NEW PERSPECTIVES ON QUATERNARY FAULTING IN THE SOUTHERN WALKER LANE, NEVADA AND CALIFORNIA

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Introduction

A preliminary survey of aerial photographs of the southern Walker Lane began in late 1986. The purpose of this survey is to determine the nature and scope of future studies required to (1) ascertain whether the apparent concentration of Quaternary faults in and near the Nevada Test Site is real or is simply a result of the greater effort invested in mapping Quaternary deposits in that area, and (2) determine whether faults in the southern Walker Lane are active and could produce significant earthquakes. The survey is focused on the area extending south from Lone Mountain to Pahrump Valley and east from the Furnace Creek fault zone to an irregular line passing through the Cactus Range and Pahute Mesa.

Lineaments and scarps were identified on stereopairs of black-and-white aerial photographs at scales of 1:80,000 or 1:60,000. The lineaments and scarps were plotted on 1:24,000- and 1:62,500-scale topographic maps using a PG-2 plotter, and were color-coded according to distinctness and occurrence in Quaternary or Tertiary deposits (age assignments based on appearance in aerial photographs and on existing geologic maps). Additional lineaments identified on the topographic maps were also plotted. Areas of particular interest were selected for more detailed study using larger-scale aerial photographs. Most of the lineaments and scarps identified in the survey, although referred to as faults in this paper, have not been checked in the field.

Description of Newly Found Faults

The area studied thus far extends south from Lone Mountain to Sarcohatus Flat and west from Pahute Mesa to Fish Lake Valley (fig. 1), an area that roughly corresponds to the Goldfield section of the Walker Lane tectonic belt, as defined by Stewart (1987). This section has been characterized by a conspicuous lack of both dip-slip basin-range faults and northwest-trending strike-slip faults in comparison to other sections of the Walker Lane belt (Carr, 1984; Stewart, 1987).

Our studies have revealed many clusters of previously unmapped Quaternary faults within the Goldfield section of the Walker Lane belt. Most of these faults trend northeast, but some faults near the Furnace Creek fault zone and on or north of Pahute Mesa trend north-northwest to north-northeast (fig. 1). The newly found faults include range-front faults and faults in Quaternary fan and basin-fill deposits.

Northeast-trending range-front faults identified in this study lie along the north and (or) west sides of Paymaster and Clayton Ridges, the Montezuma Range, Gold and Magrunder Mountains, and the Grapevine Mountains, and along the southeast side of the General Thomas Hills and the Palmetto Mountains (fig. 1). Interpretation of aerial photographs and limited field data suggest that most of these faults place bedrock against Quaternary fans, and that they are...
normal and dip steeply (70-90°) northwest. Left-lateral oblique slip, suggested by crenulations and slickensides within bedrock shear zones, has been seen only on the northeast end of the Clayton Ridge fault and the southwest end of the Stonewall Mountain fault. In addition, a horizontal mine adit at Stonewall Mountain penetrates about 65 m of unconsolidated Quaternary fan alluvium. Near the end of the shaft, Tertiary rhyolitic tuff appears to have been thrust over the alluvium at an angle greater than 70°, indicating high-angle reverse movement on part of the range-front fault. Late Pleistocene to Holocene alluvial fans abut several range fronts, such as parts of Paymaster and Clayton Ridges and Stonewall Mountain; they appear to bury older fans, suggesting fault movements in late Quaternary time (as described elsewhere by Bull, 1964). Layers of sheared alluvium and (or) colluvium were observed to overlie sheared bedrock along the Clayton Ridge and Grapevine Mountains faults. Variations in the particle size, extent of shearing, and cementation of these layers suggest that the layers become younger and less disturbed by faulting away from the bedrock; thus, they appear to record a succession of fault movements rather than one episode of faulting.

Northeast-trending faults found in this study in alluvial fans and basin-fill deposits commonly occur in clusters. Areas with fault clusters include Clayton Valley, the valleys east and west of the Montezuma Range, and the valleys north of the Goldfield Hills and Stonewall Mountain (fig. 1). Most of these faults are short and cut surfaces of only one age. Notable exceptions are (1) the scarps in Clayton Valley, which are relatively long and appear to offset surfaces of several ages, and (2) the faults east of the Montezuma Range that define the Palmetto graben. These faults appear to offset one fan and two graben-fill deposits which are middle to late Pleistocene in age; offsets are successively smaller with decreasing age of the deposit.

Of the north- to north-northeast-trending faults near the Furnace Creek fault zone, only those at the northern end of Fish Lake Valley have been observed in the field. Prominent faults shatter the surface of the middle (?) Pleistocene Indian Creek fan on the northwest side of the valley. Some of these faults offset deposits down to the east, others offset deposits down to the west, but thus far none show clear evidence of strike-slip motion. Faults on the northeast side of the valley (some of which were mapped by Robinson and others, 1976) displace sediments ranging from late Pliocene to Holocene in age down to the west. These faults are here called the Emigrant Peak fault zone (Reheis, 1988). One of the faults in this zone appears to be offset in a left-lateral sense by a north-northwest-trending tear fault with Holocene displacement.

Most of the north-northwest- to north-northeast-trending lineaments and scarps on the west side of Pahute Mesa have not been observed in the field. Two sets of faults in the Oasis Valley have been observed to offset early to middle Pleistocene fan deposits. The eastern fault in Oasis Valley displaces old dissected fan gravel (QTa of Hoover and others, 1981) about 4 m down to the east, and may also displace younger deposits (Q2b or Q2c of Hoover and others, 1981). The western faults bound a narrow graben in middle Pleistocene fan deposits (Q2b or Q2c); this graben may be inset within an ill-defined larger graben that displaces older deposits.
Discussion and Preliminary Interpretation

The geomorphic and stratigraphic evidence discussed above suggests that many of the newly found faults in the Goldfield section of the Walker Lane belt have been recently active and have experienced recurrent movement in Quaternary time. Thus, these faults could generate earthquakes in the future. Some earthquakes as large as magnitude 5.0 recorded between 1931 and 1974 (W.J. Carr, written commun., 1987) were located near two areas of Quaternary displacement: the Emigrant Peak fault zone in northeast Fish Lake Valley and the faults on the northwest side of the Grapevine Mountains.

The many northeast-trending faults east of the Furnace Creek fault zone (fig. 1) are difficult to interpret. One possibility is that they are conjugate shears to the Furnace Creek fault zone, along which the least principal stress would be west-northwest and the greatest principal stress north-northeast (Wright, 1976; Zoback and Zoback, 1980; Carr, 1984). In such a stress field, however, northeast-trending faults should have a component of left-lateral motion in addition to normal dip-slip motion. Although much more field work needs to be done, at present there is little evidence to support left-lateral motion on the northeast-trending faults in the Goldfield section, with the exceptions mentioned above at Clayton Ridge and Stonewall Mountain. An alternative possibility is that the northeast-trending faults are a simple expression of dip-slip motion perpendicular to a northwest direction of least principal stress. If this is so, then east of the Furnace Creek fault zone the direction of least principal stress may be different from that along the Furnace Creek fault zone.

The north- to north-northeast-trending scarp s and lineaments adjacent to the Furnace Creek fault zone appear to be normal dip-slip faults; their strikes are consistent with the interpretation that they are pull-apart faults related to strike-slip movement on the Furnace Creek fault zone. Faults with this orientation are common in Fish Lake Valley and in the foothills of the adjacent Silver Peak Range, especially at the northern end of the valley, where the Furnace Creek fault zone appears to die out. The north-trending faults in northern Fish Lake Valley may function as pull-apart faults in a giant right step between the northern end of the right-lateral Furnace Creek fault zone and the southern ends of the right-lateral Bettles Well and Soda Springs Valley faults to the north. This right step occurs in the area where Stewart (1985) described right-lateral offset along the Excelsior and Coaldale fault zones. The existence of the Silver Peak caldera (fig. 1) and associated volcanic rocks adjacent to northern Fish Lake Valley may indicate significant extension in this area (Carr, 1984).

North-trending faults in the area of Pahute Mesa (fig. 1) are most likely a continuation of the north-trending faults characteristic of the Basin and Range province to the north and east of the Walker Lane. Earthquakes and movements on north- to north-northeast-trending faults triggered by underground nuclear explosions on Pahute Mesa had both dip-slip and right-lateral components (Hamilton and others, 1972). Thus, the north-trending faults in western Pahute Mesa in part may be strike-slip conjugate shears; field work, however, is needed to determine whether these faults have a component of lateral slip.
The generally northeast-trending faults east of the Furnace Creek fault zone and west of Pahute Mesa have a preferred down-to-the-northwest displacement. Of the range-front faults, only those bounding the southeast sides of the General Thomas Hills and the Palmetto Mountains (fig. 1) have displaced deposits down to the southeast. Faults along the General Thomas Hills appear inactive. Faults in intermontane basins in the study area either displace sediments down to the northwest or else bound grabens that have about equal displacements on both sides. The relatively uniform down-to-the-northwest sense of displacement could be interpreted to suggest that the faults in the Goldfield section of the Walker Lane belt are rooted in a detachment at depth.

References Cited


Figure 1. Physiography and Quaternary faults and lineaments of the southern Walker Lane. Previously mapped faults are taken mainly from Nakata and others (1982). Positions of Excelsior and Coaldale fault zones (EFZ and CFZ, respectively) from Stewart (1985). Faults west of Fish Lake Valley and Death Valley not shown. Data for least principal stress directions from Zoback and Zoback (1980). BWF, Bettles Well fault; SSVF, Soda Springs Valley fault; FCFZ, Furnace Creek fault zone; EPFZ, Emigrant Peak fault zone; PG, Palmetto graben; RVFZ, Rock Valley fault zone.