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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

AERIAL PHOTOGRAPHIC INTERPRETATION OF LINEAMENTS AND FAULTS IN LATE CENOZOIC DEPOSITS IN THE EASTERN PARTS OF THE SALINE VALLEY 1:100,000 QUADRANGLE, NEVADA AND CALIFORNIA, AND THE DARWIN HILLS 1:100,000 QUADRANGLE, CALIFORNIA

By

Marith C. Reheis

Open-File Report 90-500

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ABSTRACT

Faults and fault-related lineaments in Quaternary and late Tertiary deposits in the southern part of the Walker Lane are potentially active and form patterns that are anomalous compared to those in most other areas of the Great Basin. Two maps at a scale of 1:100,000 summarize information about lineaments and faults in the area around and southwest of the Death Valley-Furnace Creek fault system based on extensive aerial-photo interpretation, limited field investigations, and published geologic maps.

There are three major fault zones and two principal faults in the Saline Valley and Darwin Hills 1:100,000 quadrangles. (1) The Death Valley-Furnace Creek fault system and (2) the Hunter Mountain fault zone are northwest-trending right-lateral strike-slip fault zones. (3) The Panamint Valley fault zone and associated Towne Pass and Emigrant faults are north-trending normal faults. The intersection of the Hunter Mountain and Panamint Valley fault zones is marked by a large complex of faults and lineaments on the floor of Panamint Valley. Additional major faults include (4) the north-northwest-trending Ash Hill fault on the west side of Panamint Valley, and (5) the north-trending range-front Tin Mountain fault on the west side of the northern Cottonwood Mountains.

The most active faults at present include those along the Death Valley-Furnace Creek fault system, the Tin Mountain fault, the northwest and southeast ends of the Hunter Mountain fault zone, the Ash Hill fault, and the fault bounding the west side of the Panamint Range south of Hall Canyon. Several large Quaternary landslides on the west sides of the Cottonwood Mountains and the Panamint Range apparently reflect slope instability due chiefly to rapid uplift of these ranges.

INTRODUCTION

The site being evaluated as a potential high-level nuclear waste repository at Yucca Mountain, Nevada, lies in a tectonic province in the western Great Basin called the Walker Lane belt (Stewart, 1987). This belt, which includes the Walker Lane as originally defined (Locke and others, 1940), has long been recognized as an area of active faulting containing patterns of faults that are anomalous with respect to the typical fault patterns in the central and eastern parts of the Great Basin (Gianella and Callaghan, 1934; Albers, 1967; Stewart, 1987). Little work has been done to identify and characterize Quaternary faults in the southern part of the belt, with the exception of faults in the Death Valley-Furnace Creek (DVFC) fault system and faults in and near the Nevada Test Site. These maps are part of a study to locate and characterize Quaternary faults within a 100-km radius of Yucca Mountain including the southern part of the Walker Lane belt. Previously published maps in this study include part of the Benton Range 1:100,000 quadrangle and the Goldfield, Last Chance Range, Beatty, and Death Valley Junction 1:100,000 quadrangles (Reheis and Noller, in press). The study is supported in part by the U.S. Department of Energy as part of the Yucca Mountain Project under Interagency Agreement DE-AI08-78ET44802.

Fault-related lineaments in Quaternary and late Tertiary deposits were identified on stereopairs of black-and-white aerial photographs at scales ranging from 1:24,000 to 1:80,000. Lineaments are most commonly recognized by linear scarps or topographic breaks, but they may also be recognized by linear patterns of drainages, tonal contrasts, vegetation, and surface cracks. The lineaments were transferred to 1:24,000- and 1:62,500-scale topographic maps by hand and by using the Kern PG-2 stereographic plotter. These maps were then photographically reduced and compiled onto 1:100,000-scale base maps.

A numerical scale was devised in order to assign subjective degrees of prominence to the lineaments (see map explanation). Prominent topographic lineaments, such as straight segments of range fronts, are assigned the number 0. Such lineaments typically separate late Cenozoic deposits from bedrock; in this setting, they suggest Quaternary faulting. Topographic lineaments within bedrock are only mapped where they are associated with known deposits or fault systems of late Cenozoic age. Scarps and lineaments in Quaternary deposits are described on a scale of 1 to 4, the prominence of the lineament increasing with the assigned number. Limited field observations indicate that high-numbered scarps and lineaments tend to correspond with faults that show either recurrent movement or relatively recent movement. Low-numbered scarps and lineaments are less likely to reflect actual faults unless they occur in the vicinity of high-numbered lineaments. Scarps and lineaments in Tertiary deposits are described in a similar manner on a scale of 6 to 9. Finally, the scarps and lineaments are compared to faults on published maps. Scarps and lineaments in Quaternary and Tertiary deposits that coincided with mapped faults are assigned the numbers 5 and 10 respectively. In general, mapped faults correspond in prominence to scarps and lineaments rated 3 or 4. The few mapped Quaternary faults that had not been identified during aerial-photo interpretation were added to the map and assigned the number 5. Most of these additions are along the DVFC fault system and are based on new work (G.E. Brogan, K.S. Kellogg, and C.L. Terhune, U.S. Geological Survey, written commun., 1989) that employed 1:12,000-scale low-sun-angle photography to map youthful faulting within this fault system in fine detail.

DISCUSSION OF LINEAMENTS AND FAULTS

Three major fault zones occur within the map area. The Death Valley-Furnace Creek (DVFC) fault system (Hunt and Mabey, 1966) trends northwest across the eastern part of the Saline Valley quadrangle. The Hunter Mountain (HM) fault zone (Burchfiel and others, 1987) trends northwest across the western part of the Saline Valley quadrangle and extends south into the Darwin Hills quadrangle, where it bounds the west front of the northern Panamint Range. The Panamint Valley (PV) fault zone (Albee and others, 1981) trends north across the Darwin Hills quadrangle, where it bounds the west front of the central Panamint Range. Faults and lineaments of the PV fault zone that lie within the Panamint Range offset Pliocene to Quaternary megabreccias (Albee and others, 1981), but apparently have been inactive in the late Quaternary. From the intersection of the PV and HM fault zones at Wildrose Canyon, splays of the PV fault zone extend north and merge with the Towne Pass and Emigrant Faults on the west side of Tucki Mountain (Wernicke and others, 1986: Hamilton, 1988). The DVFC fault system and the Hunter Mountain fault zone are right-lateral strike-slip fault zones, whereas the Panamint Valley fault zone consists mainly of normal faults that are probably a continuation and (or) a reactivation of the Tucki Mountain detachment fault (Hamilton, 1988).

Many north- to north-northwest-trending faults lie west of the PV fault zone in Panamint Valley. The Ash Hill fault is continuous for over 45 km. It occurs mainly in alluvium on the west side of Panamint Valley and offsets deposits down to the west. One north-northwest-trending segment of this fault near the mouth of Snow Canyon displays evidence of right-lateral movement. Another continuous fault, previously unmapped, trends north-northwest for 15 km on the east side of Panamint Valley from Wildrose Canyon to Panamint Canyon and also shows evidence of right-lateral movement. This fault appears to be an extension of the HM fault zone, as shown on the map. Two large clusters of north-trending faults and lineaments extend across the floor of Panamint Valley between the PV fault zone and the Ash Hill fault. The northern cluster, including the grabens near the mouth of Wildrose Canyon, may be a surface response to stresses concentrated at the intersection of the PV and HM fault zones. Some of the northwest-trending faults and lineaments in this cluster are arranged in a left-stepping en echelon pattern, suggesting a component of right-lateral movement in this area.

The area between the HM fault zone and the DVFC fault system in the Saline Valley quadrangle contains numerous north- to north-northeast-trending and a few northwest-trending lineaments that bound ranges and small structural blocks within ranges. Many of the lineaments appear to be faults that offset Quaternary deposits. Only two of these, that bounding the east side of Racetrack Valley and the Tin Mountain fault bounding the west side of the northern Cottonwood Mountains, have been previously mapped as faults. An additional fault that is mainly contained within bedrock trends north-northeast in the northwest corner of the map area. The north- to north-northeast-trending scarps recognized on aerial photographs appear to display only dip-slip motion. Most of the faults and scarps in this area are downthrown to the west and apparently reflect westward-directed extension adjacent to the structurally high Cottonwood Mountains.

A pair of west-northwest-trending lineaments that lie on the north side of Hunter Mountain are mainly contained within granitic rocks of the Hunter Mountain batholith (Streitz and Stinson, 1974). These lineaments are parallel to the nearby strike-slip HM fault zone and may be shear zones like those in the granitic rocks of the Sylvania Mountains to the north that are adjacent to the DVFC fault system (Reheis and Noller, in press).

Several large Quaternary landslides were mapped in the Saline Valley and Darwin Hills quadrangles. These landslides are remarkable for their size and their occurrence in a very arid region; similar landslides have not been observed in this region (see Reheis and Noller, 1990). One group of landslides occurs on the west side of the Cottonwood Mountains; of these, the landslide west of Tin Mountain was previously mapped by Burchfiel (1966, 1969). This landslide appears to be the youngest of all those in the map area based on the preservation of hummocky topography and closed depressions. The other landslides, including one in the southern Cottonwood Mountains and a group south of Wildrose Canyon in the Panamint Range (in part mapped by Albee and others, 1981), lie east of the active range-front faults and are probably much older than those near Tin Mountain. The association of these landslides with Quaternary faults suggests that they are related to rapid uplift along the west sides of the Cottonwood Mountains (Burchfiel, 1966) and the Panamint Range.

The orientations of the right-lateral strike-slip faults and the normal faults and lineaments in the Saline Valley and Darwin Hills quadrangles are consistent with an approximate west or west-northwest direction of least principal stress. This conclusion is consistent with that reported by Reheis and Noller (in press) for the DVFC fault zone north and east of the map area, and is similar to a N. 80° W. least-principal-stress direction reported by Zoback and Zoback (1980) in the Coso Hills just west of the southern part of the map area. They also reported a least-principal-stress direction of N. 45° W. in Death Valley east of the map area, but this interpretation was based on striations on smooth, curved bedrock surfaces or "turtlebacks" which may have formed in pre-Quaternary time.

The most active faults in the Saline Valley and Darwin Hills quadrangles at present appear to be, from north to south, (1) the DVFC fault system, (2) the Tin Mountain fault, (3) the northwest and southeast ends of the HM fault zone, (4) the Ash Hill fault, and (5) the western range-front fault of the Panamint Range south of Hall Canyon.

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MAP SYMBOLS

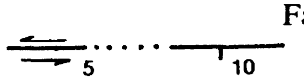
Quaternary landslide deposit. Symbol queried where uncertain. Contact dashed where inferred

Lineament--Dots connect linear features interpreted to be related. Bar indicates facing direction of scarp. Arrows show inferred direction of strike-slip motion. Number indicates:

0 — Topographic lineament, either bounding a linear range front or, rarely, within bedrock

1-4 — Lineament or scarp in Quaternary deposits; number increases with prominence of lineament

6-9 — Lineament or scarp in Tertiary deposits; number increases with prominence of lineament



Fault--dashed where inferred, dotted where concealed. Bar indicates downthrown side. Arrows show direction of strike-slip motion. Number indicates:

5 — Fault in Quaternary deposits identified from previous mapping; generally equivalent in prominence to lineaments number 3 or 4

10 — Fault in Tertiary deposits identified from previous mapping; generally equivalent in prominence to lineaments numbered 8 or 9