	--	--	--	82	813
Groom Range East fault (GRE)	P1	20	--	--	--	85	813
Hidden Valley–Sand Flat faults (HVSF)	P2	--	--	--	--	87	
[Fault along the eastern sides of Hidden Valley/Ulida Flat]	P2	12	--	--	--	--	239
[Fault along the southern sides of Ulida Flat/Sand Flat]	P2	9	--	--	--	--	239
[Fault along the southeastern side of Sand Flat]	P2	10	--	--	--	--	239
[Fault along the northeastern side of Sand Flat]	P2	7.5	--	--	--	--	239
[Fault along the western side of Ulida Flat]	P2	3	--	--	--	--	239
Hunter Mountain fault (HM)	P2	78; 85	--	[10]≥(1 to 1.5); ≤2; ≥6	[11]0.7 to 2; 1; ≥6; 8 to 10	95	239, 356, 697, 864, 1148, 1274
Indian Springs Valley fault (ISV)	P1, P2	23; 28	--	--	--	67	813, 852
Jumbled Hills fault (JUM)	P1	27	--	--	--	77	813
Kawich Range fault (KR)	P1	80; 84	--	0.9; ≥1.2	--	57	5, 232, 813

Table 9. Estimated length, total displacement, and distance from the site for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Plate (P) or Figure (F) number	Total fault length (km)	Percent of total length with late Quaternary displacement	Total vertical displacement (km)	Total lateral displacement (km)	Closest approach to YM (km)	References (Y-)
Kawich Valley fault (KV)	P1	43	--	--	--	61	813
La Madre fault (LMD)	P2	33	--	--	--	82	813
North Desert Range fault (NDR)	P1	[12]3.5, 24	--	--	--	61	813
Oak Spring Butte faults (OAK)	P1	[13]19; 21; 40	--	[14]≥0.46	--	57	693, 813, 853
Pahrump fault (PRP)	P2	50; 65 to 70; 130	--	[15]≥0.3	[16]>(16 to 19)	70	161, 238, 696, 813, 845, 888, 1105
Panamint Valley fault (PAN)	P2	80; 100	[17]25 to 38	[18]1.8; 9.2	--	95	397, 399, 427, 697, 698, 868
[Fault south of Ballarat]	P2	30	100	--	8 to 10	--	427, 864
[Fault north of Ballarat]	P2	50	--	--	[19]≥(3.1 to 4.6)	--	614, 632, 698
Penoyer fault (PEN)	P1	25; 35, 56	--	--	--	97	25, 404, 1032
Racetrack Valley faults (RTV)	P2						
[Eastern fault]	P2	22	--	--	--	97	239
[Western fault]	P2	22	--	--	--	102	239
Sarcobatus Flat fault (SF)	P1	27; 51	--	--	--	52	238, 813, 853
Slate Ridge faults (SLR)	P1					87	
[Northern fault]	P1	12; 13	--	--	--	--	238, 853
[Southern fault]	P1	5; 12	--	--	--	--	238, 853
South Ridge faults (SOU)	P2	--	--	--	--	--	
[Northern fault]	P2	[20]1 to 3, 2.5, 5	--	--	--	55	852
[Southern fault]	P2	[21]7, 19	--	--	--	50	813
Spotted Range faults (SPR)	P1, P2	--	--	--	--	59	
[Range-front fault]	P1, P2	20 to 30	--	--	--	--	813, 852
[Fault along unnamed ridge]	P1, P2	9 to 12	--	--	--	--	813, 852
[Faults within the range]	P1, P2	4; 7	--	--	--	--	813, 852
Stonewall Mountain fault (SWM)	P1	10; 13; 22	--	--	--	92	232, 238, 813, 853
Stumble fault (STM)	P1	31 to 33	--	--	--	74	25, 813

Table 9. Estimated length, total displacement, and distance from the site for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Plate (P) or Figure (F) number	Total fault length (km)	Percent of total length with late Quaternary displacement	Total vertical displacement (km)	Total lateral displacement (km)	Closest approach to YM (km)	References (Y-)
Three Lakes Valley fault (TLV)	P1	[22]≥9; 27	--	--	--	84	813
Tikaboo fault (TK)	P1	10; 33	--	--	--	92	25, 813, 1032
Tin Mountain fault (TM)	P1, P2	29	--	--	--	90	238, 239
Towne Pass fault (TP)	P2	38	--	[23]≥0.2; ≥2.4	--	76	239, 390, 427, 458, 763
West Pintwater Range fault (WPR)	P1, P2	≥60	--	--	--	76	813, 852
West Spring Mountains fault (WSM)	P2	[24]30; 36; 60	--	≥3.5	--	53	161, 238, 696, 813, 852

[1]The BH includes three faults. Two of the faults are adjacent to the Buried Hills: one about 10 km long along their eastern side and one about 26 km long along the western side of the hills. The third fault, about 10 km long, is along northern Nye Canyon, which is about 3 km west of the Buried Hills.

[2]CPR is composed of two main faults, one along the eastern side and one along the western side of an unnamed valley within the northern Pintwater Range. The eastern fault of CPR is about 16 km long. The western fault is about 4.5 km long.

[3]CSM includes three faults: (1) one on the northwestern side of Wheeler Wash (Northwest fault), (2) one on the northeastern side of the Wheeler Wash drainage (Northeast fault), and (3) one on the southeastern side of the Wheeler Wash drainage (Southeast fault).

[4]Length of CLK could be as much as 20 km if north-striking faults on the western side of northern Emigrant Valley are included in CLK. (The north-striking faults are shown in this compilation as possibly part of the Emigrant Valley North fault (EVN?; pl. 1).)

[5]CHR is composed of numerous faults along the eastern and western sides of Chert Ridge.

[6]Estimates of the length of the Death Valley fault range between 51 and 104 km. The difference in length estimates results from differences in the interpretation of the end points of the fault with the Southern Death Valley fault (SDV) to the south and the Furnace Creek fault (FC) to the north. (See the data sheet for the Death Valley fault in appendix 2.)

[7]Estimates of total vertical displacement are based on a variety of topographic, structural, gravity, and geobarometric data. (See data sheet for the Death Valley fault in appendix 2.)

[8]This is the amount of apparent vertical displacement estimated from fault scarps on early Pleistocene and (or) Tertiary surfaces thought by Y-69 to be older than 300 ka to 500 ka (Y-696, p. 40).

[9]The fault along the southeastern side of Sand Flat may extend an additional 13 km north of Sand Flat toward White Top Mountain.

[10]Y-864 (p. 10,424) estimated down-to-the-southwest vertical displacement of 0 to 2 km on HM in the area of Panamint Butte in northern Panamint Valley. This estimate was made using outcrops of a near-vertical contact between early Jurassic Hunter Mountain batholith and an unconformity at the base of Miocene/Pliocene volcanic rocks. Y-1148 (p. 25) reported a vertical displacement of "perhaps tens of meters" on HM in southeastern Saline Valley at Grapevine Pass and a vertical displacement of at least 6,000 m on HM in southwestern Saline Valley at Daisy Canyon. These amounts were estimated using the elevation difference between the Inyo Mountains and the depth of fill in Saline Valley that was inferred from gravity data by Y-917. Y-864 (p. 10,423) interpreted a steep escarpment at the northern end of Panamint Valley as corresponding to HM. The escarpment has 1 to 1.5 km of topographic relief that is assumed to reflect the minimum vertical displacement on HM.

[11]Y-864 (p. 10,424) estimated right-lateral displacement of 8 to 10 km on HM in the area of Panamint Butte in northern Panamint Valley. This estimate was made using outcrops of a near-vertical contact between early Jurassic Hunter Mountain batholith and an unconformity at the base of Miocene/Pliocene volcanic rocks as piercing points. On the basis of displaced stream channels, Y-1148 (p. 25, 34) estimated a total lateral displacement between 700 and 2,000 m on HM in Saline Valley. He speculated that right-lateral displacement at the northwestern end of HM in Saline Valley at San Lucas Canyon may be nearly 1,000 m. Y-1274 (p. 38) noted that the displacement of a prominent magnetic anomaly centered over Hunter Mountain indicates right-lateral displacement of at least 6 km along HM.

[12]The first entry is for fault traces along the front of the northern Desert Range; the second entry is for fault traces 0.5 to 1 km west of the range front.

[13]The 40 km length is the combined length of the Butte fault (BT, a portion of one fault in OAK) and the Yucca fault (YC) to the south. Y-693 (p. 209) suggested that BT and YC join.

[14]Y-693 (p. 210) reported a vertical displacement of nearly 458 m in Tertiary volcanic rocks (Belted Range Tuff) along the Butte fault (a portion of one fault in OAK).

[15]A minimum vertical displacement of about 300 m along PRP was estimated by Y-845 (p. 18, 21) on the basis of this amount of erosion of basin-fill sediments from the upthrown block of the fault.

[16]Right-lateral displacement of greater than about 16 to 19 km was estimated by Y-888 (p. 694) from relationships among Precambrian and Paleozoic rocks.

[17]The length of the scarps formed in the most-recent pre-historic earthquake (≤10 ka) south of Ballarat is 25 to 30 km (Y-697, p. 4859). Using a total length for PAN of 80 to 100 km, the rupture length in this most-recent event is 25 to 38% of the estimated total length of PAN.

[18]Total pre-Quaternary dip slip across faults bounding the eastern side of Panamint Valley, which includes the modern trace of PAN, is 9,150 m (Y-399, p. 426; Y-698, p. 112). Total vertical displacement on PAN is reported by Y-427 (p. 6) to be about 1.8 km.

[19]About 11 km south-southeast of Highway 19, near the mouth of Wildrose Canyon, a landslide is displaced right laterally 3,050 to 4,575 m from its source at Wildrose Canyon (Y-614; Y-632).

[20]The northern fault includes a western trace that is 1 to 3 km long and that is less than 1 km north of the front of South Ridge, a central trace that is 5 km long and that is along the front of the ridge, and an eastern trace that is 2.5 km long and that is at the very eastern end of South Ridge (Y-852).

[21]The trace of the southern fault as shown by Y-813 is nearly continuous for 19 km. A branch fault south of the southern fault is 7 km long (Y-813). Y-852 showed each of the two traces south of the ridge as 2 to 3 km long.

[22]The length of TLV is 9 km as estimated from Y-813, but the fault intersects the eastern edge of her map area at long 115°30'W. The linearity of the range front east of this point suggests that TLV may continue southeastward, so that the total length of TLV could be about 27 km.

[23]Y-390 (p. A114) reported displacement on TP of at least 153 m. Y-458 (p. 57-58) noted at least 2,380 m of displacement on TP and concluded that this displacement has accounted for most of the elevation of the Panamint Range southeast of Towne Pass.

[24]WSM is noted by Y-696 (p. 83) as about 30 km long, which includes a nearly continuous, 12-km-long section along the range front. WSM is about 36 km long as estimated from Y-238 and Y-813. If north-trending traces in Pahrump Valley between Hidden Hills and Manse, Nevada, are considered part of WSM, then WSM would have a total length of about 60 km.

Table 10. Estimated ages of displaced and undisplaced deposits and amounts of youngest displacement for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain

[Detailed data are on description sheets in appendix 2. Ages are estimated primarily from photogeologic, geomorphic, and pedologic criteria. (See individual references and description sheets in appendix 2 for limitations.) References are listed by number in appendix 4. Overlap of ages reported in columns 2 and 3 reflects uncertainties in age estimates and in stratigraphic interpretations (appendix 2). Abbreviations for ages (used where age is not specified in years): Hol., Holocene; L.Hol., Late Holocene; E.Hol., Early Holocene; Lt.Pleist., Latest Pleistocene; L.Pleist., Late Pleistocene; Pleist., Pleistocene; Plio., Pliocene; L.Quat., Late Quaternary; Quat., Quaternary; Tert., Tertiary. Late Quaternary displacement is since 130 ka. Quaternary displacement is since 1.6 Ma. Queried entries indicate uncertainty in information. Entries separated by a semicolon (;) indicate different interpretations by different authors; leaders (– –), no information was noted during the literature review]

Fault or faults [Segment or individual fault]	Age of youngest unit/surface displaced (10^3 yr)	Age of oldest unit/surface undisplaced (10^3 yr)	Displacement in youngest event (m)		Late Quaternary displacement (m)		References (Y-)
			Vertical	Lateral	Vertical	Lateral	
Belted Range fault (BLR)	10 to 130	Quat.	--	--	--	--	5, 232, 853
Bonnie Claire fault (BC)	Quat.	--	--	--	--	--	232, 238, 853
Boundary fault (BD)	[1]8 to 10; >8; 130 to 1,500	≤10	--	--	--	--	90, 526
Buried Hills faults (BH)	Quat.	--	--	--	--	--	404, 813, 852
Cactus Flat fault (CF)	L.Pleist.	--	--	--	--	--	813
Cactus Flat–Mellan fault (CFML)	Quat.	--	--	--	--	--	813
Cactus Range–Wellington Hills fault (CRWH)	Quat.	Quat.	--	--	--	--	232, 813
Cactus Springs fault (CAC)	Quat.	--	--	--	--	--	813, 852
Central Pintwater Range faults (CPR)	Quat.	--	--	--	--	--	404, 813, 852
Central Spring Mountains faults (CSM)							
[Northwest fault]	Quat.	--	--	--	--	--	813
[Northeast fault]	Quat.	--	--	--	--	--	813, 852
[Southeast fault]	Quat.; 10 to 1,500	--	--	--	--	--	813, 852
Chalk Mountain fault (CLK)	Quat.	--	--	--	--	--	813
Chert Ridge faults (CHR)							
[Eastern faults]	Quat.	--	--	--	--	--	404, 813, 852
[Western faults]	Quat.	--	--	--	--	--	813
Chicago Valley fault (CHV)	>10 and <(300 to 500)	([2])	--	--	--	--	69
Cockeyed Ridge–Papoose Lake fault (CRPL)	Quat.	--	--	--	--	--	232, 813

Table 10. Estimated ages of displaced and undisplaced deposits and amounts of youngest displacement for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Age of youngest unit/surface displaced (10^3 yr)	Age of oldest unit/surface undisplaced (10^3 yr)	Displacement in youngest event (m)		Late Quaternary displacement (m)		References (Y-)
			Vertical	Lateral	Vertical	Lateral	
Death Valley fault (DV)	[3]0.2; 0.2 to 2; ≤10	[3]<0.2	[4]0.15 to 3	[5]1.8 to 3.6	[6]6.6 to 15; 61; 63	--	216, 252, 390, 429, 474, 1020
East Belted Range fault (EBR)	Quat.	--	--	--	--	--	813, 853
East Nopah fault (EN)	[7]>10 and <(300 to 500); E.Hol. to Lt.Pleist.	E.Hol. to L.Hol.	[8]3?	--	[8]≤8	--	69, 696
East Pintwater Range fault (EPR)	130 to 1,500	--	--	--	--	--	852
Emigrant fault (EM)	Quat.	--	--	--	--	--	222, 239
Emigrant Valley North fault (EVN)	[9]L.Quat.	--	--	--	--	--	813
Emigrant Valley South fault (EVS)	Quat.	--	--	--	--	--	813
Fallout Hills faults (FH)	Quat.	--	--	--	--	--	813
Gold Flat fault (GOL)	Quat.	--	--	--	--	--	813
Gold Mountain fault (GOM)	10 to 130	--	--	--	--	--	853
Grapevine fault (GV)	[10]Quat.	[10]Plio.?	--	--		--	236, 239, 755
Grapevine Mountains fault (GM)							
[Southern trace]	Quat.	--	--	--	--	--	238, 239, 853
[Northern trace]	(10 to 130)?; Quat.	--	--	--	--	--	238, 239, 853
Groom Range Central fault (GRC)	Quat.	--	--	--	--	--	25, 813
Groom Range East fault (GRE)	Tert.?	Quat.	--	--	--	--	25, 813
Hidden Valley–Sand Flat faults (HVSF)							
[Fault along the eastern sides of Hidden Valley/Ulida Flat]	Quat.	--	--	--	--	--	239
[Fault along the southern sides of Ulida Flat/Sand Flat]	Quat.	--	--	--	--	--	239
[Fault along the southeastern side of Sand Flat]	Quat.	--	--	--	--	--	239
[Fault along the northeastern side of Sand Flat]	Quat.	--	--	--	--	--	239

Table 10. Estimated ages of displaced and undisplaced deposits and amounts of youngest displacement for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Age of youngest unit/surface displaced (10^3 yr)	Age of oldest unit/surface undisplaced (10^3 yr)	Displacement in youngest event (m) Vertical	Displacement in youngest event (m) Lateral	Late Quaternary displacement (m) Vertical	Late Quaternary displacement (m) Lateral	References (Y-)
[Fault along the western side of Ulida Flat]	Quat.	--	--	--	--	--	239
Hunter Mountain fault (HM)	≤10	--	--	--	--	[11]183; 305 to 610	698, 1020
Indian Springs Valley fault (ISV)	Quat.	--	--	--	--	--	813, 852
Jumbled Hills fault (JUM)	Quat.	--	--	--	--	--	813
Kawich Range fault (KR)	10 to 1,500; Quat.	Quat.	--	--	--	--	5, 232, 813, 853
Kawich Valley fault (KV)	Quat.	--	--	--	--	--	813, 853
La Madre fault (LMD)	Quat.	--	--	--	--	--	813, 852
North Desert Range fault (NDR)	Quat.	--	--	--	--	--	813
Oak Spring Butte faults (OAK)	10 to 130	Quat.	--	--	--	--	50, 212, 693, 813, 853
Pahrump fault (PRP)	[12]Hol. or L.Pleist.(?)	≤10	--	--	[13]≥(5 to 15)	--	696
Panamint Valley fault (PAN)							239, 697
[Fault south of Ballarat]	([14])	--	[15]0.4 to 1.2; 0.6 to 1.8	[16]3.2±0.5; 2.0±0.6	--	[17]≥11±2; ≥20	697, 868
[Fault north of Ballarat]	--	--	--	--	--	[18]183	698
Penoyer fault (PEN)	15 to 200; Quat.	15 to 200; Quat.	--	--	--	--	404, 813, 1032
Racetrack Valley faults (RTV)							
[Eastern fault]	Quat.	--	--	--	--	--	239
[Western fault]	Quat.	--	--	--	--	--	239
Sarcobatus Flat fault (SF)	Quat.	--	--	--	--	--	238, 813, 853
Slate Ridge faults (SLR)							
[Northern fault]	Quat.	Hol.	--	--	--	--	238, 407, 853
[Southern fault]	Tert.	Hol.	--	--	--	--	238, 407
South Ridge faults (SOU)							
[Northern fault]	Quat.	--	--	--	--	--	813, [illegible]

Table 10. Estimated ages of displaced and undisplaced deposits and amounts of youngest displacement for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Age of youngest unit/surface displaced (10^3 yr)	Age of oldest unit/surface undisplaced (10^3 yr)	Displacement in youngest event (m)		Late Quaternary displacement (m)		References (Y-)
			Vertical	Lateral	Vertical	Lateral	
[Southern fault]	Quat.?	Quat./Tert.	--	--	--	--	62, 813
Spotted Range faults (SPR)							
[Range-front fault]	Quat.	--	--	--	--	--	813, 852
[Faults along unnamed ridge]	Quat.	--	--	--	--	--	813
[Faults within the range]	Quat.?	--	--	--	--	--	813, 852
Stonewall Mountain fault (SWM)	10 to 130; 10 to 1,500; Quat.	--	--	--	--	--	232, 238, 813, 853
Stumble fault (STM)	Quat.	Hol. to Plio.; Quat./Tert.	--	--	--	--	25, 404, 813
Three Lakes Valley fault (TLV)	Quat.	--	--	--	--	--	813
Tikaboo fault (TK)	≤200	≤15	--	--	--	--	1032
Tin Mountain fault (TM)	Quat.	--	--	--	--	--	216, 238, 239
Towne Pass fault (TP)	[19]Hol.; Lt.Pleist. to Hol.; Quat.	Pleist./Plio.	--	--	--	--	222, 239, 427, 458, 763, 1020, 1032
West Pintwater Range fault (WPR)	10 to 1,500; Quat.	--	--	--	--	--	813, 852
West Spring Mountains fault (WSM)	[20]L.Pleist. to Hol.; 10 to 130; <130?; ≥120; Quat.	--	--	--	[21]≥12; >20	--	238, 696, 813, 845, 852

[1]The youngest event inferred by Y-90 from scarp morphology occurred between 8 ka and 10 ka and is the youngest reported age for displacement on BD. A caliche that yielded a date (uranium-thorium) of >8 ka is displaced by BD (Y-90). Y-526 estimated an age between about 160 ka and 800 ka for displaced deposits. Y-853 noted scarps on surfaces with estimated ages between 130 ka and 1.5 Ma.

[2]No faults are shown by Y-69 on surfaces of either early Holocene and (or) latest Pleistocene age or in deposits of Holocene age.

[3] Ages of the youngest units displaced by DV and overlying DV are based on a variety of data noted at different localities. (See data sheet for the Death Valley fault in appendix 2.) Y-216 suggested that the youngest section of DV is near Golden Canyon. A level line established by Y-252 in 1970 across DV about 2 km south of Furnace Creek Wash (near Golden Canyon) suggests that vertical displacement continues.

[4]Maximum vertical separations estimated across scarps on late Holocene (0.2 ka to 2 ka) surfaces range between 0.15 m on the main trace of DV along the Badwater turtleback to 3 m near Salt Springs (north of Furnace Creek Wash) (Y-216).

[5]Right-lateral displacement is for a gully on a northwest-striking section of DV south of Copper Canyon as reported by Y-429 (p. 7).

[6]Maximum vertical separations across scarps on Pleistocene surfaces range between 6.6 m near Ashford Mill and 15 m near Copper Canyon (Y-216, table 4). Y-390 (p. A71-A72) proposed eastward tilting of 61 m and northward tilting of 92 m on the basis of deformed strandlines and lake gravels between Mesquite Flat and Shore Line Butte. They thought that the lake features were formed during the Wisconsin (correlated to the Tahoe glaciation in the Sierra Nevada). Y-474 (p. 2073, 2091) estimated a total post-Wisconsin (since about 10 ka to 11 ka) displacement of 63 m on DV using the present elevations of tufa and strandlines on the east and west sides of Death Valley.

[7]Surfaces of this age (10 ka to 300-500 ka) are displaced by abundant fault traces. Surfaces of early Holocene and (or) latest Pleistocene age may also be displaced at one locality (Y-69; Y-696).

[8]A scarp on a surface for which no age was estimated is 3 m high (Y-696). Scarps on early Pleistocene and (or) late Tertiary surfaces are 8 m high (Y-696, p. 40).

[9]Y-813 (p. 6) noted that fault traces included in EVN include "many scarps formed on late Quaternary fan deposits and possibly on pluvial lake deposits of Groom Lake." No further age was specified by Y-813.

[10]North of Red Wall Canyon, rocks of possible Pliocene age are noted by Y-236 (p. 234) to overlie GV. Y-755 (p. 21) inferred recurrent Quaternary displacement on different sections of GV between Red Wall Canyon and Titanothere Canyon, because Quaternary alluvium that was subdivided into at least four different age groups by Y-390 and Y-236 is faulted against the range front at some localities and deposited against fault scarps at other localities.

[11]Along a northwest-striking fault that could be part of HM (shown on HM? on plate 2 of this compilation) and that is north of Highway 19, Y-698 (p. 113) noted 183 m of right-lateral displacement that was estimated on the basis of the juxtaposition of a late Quaternary alluvial-fan deposit that is composed of clasts of Precambrian and Paleozoic rocks against a 61-m-high hill of Tertiary volcanic rocks. About 3 km southeast of Highway 19, right-lateral displacement of older alluvial-fan deposits totals 305 to 610 m (Y-698, p. 114).

[12]Y-696 (table 1, p. 28) suggested that the youngest geomorphic surfaces displaced by PRP are middle to late Holocene at the northern end of the fault and late Pleistocene(?) at the southern end. In Stewart Valley, the youngest displaced deposits are reported to be probably late Pleistocene to early Holocene (Y-696, p. 81-82).

Table 10. Estimated ages of displaced and undisplaced deposits and amounts of youngest displacement for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain — Continued

[13]South of lat 36°05'N. (but north of lat 36°00'N.), the main escarpment of PRP is up to 15 m high (Y-696, p. 53). North of lat 36°05'N., the maximum scarp height is 5 m (Y-696, p. 78). The surfaces on which these scarps are located have not been dated.

[14]The youngest event is estimated to have occurred during the last few hundred years (Y-697).

[15]Y-697 (p. 4859) recognized dip-slip displacement from the most-recent event of 0.4 to 1.2 m along the trace of PAN along the range front at Goler Wash. Y-868 (p. 413) suggested that scarps between 0.6 and 1.8 m high represent single-event displacement on fault traces that are subsidiary to the main trace of PAN.

[16]Y-697 (p. 4862-4863) reported an average right-lateral displacement during the most-recent event south of Ballarat of 3.2±0.5 m as indicated by scarps at six localities. Y-868 (p. 412-413) concluded that right-lateral displacements of 2.0±0.6 m characterize the last surface-rupturing event on PAN between Ballarat and Goler Wash.

[17]Y-697 (p. 4861-4762) noted right-lateral displacements of 11±2 m for three to four surface-rupturing events on PAN near Manly Peak Canyon. Y-868 (p. 411, 413, 415) noted a maximum right-lateral displacement along PAN near Manly Peak Canyon of 20 m in mudflow levees that were buried by strandlines that date between 10 ka and 20 ka.

[18]Y-698 (p. 113) noted 183 m of right-lateral displacement along the northwest-striking section that could be part of either PAN or HM (shown as HM? on plate 2 of this compilation). This estimate of displacement is based on the juxtaposition of a late Quaternary alluvial-fan deposit that is composed of Precambrian and Paleozoic rocks against a 61-m-high hill of Tertiary volcanic rocks.

[19]Y-1020 showed one short section of TP as Holocene, but the rest as having Quaternary displacement. Y-763 (p. 13) reported that locally TP juxtaposes Paleozoic bedrock against Holocene alluvium. Y-222 showed the northern part of TP as juxtaposing Holocene alluvium against Pliocene and (or) Pleistocene rocks. Y-427 (table 1, p. 22) noted beheaded drainages, which he thought suggested latest Pleistocene to Holocene displacement. Most of TP is portrayed by Y-239 as prominent lineaments or scarps on surfaces of Quaternary deposits.

[20]The youngest scarps that were noted by Y-852 along the Spring Mountains range front and 2 to 3 km west of the front near the northern end of WSM are on depositional or erosional surfaces of late Pleistocene age (10 ka to 130 ka). Some fault traces in Pahrump Valley between Hidden Hills and Manse, Nevada, cut paludal sediments of probable late Pleistocene to Holocene age (<130 ka?; Y-696, p. 91). The youngest geomorphic surfaces with scarps along the western front of the Spring Mountains may be about or older than 120 ka when compared to surfaces at Kyle Canyon on the eastern side of the Spring Mountains (Y-696, p. 86). Y-238 and Y-813 portrayed much of WSM as prominent (mainly) to weakly expressed lineaments and scarps on surfaces of Quaternary deposits.

[21]A graben on a surface of unspecified age just north of Wheeler Wash has a minimum displacement of 12 m (Y-696, p. 87-88). Scarps on surfaces of alluvium with an estimated age of 120 ka? or >730 ka? are noted by Y-696 as >20 high.

Table 11. Slip rates (mm/yr) for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain

[Detailed data are on description sheets in appendix 2. Rates in italics are for apparent lateral slip; rates in vertical type are for apparent vertical slip. Numbers in parentheses indicate the time interval for which the rate has been estimated. The pre–Quaternary rates are based on displacement of units that are older than 1.6 Ma, but the time interval over which the rates are estimated may continue into the Quaternary. Entries separated by a comma (,) indicate data for different time intervals for a portion of the fault; entries separated by a semicolon (;) indicate different interpretations by different authors. Queried entries indicate uncertainty in information. Leaders (—), no information was noted during the literature review]

Fault or faults	Holocene			Pleistocene		Late		Pre-Quaternary	
	Late	Middle	Early	Late	Middle	Quaternary	Quaternary		Interval
[Segment or individual fault]	0-4 ka	4-8 ka	8-10 ka	10-130 ka	130-790 ka	<130 ka	<1.6 Ma	Rate	(10^6 yr)
Belted Range fault (BLR)	—	—	—	—	—	—	—	—	—
Bonnie Claire fault (BC)	—	—	—	—	—	—	—	—	—
Boundary fault (BD)	—	—	—	—	—	—	—	—	—
Buried Hills faults (BH)	—	—	—	—	—	—	—	—	—
Cactus Flat fault (CF)	—	—	—	—	—	—	—	—	—
Cactus Flat–Mellan fault (CFML)	—	—	—	—	—	—	—	—	—
Cactus Range–Wellington Hills fault (CRWH)	—	—	—	—	—	—	—	—	—
Cactus Springs fault (CAC)	—	—	—	—	—	—	—	—	—
Central Pintwater Range faults (CPR)	—	—	—	—	—	—	—	—	—
Central Spring Mountains faults (CSM)									
[Northwest fault]	—	—	—	—	—	—	—	—	—
[Northeast fault]	—	—	—	—	—	—	—	—	—
[Southeast fault]	—	—	—	—	—	—	—	—	—
Chalk Mountain fault (CLK)	—	—	—	—	—	—	—	—	—
Chert Ridge faults (CHR)									
[Eastern faults]	—	—	—	—	—	—	—	—	—
[Western faults]	—	—	—	—	—	—	—	—	—
Chicago Valley fault (CHV)	—	—	—	—	—	—	—	—	—
Cockeyed Ridge–Papoose Lake fault (CRPL)	—	—	—	—	—	—	—	—	—
Death Valley fault (DV)	(<0.2 ka) [1]0.08 to 11.5 (<2 ka)	(>2 ka) ------[1]0.15 to 2.5	------- (≤10 ka)	---- [1]7 ----	—	—	—	0.03, 0.08	([2])
East Belted Range fault (EBR)	—	—	—	—	—	—	—	—	—
East Nopah fault (EN)	----------------	----------[3]0.006 to 0.06	----------	----------	----------(<(50 to 500) ka)	—	—	—	—

Table 11. Slip rates (mm/yr) for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Holocene Late 0-4 ka	Holocene Middle 4-8 ka	Holocene Early 8-10 ka	Pleistocene Late 10-130 ka	Pleistocene Middle 130-790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma	Pre-Quaternary Rate	Pre-Quaternary Interval (10^6 yr)
East Pintwater Range fault (EPR)	--	--	--	--	--	--	--	--	--
Emigrant fault (EM)	--	--	--	--	--	--	--	--	--
Emigrant Valley North fault (EVN)	--	--	--	--	--	--	--	--	--
Emigrant Valley South fault (EVS)	--	--	--	--	--	--	--	--	--
Fallout Hills faults (FH)	--	--	--	--	--	--	--	--	--
Gold Flat fault (GOL)	--	--	--	--	--	--	--	--	--
Gold Mountain fault (GOM)	--	--	--	--	--	--	--	--	--
Grapevine fault (GV)	--	--	--	--	--	--	--	--	--
Grapevine Mountains fault (GM)									
[Southern trace]	--	--	--	--	--	--	--	--	--
[Northern trace]	--	--	--	--	--	--	--	--	--
Groom Range Central fault (GRC)	--	--	--	--	--	--	--	--	--
Groom Range East fault (GRE)	--	--	--	--	--	--	--	--	--
Hidden Valley–Sand Flat faults (HVSF)									
[Fault on the eastern sides of Hidden Valley/Ulida Flat]	--	--	--	--	--	--	--	--	--
[Fault on the southern sides of Ulida Flat/Sand Flat]	--	--	--	--	--	--	--	--	--
[Fault on the southeastern side of Sand Flat]	--	--	--	--	--	--	--	--	--
[Fault on the northeastern side of Sand Flat]	--	--	--	--	--	--	--	--	--
[Fault on the western side of Ulida Flat]	--	--	--	--	--	--	--	--	--
Hunter Mountain fault (HM)	--	--	--	--	--	--	--	[4]*2 to 3.2*; [5]*2 to 2.7*; [5]*<(1.3 to 1.8)*	≤3 ≤4; <6
Indian Springs Valley fault (ISV)	--	--	--	--	--	--	--	--	--
Jumbled Hills fault (JUM)	--	--	--	--	--	--	--	--	--
Kawich Range fault (KR)	--	--	--	--	--	--	--	--	--
Kawich Valley fault (KV)	--	--	--	--	--	--	--	--	--

Table 11. Slip rates (mm/yr) for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Holocene Late 0-4 ka	Holocene Middle 4-8 ka	Holocene Early 8-10 ka	Pleistocene Late 10-130 ka	Pleistocene Middle 130-790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma	Pre-Quaternary Rate	Pre-Quaternary Interval (10^6 yr)
La Madre fault (LMD)	--	--	--	--	--	--	--	--	--
North Desert Range fault (NDR)	--	--	--	--	--	--	--	--	--
Oak Spring Butte faults (OAK)	--	--	--	--	--	--	--	--	--
Pahrump fault (PRP)	--	--	--	--	--	--	([6])	--	--
Panamint Valley fault (PAN)									
[Fault south of Ballarat]	[7] ≥2.36±0.79 (<17±4 ka) [8] ≥1.74±0.65 (<17±4 ka) [9] 2.5 (<15 ka) [10] 1 to 2 (<(10 to 20)				--	--	--	--	--
[Fault north of Ballarat]	--	--	--	--	--	--	--	--	--
Penoyer fault (PEN)	--	--	--	--	--	--	--	--	--
Racetrack Valley faults (RTV)									
[Eastern fault]	--	--	--	--	--	--	--	--	--
[Western fault]	--	--	--	--	--	--	--	--	--
Sarcobatus Flat fault (SF)	--	--	--	--	--	--	--	--	--
Slate Ridge faults (SLR)									
[Northern fault]	--	--	--	--	--	--	--	--	--
[Southern fault]	--	--	--	--	--	--	--	--	--
South Ridge faults (SOU)									
[Northern fault]	--	--	--	--	--	--	--	--	--
[Southern fault]	--	--	--	--	--	--	--	--	--
Spotted Range faults (SPR)									
[Range-front fault]	--	--	--	--	--	--	--	--	--
[Fault along unnamed ridge]	--	--	--	--	--	--	--	--	--
[Faults within the range]	--	--	--	--	--	--	--	--	--
Stonewall Mountain fault (SWM)	--	--	--	--	--	--	--	--	--
Stumble fault (STM)	--	--	--	--	--	--	--	--	--
Three Lakes Valley fault (TLV)	--	--	--	--	--	--	--	--	--
Tikaboo fault (TK)	--	--	--	--	--	--	--	--	--

Table 11. Slip rates (mm/yr) for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Holocene Late 0-4 ka	Holocene Middle 4-8 ka	Holocene Early 8-10 ka	Pleistocene Late 10-130 ka	Pleistocene Middle 130-790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma	Pre-Quaternary Rate	Pre-Quaternary Interval (10^6 yr)
Tin Mountain fault (TM)	--	--	--	--	--	--	--	--	--
Towne Pass fault (TP)	--	--	--	--	--	--	--	--	--
West Pintwater Range fault (WPR)	--	--	--	--	--	--	--	--	--
West Spring Mountains fault (WSM)	---- [11]0.06 ---- (<200 ka)					--	--	--	--
	---- [12]0.02 to 0.2 ---- (<(50 to 500) ka)					--	--	--	--

[1]Using the range of maximum vertical separations of 0.15 to 2.3 m in deposits estimated to be 0.2 ka to 2 ka as reported by Y-216 (table 4) for DV south of Furnace Creek Wash, the apparent vertical slip rate ranges between 0.08 to 11.5 mm/yr for this portion of DV during late Holocene. Using the range of maximum vertical separations of 1.5 to 5 m that is reported by Y-216 (table 4) for older Holocene (2 ka to 10 ka) surfaces, an apparent vertical slip rate of 0.15 to 2.5 mm/yr is estimated for DV during the Holocene. Y-474 (p. 2096) estimated a vertical slip rate of 7 mm/yr for DV since late Pleistocene using his estimate of the present tilting rate of Death Valley (0.016°/1,000 yr) and the assumption that the axis of tilting is 25 km west of DV.

[2]Y-389 (p. 66) suggested "crude" estimates of the minimum average vertical slip rates on DV: 0.03 mm/yr (100 ft/yr) since middle Miocene and 0.08 mm/yr (250 ft/yr) since middle Pliocene.

[3]This is an apparent vertical slip rate estimated by Y-696 (p. 48) at one locality along EN using a 3-m-high scarp on a middle to late Pleistocene surface with an estimated age of 50 ka to 500 ka (Y-69).

[4]By assuming that a maximum age of 3 Ma for the formation of Saline Valley reflects the age of inception of HM at the northern end of Panamint Valley and that the net slip on HM is reflected by 8 to 10 km of lateral slip and 0 to 2 km of vertical slip, Y-864 (p. 10,424) calculated a minimum average slip rate of 2 to 3.2 mm/yr for HM.

[5]Y-697 (p. 4,858) calculated an apparent (lateral?) slip rate of 2 to 2.7 mm/yr for HM using a displacement of 9.3±1.4 km for a 4-Ma basalt that they reported from Y-864. Using this same amount of displacement but assuming that displacement began about 6.1 Ma as suggested by Y-909 (p. 657), Y-697 (p. 4,858) calculated a minimum apparent (lateral?) slip rate of 1.30 to 1.75 mm/yr for HM.

[6]Slip rate for an unspecified time interval is estimated to be low (Y-696), but the actual rate is not specified.

[7]This is a minimum Holocene and latest Pleistocene right-lateral slip rate estimated on the basis of 37±4 m of right-lateral displacement of ridges with a maximum age of 17±4 ka (may be younger than 12 ka or 13 ka) near the southern extent of fault scarps at Goler Wash Canyon (Y-697).

[8]This is a minimum Holocene and latest Pleistocene right-lateral slip rate estimated on the basis of 24±4 m and 27±4 m of right-lateral displacement of ridges with a maximum age of 17±4 ka (may be younger than 12 ka or 13 ka) near Manly Peak 5.3 km north of Goler Wash Canyon (Y-697).

[9]This right-lateral slip rate was estimated using the 20 m of displacement of mudflow levees observed by Y-868 (p. 413) at the mouth of Goler Wash Canyon and an estimated age of 10 ka to 20 ka for the levees (Y-868, p. 411).

[10]Y-900 (p. 465) suggested that the lateral slip rate on the southern portion of PAN since 15 ka has been about 2.5 mm/yr.

[11]This is an average apparent vertical slip rate on WSM that was estimated by Y-696 (p. 87) assuming an age of 200 ka for a surface containing a graben near the mouth of Wheeler Wash and a minimum displacement of 12 m across the graben.

[12]Y-696 (p. 87) estimated an apparent vertical slip rate of 0.02 to 0.2 mm/yr for WSM near the mouth of Wheeler Wash, using a range of 50 ka to 500 ka for the age of the displaced surface.

Table 12. Estimated number of events/time interval for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain

[Detailed data are on description sheets in appendix 2. Numbers with age units in parentheses indicate the estimated age of the faulting event(s). Queried entries indicate uncertainty in information. Leaders (– –), no information was noted during the literature review. Number of events is shown in the last two columns only if more specific information is not available]

Fault or fault [Segment or individual fault]	Holocene Late 0-4 ka	Holocene Middle 4-8 ka	Holocene Early 8-10 ka	Pleistocene Late 10-130 ka	Pleistocene Middle 130-790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma
Belted Range fault (BLR)	------ ≥1 ------ (≤10 to 130) ka)				– –	– –	– –
Bonnie Claire fault (BC)	– –	– –	– –	– –	– –	– –	≥1
Boundary fault (BD)	– –	– –	--- 1 -- (8 to 10 ka)	– –	– –	– –	– –
Buried Hills faults (BH)	– –	– –	– –	– –	– –	– –	≥1
Cactus Flat fault (CF)	------ ≥1 ------					– –	– –
Cactus Flat–Mellan fault (CFML)	– –	– –	– –	– –	– –	– –	≥1
Cactus Range–Wellington Hills fault (CRWH)	– –	– –	– –	– –	– –	– –	≥1
Cactus Springs fault (CAC)	– –	– –	– –	– –	– –	– –	≥1
Central Pintwater Range faults (CPR)	– –	– –	– –	– –	– –	– –	≥1
Central Spring Mountains faults (CSM)							
[Northwest fault]	– –	– –	– –	– –	– –	– –	≥1
[Northeast fault]	– –	– –	– –	– –	– –	– –	≥1
[Southeast fault]	– –	– –	– –	– –	– –	– –	≥1
Chalk Mountain fault (CLK)	– –	– –	– –	– –	– –	– –	≥1
Chert Ridge faults (CHR)							
[Eastern faults]	– –	– –	– –	– –	– –	– –	≥1
[Western faults]	– –	– –	– –	– –	– –	– –	≥1
Chicago Valley fault (CHV)	– –	– –	– –	(≥10 ka)------- ≥1 -------(≤300 to 500) ka)		– –	– –
Cockeyed Ridge–Papoose Lake fault (CRPL)	– –	– –	– –	– –	– –	– –	≥1
Death Valley fault (DV)	(>0.2 ka)----≥3--- (<2 ka)			– –	– –	– –	– –
East Belted Range fault (EBR)	– –	– –	– –	– –	– –	– –	≥1
East Nopah fault (EN)	– –	– –	(10 ka)---------- ≥1 ------------(≤300 to 500) ka)			– –	– –
East Pintwater Range fault (EPR)	------ ≥1? ------(≤130 to 1,500) ka)					– –	≥1
Emigrant fault (EM)	– –	– –	– –	– –	– –	– –	≥1

Table 12. Estimated number of events/time interval for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain — Continued

Fault or fault [Segment or individual fault]	Holocene Late 0-4 ka	Holocene Middle 4-8 ka	Holocene Early 8-10 ka	Pleistocene Late 10-130 ka	Pleistocene Middle 130-790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma
Emigrant Valley North fault (EVN)	--	--	--	--	--	≥1	--
Emigrant Valley South fault (EVS)	--	--	--	--	--	--	≥1
Fallout Hills faults (FH)	--	--	--	--	--	--	≥1
Gold Flat fault (GOL)	--	--	--	--	--	--	≥1
Gold Mountain fault (GOM)	≥1 (<(10 to 130) ka)				--	--	--
Grapevine fault (GV)	--	--	--	--	--	--	>1
Grapevine Mountains fault (GM)							
[Southern trace]	--	--	--	--	--	--	≥1
[Northern trace]	≥1? (<(106 to 130) ka[illegible]) or (<(1[illegible] 150) ka)					--	--
Groom Range Central fault (GRC)	--	--	--	--	--	--	≥1
Groom Range East fault (GRE)	--	--	--	--	--	--	≥1?
Hidden Valley–Sand Flat faults (HVSF)							
[Fault along the eastern sides of Hidden Valley Ulida Flat]	--	--	--	--	--	--	≥1
[Fault along the southern sides of Ulida Flat/Sand Flat]	--	--	--	--	--	--	≥1
[Fault along the southeastern side of Sand Flat]	--	--	--	--	--	--	≥1
[Fault along the northeastern side of Sand Flat]	--	--	--	--	--	--	≥1
[Fault along the western side of Ulida Flat]	--	--	--	--	--	--	≥1
Hunter Mountain fault (HM)	≥1 (≤10 ka)			--	--	--	--
Indian Springs Valley fault (ISV)	--	--	--	--	--	--	≥1
Jumbled Hills fault (JUM)	--	--	--	--	--	--	≥1
Kawich Range fault (KR)	≥1 (<(10 to 1,500) ka)					--	--
Kawich Valley fault (KV)	--	--	--	--	--	--	≥1
La Madre fault (LMD)	--	--	--	--	--	--	≥1
North Desert Range fault (NDR)	--	--	--	--	--	--	≥1
Oak Spring Butte faults (OAK)	≥1 (<(10 to 130) ka)				--	--	--

Table 12. Estimated number of events/time interval for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain — Continued

Fault or fault [Segment or individual fault]	Holocene Late 0-4 ka	Holocene Middle 4-8 ka	Holocene Early 8-10 ka	Pleistocene Late 10-130 ka	Pleistocene Middle 130-790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma
Pahrump fault (PRP)	?------------ ≥1 ------------?				--	--	--
Panamint Valley fault (PAN)							
[Fault south of Ballarat]	------------ [1]6 to 14 ------------(<17±4 ka)				--	--	--
[Fault north of Ballarat]	--	--	--	--	--	--	≥1
Penoyer fault (PEN)	------------ ≥1 ------------(≤(15 to 200) ka)					--	--
Racetrack Valley faults (RTV)							
[Eastern fault]	--	--	--	--	--	--	≥1
[Western fault]	--	--	--	--	--	--	≥1
Sarcobatus Flat fault (SF)	--	--	--	--	--	--	≥1
Slate Ridge faults (SLR)							
[Northern fault]	--	--	--	--	--	--	≥1
[Southern fault]	--	--	--	--	--	--	1?
South Ridge faults (SOU)							
[Northern fault]	--	--	--	--	--	--	≥1
[Southern fault]	--	--	--	--	--	--	1?
Spotted Rage faults (SPR)							
[Range-front fault]	--	--	--	--	--	--	--
[Fault along unnamed ridge]	--	--	--	--	--	--	≥1
[Faults within the range]	--	--	--	--	--	--	1?
Stonewall Mountain fault (SWM)	------------ ≥1 ------------(≤(10 to 130) ka)				--	--	--
Stumble fault (STM)	--	--	--	--	--	--	≥1
Three Lakes Valley fault (TLV)	--	--	--	--	--	--	1?
Tikaboo fault (TK)	(≤15 ka)------------ ≥1 ------------(≤200 ka)					--	--
Tin Mountain fault (TM)	--	--	--	--	--	--	≥1
Towne Pass fault (TP)	------------ ≥1 ------------(≤10 ka)			--	--	--	--
West Pintwater Range fault (WPR)	------------ ≥1 ------------(≤(10 to 1,500) ka)					--	--
West Spring Mountains fault (WSM)	------------ ≥1 ------------(≤(10 to 130) ka)				--	--	--

[1]Y-697 (p. 4866) inferred that strandlines from the last high stand of Lake Panamint (estimated to have occurred about 17 ka ± 4 ka) are displaced by possibly six to fourteen events, assuming single-event displacements of about 3 m.

Table 13. Recurrence interval, strike, and type displacement for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain

[Detailed data are on description sheets in appendix 2. References are listed in appendix 4. Abbreviations of trends: E, east; N, north; NE, northeast; NW, northwest; ENE, east–northeast; NNE, north–northeast; NNW, north–northwest; WNW, west-northwest. Abbreviations for displacement type: L, unspecified lateral; LL, left lateral; LO, left oblique; N, normal; R, reverse; RO, right oblique; RL, right lateral. Number of events and time period are shown only when used to estimate recurrence interval. Queried entries indicate uncertainty in information. Entries separated by a comma (,) indicate data from individual fault traces or for different localities along the fault or faults; entries separated by a semicolon (;) indicate different interpretations by different authors; leaders (––), no information was noted during the literature review]

Fault or faults [Segment or individual fault]	Number of events events	Time period (10^3 yr)	Recurrence interval (10^3 yr)	Strike	Type displacement	References (Y-)
Belted Range fault (BLR)	––	––	––	[1]N; NNE	N?	5, 232, 813, 853
Bonnie Claire fault (BC)	––	––	––	NE	N?	232, 238, 853
Boundary fault (BD)	––	––	––	NE	N	50, 224, 526, 813, 853
Buried Hills faults (BH)	––	––	––	N	N	813
Cactus Flat fault (CF)	––	––	––	N	([2])	813
Cactus Flat–Mellan fault (CFML)	––	––	––	N	––	813
Cactus Range–Wellington Hills fault (CRWH)	––	––	––	NW	N	813
Cactus Springs fault (CAC)	––	––	––	ENE, E, WNW	N	813
Central Pintwater Range faults (CPR)	––	––	––	N to NNW	N	404, 813, 852
Central Spring Mountains faults (CSM)						
[Northwest fault]	––	––	––	NNE	N	813
[Northeast fault]	––	––	––	NNW	N	813, 852
[Southeast fault]	––	––	––	N, E	N	813, 852
Chalk Mountain fault (CLK)	––	––	––	NE to NNE	––	813
Chert Ridge faults (CHR)						
[Eastern faults]	––	––	––	[3]N	[4]N	813
[Western faults]	––	––	––	[3]N	[4]N, RL	813
Chicago Valley fault (CHV)	––	––	––	N to NNW	N	69, 238
Cockeyed Ridge–Papoose Lake fault (CRPL)	––	––	––	NNW	N	232, 813
Death Valley fault (DV)	3	<2	0.65	N.4°W. to N.28°W.	[5]N, RL; RO	216, 389, 429, 473, 474
East Belted Range fault (EBR)	––	––	––	NNW	––	813, 853
East Nopah fault (EN)	––	––	––	[6]N.33°W.	RL	696
East Pintwater Range fault (EPR)	––	––	––	N	N	404, 813, 852

Table 13. Recurrence interval, strike, and type displacement for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Number of events events	Time period (10^3 yr)	Recurrence interval (10^3 yr)	Strike	Type displacement	References (Y-)
Emigrant fault (EM)	--	--	--	N	N	239
Emigrant Valley North fault (EVN)	--	--	--	NNE to NE	N, L	813
Emigrant Valley South fault (EVS)	--	--	--	NNE	N, L	813
Fallout Hills faults (FH)	--	--	--	NNW	N	813
Gold Flat fault (GOL)	--	--	--	NE	--	813
Gold Mountain fault (GOM)	--	--	--	ENE	--	238, 853
Grapevine fault (GV)	--	--	--	NW	N, L?	236
Grapevine Mountains fault (GM)						
[Southern trace]	--	--	--	NNE to NE	N	238, 239, 853
[Northern trace]	--	--	--	NE	N	238, 239, 853
Groom Range Central fault (GRC)	--	--	--	[7]N to NNE, NNW	N	813
Groom Range East fault (GRE)	--	--	--	NNE	N	813
Hidden Valley–Sand Flat faults (HVSF)						
[Fault along the eastern sides of Hidden Valley/Ulida Flat]	--	--	--	N to NE	N	239
[Fault along the southern sides of Ulida Flat/Sand Flat]	--	--	--	NW	N	239
[Fault along the southeastern side of Sand Flat]	--	--	--	N to NE	N	239
[Fault along the northeastern side of Sand Flat]	--	--	--	NW	N	239
[Fault along the western side of Ulida Flat]	--	--	--	N to NE	N	239
Hunter Mountain fault (HM)	--	--	--	[8]NNW, WNW	RO?	239, 356, 427, 494, 698, 864, 1148
Indian Springs Valley fault (ISV)	--	--	--	NNW	N	813, 852
Jumbled Hills fault (JUM)	--	--	--	N	N	25, 813
Kawich Range fault (KR)	--	--	--	NE, NNW, NW, NNE	N	5, 813, 853
Kawich Valley fault (KV)	--	--	--	NE, NNE, N	--	813, 853
La Madre fault (LMD)	--	--	--	NW	N	813

Table 13. Recurrence interval, strike, and type displacement for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Number of events events	Time period (10^3 yr)	Recurrence interval (10^3 yr)	Strike	Type displacement	References (Y-)
North Desert Range fault (NDR)	--	--	--	N	N	813
Oak Spring Butte faults (OAK)	--	--	--	N	N	50, 212, 813, 853
Pahrump fault (PRP)	--	--	--	N.45°W.	RO	161, 238, 696, 806
Panamint Valley fault (PAN)						
[Fault south of Ballarat]	[9]6 to 14; [10]8 to 14	[9]<17±4; [10]<(10 to 20)	[9]0.86 to 2.36; [10]0.7 to 2.5	NNW	[11]N, RL, RO	697, 868
[Fault north of Ballarat]	--	--	--	N	N	239
Penoyer fault (PEN)	--	--	--	[12]NNE to NE, N to NNW	N	25, 404, 813, 1032
Racetrack Valley faults (RTV)						
[Eastern fault]	--	--	--	NNE	N	239
[Western fault]	--	--	--	NNE to NNW	N	239
Sarcobatus Flat fault (SF)	--	--	--	NNW	N	238, 813, 853
Slate Ridge faults (SLR)						
[Northern fault]	--	--	--	E to ENE	N	238, 853
[Southern fault]	--	--		E to ENE	N	238, 853
South Ridge faults (SOU)						
[Northern fault]	--	--	--	E	N	813, 852
[Southern fault]	--	--	--	[13]E, ENE, NE	N, LL	62, 813
Spotted Range faults (SPR)						
[Range-front fault]	--	--	--	N, NNE	--	813
[Fault along unnamed ridge]	--	--	--	NE	--	813
[Faults within the range]	--	--	--	N, NNE	N	813
Stonewall Mountain fault (SWM)	--	--	--	NE, ENE	[14]N; LO, R	10, 238, 813, 853
Stumble fault (STM)	--	--	--	[15]NNE, N to NNW	N	25, 404, 813
Three Lakes Valley fault (TLV)	--	--	--	NW	N?	404, 813
Tikaboo fault (TK)	--	--	--	NNW	N	25, 813, 1032
Tin Mountain fault (TM)	--	--	--	N to NNE	N	238, 239

Table 13. Recurrence interval, strike, and type displacement for known and suspected Quaternary faults between >50 and 100 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Number of events events	Time period (10^3 yr)	Recurrence interval (10^3 yr)	Strike	Type displacement	References (Y-)
Towne Pass fault (TP)	--	--	--	NNE	N; ([16])	239, 390, 458
West Pintwater Range fault (WPR)	--	--	--	[17]N, NNW, NNE	N	852
West Spring Mountains fault (WSM)	--	--	--	N.12°W.	[18]N, RL	161, 696, 813, 852

[1]The southern half of BLR strikes north-northeast; the northern half strikes north. Short sections of BLR strike between north-northwest and north-northeast (Y-5; Y-232; Y-813; Y-853).

[2]Y-813 shows four north-northeast-trending folds subparallel to the northern end of CF. Y-813 (p. 6) suggested that these folds indicate that compression has been associated with CF during the Quaternary.

[3]Faults included in CHR generally strike north, but individual faults curve so that their strikes range between north-northwest and northeast (Y-813).

[4]Faults in CHR are shown to have vertical displacement except for short faults at the southern end of the western side of Chert Ridge. These faults are portrayed by Y-813 as having right-lateral displacement.

[5]Displacement on DV is reported to have been predominantly dip slip (normal; Y-216; Y-389; Y-429), but Y-216 and Y-474 both noted evidence for right-lateral displacement near Badwater and Copper Canyon. Y-473 (p. 436) noted a component of right-lateral displacement on northeast-striking fault traces along the Black Mountains. Y-429 (p. 6) thought displacement on DV had been right-oblique.

[6]The southern 9 km of EN strike N. 16° W. to N. 30° W. (Y-696, p. 41). Fault traces that splay to the southeast away from the main trace of EN strike between N. 18° W. and N 8° E. (Y-696, p. 41).

[7]Traces of GRC strike generally north to north-northeast (Y-813). The left-stepping pattern of traces results in a general north-northwest strike for the entire fault.

[8]HM in northern Panamint Valley and adjacent to Hunter Mountain strikes north-northwest. Y-864 (p. 10,422) noted a strike of N. 6° W. near Panamint Butte in northern Panamint Valley. Y-494 (p. 175) and Y-698 (p. 113) both noted a strike of N. 55° W. for a near-vertical fault trace at Grapevine Pass southwest of Hunter Mountain. HM strikes west-northwest between Hunter Mountain and Daisy Canyon along the southern edge of Saline Valley. Y-1148 (p. 20) reported a strike of N. 60° W. for HM in Saline Valley.

[9]This is the average recurrence interval for the southern section of PAN estimated by Y-697 (p. 4868) for the Holocene and latest Pleistocene assuming single-event lateral displacements of about 3 m (3.2 ± 0.5) and a right-lateral slip rate of 2.36 ± 0.79 mm/yr.

[10]This is the average recurrence interval for surface-rupturing events on a 20-km-long section of PAN between Ballarat and Goler Wash. The interval was estimated by Y-868 (p. 415) assuming that all events produced right-lateral displacement of 1.4 to 2.6 m and that the total displacement of 20 m represents eight to fourteen events since 10 ka to 20 ka.

[11]Along the southern section of PAN, fault traces at the range front have dip-slip (normal), down-to-the-west displacement (Y-697, p. 4858). Right-lateral displacement has been dominant along fault traces several hundred meters west of the range front. Y-697 (p. 4869) noted that right-oblique slip is "partitioned between strike-slip and dip-slip faults."

[12]The first entry is for the southern half of PEN; the second entry is for the northern half of PEN (Y-1032).

[13]The main trace of the southern fault varies in strike from east-northeast at the western end of South Ridge, to northeast in the central part of the ridge, to east at the eastern end of the ridge (Y-813). A branch fault south of the main trace strikes primarily northeast.

[14]SWM generally exhibits evidence for dip-slip (normal) displacement (Y-813), but the fault may have had left-oblique displacement at its southwest end (Y-10). Y-10 (p. 58) suggested that high-angle reverse displacement may have occurred on part of SWM.

[15]The first entry is for the southern half of STM (south of about Cattle Spring); the second entry is for the curving, northern half of STM. The northern half is composed of four fault traces (Y-813).

[16]Y-458 (p. 57) reported that he observed no evidence for lateral displacement on TP.

[17]WPR strikes generally north, but its trace curves, so that the southern end of WPR strikes north-northeast and the northern portion strikes north-northwest (Y-852). WPR is portrayed by Y-852 as composed of curving, overlapping, and branching traces with strikes ranging between north-northwest and northeast.

[18]Y-696 (p. 86-87) noted that dip-slip (normal) and down-to-the-west displacement on WSM is indicated by bedrock relationships in the Spring and Montgomery mountains and by scarps (Y-696; Y-813; Y-852). Y-696 (p. 84-85) suggested that sharp bends in the fault's trace preclude a significant lateral component of displacement. Y-813 (p. 9) noted that displacement on WSM is predominantly dip slip with little or no strike slip. Fault traces in Pahrump Valley between Hidden Hills and Manse, Nevada, exhibit dip slip, but a left-stepping fault pattern suggests some right-lateral displacement (Y-696).

Table 14. Estimated length, total displacement, and distance from the site for known and suspected Quaternary faults greater than 100 km from Yucca Mountain

[Detailed data are on description sheets in appendix 2. References are listed by number in appendix 4. Queried entries indicate uncertainty in information. Entries separated by a comma (,) indicate data for individual fault traces or for different localities along the fault or faults; entries separated by a semicolon (;) indicate different interpretations by different authors; leaders (--), no information was noted during the literature review; YM, the proposed repository site at Yucca Mountain]

Fault or faults [Segment or individual fault]	Plate (P) or Figure (F) number	Estimated total fault length (km)	Percent of total length with late Quaternary displacement	Total vertical displacement (km)	Total lateral displacement (km)	Closest approach to YM (km)	References (Y-)
Airport Lake fault (AIR)	P2	≥30; >35; >50; ≥60	--	≥0.5; ≥0.6	--	138	640, 1035, 1052, 1110, 1145
Ash Hill fault (AH)	P2	>45	--	0.1	--	105	239, 399
Badger Wash faults (BDG)	P1	[1]4, 8, 13	--	--	--	111	25
Cedar Mountain fault (CM)	F1	≥45; 60	100	--	[2]≥0.1	200	17, 170, 794, 969
Central Reveille fault (CR)	P1	29	--	--	--	108	1032
Clayton–Montezuma Valley fault (CLMV)	P1	13; 14	--	--	--	126	238, 853
Clayton Ridge–Paymaster Ridge fault (CRPR)	P1	≥51; ≥53	--	--	--	126	238, 853
Clayton Valley fault (CV)	P1	26; 27	--	--	--	132	238, 853
Deep Springs fault (DS)	P1	27	--	[3]1.5; ≥1.6	--	148	651, 872, 1033
East Magruder Mountain fault (EMM)	P1	7	--	--	--	113	238
East Reveille fault (ERV)	P1	19; 22; 36	--	--	--	112	5, 232, 813, 853, 1032
East Stone Cabin fault (ESC)	P1	35	--	--	--	115	1032
Emigrant Peak faults (EPK)	P1	[4]26	--	[5]>0.9	--	166	635, 665, 853
Eureka Valley East fault (EURE)	P1	34; 50?	--	--	--	110	853, 1031
Eureka Valley West fault (EURW)	P1	22	--	--	--	140	853
Fish Lake Valley fault (FLV)	P1	≥80	≥25	≥(0.54 to 0.75); ≥0.68	<(15 to 25)	135	647, 651
Freiburg fault (FR)	P1	18; 19	--	--	--	133	404, 1032
Frenchman Mountain fault (FM)	P2	18; 20	--	--	--	146	852, 1073
Garden Valley fault (GRD)	P1	12 to 15(?)	--	--	--	126	25
General Thomas Hills fault (GTH)	P1	11; 26	--	--	--	137	238, 853
Golden Gate faults (GG)	P1	23; 24	--	--	--	144	25, 404
Hiko fault (HKO)	P1	15; 45; 47	--	--	--	131	25, 404, 1032
Hiko–South Pahroc faults (HSP)	P1	27	--	--	--	130	25, 404

Table 14. Estimated length, total displacement, and distance from the site for known and suspected Quaternary faults greater than 100 km from Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Plate (P) or Figure (F) number	Estimated total fault length (km)	Percent of total length with late Quaternary displacement	Total vertical displacement (km)	Total lateral displacement (km)	Closest approach to YM (km)	References (Y-)
Hot Creek–Reveille fault (HCR)	P1	83	--	[6]≥0.46	--	103	232, 1032
Lee Flat fault (LEE)	P2	[7]0.5, 5, 7	--	--	--	113	356, 1148
Lida Valley faults (LV)	P1	[8]3.5, 10	--	--	--	115	238
Little Lake fault (LL)	P2	≥24; >30; 40	[9]25	--	[10]>0.25; ≥0.4	163	374, 542, 1035, 1052, 1110
Lone Mountain fault (LMT)	P1	9; 15; 70	--	--	--	165	238, 407, 853
McAfee Canyon fault (MAC)	P1	14; 17	--	--	--	155	238, 853
Monitor Hills East fault (MHE)	P1	8	--	--	--	125	813
Monitor Hills West fault (MHW)	P1	12 to 15	--	--	--	124	813
Monotony Valley fault (MV)	P1	[11]1; 5.5	--	--	--	103	813
Montezuma Range fault (MR)	P1	≥18; 29; 33	--	--	--	121	238, 853, 1032
Mud Lake–Goldfield Hills fault (MLGH)	P1	≥33	--	--	--	113	238
Owens Valley fault (OWV)	P2	100	[12]100	[13]1.8 to 3.1; 2.4; 5.8	[14]20	126	427, 694, 1046, 1055, 1115, 1116
Pahranagat fault (PGT)	P1	40 to 45	--	--	[15]9 to 16	106	25, 395, 404
[Arrowhead Mine fault (ARM)]	P1	14; 15; 66	--	≥0.5	2; 8	--	25, 395, 404
[Buckhorn fault (BUC)]	P1	20 to 25; 27; 40; 42	--	--	5	--	25, 395, 404, 1032
[Maynard Lake fault (MAY)]	P1	40; 44; ≥45; 91	--	--	≤(5 to 6)	--	25, 395, 404, 1032
Pahroc fault (PAH)	P1	42; 59; 74	--	--	--	144	25, 404, 1032
Pahrock Valley faults (PV)	P1	[16]9, 11	--	--	--	155	25, 404
Palmetto Mountains–Jackson Wash fault (PMJW)	P1	12	--	--	--	112	238
Palmetto Wash faults (PW)	P1	[17]8; 10; 14 to 16?	--	--	--	131	238, 853
Quinn Canyon fault (QC)	P1	16; 18; 19	--	--	--	127	25, 404, 1032
Saline Valley faults (SAL)	P2		--	--	--	108	
[Fault along the front of the Inyo Mountains (WF)]	P2	13.5; 22	--	[18]6	--	--	222, 1148

Table 14. Estimated length, total displacement, and distance from the site for known and suspected Quaternary faults greater than 100 km from Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Plate (P) or Figure (F) number	Estimated total fault length (km)	Percent of total length with late Quaternary displacement	Total vertical displacement (km)	Total lateral displacement (km)	Closest approach to YM (km)	References (Y-)
[Fault along the eastern side of Saline Valley (ES)]	P2	5, 6	--	--	--	--	356
[Fault in central Saline Valley (CEN)]	P2	20	--	--	--	--	222
Seaman Pass fault (SPS)	P1	[19]22; ≥34	--	--	--	153	404
Sheep Basin fault (SB)	P1, P2	[20]≥35; ≥42; 47	--	[21]≥0.37; >0.46	--	112	852, 918, 1148
Sheep–East Desert Ranges fault (SEDR)	P2	45	--	--	--	104	852
Sheep Range fault (SHR)	P1, P2	30; ≥50	[22]≥40	--	--	122	852, 1032
Sierra Nevada fault (SNV)	P2	25	--	--	--	154	1054
Silver Peak Range faults (SIL)	P1	24	--	--	--	142	238
Six-Mile Flat fault (SMF)	P1	24	--	--	--	138	1032
Southeast Coal Valley fault (SCV)	P1	[23]8; ≥19	--	--	--	132	1032
Southern Death Valley fault (SDV)	P2	[24]51; 63; 85; 200; 300	--	--	[25]≤8; <(10 to 12); ≥19; 24 to 48; 50	105	389, 413, 468, 479, 592, 593, 602, 612, 955
State Line fault (SL)	F1	32	--	[26]>3.5	--	130	743, 893, 1105
Stonewall Flat fault (SWF)	P1	5; 22	--	--	--	101	238, 853
Sylvania Mountains fault (SYL)	P1	14	--	--	--	111	238
Tem Piute fault (TEM)	P1	8; 22	--	--	--	101	25, 404, 1032
Tule Canyon fault (TLC)	P1	[27]10; 14; 26	--	--	--	104	238, 853
Weepah Hills fault (WH)	P1	15	--	--	--	145	238
West Railroad fault (WR)	P1	42	--	--	--	112	1032
Wilson Canyon fault (WIL)	P2	[28]29; 42	--	--	--	140	415, 1020, 1122

[1]BDG includes four faults. The east-central fault is the longest (13 km). The eastern and western faults are each 8 km long. The west-central fault is 4 km long.

[2]Along the northern section of CM, a minimum of 100 m of right-lateral displacement was inferred by Y-170 (p. 53) from displacement of the contact between Miocene units and the rake of exposed striations.

[3]Y-872 (p. 55) estimated a total apparent vertical displacement across DS of 1525 m based on identification of basement rock beneath Deep Springs Valley from a geophysical survey and the present height of the front of the Inyo Mountains above the valley. Y-651 (p. 40) suggested a minimum estimate of total apparent vertical displacement on DS of 1625 m on the basis of the topographic height of bedrock and its location beneath Deep Springs Valley as interpreted from gravity data.

[4]This is the length of the longest fault included in the Emigrant Peak faults. It is the westernmost of four faults. The west-central fault (north of Middle Wash) is 9.5 to 11.5 km long. The east-central fault is only 2 km long. The easternmost fault of EPK is greater than 12 km long.

[5]Y-665 (p. 30) suggested that late-early to middle Pliocene sediments in the present Silver Peak Range between Fish Lake Valley and Clayton Valley have been uplifted at least 900 m since 5.9 Ma (K-Ar date on trachyandesite flows in the sediments).

[6]The is the stratigraphic throw (stratigraphic unit is not specified) across a normal fault on the eastern side of the Kawich Range (Y-232, p. 32). It is not clear if this fault is part of HCR as defined in this compilation.

[7]LEE includes fault traces within and bordering northern Lee Flat. The longest trace, which is on the eastern side of Lee Flat, is 7 km long (Y-1148). The longest trace on the western side of Lee Flat is 5 km long as estimated from Y-1148 and 6.5 km long as estimated from Y-356. Lengths of other traces are variable with 0.5 km as the shortest (Y-1148).

Table 14. Estimated length, total displacement, and distance from the site for known and suspected Quaternary faults greater than 100 km from Yucca Mountain — Continued

[8]The first entry is for the fault along the northwestern side of Lida Valley; the second entry is for the fault along the southeastern side of Lida Valley (Y-238).

[9]Ground cracks attributed to a 1982 magnitude 5.2 earthquake occur in two areas over a combined length of about 10 km (Y-1035, p. 199).

[10]Southeast of the Owens River, a basalt flow dated at about 400 ka is displaced right laterally about 250 m (Y-542), ≥250 m (Y-1110, p. 10, 12), or 400 m (Y-1052, p. [5]).

[11]The first entry is for the fault trace on the northern side of the highland (northern trace); the second entry is for the fault trace on the western side of the highland (western trace) (Y-813).

[12]Surface rupture length in 1872 (M7.8, March 26) occurred on 90 to 110 km of OWV between Owens Lake and north of Big Pine, essentially the entire mapped length of OWV (Y-1046, p. 2; Y-1055).

[13]On the basis of gravity data interpreted by them, Y-1116 (p. 50) reported that the Cenozoic rocks that are faulted against pre-Tertiary rocks in the Inyo Mountains south of Independence, California, are about 1,830 to 3,050 m thick. Y-1046 (p. 2, *citing* Y-1116) noted a maximum vertical displacement on OWV of about 2,400 m near Lone Pine. Y-1116 (p. 54) inferred a total vertical displacement of about 5,800 m, which is "the difference in altitude between the summit of Mount Whitney and the buried pre-Tertiary floor of Owens Valley east of Line Pine."

[14]Y-1046 (p. 2) noted a maximum right-lateral displacement on OWV of about 20 km based on the correlation of two Cretaceous plutons by Y-1115 (p. D88) and work by Y-694.

[15]This is given as the displacement of unspecified type (Y-25; Y-395; Y-404). This may be primarily lateral displacement because of the orientation of the fault.

[16]The first entry is for the eastern fault; the second entry is for the western fault (Y-25; Y-404).

[17]PW may be as long as 14 to 16 km if traces with similar strike to that of PW but south of PW in Fish Lake Valley are included in PW (shown as PW? on plate 1 of this compilation).

[18]This is the total vertical displacement on WF estimated by Y-1148 (p. 50) on the basis of the elevation difference between the height of the Inyo Mountains and the depth of fill within Saline Valley as determined from gravity data.

[19]The portion of SPS with surficial expression is 22 km long. The fault is portrayed by Y-404 as concealed for another 12 km along Seaman Wash, so that the total length of SPS could be 34 km. However, SPS extends to the northern edge of their map area, so that this would be a minimum length.

[20]The length of SB is at least 35 km, as mapped by Y-852. The straight range front continues another 12 km to the north, so that the length of SB could be as much as 47 km.

[21]Using the elevation difference between the floor of Sheep Basin and a pass at the northern end of the Sheep Range, Y-918 (p. 4) estimated a minimum of 366 m of subsidence of the basin. Y-1148 (p. 4-5) inferred that pediments that were once connected to the Sheep Range have been faulted below the present floor of the basin on the footwall of SB and are preserved about 458 m above the basin floor in the Desert Range on the hanging wall.

[22]Percent was calculated using 20 km for the length of continuous scarps and 50 km for the total length of the fault.

[23]If SCV extends to the south to the Pahranagat Valley, then its length may be ≥19 km (Y-1032).

[24]The length of SDV is at least 51 km between Cinder Hill in southern Death Valley and the northeastern side of the Avawatz Mountains in the Silurian Valley as estimated from Y-413. The length may be 63 km if a concealed trace shown by Y-413 along the northeastern side of the Avawatz Mountains is included. If SDV extends 20 km south of the Avawatz Mountains to the southern Halloran Hills as suggested by Y-602 (p. 180-181) and Y-955 (p. 1, 10-11), then the total length of SDV is about 85 km. The length of SDV may be about 200 km, if SDV extends southeast from the Avawatz Mountains through a series of aligned valleys as speculated by Y-479 (p. 934). Y-612 (p. 530-531) proposed that SDV extends about 250 km southeast of the Avawatz Mountains along northwest-striking faults to the Big Maria, Little Maria, and Riverside mountains, which are just north of Blythe, California, along the Colorado River, for a total length of about 300 km for SDV.

[25]Y-479 (p. 947) inferred that the total right-lateral displacement on the northern part of SDV could be no more than 8 km based on trends of formational contacts (e.g., Precambrian Kingston Peak Formation and Noonday Dolomite). Y-593 (p. 1413) estimated that the displacement on the Garlock fault by SDV has been limited to about 8 km. Y-592 (p. 29, 31) concluded that "considerable geologic evidence" suggests that the maximum lateral displacement on SDV has been about 8 km. Y-602 (p. 130, 191) estimated that the total lateral displacement across the Noble Hills is less than 10 to 12 km. Y-468 (p. 157) interpreted the distribution of Precambrian Pahrump Series as indicating a minimum of about 19 km of right-lateral displacement on SDV. Y-389 (p. 56) concluded that the distribution of these same rocks suggested right-lateral displacement of 24 to 48 km. Y-612 (p. 530-531) recontoured isopach data of Y-479 and concluded that SDV had experienced 50 km of right-lateral displacement.

[26]This is the apparent vertical separation of pre-Tertiary rocks across the steep escarpment along the northeastern side of Mesquite Valley and interpreted by Y-1105 to be an extension of SL. The estimate is based on a maximum depth of 2 to 3 km to pre-Tertiary rocks beneath Mesquite Valley as interpreted from geophysical data and the elevations of the surrounding mountains (Y-1105, p. 8689).

[27]The length of TLC north of the mouth of Oriental Wash at the eastern edge of Death Valley is 10 km as estimated from Y-853 and about 14 km as estimated from Y-238. If north- and north-northwest-striking fault traces in Death Valley south of Oriental Wash are included in TLC, then the length of TLC is about 26 km.

[28]WIL is about 42 km long as estimated from Y-1020. Of this length, the eastern 21 km north and east of Searles Lake is shown by Y-1020 as concealed and has been inferred from geophysical evidence (Y-415, p. 191). Y-1122 (p. 49) noted that WIL is about 29 km long.

Table 15. Estimated ages of displaced and undisplaced deposits and amounts of youngest displacement for known and suspected Quaternary faults greater than 100 km from Yucca Mountain

[Detailed data are on description sheets in appendix 2. Ages are estimated primarily from photogeologic, geomorphic, and pedologic criteria. (See individual references and description sheets in appendix 2 for limitations.) References are listed by number in appendix 4. Overlap of ages reported in columns 2 and 3 reflects uncertainties in age estimates and in stratigraphic interpretations (appen. 2). Abbreviations for ages (used where age is not specified in years): Hist., Historical; Hol., Holocene; L.Hol., Late Holocene; M.Hol., Middle Holocene; E.Hol., Early Holocene; Lt.Pleist., Latest Pleistocene; L/M Pleist., Late and Middle Pleistocene; M.Pleist., Middle Pleistocene; Pleist., Pleistocene; Quat., Quaternary; Tert., Tertiary. Late Quaternary displacement is since 130 ka. Queried entries indicate uncertainty in information. Entries separated by a semicolon (;) indicate different interpretations by different authors; leaders (– –), no information was noted during the literature review]

Fault or faults [Segment or individual fault]	Age of youngest unit/surface displaced (10^3 yr)	Age of oldest unit/surface undisplaced (10^3 yr)	Displacement in youngest event (m)		Late Quaternary displacement (m)		References (Y–)
			Vertical	Lateral	Vertical	Lateral	
Airport Lake fault (AIR)	≤10	– –	– –	– –	[1]3, 4	– –	1052, 1110
Ash Hill fault (AH)	≤10	Active stream channels	– –	– –	– –	– –	222, 427, 458, 1020
Badger Wash faults (BDG)	[2]Quat.	– –	– –	– –	– –	– –	25
Cedar Mountain fault (CM)	[3]Hist.	– –	[4]0.15 to 0.3; ≤0.5; 0.6	[4]1 to 2	[5]3	[5]≥21	13, 17, 170, 794, 795, 1069
Central Reveille fault (CR)	15 to 200	≤15	– –	– –	– –	– –	1032
Clayton–Montezuma Valley fault (CLMV)	10 to 1,500; Quat.	– –	– –	– –	– –	– –	238, 853
Clayton Ridge–Paymaster Ridge fault (CRPR)	700 to 1,800; Quat.	15 to 200	– –	– –	– –	– –	238, 1032
Clayton Valley fault (CV)	10 to 1,500; Quat.	≤10	– –	– –	– –	– –	238, 407, 853
Deep Springs fault (DS)	≤6 ka	– –	[6]2.3 to >20	– –	[7]≥180; ≥201	– –	651, 861, 1020, 1033
East Magruder Mountain fault (EMM)	Quat.?	– –	– –	– –	– –	– –	238
East Reveille fault (ERV)	700 to 1800; Quat.	≤15	– –	– –	– –	– –	813, 1032
East Stone Cabin fault (ESC)	15 to 200; 10 to 130	≤15	– –	– –	– –	– –	853, 1032
Emigrant Peak faults (EPK)	[8]1 to 1.4	– –	[9]≥1	– –	[10]≥25.7	– –	635
Eureka Valley East fault (EURE)	10 to 130	– –	– –	– –	– –	– –	853
Eureka Valley West fault (EURW)	10 to 1,500	Hol./Lt.Pleist.	– –	– –	– –	– –	762, 853
Fish Lake Valley fault (FLV)	≤0.2; 0.6 to 1 or 1.5	– –	≤1	≤3	40	92; 122	216, 647, 665
Freiburg fault (FR)	Quat.	15 to 200	– –	– –	– –	– –	404, 1032
Frenchman Mountain fault (FM)	10 to 130; [11]30 to >500(?)	[11]1 to 7	2	– –	– –	– –	852, 1073
Garden Valley fault (GRD)	Quat.	– –	– –	– –	– –	– –	25, 1032

Table 15. Estimated ages of displaced and undisplaced deposits and amounts of youngest displacement for known and suspected Quaternary faults greater than 100 km from Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Age of youngest unit/surface displaced (10^3 yr)	Age of oldest unit/surface undisplaced (10^3 yr)	Displacement in youngest event (m)		Late Quaternary displacement (m)		References (Y–)
			Vertical	Lateral	Vertical	Lateral	
General Thomas Hills fault (GTH)	Quat.	--	--	--	--	--	238, 853
Golden Gate faults (GG)	Quat.	Quat./Tert.	--	--	--	--	404, 1032
Hiko fault (HKO)	15 to 200; Quat.	≤15	--	--	[12]≥9	--	25, 1032
Hiko–South Pahroc faults (HSP)	Quat.	--	--	--	--	--	25, 404, 1032
Hot Creek–Reveille fault (HCR)	15 to 200; 10 to 130	≤15	--	--	[12]≤134	--	853, 1032
Lee Flat fault (LEE)	Quat.	--	--	--	--	--	356, 1148
Lida Valley faults (LV)	Quat.	--	--	--	--	--	238
Little Lake fault (LL)	Hist.	--	([13])	--	--	[14]≥30	427, 1035, 1110
Lone Mountain fault (LMT)	Hol; 10 to 130; 15 to 200	15 to 200	1	--	[15]≤5	--	407, 853, 1032, 1069, 1070
McAfee Canyon fault (MAC)	10 to 1,500; Quat.	--	--	--	--	--	238, 853
Monitor Hills East fault (MHE)	Quat.	--	--	--	--	--	813
Monitor Hills West fault (MHW)	Quat.	--	--	--	--	--	813
Monotony Valley fault (MV)	Quat.?	--	--	--	--	--	813
Montezuma Range fault (MR)	15 to 200; 10 to 1,500; Quat.	≤15	--	--	--	--	238, 853, 1032
Mud Lake–Goldfield Hills fault (MLGH)	Quat.	--	--	--	--	--	238
Owens Valley fault (OWV)	Hist.	--	[16]1±0.5; 2 to 3	[17]6±2; 7 to 11	--	--	1025, 1055
Pahranagat fault (PGT)							
[Arrowhead Mine fault (ARM)]	Quat.	--	--	--	--	--	25, 332, 395
[Buckhorn fault (BUC)]	17,000 to 34, 000	15 to 200	--	--	--	--	1032
[Maynard Lake fault (MAY)]	[18]15 to 200	[18]15 to 200	--	--	--	--	1032
Pahroc fault (PAH)	700 to 1,800	15 to 200	--	--	--	--	1032
Pahrock Valley faults (PV)	Quat.?	--	--	--	--	--	25, 404
Palmetto Mountains–Jackson Wash fault (PMJW)	L/M Pleist.; Quat.	--	--	--	--	--	10, 238

Table 15. Estimated ages of displaced and undisplaced deposits and amounts of youngest displacement for known and suspected Quaternary faults greater than 100 km from Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Age of youngest unit/surface displaced (10^3 yr)	Age of oldest unit/surface undisplaced (10^3 yr)	Displacement in youngest event (m)		Late Quaternary displacement (m)		References (Y–)
			Vertical	Lateral	Vertical	Lateral	
Palmetto Wash faults (PW)	10 to 1,500; <1,500; [19]E.Hol. to M.Pleist.	[20]L.Hol. and M.Hol.	--	--	--	--	238, 853, 1031
Quinn Canyon fault (QC)	700 to 1,800; Quat.; Pleist.(?)	--	--	--	--	--	25, 404, 1032
Saline Valley faults (SAL)							
[Fault along the front of the Inyo Mountains (WF)]	Hol.	--	--	--	--	--	1148
[Fault along the eastern side of Saline Valley (ES)]	Hol. or Pleist.; [21]0.17 to 27	--	--	--	≥12	--	356, 1148
[Fault in central Saline Valley (CEN)]	Hol.	--	--	--	--	--	222
Seaman Pass fault (SPS)	[22]15 to 1,800; Quat.	--	--	--	--	--	404, 1032
Sheep Basin fault (SB)	10 to 30; 15 to 1,800; ([23])	--	--	--	--	--	852, 918, 1032
Sheep–East Desert Ranges fault (SEDR)	10 to 1,500; <1,500	--	--	--	--	--	852
Sheep Range fault (SHR)	15 to 200; ≤30	≤15	--	--	--	--	852, 1032
Sierra Nevada fault (SNV)	Hol.; Lt.Pleist.; <700	Lt.Pleist.	--	--	--	--	425, 1020, 1054
Silver Peak Range faults (SIL)							
[Northeastern fault]	Quat.	--	--	--	--	--	238
[Southwestern fault]	Quat.	--	--	--	--	--	238
Six–Mile Flat fault (SMF)	15 to 200	≤15	--	--	--	--	1032
Southeast Coal Valley fault (SCV)	15 to 200	≤15	--	--	--	--	1032
Southern Death Valley fault (SDV)	[24]8 to 15.5; Hol.				[25]100	[26]200; <500	429, 602, 603, 955, 1020
State Line fault (SL)	[27]M.Pleist.(?); Quat.; ([28])	Quat.; ([29])	--	--	--	--	742, 893, 1020, 1105
Stonewall Flat fault (SWF)	≤30; 10 to 1,500; Quat.	--	--	--	--	--	238, 853
Sylvania Mountains fault (SYL)	Quat.	--	--	--	--	--	238
Tem Piute fault (TEM)	Quat.	15 to 200	--	--	--	--	1032

Table 15. Estimated ages of displaced and undisplaced deposits and amounts of youngest displacement for known and suspected Quaternary faults greater than 100 km from Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Age of youngest unit/surface displaced (10^3 yr)	Age of oldest unit/surface undisplaced (10^3 yr)	Displacement in youngest event (m) Vertical	Displacement in youngest event (m) Lateral	Late Quaternary displacement (m) Vertical	Late Quaternary displacement (m) Lateral	References (Y–)
Tule Canyon fault (TLC)	10 to 1,500; Quat.	--	--	--	--	--	238, 853
Weepah Hills fault (WH)	Quat.	--	--	--	--	--	238
West Railroad fault (WR)	[30]10 to 130; 15 to 200; Quat.	≤15	--	--	[31]≥10	--	813, 853, 1032
Wilson Canyon fault (WIL)	[32]Hol.; Pleist.; Quat.	--	--	--	--	--	413, 415, 1020, 1110

[1]This is the apparent vertical displacement for the southern segment of Y-1110 (pls. 2 and 3). Displacement is for alluvium containing clasts of obsidian that is correlated with rhyolitic domes dated at 90 ka±25 ka and 88 ka±38 ka (K-Ar: Y-1110, p. 31, 74).

[2]A portion of the east-central fault and portions of the two western faults included in BDG are shown by Y-25 as faulted contacts between pre-Tertiary or Tertiary rocks and Holocene and Pleistocene alluvium.

[3]CM ruptured in an earthquake (M7.2) on December 20, 1932.

[4]In Monte Cristo and Stewart valleys, right-lateral displacements in 1932 were up to 1 to 2 m; vertical displacements were ≤0.5 m (Y-13; Y-170; Y-794; Y-1069). Y-17 reported as much as 0.6 m of vertical displacement at one locality. Y-795 noted 15 to 30 cm of vertical displacement and about 1 to 2 m of right-lateral displacement from the 1932 earthquake as interpreted from a trench in Monte Cristo Valley. Y-13 inferred that the ratio of vertical to horizontal displacement in 1932 was at least 1:3. Rupture in 1932 was primarily along a southern section of the fault between northwestern Monte Cristo Valley and the southern edge of Kibby Flat (Y-170).

[5]This is the displacement inferred by Y-795 since 730 ka from trench exposures in Monte Cristo Valley. The lateral displacement is based on a ratio of vertical to horizontal displacement of 1 to 7.

[6]This is the range of heights of scarps on surfaces of unspecified age (Y-1033, p. 244-245). Slope angles of these scarps range between 21° and 39° (Y-1033).

[7]Using the elevation differences of Bishop ash (740 ka), Y-1033 (p. 247) estimated a minimum vertical displacement of 180 m and Y-651 (p. 40) estimated a minimum apparent vertical displacement of 201 m.

[8]Late Holocene scarps are along the westernmost fault of EPK (Y-635).

[9]This is the minimum vertical surface displacement across a scarp on late Holocene alluvium (Y-635). Scarp is on the westernmost fault of EPK.

[10]This is the minimum vertical surface displacement across scarps on early Holocene and late Pleistocene alluvium. Scarps are along the westernmost fault of EPK (Y-635).

[11]Y-1073 (p. 49, 101) stated that their best guess for the age of the youngest rupture on FM is late Quaternary (<130 ka), but that this event could be as young as early Holocene. Scarps are preserved on surfaces with estimated ages of 30 ka to >500 ka(?). The only deposits that overlie the fault could be as young as late to middle Holocene (1 ka to 7 ka; Y-1073, appen. 2).

[12]This is the maximum scarp height reported. No age was specified (Y-1032).

[13]Ground cracks up to 4 mm in width were reported from a 1982 (M 5.2) earthquake (Y-1035).

[14]Y-1110 (p. 10, 27) reported that young (not dated but probably Holocene) alluvium and landslide debris are displaced right laterally 30 m at the northern end of LL where the fault merges with the Sierra Nevada fault.

[15]Y-1069 (p. 388) and Y-1070 (p. 406) both reported that middle and late Pleistocene surfaces are displaced up to 5 m.

[16]The first entry is the average vertical component of displacement in the 1872 earthquake. Y-1025 (p. 763, 766) reported an additional dip-slip component of 1 to 2 m on the Lone Pine fault, a secondary trace of OWV. Average net oblique displacement was 6.1±2.1 m with a maximum net oblique displacement of 11 m (Y-1055).

[17]The first entry is the average right-lateral component of displacement in the 1872 earthquake. Maximum displacement was about 10 m at Lone Pine (Y-1055). Including the horizontal component of slip on the Lone Pine fault (a secondary trace of OWV) in 1872, Y-1025 (p. 766) concluded that the maximum horizontal component of slip in 1872 was 7 to 11 m.

[18]Data in columns 2 and 3 are from different localities along the fault.

[19]The map by Y-1031 shows that faults that are possibly part of PW (the traces that are in Fish Lake Valley and that are shown as PW? on plate 1 of this compilation) displace alluvial-fan deposits of early Holocene to late-middle Pleistocene age.

[20]The map by Y-1031 shows that faults that are possibly part of PW (the traces that are in Fish Lake Valley and that are shown as PW? on plate 1 of this compilation) are concealed by late and middle Holocene alluvium.

[21]This is the age range for the youngest event on ES estimated by Y-1148 (p. 63-64) on the basis of a comparison of the characteristics of the scarps along ES with those of scarps studied by Y-1118, the lack of varnish on scarp faces, the presence of scarps on all but the most-recent surfaces, and the disruption of drainages by the scarps.

[22]This is the probable age of the youngest event as estimated by Y-1032 (pl. 9).

[23]Y-918 (p. 5-7) concluded that scarps "preserved between canyons appear remarkably fresh" given the unconsolidated character of the alluvial-fan deposits. He (Y-918, p. 7) suggested that displacement probably occurred not "more than a few hundred years ago."

[24]Y-602 (p. 127) reported that an eastern branch of SDV in the northern Avawatz Mountains cuts early Holocene to late Pleistocene (8 ka to 15.5 ka) alluvial-fan deposits, so that displacement could be as young as 8 ka, although Y-602 (p. 130) speculated that most of the displacement in this area occurred between 1 Ma and 2 Ma. Along the eastern side of the Avawatz Mountains, bedrock is faulted over late Pleistocene or early Holocene (8 ka to 15.5 ka) alluvial-fan deposits (Y-955, p. 6). Y-1020 portrayed displacement on some traces of SDV as Holocene (≤10 ka). Y-429 (p. 10, fig. 3f) reported that the expression of SDV along the northeastern side of the Noble Hills suggests some Holocene displacement.

[25]Y-603 (p. 26) reported a maximum vertical displacement of about 100 m for their eastern subzone of SDV in southern Death Valley since 700 ka to 900 ka.

[26]Y-603 (p. 30, 99) estimated about 200 m of right-lateral displacement of Cinder Hill in southern Death Valley since 700 ka to 900 ka. Y-955 (p. 9-10) estimated that late Pleistocene-early Holocene (8 ka to 15.5 ka) alluvial-fan deposits in the northern Avawatz Mountains have a cumulative lateral displacement of <500 m on western traces of SDV.

[27]Y-742 (p. 18) concluded that normal faults bounding Ivanpah Valley are younger than basalt flows that overlie an upland surface. He inferred that the upland was eroded and that the basalt flows were extruded during middle Pleistocene (Y-742, p. 18).

Table 15. Estimated ages of displaced and undisplaced deposits and amounts of youngest displacement for known and suspected Quaternary faults greater than 100 km from Yucca Mountain — Continued

[28]Y-893 (p. 103) suggested that displacement along SL possibly coincided with downwarping of Mesquite Valley, which he thought had occurred recently.

[29]Y-1105 (p. 8689) concluded that the lack of obvious topographic expression of a range-bounding fault in Mesquite Valley (an inferred extension of SL) "suggests that most of the slip probably occurred before Holocene or even late Quaternary time."

[30]The youngest fault scarps along WR that are shown by Y-853 are on depositional or erosional surfaces of late Pleistocene age (10 ka to 130 ka). Y-1032 (tables 3 and A2) noted that the youngest unit displaced along WR is alluvial-fan deposits with an estimated age of 15 ka to probably about 200 ka. WR is shown by Y-813 as weakly expressed to prominent lineaments and scarps on surfaces of Quaternary deposits.

[31]Y-1032 (table A2, p. A19) noted a maximum scarp height of 10 m on surfaces of unspecified age.

[32]Y-413 showed the western end of WIL in the Coso Basin as displacing Holocene alluvium. WIL is noted by Y-415 (p. 191) to cut Pleistocene volcanic rocks. Y-1020 portrayed the entire length of WIL as having Quaternary displacement. The eastern portion of WIL is not exposed at the ground surface but is reported by Y-415 (p. 191) to affect Quaternary sediments at depth as inferred from geophysical data. Y-1110 (p. 79) concluded that WIL has not been active during the Quaternary.

Table 16. Slip rates (mm/yr) for known and suspected Quaternary faults greater than 100 km of Yucca Mountain

[Detailed data are on description sheets in appendix 2. Rates in italics are for apparent lateral slip; rates in vertical type are for apparent vertical slip. Numbers in parentheses indicate the time interval for which the rate has been estimated. Abbreviation Lt.Pleist. is Latest Pleistocene. The pre-Quaternary rates are based on displacement of units that are older than 1.6 Ma, but displacement may have continued into the Quaternary. References are listed on Tables 14, 15, and 18 and on data sheets in appendix 2. Queried entries indicate uncertainty in information. Entries separated by a semicolon (;) indicate different interpretations by different authors; leaders (– –), no information was noted during the literature review]

Fault or faults	Holocene			Pleistocene		Late		Pre-Quaternary	
	Late	Middle	Early	Late	Middle	Quaternary	Quaternary		Interval
[Segment or individual fault]	0-4 ka	4-8 ka	8-10 ka	10-130 ka	130-790 ka	<130 ka	<1.6 Ma	Rate	(10^6 yr)
Airport Lake fault (AIR)	----- [1]0.03 to 0.07 ----- (<(50 to 126) ka)				– –	– –	[2]*0.1 to 0.3*	– –	– –
Ash Hill fault (AH)	– –	– –	– –	– –	– –	– –	– –	– –	– –
Badger Wash faults (BDG)	– –	– –	– –	– –	– –	– –	– –	– –	– –
Cedar Mountain fault (CM)	----- *0.1* -----			[3]*0.05*	[4]*>0.03*	– –	– –	– –	– –
Central Reveille fault (CR)	– –	– –	– –	– –	– –	– –	– –	– –	– –
Clayton–Montezuma Valley fault (CLMV)	– –	– –	– –	– –	– –	– –	– –	– –	– –
Clayton Ridge–Paymaster Ridge fault (CRPR)	– –	– –	– –	– –	– –	– –	– –	– –	– –
Clayton Valley fault (CV)	– –	– –	– –	– –	– –	– –	– –	– –	– –
Deep Springs fault (DS)	– –	– –	– –	– –	– –	– –	[5]≥0.24; ≥0.3	[6]≥(0.06 to 0.07); ≥(0.13 to 0.16)	<(10 to 12)
East Magruder Mountain fault (EMM)	– –	– –	– –	– –	– –	– –	– –	– –	– –
East Reveille fault (ERV)	– –	– –	– –	– –	– –	– –	– –	– –	– –
East Stone Cabin fault (ESC)	– –	– –	– –	– –	– –	– –	– –	– –	– –
Emigrant Peak faults (EPK)	[7]<(0.5 to 1)	– –	– –	– –	– –	– –	[8]≥0.16; [9]≥0.2	0.15	<5.9
Emigrant Valley East fault (EURE)	– –	– –	– –	– –	– –	– –	– –	– –	– –
Emigrant Valley West fault (EURW)	– –	– –	– –	– –	– –	– –	– –	– –	– –
Fish Lake Valley fault (FLV)	----- [10]*0.4 to 0.6* ----- (<5 to 8 ka)			– –	– –	– –	[11]0.3 to 0.7	– –	– –
	----- [10]0.1 to 0.3 ----- (<5 to 8 ka)			– –	– –	– –	– –	[12]0.05 to 0.2	0.74 to 10.8
	----- [13]*0.6 to 0.8* ----- (<150 ka)					– –	– –	[14]0.3	<1
	----- [15]0.8 to 1.6 ----- (<150 ka)					– –	– –	[16]0.15 to 0.25	<3
	– –	– –	– –	– –	– –	– –	– –	[17]0.06 to 0.07	<(10 to 12)
	– –	– –	– –	– –	– –	– –	– –	[illegible]	<(8.2 to 11.9)
	– –	– –	– –	– –	– –	– –	– –	[illegible]	<5.5, <160
Freiburg fault (FR)	– –	– –	– –	– –	– –	– –	– –	– –	– –

Table 16. Slip rates (mm/yr) for known and suspected Quaternary faults greater than 100 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Holocene Late 0-4 ka	Holocene Middle 4-8 ka	Holocene Early 8-10 ka	Pleistocene Late 10-130 ka	Pleistocene Middle 130-790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma	Pre-Quaternary Rate	Pre-Quaternary Interval (10^6 yr)
Frenchman Mountain fault (FM)	--	--	--	--	--	--	--	--	--
Garden Valley fault (GRD)	--	--	--	--	--	--	--	--	--
General Thomas Hills fault (GTH)	--	--	--	--	--	--	--	--	--
Golden Gate faults (GG)	--	--	--	--	--	--	--	--	--
Hiko fault (HKO)	--	--	--	--	--	--	--	--	--
Hiko–South Pahroc faults (HSP)	--	--	--	--	--	--	--	--	--
Hot Creek–Reveille fault (HCR)	--	--	--	--	--	--	--	--	--
Lee Flat fault (LEE)	--	--	--	--	--	--	--	--	--
Lida Valley faults (LV)	--	--	--	--	--	--	--	--	--
Little Lake fault (LL)	*3* (≤10 ka)					[20]*0.6 to 1.8; ≥1; ≤1*	--	--	--
	1.1 to 4.9 (<151 to 229 ka)								
Lone Mountain fault (LMT)	--	--	--	--	--	--	--	--	--
McAfee Canyon fault (MAC)	--	--	--	--	--	--	--	--	--
Monitor Hills East fault (MHE)	--	--	--	--	--	--	--	--	--
Monitor Hills West fault (MHW)	--	--	--	--	--	--	--	--	--
Monotony Valley fault (MV)	--	--	--	--	--	--	--	--	--
Montezuma Range fault (MR)	--	--	--	--	--	--	--	--	--
Mud Lake–Goldfield Hills fault (MLGH)	--	--	--	--	--	--	--	--	--
Owens Valley fault (OWV)	[21]*3 to 7*					[22]*3*	--	--	--
	[23]*2±1* (≤10 ka)					--	--	--	--
	[24]*0.7 to 2.2* (≤10 ka)					--	--	--	--
	[25]0.4 to 1.3 (<Lt.Pleist.)					--	--	--	--
	[26]*1.5±1* (<300 ka)					--	--	--	--
Pahranagat fault (PGT)									
[Arrowhead Mine fault (ARM)]	--	--	--	--	--	--	--	--	--
[Buckhorn fault (BUC)]	--	--	--	--	--	--	--	--	--
[Maynard Lake fault (MAY)]	--	--	--	--	--	--	--	--	--
Pahroc fault (PAH)	--	--	--	--	--	--	--	--	--
Pahrock Valley faults (PV)	--	--	--	--	--	--	--	--	--
Palmetto Mountains–Jackson Wash fault (PMJW)	--	--	--	--	--	--	--	--	--

Table 16. Slip rates (mm/yr) for known and suspected Quaternary faults greater than 100 km of Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Holocene Late 0-4 ka	Holocene Middle 4-8 ka	Holocene Early 8-10 ka	Pleistocene Late 10-130 ka	Pleistocene Middle 130-790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma	Pre-Quaternary Rate	Pre-Quaternary Interval (10^6 yr)
Palmetto Wash faults (PW)	--	--	--	--	--	--	--	--	--
Quinn Canyon fault (QC)	--	--	--	--	--	--	--	--	--
Saline Valley faults (SAL)									
[Fault along the front of the Inyo Mountains (WF)]	--	--	--	--	--	--	--	--	--
[Fault along the eastern side of Saline Valley (ES)]	--	--	--	--	--	--	--	--	--
[Fault in central Saline Valley (CEN)]	--	--	--	--	--	--	--	--	--
Seaman Pass fault (SPS)	--	--	--	--	--	--	--	--	--
Sheep Basin fault (SB)	--	--	--	--	--	--	--	--	--
Sheep–East Desert Ranges fault (SEDR)	--	--	--	--	--	--	--	--	--
Sheep Range fault (SHR)	--	--	--	--	--	--	--	--	--
Sierra Nevada fault (SNV)	------ [27]0.1 to 0.8 ------ (≤10 ka)			--	--	--	--	--	--
Silver Peak Range faults (SIL)									
[Northwestern fault]	--	--	--	--	--	--	--	--	--
[Southeastern fault]	--	--	--	--	--	--	--	--	--
Six–Mile Flat fault (SMF)	--	--	--	--	--	--	--	--	--
Southeast Coal Valley fault (SCV)	--	--	--	--	--	--	--	--	--
Southern Death Valley fault (SDV)	------ [28]*≤(32 to 63)* ------ (<(8 to 15) ka) ------ [29]*0.3* ------ (<700 ka)					--	--	[30]*2 to 3*	1 to 10
State Line fault (SL)	--	--	--	--	--	--	--	--	--
Stonewall Flat fault (SWF)	--	--	--	--	--	--	--	--	--
Sylvania Mountains faults (SYL)	--	--	--	--	--	--	--	--	--
Tem Piute fault (TEM)	--	--	--	--	--	--	--	--	--
Tule Canyon fault (TLC)	--	--	--	--	--	--	--	--	--
Weepah Hills fault (WH)	--	--	--	--	--	--	--	--	--
West Railroad fault (WR)	--	--	--	--	--	--	--	--	--
Wilson Canyon fault (WIL)	--	--	--	--	--	--	--	--	--

[1]This is the apparent vertical slip rate for the Southern segment of Y-1110 (pls. 2 and 3) estimated using the displacement of alluvium with a maximum age of 50 ka to 126 ka (Y-1110, p. 31).

[2]This rate is for the Southern segment of Y-1110 (pls. 2 and 3) and is based on the apparent right-lateral displacement of 125 m of a basalt flow assumed by Y-1110 (p. 74, pl. 2) to be >400 ka and <1 Ma

Table 16. Slip rates (mm/yr) for known and suspected Quaternary faults greater than 100 km of Yucca Mountain — Continued

[3]This is the rate since 135 ka and was estimated assuming 7 m of right-lateral displacement (Y-795, p. 1-35).

[4]This is the rate since 730 ka and was estimated assuming >21 m of right-lateral displacement (Y-795, p. 1-35).

[5]These are minimum apparent vertical slip rates since 740 ka. The rates were estimated by Y-651 (p. 37, 40) and Y-1033 (p. 254) on the basis of the inferred displacements of Bishop ash. These displacements were inferred from ≥180 m, which is the uplift of fluvial gravels interbedded with pumice fragments tentatively correlated with the Bishop ash, and 201 m, which is the elevation difference across the fault between uplifted fluvial gravel that contains Bishop ash and the floor of Deep Springs Valley.

[6]These are minimum apparent vertical slip rates estimated by Y-651 (p. 37, 40) for the period since 10 Ma to 12 Ma using the elevation of a basalt of this age and its inferred elevation beneath Deep Springs Valley (yields a rate of 0.06 to 0.07 mm/yr) and using the elevation of bedrock and its inferred elevation beneath Deep Springs Valley and assuming that all displacement has occurred since 10 Ma to 12 Ma (yields a rate of 0.13 to 0.16 mm/yr).

[7]This is a maximum apparent vertical slip rate for the westernmost fault of EPK during the late Holocene. The rate was estimated by Y-330 (p. 223) using 1 to 2 m of displacement in deposits that date at about 2 ka.

[8]This is the minimum vertical slip rate since about 740 ka (Bishop ash) along the westernmost fault of EPK (Y-635).

[9]This is the minimum vertical slip rate since about 1 Ma for the westernmost fault of EPK (Y-651). It is also the apparent vertical slip rate since about 2 Ma for the three western faults of EPK (Y-651).

[10]This rate is based on data from only a single trace of FLV at Indian Creek in northern Fish Lake Valley (Y-647; Y-665).

[11]This is the range in vertical slip rates estimated at several places along FLV for deposits containing Bishop ash (0.74 Ma; Y-651).

[12]This is a post-Miocene apparent vertical slip rate (Y-651, p. 26, 42).

[13]This rate is based on data from only a single trace of FLV at Leidy Creek and Indian Creek in northern Fish Lake Valley (Y-647; Y-665).

[14]This is a minimum vertical slip rate estimated for FLV at Perry Aiken Creek in central Fish Lake Valley (Y-651, p. 39).

[15]This rate was estimated across the entire FLV at Indian Creek in northern Fish Lake Valley (Y-647). The apparent vertical slip rate at this same locality across a single trace of FLV is about 0.3 mm/yr (Y-647; Y-665).

[16]This is the range of vertical slip rates estimated for FLV near Davis Mountain in southern Fish Lake Valley (Y-651, p. 40).

[17]This vertical slip rate is based on displacement of a 10-Ma-to12-Ma basalt near Chocolate Mountain in southern Fish Lake Valley (Y-651, p. 38).

[18]In the Horse Thief Hills–Willow Wash area just south of Fish Lake Valley, volcanic rocks that underlie and that are interbedded with fault-derived sediments yield ages of 8.2 Ma and 11.9 Ma (Y-651, p. 36). If the 50 m of right-lateral displacement that was noted by Y-475 (p. 509-510, 512) is assumed, then the post-Miocene right-lateral slip rate is 4 to 6 mm/yr for FLV in southern Fish Lake Valley (Y-651, p. 36).

[19]Right-lateral slip rates of 0.26 mm/yr since about 3.5 Ma and 0.3 mm/yr since about 160 Ma were estimated by Y-475 (p. 510, 512) for FLV in the Cucomungo Canyon area between Fish Lake Valley and Death Valley. Y-651 (p. 27) speculated that the rate in the older rocks is a minimum value because displacement on FLV probably did not begin until middle Miocene (Y-26, *cited by* Y-651, p. 23; Y-706, p. 2).

[20]Y-1052 (p. [2-3]) suggested a lateral slip rate of 0.6 to 1.8 mm/yr for LL on the basis of a reinterpretation of 250 m of apparent lateral displacement of a channel wall of the Owens River (Y-1110, p. 10). The age of displacement is bracketed by a basalt dated at about 400 ka into which the channel is cut and an intra-canyon basalt flow dated at about 140 ka. Y-374 (p. 225) suggested that the lateral slip rate on LL may be "as high as 1 mm/yr or greater based on most-recent evaluation of fault morphology." Y-1052 (p. [5], [8]) calculated a maximum lateral slip rate of 1 mm/yr of LL on the basis of 400 m of displacement of a basalt with an age of 400 ka.

[21]Y-1025 (p. 766, *citing* Y-1362 and Y-1363) reported an average historical right-lateral slip rate of about 3 to 7 mm/yr, which was measured geodetically across Owens Valley

[22]Y-427 (p. 6) reported a late Quaternary slip rate of about 3 mm/yr.

[23]At several sites, data of Y-1055 yielded an average Holocene net slip rate of 2±1 mm/yr.

[24]Y-1025 (p. 766) calculated an average Holocene horizontal slip rate at Lone Pine of 0.7 to 2.2 mm/yr using the total slip component (7 to 11 m) during the 1872 earthquake and an average recurrence interval for earthquakes similar to the one in 1872.

[25]Using an estimate of the average total slip per event (4.3 to 6.3 m) and a range of recurrence intervals (5,000 to 10,500 yr), Y-1025 (p. 765-766) calculated an average late Quaternary (oblique) slip rate of 0.4 to 1.3 mm/yr for the Lone Pine fault (one of several traces of OWV).

[26]Y-1055 reported an average net slip rate of 1.5±1 mm/yr at one site on OWV since about 300 ka.

[27]Y-1055 (p. 7) concluded that faults along the Sierra Nevada front have experienced a vertical slip rate of 0.1 to 0.8 mm/yr during the Holocene. These faults may be a part of SNV of this compilation.

[28]Using observations by Y-955 (p. 9-10, table 1) that early Holocene to late Pleistocene (8 ka to 15.5 ka) alluvial-fan deposits are displaced laterally <500 m, a maximum apparent lateral slip rate of 32 to 63 mm/yr can be estimated for SDV in the Noble Hills.

[29]Y-603 (p. 30) inferred an average apparent right-lateral slip rate on his eastern subzone of SDV of about 0.3 mm/yr, which is based on his estimate of a maximum lateral displacement of 200 m at Cinder Hill, which has been dated at about 700 ka.

[30]Y-603 (p. 29) concluded that the average apparent right-lateral slip rate on his western subzone of SDV adjacent to the Owlshead Mountains is about 2 to 3 mm/yr, which is based on 20 to 35 km of displacement that he thought occurred between about 10 Ma and 1 Ma.

Table 17. Estimated number of events/time interval for known and suspected Quaternary faults greater than 100 km from Yucca Mountain

[Detailed data are on description sheets in appendix 2. Numbers with age units in parentheses indicate the estimated age of the faulting event(s). References are listed on Tables 14, 15, and 18 and in appendix 2. Leaders (--), no information was noted during the literature review. Number of events is shown in the last two columns only if more specific information is not available]

Fault or faults [Segment or individual fault]	Holocene Late 0-4 ka	Holocene Middle 4-8 ka	Holocene Early 8-10 ka	Pleistocene Late 10-130 ka	Pleistocene Middle 130-790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma
Airport Lake fault (AIR)	----- ≥1 ----- (≤10 ka)			--	--	--	--
Ash Hill fault (AH)	----- ≥1 ----- (≤10 ka)			--	--	--	--
Badger Wash faults (BDG)	--	--	--	--	-- --	--	≥1?
Cedar Mountain fault (CM)	1	----- [1]5 to 6? ----- (?)				--	--
Central Reveille fault (CR)				(≤15 ka) ----- ≥1 ----- (<200 ka)		--	--
Clayton–Montezuma Valley fault (CLMV)	--	--	--	--	--	--	≥1
Clayton Ridge–Paymaster Ridge fault (CRPR)	--	--	--	--	(>200 ka) -- [2]≥1 -- (<1.8 Ma)	--	--
Clayton Valley fault (CV)	--	--	--	(>10 ka) ----- ≥1 ----- ?(<1.5 Ma)		--	--
Deep Springs fault (DS)	(>1.5 ka) ----- ≥1 ----- (<6 ka)		--	--	--	--	--
East Magruder Mountain fault (EMM)	--	--	--	--	--	--	≥1?
East Reveille fault (ERV)	--	--	--	(0 to 15 ka) ----- [2]≥1 ----- (<(700 to 1,800) ka)		--	--
East Stone Cabin fault (ESC)	--	--	--	(0 to 15 ka) ----- [2]≥1 ----- (<130 ka or <200 ka)		--	--
Emigrant Peak faults (EPK)	----- [3]≥1 ----- (<(1 to 1.4) ka)	--	--	--	--	--	--
Emigrant Valley East fault (EURE)	----- ≥1 ----- (<(10 to 130) ka)				--	--	--
Emigrant Valley West fault (EURW)	--	--	--	(>(10 to 15) ka) ----- ≥1 ----- (<1.5 Ma)		--	--
Fish Lake Valley fault (FLV)	--- [4]3 --- (≤2.5 ka)	--	--	--	--	--	--
Freiburg fault (FR)	--	--	--	--	--	--	≥1
Frenchman Mountain fault (FM)	(>(1 to 7) ka) ----- ≥1 ----- (<(30 to 500) ka)					--	--
Garden Valley fault (GRD)	--	--	--	--	--	--	≥1
General Thomas Hills fault (GTH)	--	--	--	--	--	--	≥1
Golden Gate faults (GG)	--	--	--	--	--	--	≥1
Hiko fault (HKO)	--	(>(≤15 ka))? ----- [2]≥1 ----- (<(15 to 200) ka)				--	--
Hiko–South Pahroc faults (HSP)	--	--	--	--	--	--	≥1
Hot Creek–Reveille fault (HCR)	--	(>(≤15 ka))? ----- [2]≥1 ----- (<(15 to 200) ka)				--	--

Table 17. Estimated number of events/time interval for known and suspected Quaternary faults greater than 100 km from Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Holocene Late 0-4 ka	Holocene Middle 4-8 ka	Holocene Early 8-10 ka	Pleistocene Late 10-130 ka	Pleistocene Middle 130-790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma
Lee Flat fault (LEE)	--	--	--	--	--	--	≥1
Lida Valley faults (LV)	--	--	--	--	--	--	≥1
Little Lake fault (LL)	≥4 (<2.5 ka)	--	--	--	--	--	--
Lone Mountain fault (LMT)		≥1 (≤10 ka)		--	--	--	--
McAfee Canyon fault (MAC)			≥1 (<(10 to 1,500) ka)			--	--
Monitor Hills East fault (MHE)	--	--	--	--	--	--	≥1
Monitor Hills West fault (MHW)	--	--	--	--	--	--	≥1
Monotony Valley fault (MV)	--	--	--	--	--	--	≥1?
Monterzuma Range fault (MR)	--	(>(≤15 ka))?	[2]≥1		(<(15 to 200) ka)	--	--
Mud Lake–Goldfield Hills fault (MLGH)	--	--	--	--	--	--	≥1
Owens Valley fault (OWV)	≥1		≥1 (<(10 to 21) ka)			--	--
Pahranagat fault (PGT)							
[Arrowhead Mine fault (ARM)]	--	--	--	--	--	--	≥1
[Buckhorn fault (BUC)]	--	--	--	--	--	--	≥1?
Maynard Lake fault (MAY)]			≥1 (<(15 to 200) ka)			--	--
Pahroc fault (PAH)	--	--	--	(15 to 200 ka) [2]≥1	(<(700 to 1,800) ka)	--	--
Pahrock Valley faults (PV)	--	--	--	--	--	--	≥1?
Palmetto Mountains–Jackson Wash fault (PMJW)			>1			--	--
Palmetto Wash faults (PW)	--	--	--	--	--	--	≥1
Quinn Canyon fault (QC)	--	--	--	(>15 ka) [2]≥1	(<1.8 Ma)	--	--
Saline Valley faults (SAL)	--	--	--	--	--	--	--
[Fault along the front of the Inyo Mountains (WF)]		≥1 (≤10 ka)		--	--	--	--
[Fault along the eastern side of Saline Valley (ES)]		≤3 (≤27 ka)			--	--	--
[Fault in central Saline Valley (CEN)]		≥1 (≤10 ka)		--	--	--	--
Seaman Pass fault (SPS)	--	--	--	(>15 ka) [2]≥1	(<1.8 Ma)	--	--
Sheep Basin fault (SB)		≥1 (<(10 to 30) ka)			--	--	--

Table 17. Estimated number of events/time interval for known and suspected Quaternary faults greater than 100 km from Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Holocene Late 0-4 ka	Holocene Middle 4-8 ka	Holocene Early 8-10 ka	Pleistocene Late 10-130 ka	Pleistocene Middle 130-790 ka	Late Quaternary <130 ka	Quaternary <1.6 Ma
Sheep–East Desert Ranges fault (SEDR)	--------- ≥ 1 --------- (<(10 to 1,500) ka)					--	--
Sheep Range fault (SHR)	(≤15 ka) --------- ≥ 1 --------- (<(15 to 200) ka; ≤30 ka)					--	--
Sierra Nevada fault (SNV)	--	--	--	--	--	≥ 1	--
Silver Peak Range faults (SIL)							
[Northwestern fault]	--	--	--	--	--	--	≥ 1
[Southeastern fault]	--	--	--	--	--	--	≥ 1
Six-Mile Flat fault (SMF)	(≤15 ka) --------- [2]≥ 1 --------- (<(15 to 200) ka)					--	--
Southeast Coal Valley fault (SCV)	(≤15 ka) --------- [2]≥ 1 --------- (<(15 to 200) ka)					--	--
Southern Death Valley fault (SDV)	--------- ≥ 1 --------- (<(8 to 15) ka)				--	--	--
State Line fault (SL)	--------- ≥ 1? ---------				--	--	--
Stonewall Flat fault (SWF)	--------- ≥ 1 --------- (≤30 ka)				--	--	--
Sylvania Mountains fault (SYL)	--	--	--	--	--	--	≥ 1
Tem Piute fault (TEM)	--	--	--	((15 to 200) ka) ------ ≥ 1 ------ (<1.6 Ma)		--	--
Tule Canyon fault (TLC)	--------- ≥ 1 --------- (<(10 to 1,500) ka)					--	--
Weepah Hills fault (WH)	--	--	--	--	--	--	≥ 1
West Railroad fault (WR)	(≤15 ka) --------- [1]≥ 1 --------- ((15 to 200) ka)					--	--
Wilson Canyon fault (WIL)	--	--	--	--	--	--	≥ 1

[1]On the basis of stratigraphic and geomorphic relationships, Y-170 (p. 73-75) inferred at least three, and probably five or six, pre-1932 surface ruptures that occurred during the latest Pleistocene and Holocene on CM between northwestern Monte Cristo Valley and the southern edge of Kibby Flat.

[2]This is the best guess of the age of the youngest event as noted by Y-1032.

[3]This is for the westernmost fault included in EPK. The other three faults appear to be older and are portrayed by Y-635 as mostly concealed by early Holocene and late middle Pleistocene alluvium. The number of older events is not known.

[4]On the basis of interpretation of four trenches in Fish Lake Valley (two between Indian and Leidy creeks in northern Fish Lake Valley and two south of Cottonwood Creek in southern Fish Lake Valley), Y-665 (table 10, p. 231-232) concluded that three ruptures had occurred since about 2.5 ka.

Table 18. Recurrence interval, strike, and type displacement for known and suspected Quaternary faults greater than 100 km from Yucca Mountain

[Detailed data are on description sheets in appendix 2. References are listed in appendix 4. Abbreviations of trends: E, east; N, north; NE, northeast; NW, northwest; ENE, east–northeast; NNE, north–northeast; NNW, north–northwest; WNW, west-northwest. Abbreviations for displacement type: LL, left lateral; LO, left oblique; N, normal; RL, right lateral; RO, right oblique. Number of events and time period are shown only when used to estimate recurrence interval. Entries separated by a semicolon (;) indicate different interpretations by different authors; entries separated by a comma (,) indicate data for individual fault traces or for different localities along the fault or faults; leaders (---), no information was noted during the literature review]

Fault or faults [Segment or individual fault]	Number of events	Time period (10^3 yr)	Recurrence interval (10^3 yr)	Strike	Type displacement	References (Y-)
Airport Lake fault (AIR)	--	--	--	N	[1]N, RL	1035, 1052, 1110
Ash Hill fault (AH)	--	--	--	NNW	RL, N?	239, 698, 1020
Badger Wash faults (BDG)	--	--	--	NNW	N?	25, 404
Cedar Mountain fault (CM)	--	--	([2])	N.30°W., N	RL, N, RO	13, 17, 170, 794, 795, 969, 1075
Central Reveille fault (CR)	--	--	--	[3]NNW, N to NNE	N	813, 853, 1032
Clayton–Montezuma Valley fault (CLMV)	--	--	--	NE	--	238, 853
Clayton Ridge–Paymaster Ridge fault (CRPR)	--	--	--	NNE	N; LO	10, 238, 852
Clayton Valley fault (CV)	--	--	--	NE	--	238, 853
Deep Springs fault (DS)	--	--	--	N.25°E.	[4]N	484, 853, 872, 1033
East Magruder Mountain fault (EMM)	--	--	--	NE	--	238
East Reveille fault (ERV)	--	--	--	NNW	N	5, 232, 813, 853, 1032
East Stone Cabin fault (ESC)	--	--	--	NE	N	813, 853, 1032
Emigrant Peak faults (EPK)	--	--	--	NNE	[5]N, LL	10, 635, 651
Emigrant Valley East fault (EURE)	--	--	--	NNW	N	853, 1031
Emigrant Valley West fault (EURW)	--	--	--	NNE	--	853
Fish Lake Valley fault (FLV)	3	≤2.5	[6]1.1±0.6	[7]N.35°W. to N.40°W.	RO	216, 665
Freiburg fault (FR)	--	--	--	N	N	404
Frenchman Mountain fault (FM)	5 to 9	≤500	([8])	NW to NE	--	852, 1073
Garden Valley fault (GRD)	--	--	--	N	N	25
General Thomas Hills fault (GTH)	--	--	--	[9]NNW; NE	--	238, 853
Golden Gate faults (GG)	--	--	--	NNE	N	25, 404, 1032
Hiko fault (HKO)	--	--	--	NNW	N	25, 404, 1032
Hiko–South Pahroc faults (HSP)	--	--	--	NNW	--	25, 404
Hot Creek–Reveille fault (HCR)	--	--	--	NNW	N	5, 232, 813, 853, 1032

Table 18. Recurrence interval, strike, and type displacement for known and suspected Quaternary faults greater than 100 km from Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Number of events	Time period (10^3 yr)	Recurrence interval (10^3 yr)	Strike	Type displacement	References (Y-)
Lee Flat fault (LEE)	--	--	--	NW	N	222, 356, 1148
Lida Valley faults (LV)	--	--	--	NE	--	238
Little Lake fault (LL)	[10]3	[10]<0.06	[10]0.02	NW	RL	374, 1020, 1035, 1052
Lone Mountain fault (LMT)	--	--	--	NE	[11]N, RL	238, 407, 853, 1069
McAfee Canyon fault (MAC)	--	--	--	N, NNW	--	238, 853
Monitor Hills East fault (MHE)	--	--	--	N	--	813
Monitor Hills West fault (MHW)	--	--	--	N to NNW	--	813
Monotony Valley fault (MV)	--	--	--	[12]NE, N to NNW	N	813
Montezuma Range fault (MR)	--	--	--	NE	N	10, 238, 853
Mud Lake–Goldfield Hills fault (MLGH)	--	--	--	NNW	--	238
Owens Valley fault (OWV)	3	≤10	3.3 to 5	N to NW	[13]RL, N	427, 694, 1046, 1055
	3	<(10 to 21)	5 to 10.5			
Pahranagat fault (PGT)	--	--	--	N.50°E.	LO	25, 395, 404
[Arrowhead Mine fault (ARM)]	--	--	--	N.50°E.	LO, RL	395, 404
[Buckhorn fault (BUC)]	--	--	--	N.50°E.	LO	395
[Maynard Lake fault (MAY)]	--	--	--	N.50°E.	LO; RL?	395, 404, 1032
Pahroc fault (PAH)	--	--	--	NNE to NNW	N	25, 404, 1032
Pahrock Valley faults (PV)	--	--	--	NNE	N?	25, 404
Palmetto Mountains–Jackson Wash fault (PMJW)	--	--	--	NE, N to NNE	N	238
Palmetto Wash faults (PW)	--	--	--	NNW, NW, N	N	238, 853
Quinn Canyon fault (QC)	--	--	--	NE	N	25, 404
Saline Valley faults (SAL)						
[Fault along the front of the Inyo Mountains (WF)]	--	--	--	N.40°W.	N	1148
[Fault along the eastern side of Saline Valley (ES)]	--	--	--	N	N, RL	356, 864, 1148
[Fault in central Saline Valley (CEN)]	--	--	--	NW to W	N, RL?	1148
Seaman Pass fault (SPS)	--	--	--	[14]N, NNW, NW	--	404, 1032
Sheep Basin fault (SB)	--	--	--	[15]N, NE, NNW	N	671, 852

Table 18. Recurrence interval, strike, and type displacement for known and suspected Quaternary faults greater than 100 km from Yucca Mountain — Continued

Fault or faults [Segment or individual fault]	Number of events	Time period (10^3 yr)	Recurrence interval (10^3 yr)	Strike	Type displacement	References (Y-)
Sheep-East Desert Ranges fault (SEDR)	--	--	--	[16]NNE	--	852
Sheep Range fault (SHR)	--	--	--	N	--	852
Sierra Nevada fault (SNV)	--	--	--	NNW	N, RL	425, 1054
Silver Peak Range faults (SIL)						
[Northwestern fault]	--	--	--	NNE	--	238
[Southeastern fault]	--	--	--	NW	--	238
Six-Mile Flat fault (SMF)	--	--	--	NE	N	1032
Southeast Coal Valley fault (SCV)	--	--	--	N, NNW	N	25, 1032
Southern Death Valley fault (SDV)	--	--	--	NW; N.30°W. to N.40°W.; ([17])	RL; ([18])	216, 248, 429, 468, 472, 473, 603
State Line fault (SL)	--	--	--	NW, N.55°W.	N; RL	743, 893, 1105
Stonewall Flat fault (SWF)	--	--	--	NE	N	238, 853
Sylvania Mountains fault (SYL)	--	--	--	[19]E	N	238
Tem Piute fault (TEM)	--	--	--	ENE	[20]LL; N	25, 404
Tule Canyon fault (TLC)	--	--	--	NNE, NNW	N	238, 853
Weepah Hills fault (WH)	--	--	--	WNW	N	238
West Railroad fault (WR)	--	--	--	[21]N; NNW, NNE	--	813, 853, 1032
Wilson Canyon fault (WIL)	--	--	--	[22]NW, NNW	LL	413, 1020, 1110

[1]Right-lateral displacement is only on the Southern and Northern segments of Y-1110 (p. 17, 19-20).

[2]On the basis of the subdued character of scarps older than the 1932 rupture, Y-795 (p. 1-34) inferred a recurrence interval of possibly tens of thousands of years for surface-rupturing events.

[3]The southern part of CR strikes north-northwest; the northern part strikes north to north-northeast (Y-853; Y-1032).

[4]Y-1033 (p. 247) noted that displacement on DS appears to be entirely dip slip (normal) and that no evidence for left-lateral strike slip, which might be expected along a northeast-striking fault, has been observed.

[5]Faults in EPK are generally down to the west with dip slip (normal) displacement (Y-10; Y-635; Y-651). Y-635 noted left-lateral displacement along one section of the westernmost fault, the portion just south of South Wash that extends into the Silver Peak Range. This section strikes north-northwest.

[6]On the basis of interpretation of four trenches in Fish Lake Valley, Y-665 (table 10, p. 231-232) concluded that the recurrence interval between three ruptures since about 2.5 ka has been about 1,100±600 yr, although the recurrence interval could be as long as 3,000 yr or as short as 500 yr.

[7]This is the average strike. Strikes range between N. 22° W. and N. 55° W. (Y-216, p. 5-13).

[8]Recurrence interval is estimated to be tens to possibly hundreds of thousands of years assuming that displacement/event has been 1 to 2 m for a 9-m-high scarp on a surface with an estimated age of 500 ka (Y-1073, p. 101).

[9]The first entry is the strike of GTH on the south along Paymaster Ridge; the second entry is the strike of GTH on the north along the General Thomas Hills (Y-238; Y-853).

[10]Y-374 (p. 225) reported that earthquakes of magnitude ≥5.0 have recurred every 20 yr for the past 60 yr on LL. Earthquakes of this size occurred in 1938, 1961, and 1981 (Y-1052, p. [4]).

[11]Predominant vertical displacement on LMT was inferred by Y-1069 (p. 388) on the basis of the sinuous character and large heights of the associated scarps. In addition, Y-1069 (p. 388) reported right-lateral displacement of stream channels at two localities.

[12]The first entry is for the fault on the northern side of the highland (northern trace); the second entry is for the fault on the western side of the highland (western trace; Y-813).

[13]Displacement on OWV has been primarily right lateral, with a minor component of dip-slip (normal) displacement (Y-427; Y-1046). However, the dip-slip component may be significant locally (Y-427, p. 6).

[14]SPS has a curving trace (Y-404). Its northern part strikes north. Its central section strikes north-northwest. Its southern part strikes northwest.

[15]SB adjacent to the Sheep Range front has a curving trace (Y-671; Y-852). The northern portion strikes north-northwest. The central portion strikes north. The southern portion strikes northeast.

[16]SEDR has a general north-northeast, curving strike (Y-852). The southern end of SEDR strikes northwest. The remainder of SEDR strikes between north-northeast and north-northwest.

[17]The western subzone of SDV of Y-472 (p. 404) and Y-603 (p. 25) between the Confidence Hills and the southern Owlshead Mountains strikes between N. 15° E. and N. 30° W., their eastern subzone in this same area strikes between N. 40° W. and N. 50° W.

Table 18. Recurrence interval, strike, and type displacement for known and suspected Quaternary faults greater than 100 km from Yucca Mountain — Continued

[18]Y-429 (p. 4) suggested that SDV has a minor component of vertical displacement. Y-472 (p. 407) recognized both lateral and vertical displacement on his eastern subzone of SDV between the Confidence Hills and the southern Owlshead Mountains. Displacement on his western subzone in this area has been predominantly right-lateral strike slip.

[19]SYL strikes generally east, but the trace curves slightly so that portions of the fault strike either northeast or northwest (Y-238).

[20]Displacement on TEM is shown by Y-25 as left-lateral strike slip and by Y-404 (pl. 3) as down-to-the-north dip slip.

[21]WR has a curving, but generally north strike. WR north of Fang Ridge strikes north-northwest; WR south of the ridge strikes north-northeast (Y-813; Y-853).

[22]WIL strikes generally northwest (Y-413; Y-1020). The southeastern end of WIL strikes north-northwest (Y-1020).

APPENDIX 2: DESCRIPTION SHEETS COMPILED FOR KNOWN AND SUSPECTED QUATERNARY FAULTS WITHIN ABOUT 100 KM OF YUCCA MOUNTAIN

This appendix summarizes available data about known and suspected Quaternary faults identified within about 100 km of the potential repository at Yucca Mountain. The data, which have been summarized from published and readily available literature, are organized on description sheets in a format that emphasizes the Quaternary characteristics of the faults. Data for each fault are assembled into the sections described below. An entry of "No information" indicates that no information for that section was found in the cited references. Measurements that were reported in the references in metric units are noted in these units in the appendix. Measurements that were reported in English units in the references are noted in both metric and English units in the appendix.

FAULT NAME

Names for the faults are taken from the cited references, if possible. The reference from which the name has been taken is indicated under the "References" section, although other authors may also use the name. If alternative names have been used in the literature, then these names are also indicated. If no name was noted in the references, a name was given to the fault, usually on the basis of a nearby geographic feature. The abbreviations noted after the fault name were assigned for ease in labeling of the faults on the plates and figures.

PLATE OR FIGURE

This is the number of the plate or figure in this compilation on which the fault is shown.

REFERENCES

References that show or discuss the fault are listed. The references have been assigned a number beginning with "Y–", so that each reference has a unique identifier. Full citations of the references are listed numerically in Appendix 4 and alphabetically in Appendix 5. References listed under "Not shown by . . ." are those references (primarily maps) that cover the area in which the fault is located but that do not show the fault. Some references that are noted show only a portion of the fault, either because the authors did not recognize the entire fault as portrayed in another reference or because their map or study area does not include the area of the entire fault. References that portray a fault in a significantly different manner from the way it is shown on plates 1 and 2 of this compilation are also noted in this section.

LOCATION

The location of each fault in relation to the potential repository site at Yucca Mountain was measured on topographic maps at a scale of 1:250,000. The first two numbers (separated by a /) give the location of the closest point of the fault to the site (indicated by the black circle labeled "YM" on plate 2 of this compilation) in terms of distance and compass direction using an azimuthal scale and north as 0°. The second group of numbers gives the same point in terms of approximate latitude and longitude.

A brief description of the location of the fault follows. Major physiographic features noted here and in the following sections are shown on fig. 4 or on plates 1 and 2.

Figure 4. Physiographic features in the area covered by plates 1 and 2.

USGS 7-1/2′ QUADRANGLE:

The U.S. Geological Survey topographic quadrangles that cover the area of the fault are listed alphabetically.

FAULT ORIENTATION

This is the general direction of the fault's strike (1) as recognized on plates 1 and 2 of this compilation, or (2) as noted in the references. A measured strike, dip direction, or dip amounts may also be listed if these figures were noted in the references. The width of the fault is sometimes given.

FAULT LENGTH

This is the length of the fault as reported in the listed references or as estimated from the maps in these references. Because the scales of the maps are variable, the accuracy of these measurements is also variable. The measurements should be considered approximations only. As noted elsewhere in this compilation, the lengths reported here are sometimes dependent upon how fault traces have been grouped together into an individual fault in this compilation. The lengths do not necessarily reflect rupture length. If a fault has been subdivided into segments or sections (e.g., the Ash Meadows fault, the Bare Mountain fault), then the length of each segment or section is noted. In some cases, several distinct faults have been grouped under one name for ease of discussion. In these cases, the lengths of the individual faults are given. If major sections of a fault are portrayed as concealed, the lengths of these sections, as well as that of the entire fault, are noted. If available, the lengths of associated scarps or the lengths of sections of the fault that have scarps are reported.

STYLE OF FAULTING

The type or types of displacement along the fault are given in this section. The type of displacement noted in this section may have been (1) reported directly in the references, (2) inferred from the portrayal of the fault on maps, or (3) interpreted from reported fault–scarp characteristics, stratigraphic relationships, or other geologic evidence, as indicated in this section. Occasionally, the types of displacement reported in the references appear to conflict. These differences are noted and may be the result of studies that were completed at different localities along the fault or of changes in displacement over time along the fault.

SCARP CHARACTERISTICS

Characteristics of associated fault scarps, such as height, surface displacement, and maximum scarp–slope angle, are noted if they are reported in the references.

DISPLACEMENT

This section includes estimates or measurements of the total fault displacement, the displacement recorded by Quaternary deposits (the Quaternary or late Quaternary displacement), and the displacement that occurred during the youngest rupture, if this information is available. The amount of displacement, the unit or deposit displaced and its estimated age, and the location at which the displacement was estimated or measured are noted. Displacements of several different deposits and at several different localities may be reported for some faults.

AGE OF DISPLACEMENT

In this section, the age of the youngest surface rupture on the fault is emphasized if it has been reported. The age of older surface ruptures are also noted, if available. The estimated ages of displaced deposits or surfaces and of undisplaced deposits or surfaces are given if possible. The techniques (e.g., radiometric, soil development, surface characteristics) used to estimate the ages for the deposits or surfaces are also noted. In some references, the ages of the displacements are reported using an age term, such as late Quaternary. If stated, the author's definition of the time interval is given. Age terms are used occasionally with no further definition of the time interval intended. If ages are reported for several localities along the fault, all of the ages are listed with a brief description of each locality. Individual references should be consulted for the exact locations and detailed information.

SLIP RATE

Rates given in this section were either reported directly in the references or were estimated using reported information about the amount and age of displacement on the fault. The time interval for which the rate is reported or estimated is noted. Because the exact displacement direction is unknown for most of the faults in this compilation and because most of the reported amounts of displacement have not been measured within the fault plane, the slip rates listed in this section are usually apparent slip rates.

RECURRENCE INTERVAL

Recurrence intervals in this section were either reported directly in the references or were estimated using reported information about the number of surface ruptures interpreted to have occurred during a given time interval. The time interval for which the recurrence is reported or estimated is noted.

RANGE–FRONT CHARACTERISTICS

If a range front is associated with the fault, the front's characteristics (e.g., straightness, steepness, general age of deposits preserved along the front) are noted. Most of the reported characteristics are from Dohrenwend and others (1991, 1992).

ANALYSIS

This is a brief description of the methods used to study the fault as reported in the references.

RELATIONSHIP TO OTHER FAULTS

The relationships noted in this sections are either (1) from the references in which authors directly or indirectly relate the fault to other faults in the region or (2) from spatial relationships observed on plates 1 and 2 of this compilation (e.g., is the fault parallel or perpendicular to adjacent faults). The relationships among some faults have received much speculation and alternative interpretations are noted, if available. In general, however, the structural relationships among faults in this region are largely unknown.

Airport Lake fault (AIR)

Plate or figure: Plate 2.

References: Y-222: Streitz and Stinson, 1974; Y-413: Jennings and others, 1962 (Trona sheet); Y-415: Jennings, 1985 (Death Valley and Trona sheets); Y-425: Stinson, 1977; Y-427: Hart and others, 1989; Y-640: Duffield and Roquemore, 1988; Y-1020: Jennings, 1992; Y-1035: Roquemore and Zellmer, 1983; Y-1052: Wills, 1988 (evaluated only the southern half of AIR, the portion on the Ridgecrest North, Volcano Peak, and White Hills quadrangles, p. [3]); Y-1053: Wills, 1989 (discussed only the Hot Springs segment of AIR); Y-1110: Roquemore, 1981 (subdivided AIR into four segments); Y-1111: Roquemore and Zellmer, 1987; Y-1112: Walter and Weaver, 1980; Y-1113: Duffield and Bacon, 1981; Y-1122: von Huene, 1960; Y-1126: Roquemore, 1980; Y-1145: Roquemore and Zellmer, 1983.

Location: 138 km/234° (distance and direction of closest point from YM) at lat 36°06'N. and long 117°40'W. (location of closest point). AIR is located along the western side of the Coso Basin (a graben), in the southern Coso Range, and in Indian Wells Valley. Y-1110 (pls. 2 and 3) subdivided AIR into four segments, from south to north: Southern segment, Northern segment, Coso Hot Springs segment, and Haiwee Springs segment. (The segments are not shown on plate 2.)

USGS 7-1/2' quadrangle: Airport Lake, Cactus Peak, Pearsonville, Petroglyph Canyon, Ridgecrest North, Volcano Peak, White Hills.

Fault orientation: AIR strikes approximately north (Y-1035, p. 198; Y-1110, pls. 2 and 3; Y-1145, p. 6) to northeast (Y-1110, pls. 2 and 3). The Southern and Northern segments of Y-1110 (pls. 2 and 3) strike north; the Coso Hot Springs segment of Y-1110 strikes northeast; the Haiwee Springs segment of Y-1110 strikes north–northeast (Y-1110, pls. 2 and 3). Y-1110 (p. 76) reported that AIR strikes between N. 10° E. and N. 20° E. and dips between 50°E. and vertical.

Fault length: The length of AIR was noted to be ≥30 km by Y-1110 (p. 21, 74), >35 km by Y-1145 (p. 6), >50 km by Y-1052 (p. [3, 8]), and ≥60 km (from the Coso Range into Indian Wells Valley) by Y-1035 (p. 198). AIR forms a narrow zone along the western side of the Coso Basin, but to the south in Indian Wells Valley, the zone widens to ≥8 km (Y-1035, p. 198; Y-1052, p. [6]). The width of AIR is reported to be 10 km by Y-427 (table 1, p. 17).

Style of faulting: AIR is a broad zone of left–stepping, *en echelon* approximately north–striking traces that show normal displacement (Y-1035, p. 198; Y-1052, p. [3]; Y-1110, p. 17, 76). A right–lateral component of displacement has been inferred by Y-1110 (p. 17, 19-20) for the his Southern and Northern segments on the basis of (1) the left–stepping, *en echelon* pattern of traces (Y-1052, p. [8]; Y-1110, p. 17), (2) the displacement of stream channels observed by Y-1110 (p. 19-20, pl. 2), (3) the presence of shutter ridges (Y-1110, p. 19-20), and (4) the first motions determined from historic earthquakes reported by Y-1112 (p. 2442, 2448-2449).

No right–lateral component of displacement has been recognized along the Coso Hot Springs segment to the north (Y-1053, p. [2]), but the segment has evidence for vertical displacement (Y-1110, p. 20). Fumaroles and hot springs are aligned with this segment (Y-1110, p. 20-22, pl. 3).

Y-1145 (p. 7, 8) interpreted geodetic and level–line surveys as showing continuing extensional deformation across the section of AIR adjacent to Indian Wells Valley.

Airport Lake fault (AIR) — Continued

Scarp characteristics: Scarps on alluvial surfaces along the Coso Hot Springs segment have slopes of 20° to 30° (Y-1053, p. [2]). On the basis of five topographic profiles measured across beveled scarps on the Coso Hot Springs segment, Y-1110 (p. 50-51, table 1) noted a maximum scarp height of 7.1 m and lower scarp heights of 6.2, 4.3, 4.1, and 3.4 m. Two or three bevels identified by Y-1110 (table 1, p. 50) on all scarps except the one that is 3.4 m high suggest that these scarps formed during multiple events.

Two scarp profiles measured across the southern segment of AIR suggest scarp heights of 16.9 and 4.8 m and "free–face" angles of 49° and 69°, respectively (Y-1110, table 1, p. 50).

Displacement: Y-1145 (p. 6) reported a total vertical displacement of at least 600 m near Coso Basin on the Southern segment of Y-1110 across a zone about 5 km wide. On the basis of trench exposures on this segment, Y-1110 (p. 31, 74) noted an apparent vertical (east–side–down) displacement of 3.4 m in alluvium containing clasts of obsidian correlated with rhyolite domes in the Coso Range. These domes have dates of 90 ka ± 25 ka and 88 ka ± 38 ka (K–Ar; Y-1110, p. 31, 74, *citing* C.R. Bacon, written commun., 1979). About 6 km north of this trench site but still on his Southern segment, Y-1110 (p. 74, pl. 2) recognized right–lateral displacement of 125 m in a basalt flow that he assumed to be >400 ka and <1 Ma.

Y-640 (p. 173) reported that Mesozoic rocks have been displaced, down to the east, at least 500 m near Coso Hot Springs and Airport Lake.

Age of displacement: Y-1052 (p. [6]) noted that AIR displaces Holocene and late Pleistocene alluvium along the western side of the Coso Basin and in Indian Wells Valley. The fault also displaces a late Pleistocene basalt in the southern Coso Range.

The youngest deposits shown by Y-1113 to be displaced by AIR are Holocene and Pleistocene alluvial deposits (their Qya unit). AIR is also portrayed by Y-1113 to displace Pleistocene alluvium (their Qoa deposits), Pleistocene basalt flows (their Qbw, Qbc (1.07 Ma ± 0.14 Ma; K–Ar), and Qba deposits), Pleistocene and Pliocene sedimentary rocks in the White Hills (their QTs unit), and Pleistocene and Pliocene basalt flow and pyroclastic deposits (their QTbr and QTbrp units). This map also shows that traces of the Southern segment of Y-1110 appear to be concealed by Pleistocene basalt west of the White Hills (their Qbh unit; 188 ka ± 35 ka; K–Ar). However, Y-1052 (p. [3]) reported that basalt of this age is displaced by AIR (*citing* Y-1113).

On his Southern segment, Y-1110 (p. 28) estimated that alluvial fans containing scarps are not older than 10 ka (Holocene). He (Y-1110, p. 17-19) inferred Holocene surface rupture on the basis of a lack of varnish on surface stones that he concluded had been flipped by seismic shaking. Scarps are noted by Y-1052 (p. [3]) to have a "fresh" morphology. The age of the youngest rupture on this segment was estimated initially by Y-1110 (p. 51) to be about 40 yr on the basis of scarp morphology. However, Y-1110 (p. 51) concluded that this age must be incorrect given the lack of recorded historic earthquakes large enough to produce this scarp. In a trench across this segment of AIR, Y-1110 (p. 31) noted displacement of alluvium containing clasts of obsidian that correlated with rhyolite domes dated at 90 ka ± 25 ka and 88 ka ± 38 ka (*citing* C.R. Bacon, written commun., 1979). Y-1110 (p. 74, pl. 2) also reported displacement of a basalt flow that has not been radiometrically dated but that Y-1110 concluded was emplaced some time between 400 ka and 1 Ma on the basis of stratigraphic relationships.

On the basis of geodetic and level–line surveys, Y-1145 (p. 7-8) concluded that deformation within the Coso Range and Indian Wells Valley is continuing "at rates significantly higher than those observed in much of the tectonically active western United States."

Slip rate: Using 3.4 m of vertical displacement in alluvium containing obsidian correlated to rhyolite dated at 90 ka ± 25 ka and 88 ka ± 38 ka (range of 50 ka to 126 ka) as noted by Y-1110 (p. 31), an apparent vertical slip rate between 0.03 and 0.07 mm/yr is estimated for his Southern segment of AIR. This would be a minimum rate because the displaced alluvium must be younger than the included obsidian clasts.

On the basis of 125 m of right–lateral displacement of a basalt flow emplaced between 400 ka and 1 Ma, Y-1110 (p. 81) noted an apparent lateral slip rate of 0.1 to 0.3 mm/yr on his Southern segment of AIR.

Recurrence interval: No information.

Airport Lake fault (AIR) — Continued

Range-front characteristics: Along a portion of the southern Coso Range adjacent to his Southern segment, Y-1110 (p. 19-20, fig. 13) noted a very sharp front with faceted spurs.

Analysis: Aerial photographs (Y-1052, p. [5], scales 1:12,000 and 1:24,000; Y-1053, p. [2], scale 1:30,000; Y-1110, p. 8, scales 1:6,000 to 1:60,000 (some low–altitude, low–sun–angle photographs); Y-1122, p. 8, scales 1:12,000 and 1:47,500). Field examination (Y-1052, p. [5]; Y-1110, p. 8). Detailed geologic mapping (Y-1122, p. 8). Topographic scarps profiles using plane table and alidade and the methods of Wallace (1977, Y-1118) (Y-1110, p. 8-9, 44-51). Trenches (Y-1110, p. 28-39, Trench A on his Southern segment). Gravimetric survey and data interpretation (Y-1122, p. 8, 54-57, appen. A). Geodetic and level–line triangulation network (Y-1145, p. 7).

Relationship to other faults: Y-427 (table 1, p. 17) and Y-1052 (p. [3]) suggested that AIR either merges with or intersects the northwest–striking Little Lake fault (LL) in Indian Wells Valley. Northwest–striking fault traces in Indian Wells Valley have been considered part of LL by Y-1035, Y-1110, and Y-1111 (all *cited in* Y-1052, p. [2]), although these traces are continuous with AIR and have similarities to both faults (Y-1052, p. [2]). In contrast, Y-1035 (p. 198) suggested that AIR is truncated by LL because their preliminary mapping revealed no evidence for AIR southwest of LL in Indian Wells Valley. Y-1035 (p. 200) also speculated that the fault pattern and distribution of epicenters of earthquakes along the traces of LL and AIR suggest that displacement along both faults has been interrelated. For example, Y-1035 (p. 200) cited the change in the dip of flexures along LL as they truncate the eastern and western sides of AIR as indicating a direct relationship between the two faults.

Y-1145 (p. 6) suggested that AIR and LL are a result of the same regional stress field and that the two faults "are components of the regional right–slip shear and the east–west extension that characterize the tectonics of the western Basin and Range physiographic province."

Amargosa River fault (AR)

Plate or figure: Plate 2.

References: Y-238: Reheis and Noller, 1991 (pl. 4); Y-695: Donovan, 1991 (name from this reference); Y-809: Donovan, 1990 (her north–northwest–striking Ash Meadows fault?); Y-892: Claassen, 1985 (his northwest–striking, inferred Stewart Valley fault?, fig. 1, p. F2). Not shown by Denny and Drewes, 1965 (Y-386, pl. 1).

Location: 40 km/183° (distance and direction of closest point from YM) at lat 36°29′N. and long 116°28′W. (location of closest point). AR is located in the Ash Meadows portion of the Amargosa Desert parallel to and about 4 km northeast of the Amargosa River (Y-695, p. 47).

USGS 7-1/2′ quadrangle: Franklin Well.

Fault orientation: AR strikes northwest. AR is shown by Y-695 (pl. 1, p. 47, 49, fig. 3-4) as discontinuous, *en echelon* lineaments and scarps that form a zone that trends N. 48° W. AR is portrayed as a nearly continuous, relatively prominent northwest–trending lineament by Y-238 (pl. 4).

Fault length: The length of AR is about 15 km as measured from sec. 17, T. 17 S., R. 49 E. to sec. 16, T. 18 S., R. 50 E. (Y-695, p. 47). AR is about 7 km wide (Y-695, p. 47-48).

Style of faulting: Y-695 (p. 50) inferred right–lateral displacement on AR, because of the possibility that AR is an extension of the Pahrump fault (PRP), on which displacement is thought to be right lateral. Y-695 (p. 50) interpreted east–trending folds in Tertiary (Miocene?) sediments to have formed by compression caused by a left step between PRP and AR. Such compression would occur if displacement on both faults has been right–lateral.

Scarp characteristics: No information.

Displacement: No information.

Age of displacement: The youngest surfaces on which scarps or lineaments have been mapped are interpreted to be Holocene (≤10 ka) by Y-695 (p. 50).

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No range front is associated with AR.

Analysis: Aerial photographs (Y-238, p. 2, scales 1:24,000 to 1:80,000; Y-695, p. 3, 37, 39, scales 1:12,000 (low–sun–angle) and 1:60:000). Field examination (Y-695, p. 37). Topographic scarp profiles (Y-695, p. 50, appen. A, profile P3).

Relationship to other faults: Y-695 (p. 50, 74) inferred AR to be an extension of the PRP because, as she noted, the two faults have parallel strikes and nearly join across a left step between Stewart Valley and southern Ash Meadows. Y-238 (pl. 4) portrayed the two faults as nearly continuous. The mapping by Y-695 (pl. 1) suggests that a 20–km–long break in surficial expression exists between PRP in Stewart Valley and AR in Ash Meadows.

Y-695 (p. 48) suggested that the southeastern end of AR may extend to the north–striking Ash Meadows fault (AM), at a point where a discontinuity exists in the surficial expression of AM. In contrast, Y-238 (pl. 4) portrayed northwest–trending lineaments associated with AR as continuing east of the northern end of the Resting Spring Range across the trace of AM as mapped by Y-695 (pl. 1).

Y-695 (p. 48) suggested that the northwestern end of AR may truncate the northern end of a zone of north–trending, west–facing fault scarps on surfaces of Quaternary/Tertiary polestrian carbonate rocks. (These scarps are shown as fault traces on plate 2 of this compilation, but they are not labeled with a fault name.) However, she noted that one north–trending graben within this zone extends north of AR.

Ash Meadows fault (AM)

Plate or figure: Plate 2.

References: Y-68: Swadley, 1983; Y-69: McKittrick, 1988; Y-238: Reheis and Noller, 1991 (pl. 4); Y-386: Denny and Drewes, 1965 (pl. 1, part of AM may correlate with their north–striking, ~1–km–long fault about 1.5 km southwest of Devils Hole); Y-389: Drewes, 1963 (fig. 2, p. 5; shows the Shoshone fault zone in Amargosa Valley south of Eagle Mountain); Y-695: Donovan, 1991 (name from this reference); Y-809: Donovan, 1990 (her north–striking Rooker Road fault?); Y-892: Claassen, 1985 (AM may correlate with a portion of his north–northwest–striking, inferred Gravity fault, fig. 1, p. F2); Y-996: Hay and others, 1986; Y-1020: Jennings, 1992 (shows two north–northwest–striking faults along the Amargosa River south of Eagle Mountain and one north–northwest–striking fault west of Eagle Mountain).

Location: 34 km/169° (distance and direction of closest point from YM) at lat 36°33′N. and long 116°22′W. (location of closest point). AM is located in the Ash Meadows portion of the Amargosa Desert and along the western side of the Resting Spring Range.

USGS 7-1/2′ quadrangle: Bole Spring, Devils Hole, Eagle Mountain, East of Deadman Pass, Skeleton Hills, Stewart Valley, Twelve Mile Spring.

Fault orientation: AM strikes generally north. AM is composed of *en echelon* lineaments and scarps that are discontinuous in geomorphic expression and variable in strike (Y-238, pl. 4; Y-695, pl. 1). Y-695 (p. 51) subdivided AM into three sections (northern, central, southern) on the basis of these discontinuities. The northern section consists of two branches, a western one striking N. 18° W. and an eastern one striking N. 28° E. (Y-68; Y-695, p. 51-52). The central section strikes north to N. 10° W. and is juxtaposed on an alignment of springs that trends N. 24° W. (Y-695, p. 51, 55). The southern section of AM, located along the Resting Spring Range, strikes north (Y-69; Y-695, p. 71).

Fault length: The total length of AM is about 60 km from just south of the Rock Valley fault (RV) to the southern end of the Resting Spring Range as estimated from Y-69 and Y-695 (pl. 1). The northern section of Y-695 is 7 km long and 3 km wide (Y-695, p. 53). The central section is 5 km long and 3 km wide (Y-695, p. 57). The southern section of AM is about 48 km long as estimated from Y-69 and Y-695. This section includes fault traces along the western side of the Resting Spring Range.

Style of faulting: Normal dip slip has been dominant along AM as indicated by (1) a graben along the southern section (Y-695, p. 71), (2) slickensides that are exposed in a trench (TR3) along the central section and that have a 90° rake (Y-695, p. 59), and (3) west–facing scarps that contain material on their hanging wall that is younger than material on their footwall (Y-695, p. 51). Faults exposed in Trenches TR3 and TR4 along the central section dip 55° to 58° to the west (Y-695, p. 59-60).

Scarp characteristics: Y-695 (p. 51) noted west–facing fault scarps associated with the western branch of the northern section. Scarps along the central section of AM are 0.35 to 1.2 m high with maximum slope angles of 10.5° and 12.5° (Y-695, p. 58, appen. A, p. 142-143). Vertical scarp heights along the southern section (along the Resting Spring Range) are generally ≤1 m (Y-69).

Displacement: Y-996 (p. 1,490) inferred at least 50 m of down–to–the–west displacement along a north–striking fault 0.5 km west of Fairbanks Butte by assuming that tuffs dated at about 3.2 Ma at several localities in the Amargosa Desert are correlative. Y-695 (p. 53) interpreted this displacement to be along the western branch of her northern section of AM.

Vertical separation is >2 m, and probably >3 m, along the central section of AM at Trench TR3 (Y-695, p. 59-60). Y-695 (p. 64) estimated a vertical displacement of 155 cm across AM at Trench TR4 along her central section of the fault. This estimate was made using the base of an exposed soil profile as a piercing point.

Ash Meadows fault (AM) — Continued

Age of displacement: Scarps along the western branch of the northern section are mostly on surfaces of Holocene alluvium (her Q1a deposits; ≤10 ka; Y-695, p. 51). The map by Y-68 portrays northeast–striking traces along the eastern branch of the northern section of Y-695 in Pleistocene deposits (his Q2bc deposits) and Pleistocene and Pliocene? deposits (his QTa deposits).

Soils developed on displaced deposits along the central section and exposed in Trench TR4 are interpreted by Y-695 (p. 64) to suggest an age of >10 ka and possibly about 40 ka for these deposits. Y-695 (p. 69) suggested that this age estimate is supported by the possible correlation of the deposits in Trench TR4 to deposits exposed along the Rock Valley fault (RV). The deposits along RV have been dated by uranium–trend methods at 38 ka by Yount and others (1987, Y-20). The youngest displaced deposits exposed in Trench TR3, another trench along the central section, are interpreted by Y-695 (p. 59) to be most likely late Pleistocene. This interpretation is based on degree of soil development and induration. A 1–km–long fault trace in the central section of Y-695 is portrayed by Y-386 (pl. 1) as displacing Quaternary playa and alluvial–fan deposits (their Qp and Qgs units). However, they inferred the presence of the fault from the distribution of the playa and alluvial–fan deposits, which abut each other, and suggested that "differential erosion along some sort of structural break" is the best explanation for the pattern that they noted (Y-386, p. L42).

The youngest surfaces that exhibit scarps along the southern section of AM (along the Resting Spring Range) are portrayed by Y-69 as early Holocene and/or latest Pleistocene (her Qf3 deposits). The map by Y-69 also shows scarps preserved on surfaces of older deposits: late and/or middle Pleistocene (her Qf2 deposits, older than 10 ka and younger than 300 ka to 500 ka), middle and/or early Pleistocene (her Qf1 deposit, older than 300 ka to 500 ka), early Pleistocene and/or late Tertiary (her QTf deposits), and Miocene and older (her Ts deposits). In addition, Y-69 noted that Holocene deposits (her Qf4 deposits, ≤10 ka) are not cut by fault traces. On the basis of these relationships, the embayed character of the range front, and the presence of pediments formed on bedrock preserved basinward of the range front, Y-69 speculated that late Quaternary fault activity has been minimal along the Resting Spring Range.

The three faults south and west of Eagle Mountain are noted to be Quaternary by Y-1020, because he noted evidence for displacement since 1.6 Ma.

Slip rate: The average apparent vertical slip rate since late Pliocene along the western branch of the northern section of AM is 0.016 mm/yr as reported by Y-695 (p. 53). This rate is based on 50 m of displacement of a 3.2–Ma tuff (Y-695, p. 53; Y-996, p. 1,490).

The apparent vertical slip rate since about 40 ka along the central section of AM is about 0.04 mm/yr. This rate assumes an estimated age of about 40 ka for a deposit displaced about 155 cm in Trench TR4 as reported by Y-695 (p. 64-69).

Recurrence interval: No information.

Range-front characteristics: No range front is associated with the northern and central sections of AM. The southern section bounds the western side of Resting Spring Range, which is noted by Y-69 to be embayed by alluvial–floored channels and to include pediments formed on bedrock basinward (west) of the range front.

Analysis: Aerial photographs (Y-69, scale 1:30,000; Y-238, p. 2, scales 1:24,000 to 1:80,000; Y-695, p. 3, 37, 39, scales 1:12,000 (low–sun–angle) and 1:60,000; Y-809 (low–sun–angle)). Field examination (Y-69; Y-695, p. 37). Scarp profiles (Y-695, appen. A, profiles P1-P2, P9-P12, p. 132-133, 140-143). Trenches (Y-695, p. 37, Trenches TR3 and TR4). Soil descriptions (Y-695). Transects measured on alluvial fans (Y-69).

Relationship to other faults: Y-695 (p. 54) speculated that the eastern branch of the northern section of AM could, instead, be a southwest–striking branch of the generally northeast–striking Rock Valley fault (RV).

Ash Meadows fault (AM) — Continued

Y-695 (p. 58) noted that an apparent discontinuity at the southern end of the central section of AM occurs across a 3–km right step that coincides with the southeastern projection of the northwest–striking Amargosa River fault (AR).

Y-892 (p. F3) noted that the hydrologic characteristics of Ash Meadows change in the vicinity of the central section of AM as portrayed by Y-695 (Gravity fault of Y-892). This change is in part indicated by large springs along and east of the fault (Y-892, p. F3).

Y-695 (p. 75-76, fig. 7-1, p. 117) proposed that the central and northern sections of AM are extensions of either the southern section along the Resting Spring Range or a north–northwest–striking branch of the Pahrump fault (PRP).

Y-389 (p. 55) inferred strike slip on his Shoshone fault zone in the Amargosa Valley and suggested that it is one of several "master" faults in the Death Valley region, along with the Furnace Creek fault (FC), the Southern Death Valley fault (SDV; his Confidence Hills fault zone), and the Death Valley fault (DV).

Badger Wash faults (BDG)

Plate or figure: Pläte 1.

References: Y-25: Ekren and others, 1977; Y-404: Tschanz and Pampeyan, 1970 (pls. 2 and 3).

Location: 111 km/68° (distance and direction of closest point from YM) at lat 37°12′N. and long 115°18′W. (location of closest point). BDG includes four faults within Badger Valley and in small unnamed valleys between the Pahranagat Range and the East Pahranagat Range.

USGS 7-1/2′ quadrangle: Alamo, Badger Spring, Desert Hills NE, Lower Pahranagat Lake NW.

Fault orientation: The four faults in BDG strike primarily north–northwest (Y-25; Y-404).

Fault length: The longest fault of the four included in BDG (the east–central fault) is about 13 km long. The eastern and western faults are each 8 km long. The shortest fault (the west–central fault) is 4 km long. These lengths were estimated from the map by Y-25.

Style of faulting: Three of the four faults included in BDG are shown by Y-25 to be down to the west; the longest fault is shown by Y-25 as down to the east.

Scarp characteristics: No information.

Displacement: No information.

Age of displacement: Portions of the two eastern faults included in BDG are shown by Y-25 as faulted contacts between pre–Tertiary or Tertiary rocks and Holocene to Pliocene alluvium and colluvium (their QTa deposits). One short section of the longest fault is shown by Y-25 as a faulted contact between their QTa deposits and Holocene and Pleistocene alluvium (their Qa deposits). Portions of the two western faults in BDG are shown by Y-25 as faulted contacts between pre–Tertiary or Tertiary rocks and their Qa deposits. Y-404 portrayed all four faults of BDG as post–Laramide structures. They showed the longest fault as a faulted contact between Tertiary volcanic rocks and either unconsolidated Quaternary and Tertiary gravel and alluvium (pl. 3) or Pliocene lake beds (pl. 2).

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No information.

Analysis: Compilation of previous work (Y-25). Aerial photographs (Y-404, p. 2, scale 1:60,000). Field mapping (Y-404, p. 2).

Relationship to other faults: The southern ends of the eastern two faults may terminate at the northeast–striking Arrowhead Mine fault (ARM) of the Pahranagat fault (PGT). Faults in BDG parallel the Hiko fault (HKO) and the Hiko–South Pahroc faults, all of which are east of ARM.

Bare Mountain fault (BM)

Plate or figure: Plätes 1 and 2, Figure 5.

Figure 5. Bare Mountain fault along the eastern side of Bare Mountain.

References: Y-1: Carr and Monsen, 1988; Y-3: Reheis, 1988 (her Bare Mountain range–front fault or range–front fault, p. 103; subdivided BM into five segments, p. 110, fig. 8.1, p. 104); Y-26: Swadley and others, 1984 (their Bare Mountain fault zone, pl. 1, p. 18); Y-40: Cornwall and Kleinhampl, 1961; Y-64: Swadley and Parrish, 1988; Y-101: Ackermann and others, 1988; Y-232: Cornwall, 1972; Y-234: Monsen, 1983; Y-238: Reheis and Noller, 1991 (pl. 3); Y-572: Zhang and Schweickert, 1991; Y-662: Hamilton, 1987; Y-1041: Monsen and others, 1992.

Location: 14 km/260° (distance and direction of closest point from YM) at lat 36°48′N. and long 116°37′W. (location of closest point). BM is located along the eastern side of Bare Mountain and the western side of Crater Flat.

USGS 7-1/2′ quadrangle: Beatty Mountain, Carrara Canyon, Crater Flat, East of Beatty Mountain.

Fault orientation: BM strikes generally north. Most fault traces dip eastward 60° to 80°; some traces dip gently southeastward (Y-1, p. 55). For example, northeast of Chuckwalla Canyon BM dips southeast 35° to 45° (Y-3, p. 105). Y-64 showed a dip of 65° near the central part of BM east of the Panama Mine. Y-1041 portrayed eastward dips between 30° and 55°.

Fault length: The length of BM is about 15.5 km as estimated from fig. 8.1 (p. 104) of Y-3 (from Joshua Hollow? on the north to Steves Pass on the south). Five segments that were identified by Y-3 (p. 110, fig. 8.1, p. 104) have been numbered from north to south (fig. 5; locality names from Beatty 1:100,000 topographic quadrangle): #1=3.5 km (Joshua Hollow? to Tarantula Canyon), #2=3.25 km (to Diamond Queen mine), #3=2.5 km (to SE1/4, sec. 13, T. 13 S., R. 471/2 E.), #4=3.75 km (to Wildcat Peak), #5=2.5 km (to Steves Pass). Lengths have been estimated from Y-3 (fig. 8.1, p. 104). Y-1 (p. 55) suggested a segment boundary at Chuckwalla Canyon along segment #2 above. The map by Y-64 portrays BM as very discontinuous, especially south of Chuckwalla Canyon.

Style of faulting: BM is shown primarily as having down–to–the–east or down–to–the–southeast dip–slip (normal) displacement (Y-1041). Y-1 (p. 55) reported a "strong component" of right–lateral displacement along steep eastward–dipping fault traces that compose a system of faults along the eastern front of Bare Mountain about 3 km north of Steves Pass. Nearly pure dip–slip was suggested by Y-1 (p. 55) for gentle southeast–dipping fault traces in this same area.

Scarp characteristics: No information.

Displacement: Y-3 (p. 107) reported a minimum vertical displacement of 1.75 m on segment #4. The displaced deposit has an age of about 9 ka as estimated by Y-3 (p. 107) on the basis of its soil development and possible correlation to Q1c deposits at Fortymile Wash.

Paleozoic rocks have been downdropped about 2.6 km into Crater Flat according to Y-101 (p. 33).

Age of displacement: Ages of displacement as estimated by Y-3 (p. 106-110, fig. 8.1, p. 104) for her five segments are as follows (fig. 5). Segment #1: Middle and late Pleistocene(?), no data. Segment #2: At least one event >350 ka and at least one younger event, based on a scarp just south of Tarantula Canyon. Segment #3: Middle to late Pleistocene(?), based on a scarp that has been destroyed by mining activities. Segment #4: Holocene or late Pleistocene, based on (1) evidence at locality 3 for one event younger than 5 ka to 15 ka, (2) evidence at locality 5 for two events younger than 40 ka to 50 ka, one of which probably occurred during early Holocene, and (3) evidence at locality 4 for one event after about 145 ka–160 ka and another event since 9 ka. Segment #5: Middle to late Pleistocene(?), no data.

Bare Mountain fault (BM) — Continued

The map by Y-64 shows BM as displacing early Pleistocene and Pliocene(?) alluvial and colluvial deposits (their QTa deposits), which they estimated to be much greater than 740 ka and probably greater than 1.2 Ma. This map also portrays BM as a faulted contact between either Miocene gravel (their Tgs deposits), QTa deposits, or Pleistocene alluvium (their Q2c deposits; <740 ka and >270 ka ± 30 ka, uranium–trend analyses) on the east side of the fault and Paleozoic and Proterozoic rocks on the west side. In addition, this map shows Holocene alluvium (their Q1c and Q1ab deposits; ≤8,300 ± 75 yr, ^{14}C date) overlying the central part of BM, east of the Panama Mine.

The map by Y-1041 shows that the youngest displaced deposits are younger alluvial fan deposits (their Qyf deposits), which they concluded are Holocene. They stated that these deposits are equivalent in part to the Q1a, Q1ac, and Q1c deposits of Y-64.

Slip rate: An apparent vertical slip rate during the Holocene of 0.19 mm/yr is estimated for segment #4 of BM, using 1.75 m minimum displacement in a deposit with an age of about 9 ka as noted by Y-3 (her locality #4, p. 107).

Recurrence interval: The average recurrence interval for ruptures at locality #4 on segment #4 is estimated to be 73,000 to 80,000 yr on the basis of the conclusions of Y-3 (p. 107) that two ruptures have occurred in a buried gravel with a soil inferred by Y-3 to have formed in 145,000 to 160,000 yr. This recurrence may be an over estimate because, as Y-3 (p. 107) noted, the soil must have been mostly developed before the first faulting event, so that this event may have occurred close to the age of the overlying unit, which was estimated to be 9 ka by Y-3 (p. 107).

The average recurrence interval for ruptures at locality #5 on segment #4 is estimated to be 20,000 to 25,000 yr on the basis of the conclusions of Y-3 (p. 110) that two ruptures occurred since deposition of an alluvial deposit with an age of 40 ka to 50 ka (correlation of the soil developed in the alluvial deposit at locality #5 with that in deposits in Fortymile Wash).

Range-front characteristics: Y-3 (p. 105) concluded that geomorphic characteristics along the eastern front of Bare Mountain south of Tarantula Canyon (segments #2 through #5) suggest recurrent Quaternary fault displacement. These characteristics are (1) a steep front with faceted spurs and (2) drainages that are deeply incised in the mountains but that are aggrading adjacent to the range front on steeply sloping Holocene alluvial fans that bury older alluvial fans. However, Y-3 (p. 105) noted that Holocene deposits north of Tarantula Canyon (segment #1) are primarily limited to arroyos cut into older deposits and concluded from this observation that fault displacement is older on this segment of BM than it is on the other segments to the south.

Analysis: Geomorphic mapping, interpretation of aerial photographs (scale 1:12,000), field reconnaissance, examination of arroyos and prospect pits, soil studies (Y-3, p. 103).

Relationship to other faults: The relationship between BM and the Fluorspar Canyon fault (and other low–angle normal faults cutting Bare Mountain) has been commented upon by several previous workers. Mapping by Y-1 (p. 54) along Tates Wash and the relationship between a low–angle fault and a 14–Ma dike at their Stop 6 suggested to them that the Fluorspar Canyon fault is separate from and older than (activity ceased by late Miocene) BM, which is located along the range–front. Y-1041 speculated that the north–northeast–striking Tates Wash fault joins the northern end of BM. Y-662 suggested that the Fluorspar Canyon fault and BM are part of the same system of detachment faults on top of the mid–crustal rocks.

Beatty scarp (BS)

Plate or figure: Plates 1 and 2.

References: Y-6: Swadley and others, 1988; Y-18: Swadley and others, 1986; Y-40: Cornwall and Kleinhampl, 1961; Y-43: Cornwall and Kleinhampl, 1964 (show only that part of BS west of long 116°45′W.); Y-113: Harding, 1988; Y-182: Carr, 1984 (fig. 26, p. 58); Y-232: Cornwall, 1972; Y-379: Cornwall and Kleinhampl, 1961; Y-629: Rodriguez and Yount, 1988; Y-1041: Monsen and others, 1992 (show BS as a heavy dashed line; an inferred fault?).

Location: 26 km/272° (distance and direction of closest point from YM) at lat 36°51′N. and long 116°45′W. (location of closest point). BS is located along the western side of Bare Mountain south of Beatty, Nevada, adjacent to the Amargosa River and in the northern Amargosa Desert.

USGS 7-1/2′ quadrangle: Beatty, Beatty Mountain, Carrara Canyon, Gold Center.

Fault orientation: BS trends N. 40° W. to N. 10° E. as estimated from Y-6 (fig. 9.1, p. 114).

Fault length: The length of BS (from Beatty, Nevada, to the northern Amargosa Desert) is about 8 km as estimated from Y-1041 or about 10 km as noted by Y-6 (p. 113) and as estimated from Y-232 (pl. 1). BS is shown by Y-232 as concealed another 15 km to the south, so that the total length of BS could be as much as 25 km.

Style of faulting: The origin of the Beatty scarp is in question. BS has been mapped as a Quaternary fault or as a faulted contact between Quaternary deposits and Paleozoic rocks by Y-40, Y-43, and Y-379. The morphology of the scarp is consistent with dip–slip (normal) displacement along a west–dipping fault.

In contrast, Y-6 (p. 119) concluded that BS "formed as an erosional scarp produced by lateral migration of the Amargosa River." They based this conclusion on "the trend and location of margins of the bottom lands occupied by the river in late Quaternary time, the occurrence of fluvial deposits at or near the base of the scarp, the lack of conclusive evidence of faulting revealed by surficial mapping and trenching, and the lack of offset of subsurface horizons as shown by seismic–refraction and seismic–reflection profiles." In addition, Y-113 (p. 123) concluded that BS is not fault related because seismic–reflection data, which he interpreted, indicate that the only possible projection of the surface scarp to depth would have down–to–the–east relative displacement, which is the reverse of the displacement direction suggested by the scarp at the ground surface.

Scarp characteristics: BS is a discontinuous scarp that has been partially eroded by crosscutting streams and partially buried by alluvium along about half its length (Y-6, p. 113). Scarp heights range between 2 and 30 m, with maximum values occurring near the middle of the scarp (Y-6, p. 116). Maximum scarp–slope angles range between 35°, where the scarp is highest, and about 20°, where the scarp is about 4 m high (Y-6, p. 116).

Displacement: No information.

Age of displacement: Y-182 (p. 65) suggested that BS may represent Quaternary reactivation of an older fault. The map by Y-43 (pl. 1) shows the northwestern 1 km of BS as an approximately located fault that juxtaposes Tertiary welded tuff (their Tw unit) and Quaternary alluvium (their Qal deposits).

BS is interpreted by Y-6 (p. 119) to be early Holocene. This estimate is based on a ^{14}C date of 10 ka ± 0.3 ka, which was determined by M. Rubin (written commun., 1985, *cited by* Y-6, p. 118), on carbonized wood fragments that were discovered in gravelly alluvium (their Qf deposits) exposed at the base of the scarp in Trench BF–1 (sample #W-5673, Y-6, fig. 9.3, p. 117). This age is supported by an additional ^{14}C date of 9.8 ka ± 0.3 ka that was determined on carbonized wood from the same stratigraphic unit (Qf deposits) exposed about 1 km southwest of Trench BF–1 in a vertical bank adjacent to the Amargosa River (sample #W-5676, Y-6, p. 118). In addition, a comparison of maximum scarp–slope angles for BS with those for dated fault scarps in north–central Nevada suggested to Y-6 (p. 116) that BS is younger than 12 ka but is "more than a few thousand years in age."

Beatty scarp (BS) — Continued

In contrast, uranium–trend analyses yielded an age estimate of 480 ka ± 50 ka for the Qf deposits (the same stratigraphic unit that contained the carbonized wood that was dated at about 10 ka; Y-6, p. 118). In addition, similar analyses suggested an age of about 70 ka for gravelly alluvium (their Q2c deposits). This age conflicts with the older age estimate "in that it infers that the fan composed of unit Q2c truncated by the scarp is younger than post–scarp deposits of unit Qf" (Y-6, p. 118). These inconsistencies in age estimates could not be resolved by Y-6 (p. 118).

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No information.

Analysis: Measurement of twenty–five topographic profiles across the scarp (Y-6, p. 116), but no plotted profiles are shown by them. Maximum scarp angles are summarized by Y-6 (p. 116) in a histogram and correlated to histograms of scarp–slope angles compiled for young fault scarps in north–central Nevada by Wallace (1977, Y-1118). Surficial mapping and a crude map that combines six Quaternary deposits into three units (Y-6, fig. 9.1, p. 114, table 9.1, p. 115-116). There are no independent age determinations for the deposits, which have been correlated to Quaternary stratigraphic units near the Nevada Test Site. Trenches (BF–1 and BF–2, Y-6, p. 116-117; Y-18). Sketch logs of these trenches are included in Y-6 (figs. 9.3 and 9.4, p. 117) and are summarized in Y-18. Radiometric age determinations (Y-6, p. 118). High–resolution seismic–reflection survey using MINI–SOSIE technique (Y-6, p. 119; Y-113, p. 121-123). Seismic–refraction profiles (Y-6, p. 118, fig. 9.5; Y-629, p. 139-140).

Relationship to other faults: No information.

Belted Range fault (BLR)

Plate or figure: Plate 1.

References: Y-5: Ekren and others, 1971; Y-232: Cornwall, 1972; Y-813: Reheis, 1992 (pls. 1 and 2); Y-853: Dohrenwend and others, 1992.

Location: 55 km/22° (distance and direction of closest point from YM) at lat 37°18′N. and long 116°13′W. (location of closest point). BLR is located along the western side of the Belted Range and along the eastern side of Kawich Valley.

USGS 7-1/2′ quadrangle: Belted Peak, Lambs Pond, Monotony Valley, Oak Spring Butte, Quartet Dome, Rhyolite Knob, Sundown Reservoir, Wheelbarrow Peak.

Fault orientation: The strike of the southern half of BLR averages north–northeast. The strike of the northern half averages north. BLR curves so that short sections strike in directions between north–northwest and north–northeast (Y-5; Y-232; Y-813; Y-853).

Fault length: The length of BLR is 38 km as estimated from Y-853. This length includes a 7–km–long gap in surficial expression. The length of BLR is 51 km as estimated from Y-813, 53 km as estimated from Y-5, and 54 km as estimated from Y-232. BLR north of Antelope Reservoir is shown as three subparallel strands by Y-5.

Style of faulting: No information.

Scarp characteristics: BLR is shown primarily as west–facing scarps (Y-5; Y-232; Y-813).

Displacement: Displacement on BLR near Cliff Spring has been interpreted from gravity data to be >610 m (2,000 ft), valley side down, by Y-5 (p. 70) and by Y-232 (p. 32), *both citing* D.L. Healy (oral commun., 1964).

Age of displacement: BLR at two localities is portrayed by Y-853 as scarps on depositional or erosional surfaces of late Pleistocene age (their Q_2 surfaces with estimated ages between 10 ka and 130 ka). They portrayed BLR at two other localities as scarps on surfaces of early to middle and (or) late Pleistocene age (their Q_{1-2} surfaces with estimated ages between 10 ka and 1.5 Ma). BLR at another locality is shown on surfaces of early to middle Pleistocene age (their Q_1 surfaces with estimated ages between 130 ka and 1.5 Ma).

BLR is shown by Y-813 as faults that are in Quaternary and Tertiary deposits and that were identified from previous mapping. She also portrayed BLR as weakly expressed to prominent lineaments and scarps on surfaces of Quaternary deposits.

BLR is shown by Y-5 as concealed by Pliocene through Holocene alluvium and colluvium (their QTa deposits). However, Y-5 (p. 70) reported that BLR is expressed on aerial photographs as a "feeble" lineament and as "small offsets of older alluvium." Y-232 (pl. 1) showed most of BLR as concealed by Quaternary alluvium (his Qal deposits). Both Y-5 and Y-232 portrayed an 8–km–long section at the southern end of BLR as a fault in Tertiary rocks (Y-5; Y-232, pl. 1).

Earliest displacement on BLR, and on other north–striking faults in the adjacent area, is interpreted by Y-5 (p. 70-71) as occurring after extrusion of the Timber Mountain Tuff (early Pliocene; about 11 Ma to 13 Ma).

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: BLR is portrayed by Y-853 as a major range–bounding fault that borders a tectonically active range front, which is characterized by "fault juxtaposition of Quaternary alluvium against bedrock, fault scarps and lineaments on surficial deposits along or immediately adjacent to the range front, a general absence of pediments, abrupt piedmont–hillslope transitions, steep bedrock slopes, faceted spurs, wineglass valleys, and subparallel systems of high-gradient, narrow, steep–sided canyons orthogonal to range front." Portions of BLR are shown by Y-813 as topographic lineaments bounding a linear range front.

Belted Range fault (BLR) — Continued

Analysis: Aerial photographs (Y-5; Y-813, p. 4, scales 1:62,500 to 1:80,000; Y-853, scales 1:115,000 to 1:124,000 and 1:58,000). Field mapping (Y-5).

Relationship to other faults: BLR is approximately parallel to other north–northeast– and north–northwest–striking faults along major range fronts in the area (Y-813; Y-853). These faults include the Hot Creek–Reveille fault (HCR) along the eastern side of the Kawich Range northwest of BLR, the Kawich Range fault (KR) along the western side of the Kawich Range east of BLR, and the West Railroad fault (WR) along the eastern side of the Reveille Range and the East Reveille fault (ERV) along the western side of the Reveille Range, both immediately north of BLR. BLR also parallels north–northeast– and north–northwest–striking faults within basins in the area, such as the Cactus Flat fault (CF) and the Cactus Flat–Mellan fault (CFML) both in Cactus Flat that is northwest of BLR, the Emigrant Valley North fault (EVN) in Emigrant Valley east of BLR, and the Kawich Valley faults (KV) along the western side of Kawich Valley immediately west of BLR (Y-813; Y-853). The relationship between BLR and KV, which bound opposite sides of Kawich Valley, is not known. The relationship between BLR and ERV, which is immediately north of BLR and has a strike similar to that of BLR, is also not known.

Bonnie Claire fault (BC)

Plate or figure: Plate 1.

References: Y-10: Reheis and Noller, 1989: Y-232: Cornwall, 1972; Y-238: Reheis and Noller, 1991 (pl. 2); Y-407: Albers and Stewart, 1972; Y-853: Dohrenwend and others, 1992.

Location: 74 km/304° (distance and direction of closest point from YM) at lat 37°13'N. and long 117°08'W. (location of closest point). BC bounds ridges west of Bonnie Claire Lake (west of Sarcobatus Flat).

USGS 7-1/2' quadrangle: Bonnie Claire, Bonnie Claire Lake, Gold Mountain, Scottys Castle, Scottys Junction, Scottys Junction SW.

Fault orientation: BC generally strikes northeast (Y-232; Y-238; Y-853). Some individual traces in BC curve, so that their strikes range between north–northwest and east–northeast (Y-232; Y-238; Y-853).

Fault length: The total length of BC is about 27 km as estimated from Y-238. The lengths of individual fault traces range between 1 km and 8 km as estimated from Y-238.

Style of faulting: Displacements on fault traces near and southwest of Bonnie Claire Lake are generally down to the northwest (Y-238). Displacements on fault traces north of Bonnie Claire Lake are generally down to the southeast (Y-238).

Scarp characteristics: No information.

Displacement: No information.

Age of displacement: The longest down–to–the–southeast fault trace at the northeastern end of BC (just southwest of Scottys Junction) is shown by Y-232 as displacing Quaternary alluvium (his Qal deposits). The map by Y-853 shows fault traces of BC at Bonnie Claire Lake primarily as scarps and (or) prominent topographic lineaments on surfaces of Tertiary volcanic and sedimentary rocks. This map may portray one curving trace immediately west of Bonnie Claire Lake as juxtaposing Quaternary alluvium against bedrock (difficult to differentiate line width on map). Y-238 portrayed portions of BC as weakly expressed or prominent lineaments or scarps on surfaces of Quaternary deposits.

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No range front is associated with BC, although some fault traces do bound outcrops of Timber Mountain Tuff (Tp unit of Y-232; Ttm unit of Y-407; about 11 Ma). The escarpments along some of these outcrops are linear. Y-238 showed additional fault traces primarily as topographic lineaments that bound linear bedrock ridges.

Analysis: Aerial photographs (Y-238, p. 2, scales 1:24,000 to 1:80,000; Y-853, scales 1:115,000 to 1:124,000 and 1:58,000).

Relationship to other faults: BC is one of several northeast–striking faults that mostly bound the northwestern sides of ranges, such as the Grapevine Mountains (Grapevine Mountains fault (GM)), Gold Mountain (Gold Mountain fault (GOM)), Magruder Mountains (Lida Valley faults (LV)), possibly Slate Ridge (Slate Ridge faults (SLR)), and the southeastern sides of Magruder Mountain (East Magruder Mountain fault (EMM)), and part of the Palmetto Mountains (Lida Valley faults (LV); Y-238, p. 4). Y-10 (p. 59) and Y-238 (p. 4) suggested that these northeast–striking faults could be conjugate shears of the northwest–striking Furnace Creek fault (FC) to the west, but the expected left–lateral displacement on BC and on the other northeast–striking faults has not been documented by field observations. Thus, Y-10 (p. 59) and Y-238 (p. 4) suspected that the northeast–striking faults are an expression of dip–slip displacement perpendicular to a northwest least–principal–stress direction.

Bonnie Claire fault (BC) — Continued

Scarps and (or) lineaments on surfaces of Tertiary deposits are shown as part of BC on plate 1 of this compilation only where they align with fault traces portrayed at least in part as having possible Quaternary displacement. Other scarps and (or) prominent topographic lineaments that are shown by Y-238 and Y-853 (primarily) to be on surfaces of Tertiary deposits between BC and the Gold Mountain fault (GOM) are not on plate 1. Some of these scarps and lineaments correlate with some of the numerous faults in Tertiary volcanic rocks shown by Y-232 and Y-407. These scarps and lineaments extend north to the eastern end of Slate Ridge where their trends are more northerly than the strikes of fault traces included in BC. If the faults between BC and GOM are included in BC, then BC could be as wide as 15 km. In addition, the boundary between BC and GOM would not be as clear as it appears on plate 1 and would be indicated only by a slight change in fault strike.

Y-407 (p. 51) described the geologic structure between Grapevine Canyon and Gold Mountain (the area of BC) as ash flows (Timber Mountain Tuff) that strike east–northeast and dip southeast. According to Y-407 (p. 51), the tuffs are cut by three prominent east–striking faults downdropped on the north and by minor northeast–striking faults (BC?) that branch from the east–striking faults and that are downdropped on the northwest.

Boundary fault (BD)

Plate or figure: Plate 1.

References: Y-50: Barnes and others, 1963 (name from this reference); Y-90: Szabo and others, [1981]; Y-181: Carr, 1974; Y-224: Frizzell and Shulters, 1990; Y-526: Swadley and Hoover, 1990; Y-813: Reheis, 1992 (pl. 2); Y-853: Dohrenwend and others, 1992.

Location: 51 km/38° (distance and direction of closest point from YM) at lat 37°13′N. and long 116°05′W. (location of closest point). BD is located at the northern end of Yucca Flat.

USGS 7-1/2′ quadrangle: Oak Spring.

Fault orientation: BD strikes northeast and is slightly sinuous. A northern extension of BD strikes north (Y-50; Y-224; Y-853).

Fault length: Mapped lengths of BD range between about 3 km and about 6.5 km. BD is shown on two maps as between Oak Spring Wash and Butte Wash only for a length of 3 km (Y-813) or about 3.5 km (Y-224). Y-526 indicated a total length of about 5 km for BD between Smoky Hills and Butte Wash. Y-50 extended the length of BD to about 6.5 km by mapping concealed portions to the south (~2 km) and north (~0.5 km). The map by Y-853 shows BD as two sections: a northeast–striking one that is 3 km long (the northeastern end of the fault mapped by Y-224 and Y-813) and a north–striking one (the northern extension) that is also 3 km long.

Style of faulting: BC is shown by Y-526 and Y-813 as down to the southeast with dip–slip (normal) displacement.

Scarp characteristics: No information.

Displacement: No information.

Age of displacement: Y-526 implied that the youngest displacement on BD is Quaternary and could be late Pleistocene, because the fault is observable on aerial photographs on surfaces of Quaternary alluvial deposits of two different ages, one with an estimated age between about 160 ka and at most 800 ka (their Qap deposits) and one with an estimated age of >740 ka (their QTa deposits). They also showed part of BD as a faulted contact between Cretaceous intrusive rocks and their Qap or QTa deposits.

Y-90 (p. 17, 19, 28) reported dates (uranium–thorium analyses; samples 50 and 51, tables 1 and 3) of >8 ka and ≥24 ka for laminar caliche exposed in a trench across BD. The younger caliche has been displaced by BD; the older caliche is from the fault zone (Y-90, p. 28). Consequently, fault displacement occurred after deposition of most of the laminar caliche. They (Y-90, p. 28) noted that the morphology of the scarp associated with BD "suggests younger significant offset than on the Rock Valley fault." A comparison of the characteristics of this scarp to those of scarps in north–central Nevada studied by Wallace (1977, Y-1118, p. 1,275) suggested to them (Y-90, p. 28) that the scarp along BD formed about 10 ka. On the basis of the uranium–thorium analyses and the scarp characteristics, they concluded that the fault "may have moved a little as recently as 8,000 years ago" (table 3, p. 19).

A 3–km–long section of the northeast–striking portion of BD is portrayed by Y-853 as a scarp on depositional or erosional surfaces of early to middle Pleistocene age (their Q_I surfaces with estimated ages between 130 ka and 1.5 Ma).

Y-526 portrayed BD as concealed beneath Holocene (≤10 ka) alluvium (their Qah deposits) at the mouth of Oak Spring Wash.

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No information.

Boundary fault (BD) — Continued

Analysis: Aerial photographs (Y-526, scale 1:24,000; Y-813, p. 4, scales 1:62,500 to 1:80,000; Y-853, scales 1:115,000 to 1:124,000 and 1:58,000). Limited field examination (Y-526). Analyses of samples from a trench across the fault (Y-90, p. 28).

Relationship to other faults: The northern end of BD is portrayed by Y-224 as merging with the north-striking Yucca fault (YC). Y-50 and Y-853 indicated that this end of BD merges with the north-striking Butte fault (BT, part of the Oak Spring Butte faults of this compilation) along the eastern side of Oak Spring Butte. The southern end of BD is shown by Y-224 as merging with the north-northeast-striking Carpetbag fault (CB). The exact relationships among these faults are not known.

Bow Ridge fault (BR)

Plate or figure: Figure 3.

References: Y-26: Swadley and others, 1984 (their Fault C, p. 13); Y-46: Maldonado, 1985; Y-55: Scott and Bonk, 1984 (name from their pl. 1); Y-73: Hoover and others, [1981]; Y-74: Hoover, 1989; Y-87: Taylor and Huckins, 1986; Y-189: Lipman and McKay, 1965; Y-217: Gibson and others, 1991; Y-224: Frizzell and Shulters, 1990; Y-238: Reheis and Noller, 1991 (pl. 3); Y-298: Gibson and others, 1990; Y-396: Scott, 1990; Y-576: O'Neill and others, 1991; Y-577: Wesling and others, 1991; Y-586: Zartman and Kwak, 1991; Y-772: Neal, 1986; Y-773: Carr, 1991; Y-1042: O'Neill and others, 1992; Y-1091: Menges and others, 1993; Y-1239: Wesling and others, 1992.

Location: 1 km/90° (distance and direction of closest point from YM) at lat 36°50′N. and long 116°26′W. (location of closest point). BR bounds the western side of the main part of Midway Valley along the western sides of Bow Ridge and Exile Hill.

USGS 7-1/2′ quadrangle: Busted Butte, Pinnacles Ridge.

Fault orientation: BR strikes generally north (Y-26, pl. 1, p. 13; Y-87, p. 418). Where it is exposed in Tertiary rocks on the western side of Bow Ridge, BR dips 75° W. (Y-55, pl. 1). BR is nearly vertical where it is exposed in Trench 14 (Y-87, p. 418) and dips 76° W. where it is exposed in Trench 14D (Y-1091, p. 120). Y-396 (p. 259) reported an average dip for BR of 69°, which was calculated on the basis of three measurements.

Fault length: Y-26 (p. 13) reported that BR extends at least 6 km north from Trench 15, which is located adjacent to Bow Ridge, but that BR does not appear to cross Yucca Wash. Y-1042 (p. 10) noted that BR may terminate on the north in Midway Valley and extend to the south to intersect the Paintbrush Canyon fault (PBC). Y-217 (p. 47) estimated a length of 9 to 10 km for BR from maps by Y-46, Y-55, and Y-224.

Style of faulting: Y-55 (pl. 1) showed BR as a dip–slip (normal) with down–to–the–west displacement. Y-1091 (p. 120) interpreted striations that plunge 65° to 20° on carbonate fault laminae as indicating left–oblique displacement. Y-1042 (p. 12) also inferred a component of left–lateral displacement on BR from a rhombic–shaped structural depression that is bounded on the east by BR.

Scarp characteristics: No information.

Displacement: As noted in Y-217 (table 4-1, p. 46), who cited data from Y-298, BR has an apparent vertical separation of 220 m in the Topopah Spring Member of the Paintbrush Tuff (13.1 ± 0.8 Ma; K-Ar). It has an apparent vertical separation of 120 m in the Tiva Canyon Member of the Paintbrush Tuff (12.5 ± 1.1 Ma; K-Ar). As also noted in Y-217 (table 4-2, p. 48), using data from Y-55, Y-772, and Y-773, the stratigraphic dip separation of the Topopah Spring Member along BR ranges between 115 ± 5 m and 145 ± 5 m at the northern end of BR adjacent to Exile Hill (Y-217, fig. 4-9, p. 62, fig. A-1, p. A-2, figs. 4-11 and 4-12, p. 66, 67) to 220 ± 5 m in the central part of BR just north of Bow Ridge (Y-217, figs. 4-9 and 4-10, p. 62, 63). Y-217 (p. 46) reported that displacement in their Q2s deposits (38 ka to 270 ka; uranium–trend analyses) has been limited to fracturing.

On the basis of exposures in a trench, Y-1091 (p. 120) inferred (1) a cumulative vertical displacement of 45 cm since middle Quaternary, (2) a cumulative net (left–oblique) displacement of 76 to 132 cm during the same time period, (3) a vertical displacement per event between 5 and 20 cm and averaging about 10 cm, and (4) an average net (left–oblique) displacement per event between 11 and 28 cm.

Bow Ridge fault (BR) — Continued

Age of displacement: On the basis of exposures in Trench 14 and uranium–trend analyses, Y-26 (table 4, p. 21) interpreted the youngest event on BR to have occurred between 270 ± 90 ka and 38 ± 10 ka, because their Q2s deposits with an estimated age of 270 ka to 700 ka are fractured by BR but their Q2a deposits with an estimated age of about 40 ka overlie BR. However, Y-217 (p. 50) noted that the dates on which this interpretation was made are inconsistent. Y-87 (p. 418) concluded that the most–recent event exposed in Trench 14 is represented by an undated basaltic ash that is preserved in the fault zone and in fractures; they correlated this ash with 1.2 Ma and 0.27 Ma ashes from Crater Flat. Y-87 (p. 418) reported that sandy colluvium faulted down against the Tiva Canyon Member of the Paintbrush Tuff has a minimum age of 490 ± 90 ka (uranium–trend analyses); an opaline band within the sandy colluvium yielded a date of >500 ka (uranium–series analyses).

Y-87 (p. 418) interpreted an eolian unit that yielded dates of 90 ± 50 ka and 38 ± 10 ka (uranium–trend analyses) as "not demonstrably fractured or offset by faulting." Y-87 (p. 418) further concluded that the K–horizon developed in the sandy colluvium and that yielded dates of 490 ± 90 ka and >500 ka is fractured but not displaced. Y-1091 (p. 120) concluded that the two youngest events on BR (out of a total of five or six recognized) occurred during the late Pleistocene.

The map by Y-55 (pl. 1) shows BR as concealed beneath alluvium over much of its length. Y-1042 (p. 7, 10) noted that BR is difficult to recognize on aerial photographs at a scale of 1:12,000, but identified north–trending tonal contrasts and aligned drainages along the western side of Exile Hill, along with segmented, left–stepping drainage alignments, all which probably correspond to BR. They also identified a small scarp along a projection of BR between Bow Ridge and Boundary Ridge (Y-1042, p. 7). Lineaments that may be associated with BR were also recognized by Y-1239 (p. 45-46) along the contact between bedrock and alluvium north of Bow Ridge and along Exile Hill and within alluvium north of Exile Hill. Y-577 (p. A119) identified lineaments of possible tectonic origin on surfaces of colluvial and alluvial deposits along BR in Midway Valley.

Slip rate: Based on 220 m of displacement since 12.3 Ma to 13.9 Ma as suggested by Y-217 (table 4-1, p. 46), the apparent vertical slip rate on BR since that time has been 0.016–0.018 mm/yr. Based on 120 m of displacement since 11.4 Ma to 13.6 Ma as suggested by Y-217 (table 4-1, p. 46), the apparent vertical slip rate on BR since that time has been 0.009–0.011 mm/yr. Y-1091 (p. 120) estimated that slip rates on BR during middle and late Quaternary have been very low (about 0.001 mm/yr).

Recurrence interval: Y-1091 (p. 120) concluded that displacements in fault colluvium and buried soils exposed in Trench 14D, along with degraded fault scarps, suggest five to six surface–rupturing events during the middle and late Quaternary with long recurrence intervals (10^4 to 10^5 yr) between events.

Range-front characteristics: No tectonic geomorphic interpretation of the west sides of Bow Ridge and Exile Hill has been done.

Analysis: Compilation of published and unpublished information (Y-26, p. 1). Lineament analyses using low–sun–angle aerial photographs (Y-1042, p. 2, scale 1:12,000) and vertical aerial photographs (Y-238, p. 2, scales 1:24,000 to 1:80,000; Y-1239, p. 3, scales 1:6,000, 1:12,000, and 1:60,000). Mapping of surficial deposits and field investigations in Midway Valley (Y-1239, p. 3). Trenches, chiefly Trench 14 excavated along the northwestern side of Exile Hill (Y-26, table 1, p. 5; Y-87, p. 418) and Trench 14D (Y-1091, p. 120). Y-26 (pl. 1, p. 13) noted that another trench across BR exists, Trench 15 on the western side of Bow Ridge, but they did not discuss it or show the results on their table 1 (p. 5). Y-217 (p. 50) mentioned that five additional trenches were planned in the area of Trench 14 but that these were not yet completed. Where BR is obscured by alluvium, the fault has been located on the basis of anomalies observed in geophysical survey data (Y-55, pl. 1).

Bow Ridge fault (BR) — Continued

Relationship to other faults: Y-1042 (p. 7) suggested that northwest–trending linear features (e.g., linear drainages, tonal contrasts, vegetation alignments) that extend from Bow Ridge to Fran Ridge onto alluvial surfaces near Fortymile Wash may structurally connect BR to the Paintbrush Canyon fault (PBC), which bounds the eastern side of Midway Valley. These linear features coincide with short faults mapped by Y-55 (pl. 1). Y-26 (pl. 1) and Y-55 (pl. 1) also suggested that the southern end of BR may merge with PBC. Y-217 (p. 47, 49) interpreted the northern end of BR as obliquely intersecting their proposed northwest–striking Yucca Wash fault.

Bullfrog Hills faults (BUL)

Plate or figure: Plate 1.

References: Y-43: Cornwall and Kleinhampl, 1964; Y-232: Cornwall, 1972. Not shown by Reheis and Noller, 1991 (Y-238, pl. 3), unless a northwest–trending scarp in southern Sarcobatus Flat is part of BUL.

Location: 38 km/280° (distance and direction of closest point from YM) at lat 36°52′N. and long 116°55′W. (location of closest point). BUL includes four faults in the Bullfrog Hills between Sawtooth Mountain and the Grapevine Mountains on the east and west, and between Sarcobatus Flat and Crater Flat on the north and south.

USGS 7-1/2′ quadrangle: Beatty, Bullfrog Mountain.

Fault orientation: Faults in BUL generally strike north–northwest to northwest (Y-232).

Fault length: The eastern and western faults in BUL are about 7 km long; the other two faults are about 4 km long. (Lengths are estimated from Y-232.)

Style of faulting: The two longer faults in BUL (the only ones for which type displacement is shown) are both down to the southwest (Y-232, pl. 1).

Scarp characteristics: No information.

Displacement: No information.

Age of displacement: Parts of each of the four faults are shown by Y-232 (pl. 1) within Quaternary alluvium (his Qal deposits) or as faulted contacts between Tertiary volcanic and sedimentary rocks (chiefly Miocene rhyolite (his Tr unit) and Pliocene Timber Mountain Tuff (his Tp unit)) and his Qal deposits. The two longer faults and the western fault of the two shorter ones are all shown by Y-43 (pl. 1) as concealed by Quaternary alluvium (their Qal deposits). Short portions (≤about 0.5 km) of the eastern fault of the two shorter ones are shown by Y-43 (pl. 1) as a faulted contact between Tertiary welded tuff (their Tw unit) and their Qal deposits (primarily), or between pre–Tertiary rocks and their Qal deposits.

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No range fronts are associated with the four faults in BUL.

Analysis: Aerial photographs (Y-232).

Relationship to other faults: All four faults of BUL are within the Bullfrog Hills caldera (Y-232, pl. 1 and fig. 2, p. 29). Other faults in the Bullfrog Hills cut Tertiary rocks (Y-232, pl. 1), but these faults are not portrayed as having possible Quaternary displacement, so they are not shown on plate 1 of this compilation. Y-232 (p. 33-34) suggested that displacement on all of these faults, those considered part of BUL plus the other faults not shown on plate 1, may have been caused by subsidence of the caldera.

The map of Y-238 (pl. 3) shows a curving, northwest–trending, down–to–the–northeast, weakly expressed scarp on the surface of a Quaternary deposit just north of the Bullfrog Hills in Sarcobatus Flat. This scarp has a trend similar to the strikes of the four faults in BUL (north–northwest) and is located near the edge of the caldera. Although this scarp could be part of the Sarcobatus Flat fault (SF), its trend is more northwesterly than the strike of SF, and it is separated from faults in SF by nearly 15 km. This scarp is only 4 km north of faults in BUL. Whether or not this scarp is related to the faults in BUL is unknown.

The relationship of BUL to either the Beatty scarp (BS) or to the Bare Mountain fault (BM), both southeast of the Bullfrog Hills, is not known.

Buried Hills faults (BH)

Plate or figure: Plates 1 and 2.

References: Y-404: Tschanz and Pampeyan, 1970 (pls. 2 and 3); Y-813: Reheis, 1992 (pls. 2 and 3); Y-852: Dohrenwend and others, 1991 (show only that part of BH south of lat 37°N., the northern edge of their map area). Not shown by Ekren and others, 1977 (Y-25).

Location: 53 km/85° (distance and direction of closest point from YM) at lat 36°52′N. and long 115°51′W. (location of closest point). BH includes two main faults adjacent to the Buried Hills: one along their eastern side and the other along their western side. It also includes a fault along northern Nye Canyon, which is located about 3 km west of the Buried Hills.

USGS 7-1/2′ quadrangle: Aysees Peak, Frenchman Lake, Frenchman Lake SE, Papoose Lake, Plutonium Valley.

Fault orientation: BH strikes generally north, but the individual faults curve so that sections strike between north–northwest and north–northeast (Y-813).

Fault length: The fault along the eastern side of the Buried Hills and the fault along Nye Canyon are both 10 km long as estimated from Y-813. The total length of the fault along the western side of the Buried Hills is about 26 km as estimated from Y-813. This length includes three overlapping traces that result in nearly continuous surface expression for about 17 km and several discontinuous, short (0.5 to 1.5 km long) traces for another about 9 km to south of Aysees Peak (Y-813). BH is 4 km wide as estimated from Y-813.

Style of faulting: The fault along the eastern side of the Buried Hills is down to the east (Y-813). The fault along the western side of the Buried Hills and the fault along Nye Canyon are shown by Y-813 as down to the west.

Scarp characteristics: No information.

Displacement: No information.

Age of displacement: Faults in BH are shown by Y-813 primarily as either lineaments along a linear range front or as weakly to moderately expressed lineaments and scarps on surfaces of Quaternary and Tertiary deposits. She also portrayed portions of some as faults that are in Quaternary and Tertiary deposits and that were identified from previous mapping. Faults in BH are also shown by Y-404 as juxtaposing Pleistocene(?) older alluvium (their Qol deposits) against bedrock. Faults of BH south of lat 37°N. are portrayed by Y-852 as juxtaposing Quaternary alluvium against bedrock.

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: Portions of range fronts along some faults within BH are shown by Y-813 to be linear. Portions of range fronts south of lat 37°N. are shown by Y-852 as having a morphology similar to that along major range–front faults.

Analysis: Aerial photographs (Y-404, p. 2, scale 1:60,000; Y-813, p. 4, scales 1:62,500 to 1:80,000; Y-852, scale 1:58,000). Field mapping (Y-404, p. 2).

Buried Hills faults (BH) — Continued

Relationship to other faults: Fault traces at the northern end of BH along the eastern side of the Buried Hills strike north–northeast and are approximately parallel to and aligned with fault traces to the north within southern Emigrant Valley (Emigrant Valley South fault, EVS). BH as a whole is approximately parallel to faults to the east, such as the Chert Ridge faults (CHR) along both sides of Chert Ridge, the Indian Springs Valley fault (ISV) along the eastern side of the Spotted Range, the Spotted Range fault (SPR) along the western side of the Spotted Range, the Fallout Hills faults (FH) within the Fallout Hills, and the three faults along and within the Pintwater Range (the East Pintwater Range fault (EPR), the Central Pintwater Range fault (CPR), and the West Pintwater Range fault (WPR)). Faults at the southern end of BH along the western side of the Buried Hills strike obliquely to the northeast–striking Rock Valley fault (RV).

Cactus Flat fault (CF)

Plate or figure: Plate 1.

References: Y-813: Reheis, 1992 (her Cactus Flat lineament, pl. 1); Y-1108: Locke and others, 1940. Not shown by Cornwall, 1972 (Y-232), except for a concealed fault that is shown along the eastern side of the Cactus Range at the southern end of CF. Not shown by Dohrenwend and others, 1992 (Y-853).

Location: 84 km/343° (distance and direction of closet point from YM) at lat 37°35'N. and long 116°44'W. (location of closest point). Most of CF is located along the western side of Cactus Flat and separates Cactus Flat from the basin of Mud Lake to the west (Y-813, p. 6). The southern end of CF is located along the southeastern side of the Cactus Range.

USGS 7-1/2' quadrangle: Breen Creek, Cactus Spring, East of Cactus Peak, Mellan, Reeds Ranch, Roller Coaster Knob, Stinking Spring NW, Stinking Spring SW, Trappman Hills.

Fault orientation: CF strikes generally north (Y-813). However, its northern end strikes north–northeast, and its southern end strikes north–northwest.

Fault length: The length of CF is 50 km as estimated from Y-813 between the northern end of her map area at lat 38°N. and south of Antelope Hill (north of Mount Helen). This length includes a gap in surficial expression along the eastern side of the Cactus Range. This gap is nearly 5 km long as estimated from Y-813.

Style of faulting: Y-813 shows four north–northeast–trending folds subparallel to the northern end of CF just south of lat 38°N. She (p. 6) suggested that these folds indicate that Quaternary compression has been associated with CF.

Scarp characteristics: CF is shown by Y-813 as having both east– and west–facing scarps at its northern end, as primarily west–facing scarps in Cactus Flat, and as primarily east–facing scarps (one is west–facing) at its southern end along the Cactus Range.

Displacement: No information.

Age of displacement: Much of the northern portion of CF in Cactus Flat is shown by Y-813 (pl. 1) as prominent topographic lineaments that she (Y-813, p. 4) interpreted as suggesting Quaternary displacement. Some of this portion of CF also is portrayed by Y-813 as weakly to moderately expressed lineaments and scarps on surfaces of Quaternary (chiefly) and Tertiary deposits. Other parts of CF are shown by Y-813 as faults that are in Tertiary deposits and that were identified by previous mapping. The southern portion of CF along the Cactus Range is shown by Y-813 as weakly expressed to prominent lineaments and scarps on surfaces of Tertiary deposits.

Late Pleistocene displacement along CF is inferred by Y-813 (p. 6) on the basis of (1) the diversion of drainages by west–facing scarps along CF (e.g., drainage from the Kawich Range to the east is ponded in an unnamed playa north of Antelope Lake), (2) the small drainages that flow along and are diverted by left–stepping scarps of CF on surfaces of Quaternary deposits, and (3) the lack of pluvial–lake shorelines and local topography, which both together suggest that Cactus Flat basin was once contiguous with Mud Lake basin (before late Pleistocene?) and that the two basins were separated by displacement along CF.

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No information.

Analysis: Aerial photographs (Y-813, p. 4, scales 1:62,500 to 1:80,000).

Relationship to other faults: Clusters of lineaments and (or) scarps with trends similar to the strike of CF are preserved 5 to 10 km east of CF in Cactus Flat. These lineaments and (or) scarps are combined into the Cactus Flat–Mellan fault (CFML) of this compilation. The relationship between CFML and CF is not known.

Cactus Flat fault (CF) — Continued

Y-232 (p. 32) stated that the Cactus Range is a horst. The east–bounding fault correlates with faults at the southern end of CF along the Cactus Range. Y-232 (p. 32) suggested that deformation resulting in the Cactus Range occurred primarily during the Miocene and was related to volcanic activity, but Y-1108 (Y-232, p. 32, *citing* Y-1108) speculated that the southeast elongation of the range may be related to the northwest–trending Walker Lane.

A discontinuity in the bedrock units that flank Mount Helen south of the Cactus Range, just south of and aligned with the southernmost fault traces of CF (pl. 1), has been suggested to be due to strike–slip faulting related to the Walker Lane (Ekren and others, written commun., 1966, *cited in* Y-232, p. 33). The relationship between this possible fault and CF is not known.

Cactus Flat–Mellan fault (CFML)

Plate or figure: Plate 1.

References: Y-232: Cornwall, 1972; Y-813: Reheis, 1992 (pls. 1 and 2). Only a few faults of CFML, as mapped by Y-813, are shown by Y-232. Not shown by Dohrenwend and others, 1992 (Y-853).

Location: 80 km/355° (distance and direction of closest point from YM) at lat 37°34′N. and long 116°38′W. (location of closest point). CFML includes several clusters of lineaments and scarps within Cactus Flat between about Gold Mountain and north of Mellan, Nevada, and east of the prominent Cactus Flat fault (CF).

USGS 7-1/2′ quadrangle: Breen Creek, Mellan, Roller Coaster Knob, Stinking Spring SW, Trappman Hills, Triangle Mountain.

Fault orientation: The strike of the entire CFML is approximately north (Y-813). Individual lineaments and scarps or clusters of lineaments and scarps trend between northeast and northwest (Y-813).

Fault length: The length of CFML, which extends from north of Gold Hill to north of Mellan, is about 35 km as estimated from Y-813. The width of CFML is about 10 km as estimated from Y-813.

Style of faulting: No information.

Scarp characteristics: Scarps within CFML are shown by Y-813 as both east– and west–facing.

Displacement: No information.

Age of displacement: CFML is portrayed by Y-813 as weakly expressed to prominent lineaments or scarps on surfaces of Quaternary deposits (primarily) or as topographic lineaments bounding a linear range front or in bedrock. Two fault traces between Gold Mountain and Mellan are shown by Y-232 as faulted contacts between Tertiary volcanic rocks and Quaternary alluvium (his Qal deposits). One of these two fault traces is also shown by Y-813.

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No range front is associated with CFML, although some of the faults do bound linear ridges or outcrops of Tertiary volcanic rocks (Y-813).

Analysis: Aerial photographs (Y-232; Y-813, p. 4, scales 1:62,500 to 1:80,000; Y-853, scales 1:115,000 to 1:124,000 and 1:58,000).

Relationship to other faults: CFML includes several groups of lineaments and scarps in Cactus Flat. Although lineaments and scarps in CFML have slight differences in trend and in relationships to geologic and topographic features, these lineaments and scarps are combined into one fault because of their location in Cactus Flat and their general north alignment. CFML does not include scarps and lineaments recognized as part of the prominent, nearly continuous Cactus Flat fault (CF) that was identified by Y-813 (pl. 1, p. 6). The structural relationship between CFML and CF is not known. CFML is shown separately from CF, although the strikes of the two faults are similar, because (1) CFML lies east of the relatively well–defined CF, (2) CFML is more discontinuous than CF, and (3) lineaments and scarps in CFML are more widely scattered than those in CF.

The structural relationships between CFML and other faults surrounding Cactus Flat are not known. These include faults bounding the eastern side of Stone Cabin Valley, the East Stone Cabin fault (ESC), which is directly north of CFML, and faults bounding the western side of the Kawich Range, the Kawich Range fault (KR), which is northwest of CFML. North of Silverbow, Nevada, ESC generally strikes more northeastward than CFML, although one trace of ESC strikes northward, which is similar to the strike of CFML. South of Silverbow, KR strikes northwest, which is markedly different from the general north strike of CFML.

Cactus Flat–Mellan fault (CFML) — Continued

The relationship between CFML and the Gold Flat fault (GOL), which is immediately south of CFML, also is not known. GOL generally strikes northeast, in contrast to the nearly north strike of CFML. However, a few fault traces in GOL do strike northward.

Fault traces at the southern end of CFML, near Gold Mountain, are subparallel to faults, lineaments, and scarps shown by Y-232 and Y-813 to affect Tertiary volcanic rocks. Only those features noted with possible Quaternary displacement are portrayed on plate 1 of this compilation.

Cactus Range–Wellington Hills fault (CRWH)

Plate or figure: Plate 1.

References: Y-5: Ekren and others, 1971; Y-232: Cornwall, 1972; Y-813: Reheis, 1992 (pl. 1). Not shown by Dohrenwend and others, 1992 (Y-853).

Location: 87 km/337° (distance and direction of closest point from YM) at lat 37°34′N. and long 116°49′W. (location of closest point). The northern portion of CRWH includes fault traces along the western side of the Cactus Range. The southern portion of CRWH includes fault traces along the western side of the Wellington Hills.

USGS 7-1/2′ quadrangle: Cactus Peak, Cactus Spring, Civet Cat Cave, White Patch Draw.

Fault orientation: CRWH strikes generally northwest, but CRWH curves so that the northern and southern ends strike north (Y-813).

Fault length: The length of CRWH is about 29 km as estimated from Y-813. This length includes about 15 km of fault traces at the northern end of CRWH along the Cactus Range, a 7–km–long gap in surficial expression, and about 7 km of fault traces at the southern end of CRWH along the Wellington Hills. The length of CRWH is about 25 km as estimated from Y-232, of which 17 km on the fault's southern end apparently has no surficial expression (shown as concealed by Y-232).

Style of faulting: Most of CRWH is shown by Y-813 as having down–to–the–west or down–to–the–southwest displacement.

Scarp characteristics: No information.

Displacement: No information.

Age of displacement: CRWH is portrayed by Y-813 primarily as weakly to moderately expressed lineaments and scarps on surfaces of Tertiary deposits, as faults that are in Tertiary deposits and that were identified by previous mapping, and as prominent topographic lineaments where upper Cenozoic deposits are juxtaposed against bedrock. At one locality near Sleeping Column Canyon, CRWH is shown by Y-813 as a moderately expressed scarp or lineament on surfaces of Quaternary deposits. In contrast, Y-232 portrayed the northern 8 km of CRWH as a fault in Tertiary rocks and the southern 17 km as concealed by Quaternary alluvium (his Qal deposits).

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No information.

Analysis: Aerial photographs (Y-813, p. 4, scales 1:62,500 to 1:80,000). Information shown by Y-232 was taken in part from Y-5.

Relationship to other faults: Y-232 (p. 32) noted that the Cactus Range is a northwest–trending horst that is bounded by "an elliptical ring of mapped and inferred faults. The complex structural evolution of the range is believed to have resulted mainly from volcano–tectonic deformation in the Miocene, but the northwest–southeast elongation of the range may be related to a major regional northwest–trending lineament, such as the Walker Lane * * *, whose extension may pass near or along the Cactus Range" (Y-232, p. 32).

The relationship of CRWH to the Cactus Flat fault (CF) along the southeastern side of the Cactus Range, to the northeast–striking Stonewall Mountain fault (SWM) along the northern side of Stonewall Mountain west of CRWH, or to the north–striking Pahute Mesa faults (PM) directly south of CRWH on Pahute Mesa is not known.

Cactus Springs fault (CAC)

Plate or figure: Plate 2.

References: Y-813: Reheis, 1992 (pl. 3); Y-852: Dohrenwend and others, 1991.

Location: 59 km/119° (distance and direction of closest point from YM) at lat 36°35′N. and long 115°52′W. (location of closest point). CAC is located along the northern side of an unnamed ridge northwest of Cactus Springs, Nevada.

USGS 7-1/2′ quadrangle: Indian Springs, Indian Springs NW, Mercury NE, Mercury SE.

Fault orientation: CAC has a curving strike that ranges between east–northeast, east, and west–northwest.

Fault length: CAC is mapped continuously along the base of the unnamed ridge for about 12 km as estimated from Y-813 and Y-852. A 2–km–long fault trace that is slightly north of the unnamed ridge is also shown by Y-852.

Style of faulting: CAC is portrayed by Y-813 (pl. 3) as down to the north.

Scarp characteristics: No information.

Displacement: No information.

Age of displacement: Part of CAC is shown by Y-813 (pl. 3) as weakly to moderately expressed lineaments or scarps on surfaces of Quaternary deposits.

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: Most of CAC is portrayed by Y-852 as a fault juxtaposing Quaternary alluvium against bedrock, but not as a major range–front fault. The morphology of the northern side of the unnamed ridge along which CAC has been mapped is noted by Y-852 as similar to that along a major range–front fault and may be characterized by "fault juxtaposition of Quaternary alluvium against bedrock, fault scarps and lineaments on surficial deposits along or immediately adjacent to range front, a general absence of pediments, abrupt piedmont–hillslope transitions, steep bedrock slopes, faceted spurs, wineglass valley, and subparallel systems of high–gradient, narrow, steep–sided canyons orthogonal to range front." However, CAC is significantly less extensive and any fault scarps are substantially lower, shorter, and less continuous than those along a major range–front fault (Y-852). Part of CAC is shown by Y-813 (pl. 3) as a topographic lineament bounding a linear range front.

Analysis: Aerial photographs (Y-813, p. 4, scales 1:62,500 to 1:80,000; Y-852, scale 1:58,000).

Relationship to other faults: The general east strike of CAC is similar to the strikes of the South Ridge faults (SOU) north of CAC. These two faults have been interpreted by Y-813 (p. 8) to be part of the Spotted Range–Mine Mountain section of the Walker Lane belt.

The strike of the generally north–striking West Pintwater Range fault (WPR) becomes more northeasterly as WPR approaches CAC from the east. The relationship between these two faults is unknown.

Cane Spring fault (CS)

Plate or figure: Plates 1 and 2.

References: Y-62: Barnes and others, 1982; Y-104: Ekren and Sargent, 1965; Y-181: Carr, 1974; Y-182: Carr, 1984; Y-192: Marvin and others, 1970; Y-205: Orkild, 1968 (shows the northeastern end of CS only); Y-210: Poole and others, 1965 (name from this reference); Y-226: Swadley and Huckins, 1990 (They show fault traces along the southern side of Skull Mountain. These traces possibly align with the southwestern end of CS, but they do not exactly correlate with CS as mapped by Y-104.); Y-232: Cornwall, 1972; Y-238: Reheis and Noller, 1991 (pl. 3; they show one fault, which is within Tertiary deposits and may align with CS as shown by Y-232.); Y-301: Fleck, 1970; Y-314: Ekren, 1968; Y-1107: Carr, 1974.

Location: 36 km/112° (distance and direction of closest point from YM) at lat 36°45'N. and long 116°11'W. (location of closest point). This includes the southwestern section of Y-232. From northeast to southwest along the fault, CS is located along the southern side of Yucca Flat, along Cane Spring Wash, and along the southern side of Skull Mountain.

USGS 7-1/2′ quadrangle: Cane Spring, Skull Mountain, Specter Range NW, Yucca Lake.

Fault orientation: CS strikes generally northeast, but its trace is slightly curving (Y-232). The map by Y-232 shows a southwestern section of CS that is separated by about 1 km from a main, continuous trace of CS to the northeast. Maps by both Y-104 and Y-210 show CS, including the southwestern section of Y-232, as having continuous surficial expression. CS also includes a northeast–striking branch fault southwest of Cane Spring and south of the main, continuous trace (Y-210; Y-232).

Fault length: The length of CS is about 14 km as estimated from Y-104 and Y-210 and up to 27 km as estimated from Y-232. The longer value includes a 4–km–long section at the southwestern end of CS that is separated from the longer, continuous trace by about 1 km. Fault traces mapped by Y-226 along the southern side of Skull Mountain are 0.6 to 2.6 km long.

Style of faulting: Displacement on CS may be oblique. The southwestern end of CS (includes the separate southwestern section of Y-232) is shown by Y-104 and Y-210 as down to the southeast; its central part near Cane Spring is shown by Y-210 as down to the northeast; its northeastern end northeast of Cane Spring is portrayed by Y-210 as left–lateral. The map by Y-232 shows CS as having left–lateral strike slip along its entire length. The southern branch of CS southwest of Cane Spring is shown as down to the northwest by Y-210 and Y-232 and down to the southeast by Y-210. Faults along the southern side of Skull Mountain are portrayed by Y-226 as both down to the northwest and down to the southeast.

Scarp characteristics: No information.

Displacement: Y-181 (p. 6) and Y-210 noted that left–lateral displacement along CS becomes progressively less in tuffs with ages ranging between 14 Ma and 11 Ma, but no amounts are specified.

Age of displacement: Some sections of CS are portrayed as faulted contacts between Tertiary rocks and younger Tertiary or Quaternary deposits. This includes (1) one 0.5–to–1.0–km–long section at the fault's southwestern end, which is shown by Y-232 as a faulted contact between Wahmonie and Salyer formations (his Tws unit) and Quaternary alluvium (his Qal deposits), (2) fault traces along Skull Mountain, which are portrayed by Y-226 as faulted contacts between Pliocene to Oligocene rocks (their Tr unit) and early Pleistocene and Pliocene(?) alluvium (their QTa deposits), and (3) other fault traces that are shown by Y-104 as displacing Tertiary volcanics of Wahmonie Flat (their Twm unit), Pliocene Piapi Canyon Formation (their Tpr and Tpat units), or Pliocene basalt of Skull Mountain (their Tbs unit) against Pliocene older alluvium (their Tao deposits) and Quaternary alluvium (their Qa deposits).

Cane Spring fault (CS) — Continued

Other sections of CS are portrayed as faults in Tertiary or Quaternary deposits, or as lineaments or scarps on Tertiary or Quaternary surfaces. Y-210 showed parts of CS as fault scarps or fault–line scarps on surfaces of Miocene and Pliocene(?) Wahmonie Formation, Pliocene alluvium and colluvium, and Pliocene Timber Mountain Tuff against which Quaternary alluvium and colluvium (their Qac deposits) have been either displaced or deposited. Y-210 also showed several fault lines or lineaments approximately parallel to CS on surfaces of Quaternary alluvium and colluvium (their Qa and Qac deposits) along Cane Spring Wash. The traces of CS mapped by Y-238 (pl. 3) are shown as faults that are in Tertiary or Quaternary deposits and that were identified by previous mapping. CS is portrayed by Y-232 to displace Pliocene and Miocene volcanic and sedimentary units, including the Wahmonie and Salyer formations (his Tws units), Timber Mountain Tuff, Paintbrush Tuff, and (or) tuff of Crater Flat (his Tp unit), and basalt flows and plugs (his Tb unit).

CS is generally shown as concealed by Quaternary alluvium by Y-104 (their Qa deposits), Y-210 (their Qac deposits), and Y-232 (his Qal deposits). The northeastern extension of CS as shown by Y-232 would be crosscut by faults or lineaments mapped by Y-210 on surfaces of Quaternary alluvium and colluvium (their Qa and Qac deposits) east of the junction of Neilson Wash with Cane Spring Wash.

The Spotted Range–Mine Mountain structural zone (SRMM), a zone of northeast–striking faults of which CS may be a part, is considered by Y-182 (p. 44, 61) to be seismically active because of the numerous earthquakes in the area. However, Y-62 (*citing* Y-301) suggested that most of the displacement on SRMM may have occurred between 5 Ma and 7 Ma, during the late Miocene and early Pliocene. In addition, Y-182 (p. 64) concluded that much of SRMM had developed and considerable erosion had occurred before middle Oligocene. This conclusion was based on the age of the oldest Tertiary rocks in SRMM, which are correlated with the Horse Spring Formation that was dated (K–Ar) at slightly greater than 29 Ma (Y-192, tables 1 and 2, sample locality #19, p. 2663, 2665).

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No range front is associated with CS.

Analysis: Aerial photographs (Y-226; Y-232; Y-238, p. 2, scales 1:24,000 to 1:80,000).

Relationship to other faults: CS is one of four main faults that have been grouped into the 30–to–60–km–wide Spotted Range–Mine Mountain structural zone (SRMM), which is characterized by northeast–striking, left–lateral faults that have experienced relatively small amounts of displacement (Y-181, p. 9; Y-182, p. 56). The other three faults in SRMM are the Mine Mountain fault (MM), the Rock Valley fault (RV), and the Wahmonie fault (WAH). These faults have been interpreted by Y-62 (*citing* Y-1107) to be "first–order structures that form a conjugate system with the northwest–striking, right–lateral faults of the Las Vegas Valley shear zone." Y-314 (p. 16-17) suggested that displacement along faults in SRMM resulted from what he called rotary slippage that occurred during right–lateral displacements along the Las Vegas Valley shear zone (LVS). However, Y-182 (p. 63) noted that neither the LVS nor the northwest–striking La Madre shear zone crosses SRMM and that significant curving or bending of faults in SRMM, which would be required if such rotation had occurred, is lacking. In contrast, faults of SRMM are probably related to northwest–striking faults and flexure zones with right–lateral displacement or bending north of LVS (e.g., the Frenchman flexure of Y-181 (fig. 11, p. 34) or the Yucca–Frenchman shear zone of Y-182 (fig. 8, p. 17)), because faults in SRMM and LVS mutually displace one another as indicated by field relationships (W.J. Carr, unpublished data, 1976, *cited by* Y-181, p. 9) and because both SRMM and LVS are locally active as indicated by associated seismicity (Y-181, p. 9).

Alternatively, Y-182 (p. 62) thought that displacements on faults in SRMM are conjugate to displacements on faults in the northwest–trending Walker Lane.

Cane Spring fault (CS) — Continued

Both the similarity in types of displacement and the alignment of surficial expression suggested to Y-182 (p. 62) that SRMM may be connected to the Pahranagat fault (PGT) to the northeast (the Pahranagat shear zone of Y-182). However, 70 km separates SRMM and PGT and no northeast–trending structures have been recognized in the Paleozoic rocks that are exposed in numerous places within this gap, which includes the north– and north–northwest–trending Spotted, Pintwater, and Desert ranges (Tschanz and Pampeyan, 1970 (Y-404); Ekren and others, 1977 (Y-25); Y-182, p. 62).

Carpetbag fault (CB)

Plate or figure: Plate 1.

References: Y-50: Barnes and others, 1963; Y-60: Colton and McKay, 1966; Y-181: Carr, 1974 (Carpetbag fault zone on his fig. 7); Y-182: Carr, 1984 (name from his fig. 12, p. 24; also shows CB as the Carpetbag fault zone on fig. 11, p. 23); Y-196: McKeown and others, 1976; Y-224: Frizzell and Shulters, 1990; Y-327: Shroba and others, 1988 (their Carpetbag fault system); Y-526: Swadley and Hoover, 1990; Y-693: Barosh, 1968; Y-813: Reheis, 1992 (pl. 2); Y-1106: Shroba and others, 1988 (their Carpetbag fault system). Not shown by Dohrenwend and others, 1992 (Y-853).

Location: 43 km/46° (distance and direction of closest point from YM) at lat 37°07'N. and long 116°06'W. (location of closest point). CB is located in the western half of central Yucca Flat.

USGS 7-1/2' quadrangle: Oak Spring, Yucca Flat.

Fault orientation: CB generally strikes north to north–northwest (Y-182, fig. 12, p. 24; Y-1106, fig. 1, p. 3). In the subsurface, CB is inferred to be slightly sinuous (Y-182; Y-224) and branching (Y-224). At the surface, CB is shown by Y-526 to be composed of several subparallel strands. Y-1106 (fig. 1, p. 3) recognized several north–northeast–striking or northeast–striking splays of CB. CB generally dips steeply to the east (Y-60; Y-182, p. 21; Y-224). Antithetic faults dip to the west (Y-182, fig. 11, p. 23). Y-181 (p. 26, fig. 8, p. 25) noted that CB in southwestern Yucca Flat may dip as little as about 40°.

Fault length: The length of CB is about 30 km as estimated from Y-224 and 16.5 km as estimated from Y-526. CB is portrayed by Y-224 as concealed beneath Quaternary alluvium along most of its length, and its extent has been inferred from drilling or gravity data.

Style of faulting: Y-60 and Y-224 both showed CB as generally down to the east. Y-181 (p. 27) noted evidence for right–lateral displacement that resulted from an underground nuclear explosion. Y-327 (p. 231) and Y-1106 (p. 30) concluded that the youngest ruptures that formed before those produced by underground nuclear testing were limited to fracturing.

Scarp characteristics: Prominent, generally east–facing scarps, some forming a graben, were produced during and following an underground explosion in Yucca Flat in 1970 (Y-181, fig. 7; Y-1106, p. 2-5, 30; the Carpetbag event). Y-327 (p. 231) and Y-1106 (p. 2) noted that, unlike the Yucca fault (YC) to the east, CB lacks prehistoric (before nuclear testing) scarps. However, Y-224 indicated that a 1–km–long portion of CB does displace surficial deposits prehistorically, but no scarp characteristics are given by them.

Displacement: The average vertical displacement in Tertiary volcanic tuff along CB is 600 m (Y-181, p. 27). Alluvium in Yucca Flat is thickest just east of the southern end of CB. The alluvium at this locality is 600 to 1,200 m (2,000 to 4,000 ft) thick in an area <3 km wide (Y-182, p. 21, figs. 11 and 12, p. 23-24). Y-182 (p. 21) interpreted this depression as a structural feature formed in part by vertical displacement on CB. Y-1106 (p. 15) measured apparent vertical offsets across explosion–produced scarps of 1.7, 2, and 2.3 m at their three trench sites.

Y-181 (p. 27) noted that the amount of right–lateral displacement on CB since deposition of Tertiary volcanic tuff could be ≥600 m. Y-181 reported that Paleozoic rocks could be displaced laterally "several thousand feet." Y-181 (p. 32) thought that CB may account for as much as 1,500 m of horizontal extension. Y-181 (p. 27) noted that the Carpetbag event (a nuclear explosion) produced at one locality (near UE2b, Y-181, fig. 7) 15 cm of right–lateral displacement across a 1.2–m–high scarp, along with left–stepping, *en echelon* cracks.

Age of displacement: A portion of CB that is about 2 km long (Y-181, fig. 7; Y-327, p. 231; Y-1106, p. 30) to 4.5 km long (as estimated from Y-224) is shown as having been reactivated by an underground nuclear explosion in 1970.

Carpetbag fault (CB) — Continued

Y-1106 (p. 2) noted that displacement on CB (and on the Yucca fault to the east) has probably occurred during late Quaternary. A 1–km–long section of CB, which is at the southern end of the fault and east of the traces reactivated by underground testing, is shown by Y-224 to displace surficial deposits prehistorically. A 1.5–km–long portion of CB has been identified by Y-182 (fig. 12, p. 24) as having Quaternary (but prehistoric) displacement. Using aerial photographs, Y-1106 (p. 14, 30) also recognized north–trending lineaments that may be associated with CB.

Y-327 (p. 231) and Y-1106 (p. 30) interpreted at least six major episodes of fracturing (and perhaps minor faulting) on CB since 250 ka. On the basis of uranium–series analyses on secondary carbonate in eight fracture–fill features interpreted by Y-1106 (p. 12) to have been produced by surface or near–surface displacement, episodes of fracturing and minor faulting on CB occurred about 30 ka, 45 ka, 65 ka, 100 ka, 125 ka to 130 ka, and 230 ka to 240 ka (Y-327, p. 231; Y-1106, p. 30). Y-1106 (p. 5) noted that a date (uranium–series analyses) of 37 ka was determined by Knauss (1981, Y-1242, *cited in* Y-1106, p. 5) on one fracture–fill deposit near CB (site CBF3, Y-1106, fig. 2).

On the basis of a lack of prehistoric scarps and undisplaced stratigraphic units exposed in three trenches, Y-327 (p. 231) and Y-1106 (p. 14, 31) concluded that no significant vertical displacement has occurred on CB at least since 10 ka, probably since 125 ka to 130 ka, and possibly since 350 ka. On the basis of a date (uranium–trend analyses) of 35 ± 15 ka for an unfractured deposit and a lack of fracture fillings in deposits younger than about 30 ka, Y-327 (p. 231) and Y-1106 (p. 25, 30) concluded that no surface fracturing (or larger surface displacements) had occurred on at least part of CB since about 30 ka. (Another unfractured surficial deposit was estimated to have an age of about 170 ka by Y-1106 (p. 30) on the basis of development of both rock varnish and an argillic soil horizon.) Y-1106 (p. 25, 30-31) also concluded that little or no fracturing or faulting occurred on CB between about 240 ka and 350 ka, because dates determined by uranium–series analyses on the carbonate–rich fracture fillings do not fall within this time interval.

Slip rate: The slip rate along CB between about 30 ka and 125 ka to 130 ka or earlier has been nearly zero, because displacements, as interpreted by Y-327 (p. 231) and by Y-1106 (p. 30), have been limited to fracturing and minor faulting. No evidence for fracturing or faulting has been recognized since about 30 ka.

Recurrence interval: Y-327 (p. 231) and Y-1106 (p. 31) inferred an average recurrence interval of about 25,000 yr for fracturing events during the last 125,000 to 130,000 yr.

Range-front characteristics: No range front is associated with CB.

Analysis: Analysis of conventional aerial photographs (Y-813, p. 4, scales 1:62,500 to 1:80,000; Y-1106, p. 14, scale about 1:5,000). Description of surficial deposits and soils (Y-1106, p. 5). Interpretation of deposits exposed in trenches at three localities (Y-327, p. 231; Y-1106, p. 4-5, Trenches T1, T2, and T3). Interpretation of exposures along explosion–produced scarps (Y-1106, p. 4-5, Sites S1–S4). Radiometric dating (uranium–trend and uranium–series methods) of surficial deposits and carbonate–rich fracture fillings (Y-1106, p. 5, 15-30). Measurement of characteristics of explosion–produced scarps (Y-1106, p. 15). Geophysical and gravity data for Yucca Flat (Y-181). Additional information from M.N. Garcia, U.S. Geological Survey, written commun., 1988 (*cited in* Y-526).

Relationship to other faults: CB is probably related to other faults in Yucca Flat: the Yucca fault (YC), the Area Three fault (AT), the Eleana Range fault (ER), the Yucca Lake fault (YL), and several short, unnamed faults. Y-182 suggested that displacement on all of these fault probably resulted in the formation of Yucca Flat as a structural basin. Y-1106 (p. 15) proposed that seismic shaking associated with YC, located about 3.5 km east of CB, may have triggered one or more episodes of minor displacement on CB and resulted in the carbonate–rich fracture fillings.

Carpetbag fault (CB) — Continued

Y-182 (p. 21) interpreted CB to be a typical Basin and Range fault. He suggested that the southern end of CB is intersected by the northwest–trending Yucca–Frenchman shear and flexure zone, which is located northwest of the Las Vegas Valley shear zone and is interpreted by Y-182 (p. 21) to be a part of the Walker Lane. Y-182 (p. 21) proposed that the interaction between CB and the Yucca–Frenchman shear zone has enhanced north–northwest extension and subsidence of Yucca Flat.

Cedar Mountain fault (CM)

Plate or figure: Figure 1.

References: Y-13: dePolo and others, 1987; Y-14: Gianella and Callaghan, 1934; Y-15: Bell, 1988; Y-16: Doser, 1987; Y-17: Gianella and Callaghan, 1934; Y-170: Molinari, 1984 (his Stewart–Monte Cristo fault zone); Y-794: dePolo and others, 1988; Y-795: Bell and others, 1988 (p. 1-25 to 1-36); Y-797: Bell and others, 1987; Y-969: Shawe, 1965; Y-1069: Yount and others, 1993; Y-1070: Yount and others, 1993; Y-1074: Doser, 1988; Y-1075: Molinari, 1983.

Location: 200 km/328° (distance and direction of closest point from YM) at lat 38°20'N. and long 117°50'W. (location of closest point). CM consists of fault traces that ruptured in an earthquake on December 20, 1932. It includes traces previously referred to as the Gabbs Valley, Cedar Mountain, and Monte Cristo faults.

USGS 7-1/2' quadrangle: Bettles Well, Dicalite Summit, Eddyville, Gabbs Mountain, Granny Goose Well, Kirby Flat, Luning, Mount Ferguson, Stewart Spring, Sunrise Flat.

Fault orientation: CM consists of a discontinuous zone of fault traces that generally strike N. 30° W. (Y-170, p. 45-46; Y-1075). Main fault traces that ruptured in 1932 in Monte Cristo Valley strike approximately north; other fault traces have varying orientations (Y-794, p. 5; Y-969, p. 1,364).

Fault length: CM is ≥45 km long along the western edge and south–central portion of Stewart Valley and in Monte Cristo Valley south of Kibby Flat playa (Y-170, p. 45, his Stewart–Monte Cristo fault zone; Y-1075). The length of the traces that ruptured in 1932 is about 60 km (38 miles) from about 6 km (3.6 miles) east of Warrens Well in Gabbs Valley southeast to about 13 km (8 miles) east of Pilot Peak (Y-17, p. 8; Y-794, p. 3; Y-969, p. 1,364). The width of the rupture zone in 1932 was about 6 to 16 km (4 to 10 miles; Y-17, p. 8; Y-794, p. 3; Y-969, p. 1,364).

Style of faulting: Displacements along CM in 1932 and in pre–1932 ruptures have been primarily right lateral, with a minor component of dip–slip (normal) displacement or normal right–oblique displacement (Y-170, p. 46; Y-794, p. 5, 6, 8; Y-1075). Right–lateral displacement in 1932 is suggested by a left–stepping, *en echelon* pattern of ruptures (Y-13; Y-17, p. 8), by lateral displacement of small–scale geomorphic features (Y-13), and by near–horizontal slickensides (Y-13).

During the 1932 earthquake, the main, north–striking fault traces in Monte Cristo Valley experienced right–lateral and normal right–oblique displacements (Y-794, p. 5). Northeast–striking fault traces, which are more numerous to the north (e.g., in Gabbs Valley), had dominantly normal displacement (Y-794, p. 5). Northwest–striking fault traces that form steps or bends in traces of the main fault appear to have evidence for compressional deformation (Y-794, p. 5).

Scarp characteristics: Y-13 noted that west–facing scarps that formed in 1932 are 30 to 50 cm high and that these scarps are superimposed on older, subdued scarps. Y-1069 (p. 386) reported scarp heights of a few centimeters to 60 cm from the 1932 earthquake. In contrast, Y-170 (p. 115) suggested that scarps from the 1932 earthquake were 1.4 m high.

Displacement: The largest and most continuous ruptures in 1932 occurred in Monte Cristo Valley (Y-794, p. 4). In this valley and in Stewart Valley, right–lateral displacements were up to 1 to 2 m in 1932; vertical displacements in this earthquake were ≤0.5 m (Y-13; Y-170, p. 115; Y-794, p. 5; Y-1069, p. 386). Y-17 (p. 15) reported as much as 0.6 m (2 ft) of vertical displacement at one locality from the 1932 earthquake. Y-795 (p. 1-35) noted 15 to 30 cm of vertical displacement and about 1 to 2 m of right–lateral displacement from the 1932 event at their Trench 3 in Monte Cristo Valley. Y-13 inferred that the ratio of vertical to horizontal displacement in 1932 was at least 1:3.

Cedar Mountain fault (CM) — Continued

On the basis of their interpretation of stratigraphy exposed in trenches, Y-795 (p. 1-34) inferred a minimum vertical separation since 730 ka of 3 m at one locality on CM in Monte Cristo Valley. They suggested that the total amount of right–lateral displacement may be >21 m, because the ratio of vertical to horizontal displacement was 1:7 (Y-795, p. 1-35). Furthermore, possible correlation of deposits across the fault at this same locality suggests that about 1 m of vertical separation has occurred since about 135 ka (Y-795, p. 1-34).

Along the northern section of CM, along the eastern side of the Gabbs Valley Range, a minimum of 100 m of right–lateral displacement is inferred by Y-170 (p. 53) from displacement of the contact between Miocene units and from the rake of exposed striations. The number and size of folds and the amounts of vertical displacement across faults along this northern section and along a central section suggested to Y-170 (p. 100) that the amount of deformation increases to the north along CM.

CM includes folds in the Esmeralda Formation (middle to late Miocene; 11 Ma to 16 Ma; Y-170, p. 31) east of the main fault trace (Y-170, p. 46). One northeast– to north–striking fault trace in south–central Stewart Valley may have experienced 0.7 m of left–lateral displacement and a minor amount of vertical displacement in middle and late Miocene rocks (Y-170, p. 57, his north section).

Age of displacement: The youngest displacement along CM is historical. Surface ruptures were associated with an earthquake (M 7.2) on December 20, 1932. The approximate epicentral location of this earthquake was in Gabbs Valley (Y-17, p. 2, 4).

On the basis of differences in style and amount of deformation, Y-170 (p. 47-48) subdivided CM (his Stewart–Monte Cristo fault zone) into three sections. These sections also show a difference in age of displacement. Along a 13–km–long northern section along the eastern side of the Gabbs Valley Range, the fault displaces and deforms Quaternary alluvium as well as middle to late Miocene volcanic rocks and lacustrine sediments, and it is expressed as prominent topographic lineaments (Y-170, p. 47-57; Y-1075). Displacement of middle(?) to late Pleistocene surfaces indicates that late Pleistocene displacement has occurred along this section (Y-170, p. 54, 100). However, late Holocene alluvium is not displaced and no surface ruptures associated with the 1932 earthquake have been identified along this section (Y-170, p. 54, 100). Along an 8–km–long central section between south–central Stewart Valley and northwestern Monte Cristo Valley, displacement is expressed as folds, faults, and tilting of Miocene sediments (Esmeralda Formation; Y-170, p. 58-59), but no Quaternary displacement has been recognized (Y-1075). Along a 24–km–long southern section between northwestern Monte Cristo Valley and the southern edge of Kibby Flat, CM is expressed as either north– to northwest–trending, west–facing, prominent scarps on surfaces of middle(?) to late Quaternary alluvial and lacustrine deposits (the northern 12 km) or as a northwest–trending vegetation lineament across Kibby Flat (the southern 12 km; Y-170, p. 61; Y-1075). The southern section is the primary location of the surface ruptures produced in 1932 (Y-170, p. 61-72).

Y-1075 (p. 384) noted that displacement along CM began after the middle to late Miocene and continues, as indicated by the 1932 earthquake.

Slip rate: The following preliminary, minimum lateral slip rates for CM in Monte Cristo Valley were estimated by Y-795 (p. 1-35): >0.03 mm/yr since 730 ka assuming >21 m of right–lateral displacement, 0.05 mm/yr since 135 ka assuming 7 m of right–lateral displacement, and 0.1 mm/yr since 10 ka assuming 1 m of right–lateral displacement.

Recurrence interval: Because Holocene deposits lack pre–1932 scarps and because pre–1932 scarps are subdued and generally lack "fresh" evidence for strike–slip displacement, Y-795 (p. 1-34) inferred that the recurrence interval for surface ruptures along CM is relatively long, "possibly tens of thousands of years." On the basis of stratigraphic and geomorphic relationships, Y-170 (p. 73-75) inferred that at least three, and probably five or six, pre–1932 surface ruptures occurred during the latest Pleistocene and Holocene along his southern section of CM, between northwestern Monte Cristo Valley and the southern edge of Kibby Flat.

Range-front characteristics: CM is located primarily in the middle of valleys and is not associated with range fronts (Y-1069, p. 386).

Cedar Mountain fault (CM) — Continued

Analysis: Aerial photographs (Y-170, p. 6, scales 1:80,000 and 1:16,000 for conventional and 1:18,000 for low–sun–angle; Y-795, p. 1-34). Field examination (Y-17; Y-170, p. 7; Y-794, p. 5). Topographic scarp profiles (Y-170, p. 77, 80). Soil development (Y-170, p. 39-44; Y-794, p. 4). Trenches (Y-13; Y-795, p. 1-34). Tephrochronology (Y-794, p. 4).

Relationship to other faults: CM is subparallel to and east of the Bettles Well fault and faults along the eastern side of the Pilot Mountains (Y-170, p. 46). CM is also subparallel to but west of the fault along the western side of the northern Cedar Mountains (Y-170, p. 46). Y-170 (p. 116) and Y-1075 suggested that right–lateral displacement along CM indicates that CM was part of a left–stepping, *en echelon* fault system that included five main right–lateral faults in the Gillis and Gabbs Valley ranges, which are west of CM.

Central Pintwater Range faults (CPR)

Plate or figure: Plate 1.

References: Y-404: Tschanz and Pampeyan, 1970 (pls. 2 and 3, show only the western fault); Y-813: Reheis, 1992 (pls. 2 and 3); Y-852: Dohrenwend and others, 1991 (show both faults, but only south of lat 37°N., which is the northern boundary of their map area). Not shown by Ekren and others, 1977 (Y-25).

Location: 79 km/77° (distance and direction of closest point from YM) at lat 36°59′N. and long 115°34 W. (location of closest point). CPR is composed of two main faults: one each along the eastern and western sides of an unnamed valley within the northern Pintwater Range.

USGS 7-1/2′ quadrangle: Quartz Peak, Southeastern Mine.

Fault orientation: The faults of CPR generally strike north to north–northwest, but they curve so that sections of the faults strike between northwest and north–northeast (Y-404; Y-813; Y-852).

Fault length: The length of the eastern fault of CPR is about 16 km as estimated from Y-813. The length of the western fault of CPR is about 4.5 km as estimated from Y-813.

Style of faulting: Sections of the eastern fault are shown by Y-813 as down to the west. These sections consist of curving, branching, and subparallel traces along the range front, within the range, and within the unnamed valley that is bounded by CPR (Y-813; Y-852).

Sections of the western fault are shown by Y-404 and Y-813 as down to the east. The western fault is generally expressed as a single surface trace along the range front; however, short subparallel traces at the northern end of the western fault extend into the unnamed valley (Y-813).

Scarp characteristics: No information.

Displacement: No information.

Age of displacement: Sections of the eastern fault along the range front and within the range are shown by Y-813 as faults that are in Tertiary rocks and that were identified from previous mapping (primarily), as weakly to moderately expressed lineaments and scarps on surfaces of Tertiary deposits, and as lineaments along linear range fronts. The sections of this fault that are within the unnamed valley are shown by Y-813 as weakly to moderately expressed lineaments and scarps on surfaces of Quaternary (mainly) and Tertiary deposits and as faults that are in Quaternary deposits and that were identified from previous mapping.

Sections of the western fault and the southern part of the eastern fault (south of lat 37°N.) are shown by Y-852 as juxtaposing Quaternary alluvium against bedrock. Sections of the western fault are also portrayed by Y-404 as post–Laramide structures; some are shown by them as faulted contacts between pre–Tertiary rocks and Pliocene(?) and Pleistocene(?) older gravels (their QTg deposits). Some fault traces are portrayed by Y-813 as faults that are in Quaternary (primarily) and Tertiary deposits and that were identified from previous mapping. The northern end of the western fault is portrayed by Y-813 as weakly expressed lineaments and scarps on surfaces of Tertiary deposits.

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: Y-852 portrayed sections of the western fault and the southern portion of the eastern fault (south of lat 37°N.) as having morphological characteristics similar to those of fronts along major range–front faults (e.g., a general absence of pediments, abrupt piedmont–hillslope transitions, steep bedrock slopes, faceted spurs, wineglass valleys, and subparallel systems of high–gradient, narrow, steep-sided canyons orthogonal to range front), except that "associated fault systems are significantly less extensive and fault scarps are substantially lower, shorter, and less continuous." Portions of the range front adjacent to sections of the western fault are shown to be linear by Y-813.

Central Pintwater Range faults (CPR) — Continued

Analysis: Aërial photographs (Y-404, p. 2, scales 1:60,000; Y-813, p. 4, scales 1:62,500 to 1:80,000; Y-852, scale 1:58,000). Field mapping (Y-404, p. 2)

Relationship to other faults: CPR is approximately parallel to faults along the eastern and western sides of the Pintwater Range: the East Pintwater Range fault (EPR) and the West Pintwater Range fault (WPR). The structural relationships among these faults are not known.

The northern end of CPR appears to terminate south of the northeast–striking North Desert Range fault (NDR), which is directly north of CPR along the northern end of the Pintwater Range.

Central Reveille fault (CR)

Plate or figure: Plate 1.

References: Y-813: Reheis, 1992 (pl. 1; shows only that part of CR south of lat 38°N., which is the northern boundary of her map area); Y-853: Dohrenwend and others, 1992 (show only that part of CR south of lat 38°N., which is the northern boundary of their map area); Y-1032: Schell, 1981 (pls. 7 and 8; name from his table A2, fault #109). Not shown by Cornwall, 1972 (Y-232, pl. 1).

Location: 108 km/12° (distance and direction of closest point from YM) at lat 37°48'N. and long 116°11'W. (location of closest point). CR is located in central Reveille Valley between the Reveille and Kawich ranges.

USGS 7-1/2' quadrangle: Georges Well, Kawich Peak NE, Reveille, Reveille Peak, Reveille Peak NW, Warm Springs SE.

Fault orientation: The southern part of CR strikes north–northwest (Y-853; Y-1032); the northern part strikes north to north–northeast (Y-853; Y-1032).

Fault length: The length of CR is 29 km as noted by Y-1032 (table A2, p. A20).

Style of faulting: Fault traces are generally shown by Y-813, Y-853, and Y-1032 as down to the west or southwest.

Scarp characteristics: Scarps are shown by Y-813, Y-853, and Y-1032 as primarily west facing. Some scarps are noted to be indistinct by Y-1032 (table 3, p. 23).

Displacement: No information.

Age of displacement: The probable age of the youngest displacement along CR is noted by Y-1032 (table A2, p. A20) as late to early Pleistocene (defined as >15 ka and <1.8 Ma by Y-1032, p. 29-30). The youngest unit displaced is his intermediate–age alluvial–fan deposits (A5i, table A2, p. A20) with an estimated age of 15 ka to probably about 200 ka (Y-1032, table 3, p. 23). Displacement is indicated by indistinct scarps on these alluvial fans (Y-1032, table 3, p. 23). The oldest unit not displaced is his young–age alluvial–fan deposits (A5y, table A2, p. A20) with an estimated age of ≤15 ka (Y-1032, table 3, p. 23). The oldest unit displaced is his latest Tertiary volcanic rocks (Tv_4, table A2, p. A20) with an estimated age of 1.8 Ma to 6 Ma (Y-1032, table A1, p. A1).

The map by Y-853 shows one scarp on a Quaternary depositional or erosional surface at the southern end of Reveille Valley, but Y-853 did not estimate a more precise age for this displacement. Their map also shows several scarps and (or) prominent topographic lineaments on the surfaces of Tertiary volcanic or sedimentary rocks just south of lat 38°N.

The map by Y-813 includes two scarps in central Reveille Valley south of lat 38°N. One is portrayed as a lineament or scarp on surfaces of Tertiary deposits; the other is portrayed as a topographic lineament within bedrock.

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No range front is associated with CR.

Analysis: Aerial photographs (Y-813, p. 4, scales 1:62,500 to 1:80,000; Y-853, scales 1:115,000 to 1:124,000 and 1:58,000; Y-1032, p. 15, scales ~1:25,000 and ~1:60,000). Field reconnaissance (Y-1032, p. 17-18). Gravity analysis (Y-1032, p. 16). Magnetometer surveys (Y-1032, p. 16-17).

Relationship to other faults: The relationship of CR either to the East Reveille fault (ERV), which bounds the eastern side of Reveille Valley at its junction with the Reveille Range, or to the Hot Creek–Reveille fault (HCR), which bounds the western side of Reveille Valley at its junction with the Kawich Range, is not known. Y-1032 (pl. 7) suggested that CR may merge with ERV north of lat 38°N. (north of the area shown in pl. 1 of this compilation).

Central Spring Mountains faults (CSM)

Plate or figure: Plate 2.

References: Y-696: Hoffard, 1991 (pl. 1, shows only the fault on the southeastern side of the Wheeler Wash drainage); Y-813: Reheis, 1992 (pl. 3); Y-852: Dohrenwend and others, 1991.

Location: 76 km/130° (distance and direction of closest point from YM) at lat 36°23′N. and long 115°48′W. (location of closest point). Faults in CSM are located within the Spring Mountains south of Wheeler Pass in the area of Wheeler Wash. CSM includes three faults: (1) one on the northwestern side of Wheeler Wash, (2) one on the northeastern side of the Wheeler Wash drainage, and (3) one on the southeastern side of the Wheeler Wash drainage.

USGS 7-1/2′ quadrangle: Horse Spring, Wheeler Well, Willow Peak.

Fault orientation: Fault orientations are variable (Y-813; Y-852). The northwest fault generally strikes north–northeast (Y-813). The northeast fault generally strikes north–northwest (Y-813; Y-852). The southeast fault generally strikes north, except at its northern end where the fault turns eastward and parallels Clark Canyon, a tributary to Wheeler Wash (Y-813; Y-852).

Fault length: The length of the northwest fault is 16 km (Y-813). The length of the northeast fault is 6 km (Y-852) to 9 km (Y-813). The length of the southeast fault is 5 km (Y-852) to 12 km (Y-813).

Style of faulting: Traces of the northwest fault are shown by Y-813 as generally down to the northwest. Traces of the northeast and southeast faults are portrayed by Y-813 and Y-852 as generally down to the west.

Scarp characteristics: No information.

Displacement: No information.

Age of displacement: The northwest fault is shown by Y-813 primarily as a topographic lineament along a linear range front or in bedrock. The northeastern end of this fault is portrayed by her as weakly expressed lineaments or scarps on surfaces of Quaternary deposits.

The northeast fault is shown by Y-813 as weakly expressed lineaments or scarps on surfaces of Quaternary deposits and as topographic lineaments along a linear front or in bedrock. Y-852 showed this fault as juxtaposing Quaternary alluvium against bedrock.

The southeast fault is portrayed by Y-813 as weakly expressed lineaments or scarps on surfaces of Quaternary deposits and as topographic lineaments along a linear front or in bedrock. Y-852 showed this fault as scarps on depositional or erosional surfaces of early to middle and (or) late Pleistocene age (their $Q_{1\text{-}2}$ surfaces with estimated ages between 10 ka and 1.5 Ma). Y-696 (pl. 1) showed part of the southeast fault as a prominent fault or lineament.

Y-813 (p. 8) noted that the Spring Mountains "contain a few possible Quaternary faults and lineaments, generally north–trending, but they appear to be relatively inactive."

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: The range front along the northeast fault and part of the range front along the southeast fault are noted by Y-852 to be similar to that along major range–front faults (e.g., characterized by "a general absence of pediments, abrupt piedmont–hillslope transitions, steep bedrock slopes, faceted spurs, wineglass valleys, and subparallel systems of high–gradient, narrow, steep–sided canyons orthogonal to range front"), except that the faults of CSM are "significantly less extensive and fault scarps are substantially lower, shorter, and less continuous."

Analysis: Aerial photographs (Y-696, p. 8-9, scale 1:80,000; Y-813, scales 1:62,500 to 1:80,000; Y-852, scale 1:58,000).

Central Spring Mountains faults (CSM) — Continued

Relationship to other faults: The relationships among the three faults combined here in CSM are not known. The northwest fault aligns with a northeast–striking portion of the West Spring Mountains fault (WSM) east of Pahrump, but the relationship of faults in CSM to WSM is not known. Y-813 (pl. 3) labeled the southwestern portion of the northwest fault of CSM as the Wheeler Pass thrust.

Chalk Mountain fault (CLK)

Plate or figure: Plate 1.

References: Y-813: Reheis, 1992 (pl. 1). Not shown by Cornwall, 1972 (Y-232).

Location: 87 km/31° (distance and direction of closest point from YM) at lat 37°32′N. and long 115°57′W. (location of closest point). CLK extends along the western side of Chalk Mountain and into southern Sand Spring Valley. It is north of the drainage divide separating Emigrant Valley from Monotony and Sand Spring valleys.

USGS 7-1/2′ quadrangle: White Blotch Springs.

Fault orientation: The southern end of CLK strikes generally north–northeast; the northern end strikes northeast (Y-813).

Fault length: The length of CLK as defined here is 8 km as estimated from Y-813. CLK could also include north–striking fault traces along the western side of northern Emigrant Valley. (These are shown as possibly part of the Emigrant Valley North fault (EVN?) on plate 1 of this compilation.) If these faults are included in CLK, then the length of the fault could be as much as about 20 km (estimated from Y-813).

Style of faulting: No information.

Scarp characteristics: CLK is shown by Y-813 as west– or northwest–facing scarps.

Displacement: No information.

Age of displacement: CLK is shown by Y-813 as weakly to moderately expressed lineaments and scarps on surfaces of Quaternary deposits, as lineaments along linear range fronts or in bedrock, and (rarely) as weakly to moderately expressed lineaments and scarps on surfaces of Tertiary deposits.

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No information.

Analysis: Aerial photographs (Y-813, p. 4, scales 1:62,500 and 1:80,000).

Relationship to other faults: North–striking fault traces along the western side of northern Emigrant Valley (shown as possibly part of the Emigrant Valley North fault, labeled EVN? on plate 1 of this compilation) could be part of CLK instead or they could connect EVN and CLK. Although CLK is relatively short, the northern part has a more easterly strike than the southern part, a pattern similar to that of the Stumble fault (STM) located east of CLK along the western side of the Groom Range. This change in strike could be the result of influence by one or both faults along the southern edge of Sand Spring Valley: the northeast–striking Penoyer fault (PEN) and the east–striking Timpahute lineament (expressed as the east–northeast–striking Tem Piute fault; TEM). The structural relationships among these faults are not known.

Checkpoint Pass fault (CP)

Plate or figure: Plate 2.

References: Y-62: Barnes and others, 1982; Y-813: Reheis, 1992 (pl. 3); Y-852: Dohrenwend and others, 1991 (show only the north–northeast–striking portion of the western half of CP as portrayed by Y-813).

Location: 44 km/113° (distance and direction of closest point from YM) at lat 36°40'N. and long 116°00'W. (location of closest point). CP is located along the northern side of unnamed bedrock hills between a narrow gap at Checkpoint Pass and northeast of Mercury, Nevada.

USGS 7-1/2' quadrangle: Mercury.

Fault orientation: CP is curved, with one orientation for the eastern half and another for the western half of the fault. The eastern half of CP, shown as a single fault trace, has a curving but a general east strike (Y-813). The western half of CP actually consists of two traces as shown by Y-813 (pl. 3). Of these two traces, the northern trace strikes northeast and the southern trace strikes north–northeast.

Fault length: The eastern half of CP is about 3.5 km long (Y-813). The northern trace of the western half of CP is about 3 km long (Y-813). The southern trace of the western half is 3 to 4 km long (Y-813; Y-852).

Style of faulting: Displacement on CP is shown by Y-813 as left–lateral for the eastern half of CP. Displacement on the northern trace of the western half is portrayed by her as down to the southeast. Displacement on the southern trace of the western half is shown by Y-813 as down to the northwest.

Scarp characteristics: No information.

Displacement: No information.

Age of displacement: Y-852 portrayed the north–northeast–striking portion of the western half of CP (the southern trace) as a fault that juxtaposes Quaternary alluvium against bedrock (*see* Range–front characteristics).

The eastern half of CP and part of the northern trace of the western half are shown by Y-813 (pl. 3) as faults that are preserved in Tertiary deposits and that were recognized by previous mapping. The southern trace of the western half in the vicinity of Checkpoint Pass is shown by Y-62 as concealed by alluvial deposits of Quaternary and Tertiary age.

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: The southern trace of the western half of CP is portrayed by Y-852 as a fault juxtaposing Quaternary alluvium against bedrock, but not as a major range–front fault. The morphology of the northwestern side of the unnamed ridge adjacent to this part of CP would be similar to that along a major range–front fault and may be characterized by "fault juxtaposition of Quaternary alluvium against bedrock, fault scarps and lineaments on surficial deposits along or immediately adjacent to range front, a general absence of pediments, abrupt piedmont–hillslope transitions, steep bedrock slopes, faceted spurs, wineglass valley, and subparallel systems of high–gradient, narrow, steep–sided canyons orthogonal to range front." Although this morphology is similar to that of major range–front faults, the "associated fault systems are significantly less extensive and fault scarps are substantially lower, shorter, and less continuous" (Y-852). Part of the northern trace and the southern trace of the western half of CP are shown by Y-813 (pl. 3) as topographic lineaments bounding a linear range front or in bedrock.

Analysis: Aerial photographs (Y-813, p. 4, scales 1:62,500 to 1:80,000; Y-852, scale 1:58,000).

Checkpoint Pass fault (CP) — Continued

Relationship to other faults: The eastern half of CP has a strike similar to that of the Rock Valley fault (RV), which is located about 6 km north of CP. The strike of this part of CP is more easterly than the strikes of the northeast–striking Mercury Ridge faults (MER) and the Crossgrain Valley faults (CGV), both of which are 3 to 6 km east and southeast of CP.

The southern trace of the western half of CP is oblique to both MER and CGV. The strike of this portion of CP is similar to the trend of a west–facing fault scarp shown by Y-852 at the southwestern end of South Ridge. This scarp is included in the South Ridge faults (SOU) of this compilation.

Chert Ridge faults (CHR)

Plate or figure: Plate 1.

References: Y-404: Tschanz and Pampeyan, 1970 (show only a few faults along Chert Ridge); Y-813: Reheis, 1992 (pls. 2 and 3); Y-852: Dohrenwend and others, 1991 (show only the southern end of one fault that is south of lat 37°N., which is the northern boundary of their map area). Not shown by Ekren and others, 1977 (Y-25).

Location: 65 km/74° (distance and direction of closest point from YM) at lat 37°00′N. and long 115°44′W. (location of closest point). CHR is composed of numerous faults along the eastern and western sides of Chert Ridge.

USGS 7-1/2′ quadrangle: Fallout Hills, Fallout Hills NW.

Fault orientation: Faults in CHR generally strike north, but individual faults curve so that their strikes range between north–northwest and northeast (Y-813).

Fault length: The length of the curving and branching faults located primarily along the range front along the eastern side of Chert Ridge is about 14 km as estimated from Y-813. The length of the curving, branching, and subparallel faults along the western side of Chert Ridge is about 12 km as estimated from Y-813. The faults along the western side of Chert Ridge form a zone up to 2.5 km wide as estimated from Y-813.

Style of faulting: The faults along the eastern side of Chert Ridge are shown as down to the east (Y-813). One branch east of the range front, along with the southern part of the fault along the range front, is shown as down to the west (Y-813). Short (0.5 to 1.2 km long) faults at the southern end of the western side of Chert Ridge are shown to have right–lateral strike–slip displacement (Y-813).

Scarp characteristics: No information.

Displacement: No information.

Age of displacement: Faults on the eastern side of Chert Ridge are portrayed by Y-813 as faults that are in Tertiary deposits and that were identified from previous mapping (primarily), as weakly to moderately expressed lineaments and scarps on surfaces of Tertiary deposits, as weakly expressed lineaments and scarps on surfaces of Quaternary deposits, and as lineaments along a linear range front. Some faults on this side of the ridge are shown by Y-404 as juxtaposing pre–Tertiary rocks and Pleistocene(?) older alluvium (their Qol deposits). The very southern 2 km (south of lat 37°N.) of CHR are portrayed by Y-852 as faults that also juxtapose Quaternary alluvium against bedrock.

Faults on the western side of Chert Ridge are portrayed by Y-813 as weakly to moderately expressed lineaments and scarps on surfaces of Quaternary deposits (primarily), as lineaments along a linear range front, and as faults that are in Quaternary and Tertiary deposits and that were identified from previous mapping.

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: Some faults along both the eastern and western sides of Chert Ridge are shown by Y-813 as lineaments that bound a linear front. According to Y-852, the eastern side of Chert Ridge adjacent to the very southern 2 km of CHR has morphologic characteristics similar to those of fronts along a major range–front fault (e.g., a general absence of pediments, abrupt piedmont–hillslope transitions, steep bedrock slopes, faceted spurs, wineglass valleys, and subparallel systems of high–gradient, narrow, steep–sided canyons orthogonal to range front), except that "associated fault systems are significantly less extensive and fault scarps are substantially lower, shorter, and less continuous."

Analysis: Aerial photographs (Y-404, p. 2, scale 1:60,000; Y-813, p. 4, scales 1:62,500 to 1:80,000; Y-852, scale 1:58,000). Field mapping (Y-404, p. 2).

Chert Ridge faults (CHR) — Continued

Relationship to other faults: Faults in CHR on the eastern side of Chert Ridge approximately align with a fault located along the western side of the Spotted Range south of the Fallout Hills. This fault is not included in CHR but is instead combined with the Spotted Range faults (SPR), because faults in CHR are generally down to the east, whereas faults in SPR are generally down to the west.

Y-813 showed northeast–striking, down–to–the–southeast faults at the northern end of Chert Ridge as faults that are in Quaternary deposits and that were identified from previous mapping. The structural relationship between these faults and faults included in CHR is not known. It is also unknown how either of these faults relate to north–northeast–striking faults to the northwest in Emigrant Valley (the Emigrant Valley South fault (EVS) of this compilation).

Chicago Valley fault (CHV)

Plate or figure: Plate 2.

References: Y-69: McKittrick, 1988; Y-161: Burchfiel and others, 1983; Y-238: Reheis and Noller, 1991 (pl. 4); Y-657: Dohrenwend and others, 1984; Y-778: Huddleston, 1986; Y-783: Butler, 1986.

Location: 90 km/163° (distance and direction of closest point from YM) at lat 36°05′N. and long 116°09′W. (location of closest point). CHV is located along the eastern side of Chicago Valley at its junction with the western side of the Nopah Range.

USGS 7-1/2′ quadrangle: Nopah Peak, North of Tecopa Pass, Resting Spring, Twelve Mile Spring.

Fault orientation: CHV strikes generally north to north–northwest. Individual fault traces strike between northwest and northeast (Y-69; Y-238).

Fault length: Discontinuous, subparallel, and *en echelon* fault traces included in CHV are mapped by Y-69 along the eastern side of Chicago Valley over a total length of about 20 km. The lengths of individual traces range between 0.2 and 0.8 km as estimated from Y-69.

One 0.6–km–long zone of subparallel fault traces is shown by Y-69 on the western side of Chicago Valley. Two fault traces are portrayed by Y-238 (pl. 4) near the center of Chicago Valley. The one that is located about 2.5 km west of the Nopah Range at Twelvemile Spring is 2.5 km long. The other, which is located about 5 km west of the range, is about 4 km long.

Style of faulting: Displacement on CHV is shown by Y-238 to be dip slip (normal) and down to the west. Y-161 (p. 1373) suggested that rocks in the Nopah Range have been tilted eastward by CHV and noted that the range front consists of several arcuate segments, each of which is concave westward. They accepted a model of a curved or listric fault that merges with a low–angle detachment fault at depth to explain the arcuate shape of the range front.

Scarp characteristics: No information.

Displacement: No information.

Age of displacement: Fault traces in CHV are shown by Y-69 on surfaces of late and (or) middle Pleistocene age (her Qf2 deposits with an estimated age between 10 ka and 300 ka to 500 ka) and on surfaces of middle and (or) early Pleistocene age (her Qf1 deposits with a minimum age of 300 ka to 500 ka). Faults are not shown by Y-69 on surfaces of either early Holocene and (or) latest Pleistocene age (her Qf3 deposits) or Holocene age (her Qf4 deposits). Fault traces along the western side of Chicago Valley are shown by Y-69 on late and (or) middle Pleistocene surfaces (her Qf2 deposits) and at the contact between a pediment on bedrock and middle and (or) early Pleistocene surfaces (her Qf1 deposits). Fault traces are absent from Holocene surfaces (her Qf4 deposits) along the western side of Chicago Valley (Y-69).

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: Part of CHV is portrayed by Y-238 (pl. 4) as a topographic lineament along a linear range front.

Analysis: Aerial photographs (Y-69; Y-238, p. 2, scales 1:24,000 to 1:80,000). Field examination (Y-69). Transects measured on alluvial fans (Y-69).

Relationship to other faults: The relationship of CHV to either the north–northwest–striking East Nopah fault (EN), which bounds the eastern side of the Nopah Range, or to the Ash Meadows fault (AM), which bounds the western side of the Resting Spring Range to the west of CHV, is not known.

Clayton–Montezuma Valley fault (CLMV)

Plate or figure: Plate 1.

References: Y-10: Reheis and Noller, 1989; Y-238: Reheis and Noller, 1991 (pl. 1); Y-407: Albers and Stewart, 1972; Y-853: Dohrenwend and others, 1992.

Location: 126 km/314° (distance and direction of closest point from YM) at lat 37°38'N. and long 117°27'W. (location of closest point). CLMV is located in an unnamed valley between Clayton Ridge and the Montezuma Range.

USGS 7-1/2' quadrangle: Lida Wash, Montezuma Peak SW, Split Mountain.

Fault orientation: CLMV strikes generally northeast, but the fault curves so that individual sections strike between north–northwest and northeast (Y-238; Y-853).

Fault length: The length of CLMV is 13 km as estimated from Y-853 and 14 km as estimated from Y-238. The width of CLMV is 1 to 4 km as estimated from Y-238.

Extension of CLMV to the north or south of the unnamed valley between Clayton Ridge and the Montezuma Range is unclear. As portrayed in this compilation, CLMV does not continue across the drainage divide at the northeastern end of the unnamed valley. However, CLMV may extend to the north or east and may include north– and east–trending lineaments south of and along Alkali Lake. The north–trending lineaments in this area are included instead with the General Thomas Hills fault (GTH; pl. 1 of this compilation). The east–trending lineaments in this area are not combined with either CLMV or GTH. CLMV may also extend to the south and include some fault traces between the Clayton Ridge–Paymaster Ridge fault (CRPR) and the Montezuma Range fault (MR). These traces have not been combined with any of the labeled faults in this compilation.

Style of faulting: No information.

Scarp characteristics: Scarps along CLMV are shown by Y-238 and Y-853 as northwest facing primarily. Some are portrayed as southeast facing.

Displacement: No information.

Age of displacement: CLMV is shown by Y-853 as scarps on depositional and erosional surfaces with ages of early to middle and (or) late Pleistocene (their Q_{1-2} surfaces with estimated ages between 10 ka and 1.5 Ma) and early to middle Pleistocene (their Q_1 surfaces with estimated ages between 130 ka and 1.5 Ma). The northeastern end of CLMV is portrayed by Y-238 as weakly to moderately expressed lineaments and scarps chiefly on surfaces of Quaternary deposits; similar features on the southwestern end are shown by Y-238 as chiefly on surfaces of Tertiary deposits. Short sections of CLMV are shown by Y-238 as faults that are in Quaternary deposits and that were identified from previous mapping.

The map by Y-407 (pl. 1) shows faults with various, but primarily northeast, strikes in the valley between Clayton Ridge and Montezuma Ridge. These faults are portrayed in Tertiary volcanic rocks (their Taf unit). Some of these faults may correlate with the lineaments and scarps identified by Y-238 (pl. 1, p. 3).

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No range front is associated with CLMV.

Analysis: Aerial photographs (Y-238, p. 2, scales 1:24,000 to 1:80,000; Y-853, scales 1:115,000 to 1:124,000 and 1:58,000). Field observations for some faults in CLMV (Y-238, p. 3).

Clayton–Montezuma Valley fault (CLMV) — Continued

Relationship to other faults: CLMV is approximately parallel to other northeast–striking major range–bounding faults west of Cactus Flat, such as the Emigrant Peak faults (EPK) along the western side of the Silver Peak Range northwest of CLMV, the Montezuma Range fault (MR) along the western side of the Montezuma Range immediately east of CLMV, the Clayton Ridge–Paymaster Ridge fault (CRPR) along the western sides of Clayton and Paymaster ridges immediately west of CLMV, and south of CLMV, the East Magruder Mountain fault (EMM) along the eastern side of Magruder Mountain and the Lida Valley faults (LV) along the southeastern side of the Palmetto Mountains. CLMV is also approximately parallel to northeast–striking faults within basins, such as the Clayton Valley fault (CV) in Clayton Valley west of CLMV, the Stonewall Flat faults (SWF) within Stonewall Flat east of CLMV, and the Palmetto Mountains–Jackson Wash faults (PMJW) within an unnamed valley northeast of the Palmetto Mountains and southeast of CLMV (Y-238; Y-853). The structural relationships among all these faults are not known.

Y-238 (p. 4) speculated that the northeast–striking faults in the area around CLMV could be conjugate shears to the northwest–striking Furnace Creek fault (FC). However, on the basis of the limited field work completed by them and others, Y-238 (p. 3) noted that the evidence for the left–lateral displacement that would be expected if the northeast–striking faults are conjugate shears has not been documented. Alternatively, Y-238 (p. 3) suggested that these faults could be an expression of dip–slip displacement perpendicular to a northwest direction of least principal stress. On the basis of the fairly consistent down–to–the–northwest displacement along the northeast–striking, range–bounding and intrabasin faults east of the FC and west of Pahute Mesa, Y-10 (p. 60) inferred these faults could be rooted in a detachment fault at depth.

Clayton Ridge–Paymaster Ridge fault (CRPR)

Plate or figure: Plate 1.

References: Y-10: Reheis and Noller, 1989 (their Clayton Ridge and Paymaster Ridge faults); Y-238: Reheis and Noller, 1991 (pl. 1); Y-407: Albers and Stewart, 1972 (pl. 1; show only one fault about 16 km long along the western side of Clayton Ridge); Y-853: Dohrenwend and others, 1992; Y-1032: Schell, 1981 (pl. 8; shows only the northern 15 km of CRPR, which is his Paymaster Canyon fault (or fault #12); the western boundary of his map area is east of long 117°30′W.)

Location: 126 km/310° (distance and direction of closest point from YM) at lat 37°34′N. and long 117°31′W. (location of closest point). The southern end of CRPR is located along the western side of Clayton Ridge at its junction with Clayton Valley. The northern end of CRPR is located along the western side of Paymaster Ridge adjacent to Paymaster Canyon. These faults are combined because Paymaster Ridge and Clayton Ridge are nearly continuous topographically. In addition, the two ridges are continuous in their stratigraphic and structural characteristics as noted by Y-407 (p. 50).

USGS 7-1/2′ quadrangle: Alcatraz Island, Lida Wash, Montezuma Peak SE, Paymaster Canyon, Paymaster Ridge, Split Mountain.

Fault orientation: CRPR strikes generally north–northeast, but the fault curves so that short sections strike between northwest and northeast (Y-238; Y-853).

Fault length: The length of CRPR is 51 km as estimated from Y-853 and 53 km as estimated from Y-238. These lengths may be minimum values, because CRPR extends to the edges of both of these map areas at lat 38°N.

Style of faulting: Y-10 (p. 57-58) reported that some traces of CRPR have dip–slip (normal) displacement and steep (70° to 90°) northwest dips. On the basis of exposures at one locality on the northeastern end of Clayton Ridge, Y-10 (p. 58) concluded that observed crenulations and slickensides within bedrock shear zones suggest left–lateral oblique displacement.

Scarp characteristics: CRPR is shown by Y-238 (pl. 1) as primarily west–facing scarps.

Displacement: No information.

Age of displacement: CRPR is portrayed by Y-238 as moderately expressed to prominent lineaments and scarps on surfaces of chiefly Quaternary deposits; a few lineaments and scarps are shown on surfaces of Tertiary deposits. Some traces of CRPR are shown by Y-238 as faults that are in Quaternary deposits and that were identified from previous mapping.

For the portion of CRPR that he shows, Y-1032 (table A2, p. A3) noted that the age of the youngest displacement is probably middle to early Pleistocene (defined as >200 ka and <1.8 Ma by Y-1032, p. 30). The youngest (and also the oldest) unit displaced along this portion of CRPR is his old–age alluvial–fan deposits (Y-1032, table A2, p. A3) with an estimated age of 700 ka to 1.8 Ma (Y-1032, table 3, p. 23). The oldest unit not displaced along this section is his intermediate–age alluvial–fan deposits (Y-1032, table A2, p. A3) with an estimated age of 15 ka to probably about 200 ka (Y-1032, table 3, p. 23).

Y-853 portrayed CRPR as one of the major range–front faults in the area; they interpreted these faults as displaying evidence for Quaternary activity. Late Quaternary displacement on CRPR is interpreted by Y-10 (p. 58) from stratigraphic relationships along both Clayton and Paymaster ridges. Upper Pleistocene and Holocene alluvial–fan deposits are reported to abut the fronts of these ridges and appear to bury older alluvial–fan deposits (Y-10, p. 58). Recurrent Quaternary displacements are inferred by Y-10 (p. 58) from layers of sheared alluvium or colluvium that overlie sheared bedrock. On the basis of variations in particle size of, extent of shearing in, and degree of cementation of the alluvial or colluvial layers, Y-10 (p. 58) concluded that the layers become younger and less disturbed by faulting away from the bedrock. These relationships suggested to them that several episodes of displacement have occurred rather than a single episode.

Clayton Ridge–Paymaster Ridge fault (CRPR) — Continued

Y-407 (p. 49) inferred that "Clayton Ridge is separated from Clayton Valley by a high–angle fault, which is mapped in places, having movement that both pre–dates and post–dates the Tertiary volcanic and sedimentary rocks in the central part of the ridge."

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: CRPR is portrayed by Y-853 as a major range–bounding fault that borders a tectonically active range front that is characterized by "fault juxtaposition of Quaternary alluvium against bedrock, fault scarps and lineaments on surficial deposits along or immediately adjacent to range front, a general absence of pediments, abrupt piedmont–hillslope transitions, steep bedrock slopes, faceted spurs, wineglass valleys, and subparallel systems of high–gradient, narrow, steep–sided canyons orthogonal to range front."

Analysis: Aerial photographs (Y-238, p. 2, scales 1:24,000 to 1:80,000; Y-853, scales 1:115,000 to 1:124,000 and 1:58,000; Y-1032, p. 15, scales ~1:25,000 and ~1:60,000). Field reconnaissance (Y-1032, p. 17-18). Field observations at two localities (Y-238, p. 3). Gravity analysis (Y-1032, p. 16). Magnetometer surveys (Y-1032, p. 16-17).

Relationship to other faults: CRPR is approximately parallel to other northeast–striking, major range–bounding faults in the area, such as the Emigrant Peak faults (EPK) along the western side of the Silver Peak Range northwest of CRPR, the Montezuma Range fault (MR) along the western side of the Montezuma Range east of CRPR, the Clayton–Montezuma Valley fault (CLMV) in an unnamed valley between Clayton and Montezuma ridges immediately east of CRPR, and south of CRPR, the East Magruder Mountain fault (EMM) along the eastern side of Magruder Mountain and the Lida Valley faults (LV) along the southeastern side of the Palmetto Mountains. The eastern end of the northwest–striking Weepah Hills fault (WH), which is along the southern side of the Weepah Hills, nearly intersects CRPR at the northern end of Clayton Valley. The structural relationships among all these faults are unknown.

Y-238 (p. 4) speculated that the northeast–striking faults in the area around CRPR could be conjugate shears to the northwest–striking Furnace Creek fault (FC). However, on the basis of the limited field work completed by them and others, Y-238 (p. 3) noted that the evidence for the left–lateral displacement that would be expected if the northeast–striking faults are conjugate shears has not been documented. Alternatively, Y-238 (p. 3) suggested that these faults could be an expression of dip–slip displacement perpendicular to a northwest direction of least principal stress. On the basis of the fairly consistent down–to–the–northwest displacement along the northeast–striking, range–bounding and intrabasin faults east of FC and west of Pahute Mesa, Y-10 (p. 60) inferred that these faults could be rooted in a detachment fault at depth.

Clayton Valley fault (CV)

Plate or figure: Plate 1.

References: Y-10: Reheis and Noller, 1989; Y-238: Reheis and Noller, 1991 (pl. 1); Y-407: Albers and Stewart, 1972 (pl. 1); Y-853: Dohrenwend and others, 1992.

Location: 132 km/310° (distance and direction of closest point from YM) at lat 37°36′N. and long 117°35′W. (location of closest point). CV is located primarily along the eastern side of Clayton Valley. It also includes fault traces in central and western Clayton Valley.

USGS 7-1/2′ quadrangle: Alcatraz Island, Goat Island, Lida Wash, Lida Wash NW, Lida Wash SW, Oasis Divide.

Fault orientation: CV strikes generally northeast, but the fault curves so that short sections strike between northwest and east–northeast (Y-238; Y-853). Fault traces in central and western Clayton Valley strike northeast or north–northeast (Y-238).

Fault length: The length of the part of CV along the eastern side of Clayton Valley is 26 km as estimated from Y-853 and 27 km as estimated from Y-238. Fault traces in both central and western Clayton Valley are about 3.5 km long (estimated from Y-238 and Y-853).

Style of faulting: No information.

Scarp characteristics: Most scarps along the part of CV along the eastern side of Clayton Valley are shown by Y-238 and Y-853 as northwest–facing. Scarps in central and western Clayton Valley are portrayed by Y-238 as both down to the northwest and down to the southeast.

Displacement: No information.

Age of displacement: Y-10 (p. 58) noted that fault scarps in Clayton Valley appear to cross surfaces of several ages. The part of CV along the eastern side of Clayton Valley is portrayed by Y-853 as scarps on depositional or erosional surfaces of early to middle and (or) late Pleistocene age (their Q_{1-2} surfaces with estimated ages between 10 ka and 1.5 Ma) and, at one locality, early to middle Pleistocene age (their Q_1 surfaces with estimated ages between 130 ka and 1.5 Ma). Most of CV is shown by Y-238 (pl. 2) as fault traces that are in Quaternary deposits and that were identified by previous mapping and, in places, as prominent scarps (primarily) on surfaces of Quaternary deposits. They also portrayed the northeastern end of CV as a lineament around Angel Island.

Y-407 portrayed fault traces in central and western Clayton Valley as a fault in Pliocene/Miocene sedimentary rocks (e.g., shale, siltstone, sandstone, tuff) and as faulted contacts between Cambrian/Ordovician rocks and Holocene alluvium, colluvium, and playa deposits (their Qal deposits). The map by Y-407 shows this part of CV as concealed by Holocene alluvium, colluvium, and playa deposits (their Qal deposits). Fault traces in this part of CV are shown by Y-238 as weakly expressed on surfaces of Quaternary deposits or as prominent on surfaces of Tertiary deposits (the ones on surfaces of Tertiary deposits are not shown on pl. 1 of this compilation).

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No range front is associated with CV.

Analysis: Aerial photographs (Y-238, p. 2, scales 1:24,000 to 1:80,000; Y-853, scales 1:115,000 to 1:124,000 and 1:58,000). Compilation by Y-407 of unpublished mapping by Moiola (1962) and by Albers, Stewart, and McKee (1960-62).

Clayton Valley fault (CV) — Continued

Relationship to other faults: CV is one of several northeast–striking faults within basins in the area, such as the Clayton–Montezuma Valley fault (CLMV) in the valley between Clayton Ridge and Montezuma Range east of CV. All of these have evidence for Pleistocene displacement (Y-238; Y-853). CV differs from these other faults in that the scarps in Clayton Valley "are relatively long and appear to offset surfaces of several ages" (Y-10, p. 58). CV is also approximately parallel to northeast–striking, major range–bounding faults west of Cactus Flat, such as the Emigrant Peak faults (EPK) along the western side of the Silver Peak Range northwest of CV, the Montezuma Range fault (MR) along the western side of the Montezuma Range east of CV, the Clayton Ridge–Paymaster Ridge fault (CRPR) along the western sides of Clayton and Paymaster ridges immediately east of CV, and southeast of CV, the Palmetto Mountains–Jackson Wash faults (PMJW) in the valley northeast of Palmetto Mountains, the East Magruder Mountain fault (EMM) along the eastern side of Magruder Mountain, and the Lida Valley faults (LV) along the eastern side of the Palmetto Mountains and the western side of Magruder Mountain (Y-238; Y-853).

Y-238 (p. 3) speculated that the northeast–striking faults in the area around CV could be conjugate shears to the northwest–striking Furnace Creek fault (FC). However, on the basis of the limited field work completed by them and others, Y-238 (p. 3) noted that the evidence for the left–lateral displacement that would be expected if the northeast–striking faults are conjugate shears has not been documented. Alternatively, Y-238 (p. 3) suggested that these faults could be an expression of dip–slip displacement perpendicular to a northwest direction of least principal stress. On the basis of the fairly consistent down–to–the–northwest displacement along the northeast–striking, range–bounding and intrabasin faults east of the FC and west of Pahute Mesa, Y-10 (p. 60) inferred that these faults could be rooted in a detachment fault at depth.

Cockeyed Ridge–Papoose Lake fault (CRPL)

Plate or figure: Plate 1.

References: Y-232: Cornwall, 1972 (pl. 1); Y-813: Reheis, 1992 (pl. 2).

Location: 53 km/63° (distance and direction of closest point from YM) at lat 37°03'N. and long 115°55'W. (location of closest point). CRPL is located along the northeastern side of Cockeyed Ridge and along the eastern sides of unnamed ridges west of Papoose Lake.

USGS 7-1/2' quadrangle: Jangle Ridge, Paiute Ridge, Papoose Lake.

Fault orientation: CRPL strikes generally north–northwest (Y-232; Y-813).

Fault length: The total length of CRPL is about 21 km as estimated from Y-813, which includes a 5–km–long gap in the surficial expression of the fault south of Cockeyed Ridge.

Style of faulting: The southern half of CRPL north of the gap in surficial expression is shown by Y-813 as down to the east. The northern half of this part of CRPL is portrayed by Y-813 as down to the west. The direction of displacement for the part of CRPL south of the gap is shown by Y-813 as down to the east.

Scarp characteristics: No information.

Displacement: No information.

Age of displacement: Most of CRPL is shown by Y-813 as faults that are in Quaternary deposits and that were identified from previous mapping (primarily) and as weakly expressed lineaments or scarps on surfaces of Quaternary deposits. Y-232 portrayed a short portion of one north–northwest–striking fault trace at the southern end of CRPL as a faulted contact between Quaternary alluvium (his Qal deposits) and Pliocene and Miocene tuff (his Tp unit). Y-813 portrayed a short section (about 1.5 km long) of CRPL along the eastern side of Cockeyed Ridge as a fault that is in Tertiary deposits and that was identified from previous mapping.

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No information.

Analysis: Aerial photographs (Y-813, p. 4, scales 1:62,500 to 1:80,000).

Relationship to other faults: The structural relationship of CRPL to other faults in the area is not known. The northern end of CRPL abuts at an oblique angle the southern end of the northeast–striking Emigrant Valley North fault (EVN; Y-813). CRPL is approximately parallel to fault traces along the western side of the Halfpint Range. These are shown as the Plutonium Valley–North Halfpint Range fault (PVNH) in this compilation (pl. 1).

Along the western side of the Papoose Range east of Papoose Lake, two west–facing scarps that are shown by Y-813 to trend slightly more eastward than CRPL are not included in CRPL (pl. 1).

Crossgrain Valley faults (CGV)

Plate or figure: Plate 2.

References: Y-62: Barnes and others, 1982; Y-813: Reheis, 1992 (pl. 3); Y-852: Dohrenwend and others, 1991.

Location: 48 km/114° (distance and direction of closest point from YM) at lat 36°40′N. and long 115°58′W. (location of closest point). CGV includes several faults within Crossgrain Valley and along the southern side of the valley at its junction with North Ridge.

USGS 7-1/2′ quadrangle: Mercury, Mercury NE.

Fault orientation: CGV has a curving but generally northeast strike.

Fault length: The fault along the front of North Ridge is 7 km or 8.5 km long as estimated from Y-852 and Y-813, respectively. Faults about 0.5 km north of North Ridge in Crossgrain Valley are 1.5 km long (Y-852). Faults at the northeastern end of the ridge are about 2 km long as estimated from both Y-813 and Y-852. A fault trace at the southwestern end of North Ridge is 3 km long (Y-813).

Style of faulting: Displacement on the fault along the front of North Ridge is shown by Y-62 as down to the northwest and left–lateral. Y-813 portrayed displacement on 2.5 km at the southwestern end and 4.5 km at the northeastern end of this fault as left–lateral. Y-813 also showed a fault in Crossgrain Valley at the southwestern end of, but north of, North Ridge as left–lateral and down to the northwest. One short section of a fault in Crossgrain Valley at the northeastern end of North Ridge is portrayed by Y-813 (pl. 3) as having left–lateral displacement. One short section of this same fault is shown as having down–to–the–north displacement (Y-813).

Scarp characteristics: Y-813 (pl. 3) portrayed a 2–km–long section near the center of the fault along the front of North Ridge as a northwest–facing scarp. Two sections of the fault in Crossgrain Valley at the northeastern end of North Ridge are portrayed by Y-813 (pl. 3) as north–facing scarps.

Displacement: No information.

Age of displacement: CGV has surficial expression on surfaces of both Quaternary and Tertiary deposits according to Y-813 and Y-852. A 2–km–long section of the fault along the front of North Ridge, a 0.5–km–long section along the fault in Crossgrain Valley along the southwestern end of North Ridge, and most of the fault in Crossgrain Valley along the northeastern end of North Ridge are shown by Y-813 (pl. 3) as moderately to strongly expressed lineaments or scarps on surfaces of Quaternary deposits. Y-62 showed the fault along the front of North Ridge as displacing pre–Tertiary rocks and as concealed by Quaternary and Tertiary alluvium. Faults north of North Ridge in Crossgrain Valley displace Oligocene tuff and limestone and pre–Tertiary rocks but are concealed by Quaternary and Tertiary alluvium according to Y-62.

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: Faults both along the front of North Ridge and within Crossgrain Valley are shown by Y-852 as juxtaposing Quaternary alluvium against bedrock, but not as major range–front faults. The morphology of the front of North Ridge is similar to that along a major range–front fault and is characterized by "fault juxtaposition of Quaternary alluvium against bedrock, fault scarps and lineaments on surficial deposits along or immediately adjacent to range front, a general absence of pediments, abrupt piedmont–hillslope transitions, steep bedrock slopes, faceted spurs, wineglass valley, and subparallel systems of high–gradient, narrow, steep–sided canyons orthogonal to range front" (Y-852). Although this morphology is similar to that along a major range–front fault, the "associated fault systems are significantly less extensive and fault scarps would be substantially lower, shorter, and less continuous" (Y-852).

Analysis: Aerial photographs (Y-813, p. 4, scales 1:62,500 to 1:80,000; Y-852, scale 1:58,000).

Crossgrain Valley faults (CGV) — Continued

Relationship to other faults: CGV may be the southwestern extension of the Spotted Range faults (SPR), which are located about 5 km east of CGV. However, the Ranger Mountains and the valley of Sandy Wash separate CGV from these faults. The strike of CGV is similar that of the Rock Valley fault (RV), located along the southern side of Frenchman Flat about 10 km north of CGV. The strike of CGV also is similar to those of the faults along Mercury Ridge (MER) about 1.5 km to the north. The structural relationships among these faults are not known.

Death Valley fault (DV)

Plate or figure: Plate 2.

References: Y-29: Hamilton, 1988; Y-216: Brogan and others, 1991 (subdivided DV between Salt Springs and Ashford Mill into eleven segments on the basis of changes in the strike or character of the fault, p. 3); Y-222: Streitz and Stinson, 1974; Y-246: Troxel, 1986; Y-249: Troxel and others, 1986; Y-251: Troxel, 1986; Y-252: Sylvester and Bie, 1986 (their Artist's Drive fault; p. 41); Y-389: Drewes, 1963 (his Black Mountains fault system, which he subdivided into three north–northwest–striking faults (southern, central, northern) that are linked by two northeast–striking faults (southern and northern); fig. 2, p. 5, 61-66); Y-390: Hunt and Mabey, 1966; Y-391: Denny, 1965; Y-399: Hopper, 1947; Y-402: Drewes, 1959 (his Black Mountains fault system); Y-413: Jennings and others, 1962; Y-415: Jennings, 1985 (his Death Valley sheet); Y-421: McAllister, 1970 (shows the part of DV north of Gower Gulch); Y-427: Hart and others, 1989; Y-429: Wills, 1989 (his Death Valley fault zone between Furnace Creek and Shore Line Butte); Y-467: Curry, 1954 (his Frontal fault; description of turtleback surfaces); Y-468: Noble and Wright, 1954; Y-471: Burchfiel and Stewart, 1966; Y-472: Butler and others, 1988; Y-473: Hill and Troxel, 1966; Y-474: Hooke, 1972 (his Black Mountain fault; subdivided alluvial–fan deposits into seven stratigraphic units; used characteristics of alluvial fans and pluvial features on the eastern and western sides of Death Valley to infer a tilting history for a structural block that includes both the Panamint Range and Death Valley); Y-594: Fleck, 1970 (his Death Valley fault zone is shown as approximately located in the central part of Death Valley; DV is referred to as the frontal fault of the Black Mountains); Y-597: Wright and others, 1974; Y-746: Wright and Troxel, 1954 (maps 7 and 8); Y-779: Cole, 1984 (measured topographic profiles of alluvial surfaces and active washes along Willow Creek and three small drainages between Willow Creek and Sheep Canyon); Y-805: Keener and others, 1990; Y-880: Curry, 1938; Y-976: Wills, 1989; Y-1020: Jennings, 1992 (his Death Valley fault zone, fault #248); Y-1039: Keener and others, 1993; Y-1040: Miller, 1991 (his active segment of the Badwater Turtleback fault; relationship between DV and his older turtleback segments); Y-1043: Pavlis and others, 1993 (attempted to explain the geometry of DV and older faults along the Mormon Point turtleback); Y-1048: Holm and Wernicke, 1990; Y-1150: Hunt, 1960 (survey of archaeology sites in and adjacent to Death Valley; used by Y-390 to assess the age of faulting in Death Valley); Y-1153: Noble, 1926; Y-1248: Holm and others, 1993; Y-1307: Curry, 1938 (named the "turtleback" surfaces along the western front of the Black Mountains).

Location: 55 km/220° (distance and direction of closest point from YM) at lat 36°28'N. and long 116°50'W. (location of closest point). DV is located along the base of the western side of the Black Mountains and the eastern side of Death Valley between about Furnace Creek Wash on the north and Shoreline Butte on the south.

USGS 7-1/2′ quadrangle: Badwater, Dantes View, Devils Golf Course, Furnace Creek, Gold Valley, Mormon Point, Shore Line Butte.

Fault orientation: Most sections of DV strike between N. 4° W. and N. 28° W. (Y-216, p. 13-18). Exceptions are the Willow Creek section of Y-216 (p. 17), which strikes N. 53° E., and the Mustard Canyon section, which strikes N 55° W (Y-216, p. 14). Y-429 (p. 1) distinguished DV from the northwest–striking Furnace Creek fault (FC) to the north and the Southern Death Valley fault (SDV) to the south by its more northerly strike.

Y-389 (p. 63) reported that dips of 40° W. to 55° W. are common on individual fault planes of DV, but that dips of up to 75° SW. were observed southwest of Badwater and near Mormon Point. Y-1153 (p. 425) noted that fault planes, where they are exposed in bedrock, are nearly vertical. On the basis of near–vertical fault scarps on alluvial surfaces and a steep fault–line scarp, Y-1040 (p. 374) inferred that DV near Badwater dips at least 60° W.

Fault length: Estimates of the length of DV range between 51 and 104 km, as described below. Differences in the length estimates result from differences in interpreting the end points of DV with the Southern Death Valley fault (SDV) to the south and the Furnace Creek fault (FC) to the north.

Y-389 (p. 61) reported a length of 64 to 104 km (40 to 65 miles) for DV (his Black Mountains fault system).

Death Valley fault (DV) — Continued

The map of Y-216 (pls. 3 and 4) shows DV to have nearly continuous expression from west–facing scarps between Furnace Creek Wash and Mormon Point for a minimum length of about 51 km as estimated from Y-216 (pls. 3 and 4). This includes a 6–km–long section of DV north of Natural Bridge, where the map by Y-216 (pl. 3) shows little surficial expression of DV.

Y-216 (fig. 2, p. 4) extended DV south of Mormon Point to the southern limit of their map area near Shore Line Butte. They recognized little geomorphic expression for lateral displacement on this section, but noted vertical scarps similar in size to those north of Mormon Point (Y-216, pl. 4). If DV extends to near Shore Line Butte, a section about 17 km long, then the length of DV would be about 68 km as estimated from Y-216 (pl. 4). However, Y-429 (p. 8, fig. 3e, locality 1) and Y-473 both reported evidence for right–lateral displacement on this portion of DV. This type of displacement is similar to that on the northwest–striking SDV south of Shore Line Butte. This section could instead be the northern part of SDV or a transitional section between DV and SDV.

Y-216 (fig. 2, p. 4) extended DV north of Furnace Creek Wash to Salt Springs, although the fault in this area is expressed as scattered scarps, some trending north (similar to the strike of DV to the south) and some trending northwest (similar to the strike of FC to the north; Y-216, pls. 2 and 3). The portion of the fault between Furnace Creek Wash and Salt Springs is about 11 km long as estimated from Y-216 (pls. 2 and 3) and would increase the length of DV to 79 km. The map by Y-216 (pl. 2) shows no surficial expression of either DV or FC between Salt Springs and a northwest–trending vegetation lineament, which appears to be surficial expression of FC. This lineament is located about 4 km north of Salt Springs. If DV extends to this lineament, then the entire length of DV could be about 83 km.

Y-429 (p. 6, fig. 3a, locality 1) noted that the northernmost well–defined surface trace of DV is just south of the Harmony Borax Works about 4 km north–northwest of Furnace Creek. This interpretation would make DV about 72 km long between this scarp and near Shore Line Butte.

Lengths of individual scarps associated with DV range between 2.3 and 13.1 km (Y-216, table 4, p. 21).

Style of faulting: Displacement on DV has been predominantly dip–slip (normal) according to Y-216 (p. 13), Y-389 (p. 61), and Y-429 (p. 2). DV dips generally west (Y-389, p. 61; Y-429, p. 2). Y-216 (p. 18, table 4, p. 21) noted some evidence for right–lateral displacement, but only on his Badwater turtleback and Copper Canyon sections.

Y-429 (p. 6) called DV a "right–oblique fault with the west side down." He (Y-429, p. 6, fig. 3a) noted two northwest–trending, *en echelon* anticlines, one at Mustard Canyon and the other south of the Harmony Borax Works. (This sections is north of Furnace Creek Wash and could be part of FC instead of DV.) He (Y-429, p. 6) interpreted the anticlines to be the result of right–lateral displacement. On the basis of oblique–slip striations on some fault surfaces, Y-473 (p. 436) inferred a component of right–lateral slip on northeast–striking faults along the Black Mountains (e.g., north of Mormon Point). Y-429 (p. 6) reasoned that numerous small gullies that cross DV at about 30° clockwise to the fault scarp south of Breakfast Canyon indicate right–lateral displacement (e.g., tension fractures or reidel shears along a right–lateral fault). Y-429 noted right–lateral deflection of small drainages along DV east of Desolation Canyon (p. 6, fig. 3a, locality 4) and along a northwest–striking section of DV south of Copper Canyon (p. 7, figs. 2b and 3d, locality 9). Because deposition has been concentrated on the southwestern sides of alluvial fans between Badwater and Copper canyons, Y-474 (p. 2096) inferred that the youngest displacements on DV have been right–lateral strike slip.

Y-389 (fig. 2, p. 5, 56, 61) inferred a fault near the axis of Death Valley (his Death Valley fault zone) and suggested that the north–northwest–striking faults along the front of the Black Mountains (part of his Black Mountains fault system) splay away from his inferred fault within the valley and are connected to each other by shorter, northeast–striking faults along the mountain front (also part of his Black Mountains fault system).

Y-1153 (p. 427) described DV as irregular in detail, with a zig–zag pattern that results from a succession of faults that displace each other and create indented "cusps" along the front of the Black Mountains. Similarly, Y-29 (p. 76) suggested that DV is not likely a single steep range–front fault, but is probably "a series of step faults or the downdip continuation of the turtleback faults or a combination of steep and gentle faults."

Death Valley fault (DV) — Continued

Y-429 (p. 7, fig. 3c) interpreted a graben, which is up to 3 m deep, at the toe of the alluvial fan
Badwater to be the result of lateral spreading and liquefaction of sand beds within alluvium.

Scarp characteristics: Maximum vertical separations estimated across scarps on late Holocene
2 ka; Q_{1B}; table 2, p. 8) surfaces (these are the youngest surfaces with scarps) range between 0.15 m
fault trace of DV along the Badwater turtleback section of Y-216 (table 4, p. 21, pl. 3) and 3.0 m along
Springs section of Y-216 (north of Furnace Creek Wash; table 4, p. 21, pl. 2). The maximum slope angl
scarp along the Salt Springs section is 31° (Y-216, table 4, p. 21). The maximum slope angle reported by
(table 4, p. 21) for scarps on late Holocene surfaces is 57° for a scarp with a maximum vertical separation
This is on the Golden Canyon section of Y-216 (just south of Furnace Creek Wash) and may represent
rupturing events according to Y-216 (table 4, p. 21, pl. 3).

Maximum vertical separations across scarps on earlier Holocene (2 ka to 10 ka; Q_{1C}; table 2, p. 8)
along the main trace of DV range between 1.5 m along the Black Mountains section of Y-216 and 5.0 m
Artists Drive section of Y-216 (table 4, p. 21, pl. 3). The maximum slope angles for these scarps are about
48°, respectively (Y-216, table 4, p. 21).

The highest Holocene scarps observed by Y-429 (p. 7, fig. 3c, locality 6) are at Badwater, where he rep
that scarps are 10 m high and have free faces 3 to 4 m high.

Maximum vertical separations across scarps on Pleistocene (>10 ka; Q_2) surfaces (Y-216, table 2, p. 8) al
the main trace of DV range between 6.6 m along the North Ashford Mill section of Y-216 and 15 m along the Co
Canyon turtleback section of Y-216 (table 4, p. 21, pl. 4). Maximum slope angles for these two scarps are
90°, respectively (Y-216, table 4, p. 21).

Y-1153 (p. 427) noted that five alluvial fans along DV have scarps and that some of these scarps are 6 m (20
high.

Displacement (vertical): Estimates of vertical displacement on DV range between 2 mm and 20 km. The
estimates are based on a variety of stratigraphic and structural markers of different ages, as noted in the followin
paragraphs in which displacements are discussed in order of decreasing unit age.

Y-976 (p. 197) estimated a total vertical displacement of about 5 km (about 3 miles) in central Death Val
by adding the height of the Black Mountains (about 1,525 m; about 5,000 ft) and the thickness of the valley fill th
was estimated by Y-390 (about 3,000 m; about 10,000 ft).

On the basis of geobarometric, metamorphic, and structural data, Y-1048 (p. 523) estimated 10 to 20 km
uplift of the Black Mountains south of Badwater.

Y-594 (p. 2811) suggested that as much as 2,288 m (7,500 ft) of structural relief has resulted since depositi
of the Furnace Creek Formation began about 6.3 Ma (p. 2810) and that this formation has been vertically displaced at least 305 m (1,000 ft) along DV. He (p. 2811) also noted that the Artist Drive Formation has been vertically displaced as much as 1,525 m (5,000 ft).

Y-389 (p. 63) estimated vertical displacement on DV using topographic evidence because footwall rocks are not exposed in the hanging wall. From observations that prominent triangular facets along the front of the Black Mountains are about 610 m (2,000 ft) high and that higher ridges about 3 km (2 miles) east of the front are about 1,525 m (5,000 ft) above Death Valley, Y-389 (p. 63) concluded that the minimum vertical displacement on DV is probably "in the order of [1,220 m] 4,000 ft." He (Y-389, p. 63, 65) estimated that the maximum total vertical displacement is about 3 km (2 miles). This estimate is based on (1) gravity studies (*citing* Mabey, 1959, Y-1364, and Mabey, written commun., no date given) that suggest that Cenozoic fill in the central part of Death Valley is 1,525 to 2,135 m (5,000 to 7,000 ft) thick, (2) the assumption that this fill is probably thicker along the eastern edge of Death Valley since the valley has been tilted eastward, (3) the 3,660 m (12,000 ft) thickness of deposits in Copper Canyon basin (a small structural basin), and (4) using half of the suspected thickness of 3,050 to 4,575 m (10,000 to 15,000 ft) for the thickness of fill in Death Valley adjacent to the Black Mountains (Y-389, p. 63-65).

Y-391 (p. 32) reported that the Black Mountains have been uplifted along DV "several thousand feet relative to the valley floor" and speculated that >30 m (>100 ft) of this amount occurred during "the last few thousand years."

Using the fault scarps and range–front facets preserved along the Black Mountains, Y-389 (p. 65) suggested that the minimum displacement represented by the range front occurred during at least six events that resulted in cumulative vertical separations of 763 m (2,500 ft) in crystalline rocks, 397 m (1,300 ft) in fanglomerates of the Pliocene(?) Copper Canyon formation, 46 m (150 ft) in older Pleistocene gravel deposits near Mormon Point, 14 m (45 ft) in younger Pleistocene or Holocene gravel deposits, and about 1.5 m (about 5 ft) in all but the youngest gravel deposits.

Total vertical relief is 200 m across a dissected west–facing fault scarp at the Black Mountains range front along their North Ashford Mill section of DV (about 8 km south of Mormon Point; Y-216, p. 17). Vertical relief across fault scarps on surfaces of interlayered basalt, breccia, and fanglomerate thought by Noble (1941, Y-401) to be Pliocene(?) is 80 m along DV east of Cinder Hill on the northern part of their South Ashford Mill section (about 13 km south of Mormon Point and just north of Shore Line Butte; Y-216, p. 18).

Y-390 (p. A71-A72) suggested that shorelines and lake gravels (shingled) that are associated with a late Pleistocene stand of Lake Manly that they thought occurred during the Wisconsin (tentative correlation of the lake stand to the Tahoe glaciation in the Sierra Nevada) have been deformed between Mesquite Flat and Shore Line Butte. They (Y-390, p. A72) proposed eastward tilting of 61 m (200 ft) and northward tilting of 92 m (300 ft) on the basis of differences in the present elevations of the shorelines and lake deposits that they thought correlated to a single lake stand.

Using the present elevations of tufa and strandlines on the eastern side of Death Valley (on the uplifted footwall of DV) and on the western side of the valley, Y-474 (p. 2073, 2091) estimated a total post–Wisconsin (since about 10 ka to 11 ka; p. 2086) displacement of about 63 m on DV.

The maximum vertical separation that is reported by Y-216 (table 4, p. 21) is 15 m across a scarp on a Pleistocene surface (>10 ka; Q2; table 2, p. 8). This is along their Copper Canyon turtleback section (Y-216).

The maximum vertical separation that is reported by Y-216 (table 4, p. 21) across the main trace of DV on surfaces thought to be Holocene (<10 ka; Q1B and Q1C; table 2, p. 8) is 5.0 m along their Artists Drive section (Y-216, table 4, p. 21).

Y-390 (p. A100) reported that the eastern shoreline of a lake that they inferred existed in Death Valley about 2 ka (*see* Age of Displacement) is about 6 m (20 ft) lower than the western shoreline of this same lake. They (Y-390, p. A100) inferred that this tilting occurred abruptly, because concentric salt rings associated with the salt pan related to the lake are crowded against the eastern side of the Badwater Basin and because they thought that the tilting was related to the formation of a 3–m–high (10–ft–high) Holocene fault scarp along the base of the Black Mountains. The tilting of the shoreline is reflected in the differences in the geomorphology of alluvial fans on the eastern and western sides of Death Valley (Y-390, p. 106). Those on the eastern side are small; those on the western side are long and high (Y-390, p. 106). The tilting is also reflected by the smooth, aggrading nature of the drainages on the eastern side of Death Valley in the vicinity of Badwater and by the deeply entrenched (dissected) channels of the Amargosa River and its tributaries on the western side of the valley in this area. Y-391 (p. 37, pls. 4 and 5) also interpreted the differences in the size and morphology of alluvial fans on the western side (relatively large, gentle, incised fans that include large remnants of older varnished surfaces) and eastern side (relatively small, steep, undissected fans that include only small, scattered remnants of older varnished surfaces) as reflecting Quaternary deformation and eastward tilting of the floor of Death Valley as suggested by Y-390.

A level line established in 1970 across DV about 2 km south of Furnace Creek Wash (the Golden Canyon section of Y-216, pl. 3) and periodically resurveyed recorded about 2 mm of vertical displacement across the fault between 1978 and 1984 (Y-252, p. 41).

Displacement (right–lateral): Right–lateral displacements are reported by Y-216 (table 4, p. 21) at only two localities. Maximum right–lateral separations are 3.6 m along the Copper Canyon turtleback section of Y-216 and 0.2 m along the Badwater turtleback section of Y-216. Both of these displacements are on older Holocene (2 ka to 10 ka; Q1C; table 2, p. 8) surfaces and both are measured across branch faults rather than the main trace of DV.

Death Valley fault (DV) — Continued

Y-429 (p. 7, fig. 2b and 3d, locality 9) reported 1.8 to 3.6 m of right–lateral displacement for a gully on a northwest–striking section of DV south of Copper Canyon.

Age of displacement: The youngest displacement on most of DV is latest Holocene. A level line established by Y-252 (p. 41) in 1970 across DV about 2 km south of Furnace Creek Wash (the Golden Canyon section of Y-216, pl. 3) suggests that displacement continues.

Y-216 (p. 19) speculated that the youngest surface rupture on DV occurred on their Golden Canyon section (immediately south of Furnace Creek Wash) and may be nearly historical. They based this age estimate on the lack of varnish on the youngest disrupted surface, the preservation of scarps that have free faces that "persist only a few hundred to a few thousand years," and on the gradational contact between faulted and unfaulted alluvium (Y-216, p. 15). Y-976 (p. 198) noted that the "fresh scarps are especially well developed near the mouth of Golden Canyon." Y-389 (p. 61) observed that DV between about 2.5 km north of Badwater and about 8 km south of Mormon Point is either exposed, covered by only a thin veneer of gravel, or associated with "young fault scarps."

Y-390 (p. A100-A101, figs. 72 and 73) suggested that the youngest surface rupture on DV about 2 km south of Furnace Creek Wash (between Breakfast Canyon and Golden Canyon on the Golden Canyon section of Y-216) must be prehistoric because Indian mesquite storage pits have been constructed in "colluvium that overlaps the scarp" (Y-390, p. A100; Y-1150, p. 178-179, site 85-56, circle D). The circular pits were probably built during or after Death Valley III occupation (Y-1150, p. 1-2, 177, since 2 ka). Y-1150 (p. 178) concluded that the surface rupture that formed the fault scarp was "sufficiently older than the circles for the [scarp] to have weathered enough to produce the colluvial slope."

Y-1153 (p. 425) noted that "parts of [the] huge scarps [along DV] are fresher than any other scarps of similar magnitude in the West," but no specific location is given.

The youngest surfaces reported by Y-216 (table 4, p. 21) to lack scarps along DV are younger than 0.2 ka (table 2, p. 8, their Q1A surfaces).

The only disrupted surface that Y-216 reported as having any age control is the surface with the 3–m–high scarp along their Salt Springs section, which is the northernmost of their sections along DV (Y-216, p. 13, 19). This scarp crosscuts a lake shoreline (Lake Manly) that dates from about 2 ka, for which Y-216 (p. 13) cited Y-390 and Y-1150. Y-390 (p. A70-A82) reported that this shoreline, at elevation 240 ft below sea level, is interpreted from "the upper limit of highly saliferous ground" (p. A79). The 2–ka age estimate for this lake is based on artifacts contained in sand dunes that overlie the lake floor on the western side of Badwater Basin (west of Badwater about 35 km south of Salt Springs; Y-390, p. A82, A87). The artifacts are from Death Valley III and IV occupations as interpreted by Y-1150 (p. 2, 111-112, 163-166) and noted by Y-390 (p. A82, A87).

Y-216 (p. 19) concluded that three or more late Holocene surface ruptures have occurred on DV as indicated by displacements of late Holocene alluvium (his Q1B unit with an estimated age of 0.2 ka to 2 ka).

Y-216 (p. 18) recognized Holocene surface rupture on all of DV except for their Mustard Canyon section, which is located near the northern end of the fault as interpreted by Y-216 (between the Park Service facilities at Cow Creek and about 2 km north of Furnace Creek Ranch), and their Artists Drive section, which is between Natural Bridge and Mushroom Rock.

Y-1020 portrayed nearly all of DV (between Furnace Creek Wash or Salt Springs and south of Jubilee Pass) as having Holocene (≤10 ka) displacement. Y-429 (p. 1) noted that the evidence for Holocene displacement on DV is "abundant." Fault traces on the western side of Death Valley and some on the eastern side of Death Valley are shown as Holocene (≤10 ka) by Y-1020, based on the presence of sag ponds and fault scarps that show little erosion.

Y-429 (p. 7) noted that the alluvial fan with a scarp 10 m high at Badwater has only weak varnish and little or no carbonate in the associated soil suggesting a Holocene age for the disrupted surface.

Death Valley fault (DV) — Continued

Y-474 (p. 2073, 2077, 2086) interpreted segments (breaks in slope) of alluvial fans on the western and eastern sides of Death Valley as indicating six episodes of tilting in Death Valley, three of which occurred after the last major high stand of Lake Manly (his Blackwelder stand) that was interpreted by him to have ended between about 10 ka and 11 ka. Y-474 (p. 2073) suggested that "distinct tectonic events" occurred at about 0.2 ka, 1 ka, 6 ka, 17 ka, 30 ka, and 42 ka. These ages were derived from estimating volumes of sediment deposited after each tilting event.

Fault traces on the western side and in the central part of the valley are shown by Y-1020 as late Quaternary with displacement since 700 ka. This age estimate was based on features that are similar to but less distinct than those suggesting Holocene displacement (Y-1020).

Some fault traces are shown by Y-1020 as Quaternary, undifferentiated, with displacement since 1.6 Ma.

Y-389 (p. 65-66) concluded that displacement on DV has recurred at least six times since Miocene(?) to early Pliocene. He speculated that (1) the oldest displacement, which includes three stages, occurred in the Miocene(?) to early Pliocene, because this displacement postdates older volcanics and predates the Copper Canyon formation; (2) the second and third displacements occurred in early(?) or middle Pleistocene and in middle(?) Pleistocene, respectively, because these displacements postdate Funeral Formation and predate gravels of Lake Manly; (3) the fourth displacement occurred in late(?) Pleistocene, because it postdates gravels of Lake Manly and predates poorly indurated gravels; (4) the fifth displacement occurred in late Pleistocene or Holocene, because it postdates poorly indurated gravels and predates Holocene gravels, and (5) the sixth displacement occurred in the Holocene and disrupts all but the youngest gravels (Y-389, p. 66).

Y-594 (p. 2,811) concluded that most of the vertical displacement on DV probably occurred since about 6 Ma (before deposition of the Furnace Creek Formation), although Death Valley may have begun to form before this time.

The maximum age for the onset of faulting is assumed by Y-216 to be middle Miocene on the basis of K–Ar ages for displaced volcanics believed to be coeval with faulting.

Slip rate: An apparent vertical slip rate of 1.5 mm/yr is estimated for the Salt Springs section of Y-216 (part of DV?), using the 3 m vertical displacement of a 2,000–yr–old shoreline as reported by Y-216 (table 4, p. 21). Using the range of maximum vertical separations of 0.15 to 2.3 m in deposits estimated to be 0.2 ka to 2 ka (their Q1B deposits, table 2, p. 8) as reported by Y-216 (table 4, p. 21) for DV south of Furnace Creek Wash, the apparent vertical slip rate ranges between 0.08 to 11.5 mm/yr for this portion of DV during the late Holocene. Using the range of maximum vertical surface separations of 1.5 to 5 m that is reported by Y-216 (table 4, p. 21) for older Holocene (2 ka to 10 ka) surfaces, an apparent vertical slip rate of 0.15 to 2.5 mm/yr is estimated for DV during the Holocene.

Y-389 (p. 66) suggested that the vertical slip rate on DV has increased since middle Miocene(?). This suggestion is based on estimates of minimum displacement in rocks or deposits, which yield the following "crude" estimates of the minimum average vertical slip rates (Y-389, p. 66): 0.03 mm/yr (100 ft/1 myr) since middle Miocene, 0.08 mm/yr (250 ft/1 myr) since middle Pliocene, 0.12 mm/yr (400 ft/1 myr) since middle Pleistocene, and 0.23 mm/yr (750 ft/1 myr) since latest Pleistocene. Although Y-389 (p. 66) indicated little confidence in the actual values, he concluded that the general increase in the rates is significant.

Using differences in elevation of tufa and strandlines thought to correlate with stands of Lake Manly, Y-474 (p. 2093-2096) estimated late Pleistocene tilting rates on DV. From his estimate of the present tilting rate (0.016°/ 1,000 yr) and the assumption that the axis of tilting is 25 km west of DV, Y-474 (p. 2096) estimated a vertical slip rate of 7 mm/yr for DV since late Pleistocene.

Recurrence interval: Assuming that three or more surface ruptures have occurred on DV during the late Holocene (<2 ka) as reported by Y-216 (p. 19), the maximum recurrence interval for surface–rupturing events is about 650 yr. Y-216 concluded this number of events from three distinct scarps that are preserved on late Pleistocene surfaces. They inferred that these scarps represent three separate events on their Artists Drive section.

Range-front characteristics: Y-1153 (p. 425) described the front of the Black Mountains adjacent to DV as "exceedingly rugged" and noted that it "rises abruptly from the valley floor." He (Y-1153, p. 425-426) described the front, from its base above the alluvial scarps upward, as composed of (1) a small vertical cliff, which marks the recent fault just above the valley floor, (2) a relatively steep escarpment (just above the cliff) that slopes 35° and that is dissected by parallel drainages that are "deep, straight, and acutely V–shaped," and (3) a gentler escarpment that slopes 25° and that has a relatively subdued and rounded topographic form. Y-1153 (p. 426) attributed this configuration to recurrent "earth–movement" with the more recent movements recorded by the vertical cliff and scarps on the alluvial fans immediately west of the range front.

Y-389 (p. 63-64, fig. 11) noted that the western front of the Black Mountains adjacent to DV and above fault scarps on alluvial fans is linear, abrupt, and faceted. He (Y-389, p. 63-64) recognized two groups of facets: a lower group that is steeper and less dissected than an upper group. Facets in the lower group have an average slope of 40° to 45° toward the valley, are trapezoidal, are preserved along the lowermost 61 m (200 ft) of the range front, and are associated with gravel remnants preserved above the facets (Y-389, p. 63). Facets in the upper group slope 35° to 40°, are triangular, and are positioned between the lower group of facets and elevations of 427 to 671 m (1,400 to 2,200 ft). Y-389 (p. 63) interpreted these facets, possibly along with straight ridge segments that slope 20° to 30° for 305 to 610 m (1,000 to 2,000 ft) above the upper facets, to be the result of recurrent displacements on DV, tilting of the footwall, and subsequent erosion.

Three portions of the western front of the Black Mountains (at Mormon Point, Copper Canyon, and Badwater) are marked by "smooth, broadly convex, slightly eroded surfaces" that rise "thousands of feet toward or to the crest of the range" (Y-1307, p. 1875). These structural and topographic features, which were named "turtleback" surfaces by Y-1307 (p. 1875) because their form resembles a land tortoise, were interpreted by Y-1307 (p. 1875) to represent late Tertiary, warped thrust faults (called turtleback faults by Y-467, p. 54) "from which the hanging wall has been largely stripped." These exhumed surfaces slope between 15° and 60°, but are rarely >32° (Y-1307, p. 1875). The facets described above are on the sides of the Copper Canyon and Badwater turtlebacks (Y-467, p. 58-59).

Y-1040 (p. 372) interpreted the facets on the Badwater turtleback as "three distinct west–dipping faults that decrease in age and increase in dip westward." He (Y-1040, p. 372) called these faults from older (highest on the range front) to youngest (lowest on the range front) as the low–angle segment, the frontal segment, and the active segment (DV). The upper, low–angle segment is planar, dips 17° W., and is locally disrupted by younger faults (Y-1040, p. 374). The intermediate, frontal segment, which cuts the low–angle segment, dips between 35° and 54° W. or WSW. and juxtaposes remnants of Tertiary volcanic rocks and Quaternary(?) alluvial–fan deposits above the fault against mylonitic, mostly Precambrian rocks below the fault (Y-1040, p. 374).

Analysis: Aerial photographs (Y-216, p. 3, scale ~1:12,000 (low–sun–angle); Y-389, p. 3 (vertical black and white and low–angle oblique color); Y-390, p. A7-A8; Y-429, p. 10, scale 1:12,000 (low–sun–angle), 1:20,000, and 1:24,000). Geomorphic interpretation made using low–sun–angle aerial photography (Y-427, p. 8). Mapping at a scale of 1:24,000 (Y-429, p. 5). Aerial reconnaissance (Y-390, p. A8). Field reconnaissance (Y-216, p. 3; Y-429, p. 5-6). Subdivision of DV into eleven sections based on the orientation of the fault, the apparent age of faulting, the width of the fault zone, the pattern of faulting, and the position of the fault relative to the range front (Y-216, p. 3-4, fig. 2, pls. 2-4). Subdivision of Quaternary geomorphic surfaces into relative–age groups based primarily on surface characteristics and topographic position (Y-216, p. 5, 8, table 2, 4 groups; Y-474, p. 2073, 7 groups). Field examination (Y-216, p. 3-5; Y-427, p. 8;). Compilation of published and unpublished literature (Y-427, p. 8). Geologic field mapping (Y-389, p. 3 (work done between 1956 and 1958 and included plane table and alidade and 1:48,000–scale topographic base); Y-390, p. A7-A8 (using ground traverses); Y-474, p. 2073 (work done between 1967 and 1970)). Interpretation of geomorphic features (Y-216, p. 3-5). Surveying of level lines 300 to 500 m long and arranged perpendicular to the fault (Y-252, p. 41). Topographic profiles on alluvial fans (Y-474, p. 2081).

Death Valley fault (DV) — Continued

Relationship to other faults: The relationship between DV and the turtlebacks or turtleback faults has received much speculation. Y-467 (p. 58) noted that DV (his Frontal fault) joins the turtleback faults at Badwater and south of Copper Canyon but does not cut either turtleback. From these relationships he (Y-467, p. 58) suggested that DV "may coincide with the turtleback fault at depth, and that there may have been recurrent normal movement on the west flanks of both turtlebacks." Y-1040 (p. 374) concluded that DV (his active segment of the Badwater Turtleback fault) intersects the lower–angle faults above DV on the Badwater turtleback (his frontal segment of the Badwater Turtleback fault) because DV (1) dips more steeply than the frontal segment, (2) is younger than the frontal segment, and (3) is similar in position to that of an active fault (DV) interpreted by Y-805 (p. 34) on the Mormon Point Turtleback fault. Y-805 (p. 34) observed that Quaternary fault scarps at Mormon Point are coincident with an abrupt increase in gradient that they interpreted from gravity and magnetic data. From this observation, they (Y-805, p. 34) concluded that the faults associated with the Quaternary scarps "probably project at depth to a steeply dipping fault that cuts" a shallow–dipping portion of their Mormon Point fault system. The shallow–dipping portion separates crystalline rocks from deformed Quaternary(?) gravels (Y-805, p. 34). Y-1039 (p. 330) interpreted geophysical data as indicating that a northeast–striking, low–angle fault along the northern side of Mormon Point (their segment 5) is displaced by approximately parallel, younger, moderate–to–high–angle faults (their segment 2; part of DV). Y-251 (fig. 1, p. 38) sketched an exposure that is located about 1.6 km (about 1 mile) south of Mormon Point and that shows that west–dipping, relatively steep, west–side–down normal faults flatten and merge with the west–dipping, relatively low–angle turtleback fault. Although the relatively steep normal faults have orientations similar to that of DV, the relationship between the trace of DV that is associated with young fault scarps (west of the normal faults observed at this locality) and the turtleback fault is not exposed at this locality. Y-402 (p. 1506-1508) proposed that relatively recent displacement on DV (his Black Mountains fault system) allowed blocks of fanglomerate to slide toward Death Valley along the turtleback faults during the late Pliocene or early Pleistocene.

Y-1043 (p. 267, 270) concluded that the irregular geometry of the Quaternary ruptures along DV in the vicinity of Mormon Point is derived from the complex geometry of older faults at this locality and the rotation of these older faults (now preserved in the footwall of the active fault trace) during repeated ruptures.

Fault scarps are preserved on Quaternary surfaces on the western side of Death Valley opposite DV. Y-216 (p. 13) concluded that the main fault is along the eastern side of the valley.

DV is part of a fault system that is >300 km long (Y-216, p. 1). Other faults in the system are the Fish Lake Valley fault (FLV), the Furnace Creek fault (FC), and the Southern Death Valley fault (SDV). Y-390 (fig. 71, p. A100) suggested that DV is cut off on the north by FC and on the south by SDV (their Confidence Hills fault zone). Y-471 (p. 439-440) concluded that right–lateral displacement on northwest–striking FC and SDV (their Death Valley fault zone) has caused extension that has caused a "pulling apart" of the two sides of central Death Valley along a north trend. Y-473 (p. 435-436) suggested that geologic structures in the Death Valley region are products of northwest–southeast extension and northeast–southwest horizontal shortening on a system of strike–slip faults and that extensional features along DV are compatible with this interpretation.

On the basis of the marked differences between the large structural block of the Black Mountains and adjacent structural blocks (e.g., a near absence of Paleozoic rocks in the Black Mountains), Y-389 (p. 56) proposed that large, north–striking faults inferred in Death Valley (his Death Valley fault zone along the axis of the valley between near Furnace Creek and the Owlshead Mountains) and in the Amargosa Valley (his Shoshone fault zone) connect two large, northwest–striking faults, FC and SDV (his Confidence Hills fault zone). In addition, Y-389 (p. 56) suggested that if these faults are related physically and temporally, then they are probably also related genetically.

Y-1153 (p. 425) noted similarities in the strike, geomorphic expression, and recency of displacement between DV and the Panamint Valley fault (PAN) along the western side of the Panamint Range about 40 km (25 miles) west of DV and suggested that the faults have a "common origin."

Deep Springs fault (DS)

Plate or figure: Plate 1.

References: Y-238: Reheis and Noller, 1991 (pl. 2; show only that portion of DS north of about lat 37°21'N. and east of long 118°W., which are the boundaries of their map area); Y-427: Hart and others, 1989; Y-484: McKee and Nelson, 1967 (show only that portion of DS east of long 118°W., which is the boundary of their map area); Y-651: Reheis and McKee, [1991]; Y-762: Bryant, 1988 (preliminary report revised in Y-1033); Y-853: Dohrenwend and others, 1992 (show only that portion of DS east of long 118°W., which is the boundary of their map area); Y-861: Lustig, 1965 (does not show DS on his generalized geologic map (pl. 8), but does discuss scarps and other evidence for faulting in his text); Y-862: Miller, 1928; Y-869: Nelson, 1966 (shows only that portion of DS south of lat 37°15'N. and west of long 118°W., which are the boundaries of his map area); Y-870: Nelson, 1966 (shows only that portion of DS north of lat 37°15'N. and west of long 118°W., which are the boundaries of his map area); Y-872: Wilson, 1975; Y-1020: Jennings, 1992: Y-1033: Bryant, 1989; Y-1072: Reheis, 1993. Name from Y-862 (p. 516), *cited by* Y-762 (p. 2), Y-872 (p. 10), and Y-1033 (p. 246).

Location: 148 km/294° (distance and direction of closest point from YM) at lat 37°23'N. and long 117°57'W. (location of closest point). DS is located along the eastern side of Deep Springs Valley at its junction with the Inyo Mountains. It includes scarps shown by Y-853 along the northeastern side of Deep Springs Valley.

USGS 7-1/2' quadrangle: Chocolate Mountain, Cowhorn Valley, Deep Springs Lake, Soldier Pass.

Fault orientation: DS generally strikes northeast, but it curves to strike north and north–northwest at the northern end of Deep Springs Valley (Y-484; Y-853). Y-872 (p. 55) reported a strike of N. 25° E. and a dip of 40° ± 2° W. at one locality along DS.

Fault length: The length of DS is about 27 km as estimated from Y-1033 (fig. 1, p. 243). This is slightly longer than Deep Springs Valley, which is 24 km long (Y-762, p. 2; Y-872, p. 2).

Style of faulting: Y-1033 (p. 247) noted that displacement on DS appears to be entirely dip–slip (normal) and that no evidence for left–lateral strike slip, which might be expected along a northeast–striking fault, has been observed. At the northern end of Deep Springs Valley north of Chocolate (Piper?) Mountain, DS may include north– or north–northwest–striking faults east of Deep Springs Valley within the Inyo Mountains (Y-238; Y-484; Y-1033, p. 248). Y-1033 (p. 248) reported that a northwest–striking, well–defined fault trace north of Deep Springs playa is characterized by northeast–facing scarps on alluvial surfaces, right–laterally deflected drainages, and vegetation lineaments. Just south of Deep Springs College, DS is a complex and discontinuous zone of scarps and linear troughs in granitic rocks (Y-1033, p. 247). This zone may delineate a right step in DS (Y-1033, p. 247).

Scarp characteristics: Scarps on DS are primarily west–facing (Y-484; Y-762, p. 3; Y-870). Heights of fault scarps that are located between Deep Spring playa and an unnamed drainage from the southern side of Chocolate (Piper?) Mountain range between 2.3 m and >20 m with scarp–slope angles between 21° and 39° (Y-1033, localities 1 through 9, fig. 2, table 1, p. 244-245). Scarps on surfaces of alluvial deposits north of the right step just south of Deep Springs College are generally less steep than scarps south of the step (Y-1033, p. 247). Y-1033 suggested that scarp heights in a graben east of Deep Springs playa may have been enhanced by lateral spreading caused by liquefaction, because displacement appears to have been mostly extensional rather than vertical (Y-1033, localities 1 and 2, fig. 2, table 1, photo 5, p. 244, 248). This conclusion is based on the projection of alluvial fans across the 3.5–m–wide graben (Y-762, p. 7).

Displacement: Displacement along DS has been estimated on the basis of a variety of stratigraphic markers as shown in the following paragraphs in which displacement is discussed in order of decreasing age of the stratigraphic marker.

Deep Springs fault (DS) — Continued

Y-872 (p. 55, fig. 22, p. 58) estimated that the total apparent vertical displacement across DS is about 1,525 m (5,000 ft). This is based both on the interpretation of a geophysical survey across Deep Springs Valley, which suggests that basement rocks are 793 m (2,600 ft) below the floor of the valley (assumes that DS dips about 45°), and on the height (732 m; 2,400 ft) of the front of the Inyo Mountains above the playa in Deep Springs Valley.

A minimum estimate of total apparent vertical displacement along DS is reported by Y-651 (p. 40) as about 1,625 m. This estimate is based on (1) the highest elevation (about 2,387 m; 7,830 ft) of bedrock in the footwall near Soldier Pass, (2) the depth (about 792 m; 2,600 ft) to bedrock beneath Deep Springs Valley adjacent to the fault at Soldier Pass as inferred from gravity data by Y-872 (p. 55), and (3) the elevation (about 1,554 m; 5,100 ft) of the valley floor at this locality.

Y-872 (p. 10) noted 153 m (500 ft) of vertical displacement across DS in Tertiary units just east of Deep Springs College. Y-872 (p. 9) also reported that Pliocene basalt had been displaced 458 m (1,500 ft).

A minimum apparent vertical displacement of 714 m since 10 Ma to 12 Ma has been estimated on the basis of the difference between the highest elevation (2,348 m; 7,703 ft) of a basalt dated at 10 Ma to 12 Ma (Y-651, p. 30, *citing* Dalrymple, 1963, Y-1243) at the top of Chocolate (Piper?) Mountain and the lowest elevation (about 1,634 m; 5,360 ft) of the surface of the hanging wall. This assumes that the basalt is probably buried beneath the alluvium in Deep Springs Valley.

Y-872 (p. 10) reported 61 m (200 ft) of vertical displacement on a northeast–striking branch fault mapped through Soldier Pass. This amount of displacement was calculated on the basis of the elevation differences between ridges on opposite sides of the fault within the Inyo Mountains. Likewise, Y-861 (p. 141) estimated about 61 m (200 ft) of uplift near Soldier Pass on the basis of a west–tilted and uplifted conglomerate at the northern end of Deep Springs Valley just southwest of Piper (Chocolate?) Mountain. Y-861 (p. 141) noted that the rocks in the conglomerate could have been derived only from the Wyman–Crooked Creek drainages on the western side of Deep Springs Valley, so that uplift and tilting probably caused disruption of the drainage pattern.

The elevation (1,805 m; 5,930 ft) of gravels in a canyon south of Chocolate (Piper?) Mountain, their position above the floor of Deep Springs Valley, and the Bishop ash (740 ka; Y-651, p. 30, *citing* M.C. Reheis, personal common., 1989) that is interbedded with the gravels indicate a minimum of 180 m (590 ft) of late Quaternary vertical displacement along DS (Y-1033, p. 247).

The minimum apparent displacement since 740 ka has been estimated by Y-651 (p. 40) to be 201 m (660 ft). This is based on the elevation difference between a wind gap containing Bishop ash (740 ka) south of Chocolate (Piper?) Mountain, which is on the footwall, and the floor of Deep Springs Valley, which is on the hanging wall.

Age of displacement: The youngest displacement on DS is estimated to be Holocene by Y-1020 and Y-1033 (p. 247) on the basis of offset drainages and well–defined scarps on surfaces of Holocene deposits. Y-1033 (p. 250) reported that the morphology of scarps determined from measured topographic profiles suggests an age of middle to late Holocene (1.5 ka to 6 ka) or post–early Holocene for the youngest surface rupture. Post–early Holocene displacement is also indicated by scarps on both alluvial fans that are probably early Holocene and on younger alluvium deposited in channels incised into these alluvial fans (Y-1033, p. 254). Y-861 (p. 140-141) thought that "Recent" displacement along DS is indicated by scarps trending across alluvial surfaces, by springs and bogs, and by two carbonate–cemented conglomerates (Pleistocene?) that suggest post–lake uplift and tilting. One of these conglomerates is sparsely preserved in Soldier Canyon and dips west; the other crops out above the floor of Deep Springs Valley (Y-861, p. 140-141).

Fault scarps on Quaternary alluvial fans are also shown by Y-484 (their Qf deposits) and by Y-870 (his Qf deposits); fault scarps on early to middle and (or) late Pleistocene surfaces are shown by Y-853 (their Q_{1-2} surfaces with estimated ages between 10 ka and 1.5 Ma). Springs coincide with or parallel some scarps, especially those adjacent to Deep Springs Lake (Y-870).

Y-238 portrayed some fault traces as being in Tertiary deposits and as having been identified by previous mapping. South of lat 37°15′N. (south of Deep Springs playa), DS is concealed by Quaternary alluvial–fan deposits according to Y-869. The exception is one short (0.5 km to 0.8 km long) section that may have experienced Quaternary (Y-869) or perhaps Holocene displacement (Y-762, p. 9).

Deep Springs fault (DS) — Continued

On the basis of topographic position and lithologic composition of fluvial gravel deposits interbedded with tephra correlated with the Bishop ash (740 ka) and preserved in present–day wind gaps in the Inyo Mountains, Y-651(p. 30, 42) and Y-861 (p. 141) concluded that streams draining the White Mountains on the western side of Deep Springs Valley once flowed across Deep Springs Valley and probably into Eureka Valley across Gilbert Summit (Cottonwood Creek), south of Chocolate (Piper?) Mountains (Wyman Creek), and across Soldier Pass (unnamed creek). This drainage pattern was disrupted by uplift on DS since 740 ka. The uplift has resulted in ponding in Deep Springs Valley or capture of drainages into Fish Lake Valley (Y-651, p. 30, 42; Y-861, p. 141).

Slip rate: Several minimum apparent vertical slip rates have been estimated for DS on the basis of a variety of stratigraphic markers and assumptions as noted in the following paragraphs in which the rates are discussed in order of decreasing unit age.

Y-651 (table 2, p. 37, 40) estimated a minimum apparent vertical slip rate of 0.06 to 0.07 mm/yr since 10 Ma to 12 Ma on the basis of the elevation of a basalt of this age on Chocolate (Piper?) Mountain and its inferred elevation beneath Deep Springs Valley.

Y-651 (p. 37, 40) estimated a minimum apparent vertical slip rate of 0.13 to 0.16 mm/yr for DS at Soldier Pass using a minimum vertical displacement determined from the elevation of bedrock in the Inyo Mountains and its inferred elevation beneath Deep Springs Valley and assuming that all displacement has occurred since 10 Ma to 12 Ma.

A minimum late Quaternary (since 740 ka) apparent vertical slip rate of 0.24 mm/yr was estimated for DS south of Chocolate (Piper?) Mountain by Y-1033 (p. 254). This estimate is based on at least 180 m of uplift of fluvial gravels interbedded with pumice fragments tentatively correlated with Bishop ash (740 ka) by M. Reheis (personal commun., 1989, *cited by* Y-1033, p. 254). Y-1033 (p. 254) recognized that this is a minimum late Quaternary rate because the Bishop ash fragments were eroded and deposited with the gravel some time after eruption of the ash at 740 ka.

Y-651 (table 2, p. 37, 40) calculated a minimum apparent vertical slip rate of 0.3 mm/yr since 740 ka for DS south of Chocolate (Piper?) Mountain. This estimate is based on the elevation difference (201 m; 660 ft) across the fault between uplifted fluvial gravel that contains Bishop ash and the floor of Deep Springs Valley.

Y-651 (p. 40) noted that the apparent vertical slip rate since 740 ka has probably been nearly twice the post–Miocene apparent vertical slip rate and suggested that this apparent difference could result for one or more of the following reasons. (1) The calculated post–Miocene rate is too low because of significant erosion of rocks from the footwall. (2) Displacement along DS actually began after 6 Ma rather than beginning immediately after the basalt erupted at 10 Ma to 12 Ma and concurrently with right–lateral displacement along the Fish Lake Valley fault (FLV), which began between 8.2 Ma and 11.9 Ma. (3) The post–740–ka rate is indeed faster than the post–Miocene rate (Y-651, p. 36, 42).

Recurrence interval: No information.

Range-front characteristics: The western front of the Inyo Mountains (east of long 118°W.) is portrayed by Y-853 as a tectonically active, major range front that is characterized by "fault juxtaposition of Quaternary alluvium against bedrock, fault scarps and lineaments on surficial deposits along or immediately adjacent to range front, a general absence of pediments, abrupt piedmont–hillslope transitions, steep bedrock slopes, faceted spurs, wineglass valleys, and subparallel systems of high–gradient, narrow, steep–sided canyons orthogonal to range front." The map by Y-238 shows part of DS as lineaments bounding a linear range front. Y-1033 (p. 246) noted that this range front is linear and very steep. Y-862 (p. 516, *cited by* Y-872, p. 9 and Y-1033, p. 246) noted "great triangular facets" along the front. These facets and wineglass valleys are interpreted by Y-1033 (photo 3, p. 247, 254) as evidence for recurrent displacement along DS.

Deep Springs fault (DS) — Continued

Analysis: Aerial photographs (Y-238, p. 2, scales 1:24,000 to 1:80,000; Y-762, scale about 1:26,000; Y-853, scales 1:115,000 to 1:124,000 and 1:58,000; Y-1033, scale about 1:26,000). Field observations (Y-861; Y-872, p. 4, 18). Limited field mapping (Y-1033). Measurement of topographic scarp profiles (Y-1033). Estimates of ages of deposits and surfaces using soil development, rock varnish, pavement, gravel weathering, and surface preservation compared to similar characteristics of dated deposits or surfaces on the western side of Silver Lake (Y-1033, p. 250-254). Seismic refraction survey (Y-872, p. 4, 18-26). Gravity survey (Y-872, p. 4, 26-27). Magnetic survey (Y-872, p. 4, p. 26-27).

Relationship to other faults: The Fish Lake Valley fault (FLV) is about 5 km northeast of DS. Y-1033 (p. 248) suggested that FLV may influence displacement along DS (e.g., the relatively wide zone at the northern end of DS with displacement apparently distributed across it). Y-651 (p. 40) suggested that Deep Springs Valley "may represent a rhombochasm in the southern White Mountains between the right–oblique [FLV] and the right–lateral Owens Valley fault zone to the west." Y-861 (p. 140) also proposed that Deep Springs Valley may be connected to Fish Lake Valley, either directly or through Eureka Valley. The north–striking portion of DS along the range front south of Soldier Pass turns and becomes a northeast–striking fault through Soldier Pass. This northeast–striking fault coincides with elevation differences within the Inyo Mountains (Y-484; Y-861, p. 141, *citing* Nelson, oral commun., 1961).

The maps by Y-238 and Y-484 show a northwest–striking, left–lateral fault that extends from the northern end of Deep Springs Valley to FLV. This fault is indicated to be in Tertiary deposits and identified from previous mapping (Y-238) or in Jurassic rocks (Y-484). North–striking traces of DS appear to terminate at this left–lateral fault (Y-238). Two additional northeast–striking traces are shown by Y-238 and Y-484. These two traces are located south of the northeast–striking fault described above and north of Chocolate (Piper?) Mountain. Y-238 indicated that these two faults have down–to–the–north vertical displacement. The structural relationships among these faults and DS are not known.

Faults in DS are approximately parallel to fault traces to the east in northwestern Eureka Valley, the Eureka Valley West fault (EURW) (Y-484; Y-853).

Y-762 (p. 6) concluded that faults along the western side of Deep Springs Valley have probably been inactive since middle to late Pleistocene (in contrast to DS, which has evidence for Holocene displacement). Y-872 (p. 10) noted that faults on the western side of Deep Springs Valley are "almost entirely concealed by alluvium." The much larger size of alluvial fans along the western side of Deep Springs Valley when compared to those on the eastern side of the valley indicates eastward tilting along DS and supports the conclusion that the most–recent rate of activity has been higher along DS than along faults on the western side of Deep Springs Valley (Y-762, p. 6; Y-872, p. 10). Y-862 (p. 516, *cited by* Y-872, p. 10) estimated that the main fault on the western side of Deep Springs Valley has a maximum displacement of 427 m (1,400 ft).

East Belted Range fault (EBR)

Plate or figure: Plate 1.

References: Y-813: Reheis, 1992 (pls. 1 and 2); Y-853: Dohrenwend and others, 1992. Not shown by Cornwall, 1972 (Y-232) nor by Ekren and others, 1971 (Y-5).

Location: 80 km/29° (distance and direction of closest point from YM) at lat 37°28′N. and long 116°00′W. (location of closest point). EBR is located along the eastern side of the Belted Range at its junction with both Monotony Valley and the northern part of Emigrant Valley.

USGS 7-1/2′ quadrangle: Belted Peak, Groom Mine NW, Monotony Valley, White Blotch Springs.

Fault orientation: EBR strikes generally north–northwest (Y-813; Y-853). The very southern end of EBR strikes north–northeast (Y-813).

Fault length: The length of EBR is 26 km as estimated from Y-813 and Y-853, but the fault does not have continuous surficial expression over this entire length.

Style of faulting: No information.

Scarp characteristics: EBR is shown as east– or southeast–facing scarps (Y-813).

Displacement: No information.

Age of displacement: The northern part of EBR is shown by Y-853 as fault–related lineaments on Quaternary depositional or erosional surfaces and as faults juxtaposing Quaternary alluvium against bedrock. The southern part of EBR is shown by Y-813 as weakly expressed lineaments or scarps on surfaces of Quaternary deposits.

Slip rate: No information.

Recurrence interval: No information.

Range-front characteristics: No information.

Analysis: Aerial photographs (Y-813, p. 4, scales 1:62,500 to 1:80,000; Y-853, scales 1:115,000 to 1:124,000 and 1:58,000).

Relationship to other faults: The structural relationships between EBR and other faults in the area are not known. These faults include the north– to north–northeast–striking Belted Range fault (BLR) on the western side of the Belted Range immediately west of EBR, the north–northeast– to northeast–striking Chalk Mountain fault (CLK) along the western side of Chalk Mountain immediately east of EBR, the northeast–striking Emigrant Valley North fault (EVN) in northern Emigrant Valley southeast of EBR, and the north–striking Oak Spring Butte faults (OAK) north of Yucca Flat and on the eastern side of the Belted Range immediately south of EBR.