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Lawrence Berkeley Laboratory
UNIVERSITY OF CALIFORNIA

EARTH SCIENCES DIVISION

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March 1995

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Introduction

This report presents an examination of the geometry of the Hayward fault adjacent to the Lawrence Berkeley Laboratory and University of California campuses in central Berkeley. The fault crosses inside the eastern border of the UC campus. Most subtle geomorphic (landform) expressions of the fault have been removed by development, and by the natural processes of landsliding and erosion. Some clear expressions of the fault remain however, and these are key to mapping the main trace through the campus area. In addition, original geomorphic evidence of the fault's location was recovered from large scale mapping of the site dating from 1873 to 1897. Before construction obscured and removed natural landforms, the fault was expressed by a linear, northwest-trending zone of fault-related geomorphic features. There existed well-defined and subtle stream offsets and beheaded channels, fault scarps, and a prominent "shutter ridge". To improve our confidence in fault locations interpreted from landforms, we referred to clear fault exposures revealed in trenching, revealed during the construction of the Foothill Housing Complex, and revealed along the length of the Lawson Adit mining tunnel. Also utilized were the locations of offset cultural features. At several locations across the study area, distress features in buildings and streets have been used to precisely locate the fault. Recent published mapping of the fault (Lienkaemper, 1992) was principally used for reference to evidence of the fault's location to the northwest and southeast of Lawrence Berkeley Laboratory.

Fault-Related Landforms

Offset and beheaded streams. One of the most direct means of mapping strike-slip (lateral slip) faults is by the identification and alignment of deflected drainages along faultlines. Many drainages are offset by the Hayward fault, and these provide primary evidence of the fault's location. Before construction of the California Memorial Stadium in 1923, the largest intact channel offset along the fault's length was that of Strawberry Creek (Figure 1, location A-A'). This large, competent stream is offset 1100 feet by right-lateral motion. The channel of Blackberry Creek is offset 190 feet by faulting. These two channel offsets are the most prominent evidence of the fault's location adjacent to Lawrence Berkeley Lab. A number of more subtle stream offsets and deflections have been interpreted from the 1897 UC Berkeley Building and Grounds basemap upon which more recent cultural features and the Hayward fault have been superimposed (Figure 1.).

Two former channels of Strawberry Creek cross the Berkeley Campus. These offset channels are termed "beheaded" or "abandoned", since they have been cut off from the Strawberry Creek watershed. The beheaded channels (locations B, C; Figure 1) were described by Buwalda (1929). One is located along a line between the east entrance to UC Berkeley and the Mining Circle. This "Mining Circle Channel" is offset 1900 feet from Strawberry Canyon (Location B, Figure 1). A second (and older) beheaded channel of Strawberry Creek is located beneath Hearst Avenue (Figure 1, location C). The "Hearst

Avenue Channel" is offset 2400 feet from Strawberry Canyon. These landforms, and their deposits, provide clear evidence of the fault's location. Analysis of the morphology and ages of the beheaded and active Strawberry Creek channels also enables the quantification of both vertical and lateral deformation rates across the Hayward fault in Berkeley.

Several additional abandoned and offset stream channels are interpreted on Figure 1. The confidence of these interpretations varies, but where the offsetting fault is also located by additional evidence, the abandoned and offset streams increase confidence in the analysis.

Shutter ridge. Buwalda (1929) noted that the course of Strawberry Creek is deflected by a fault-bordering ridge of slope-base deposits, a *shutter ridge* (Located at **sr'-sr''**, Figure 1). The 1000-foot-long shutter ridge ranged in height from 16 to 28 feet. Buwalda documented both the fault's location and lithology of the shutter ridge during construction of the California Memorial Stadium. He found that the ridge contained serpentine fragments. No source of serpentine exists in the Strawberry Creek drainage, but serpentine is present in Hamilton Gulch, 1400 feet southeast. This required that "at a date so recent that the topography of the region was essentially that of today" the ridge deposits had moved at least 1,400 feet from the gulch.

Fault scarps. Fault scarps near the foot of the Berkeley Hills appear as abrupt increases in slope angle as shown by tight contour spacing (Figure 1). The crisp definition of several of these scarps indicates the recency of fault movement. The linear trend of these scarps also aids in locating the fault trace. Particularly clear is the east-facing scarp (at *sr*, Figure 1) on the uphill side of the Strawberry Creek shutter ridge

Offsets of Built Features.

Along the Hayward fault, built features such as roads, utilities, fences, and buildings are offset by the slow (0.2"/yr) "creep" motion of the Hayward fault. The phenomena of creep and attendant distress of built features provides an additional method for locating fault lines. A number of buildings in the UC Berkeley area have been offset. Most notably, a total of 14 inches of fault motion has accumulated across the UC Berkeley Memorial Stadium since construction in 1923. Fault motion is expressed as distress of interior and exterior walls and joints, and is particularly apparent in the offset of an expansion joint along the stadium's south rim. This deformation, together with preconstruction landform data, are combined to precisely locate the fault just southwest of the Lawrence Berkeley Laboratory (Figure 2).

Near the northwestern corner of the Lawrence Berkeley Laboratory site, the Highlander Apartment complex is offset by fault motion. The Highlander offset, in conjunction with the discovery of offset sidewalks, streets and foundations north of Blackberry Creek, and landform data, provide a high confidence fault location to the north and west of Lawrence Berkeley Laboratory (Figure 2).

Fault Exposures

Geotechnical investigations prior to construction of the Foothill Housing Project (Harding Lawson Associates, 1988) and study of exposures during construction provide additional information for the location of Hayward fault traces adjacent to Lawrence Berkeley Laboratory. Summary maps compiled from those observations (Williams, 1990; Williams and Hosokawa, 1992) were incorporated in this report. Evidence from direct exposure of the Hayward fault's primary traces are compiled in Figure 2. Additional information of the fault's location from pre-modification landforms and springs, and new evidence of fault creep, have confirmed many of the prior interpretations that were based primarily on exposures prior to and during construction in the fault zone.

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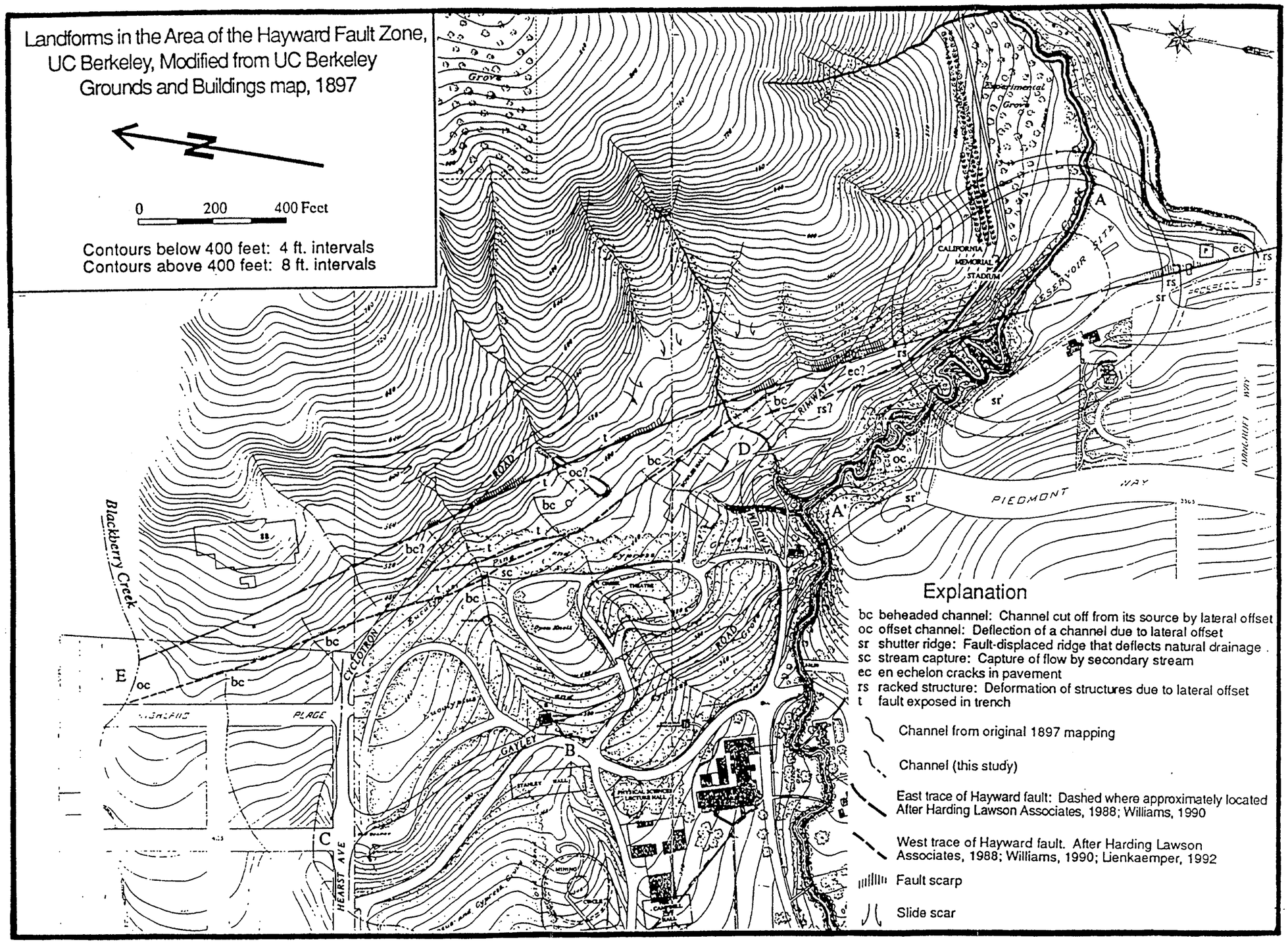
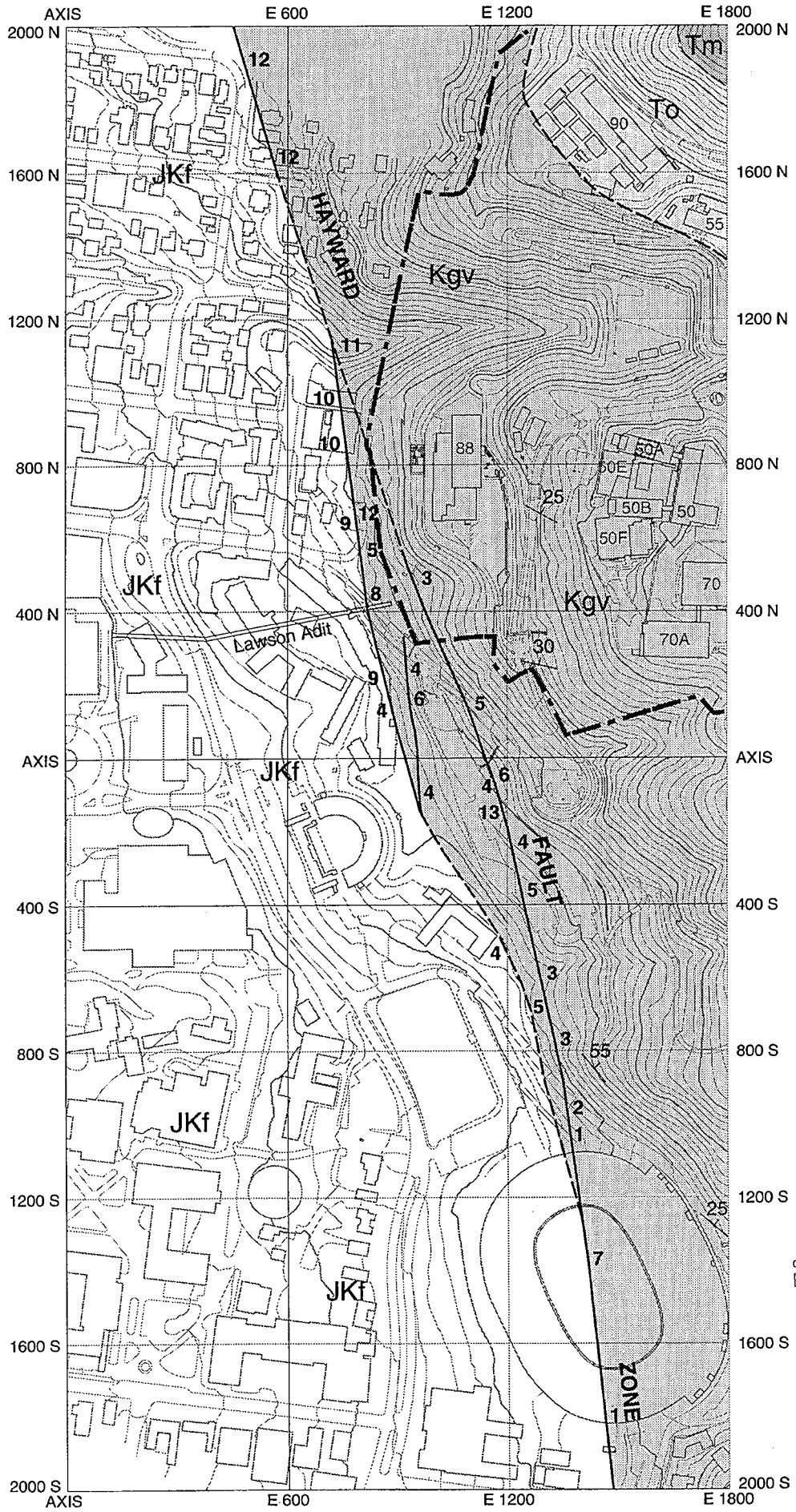

Landforms in the Area of the Hayward Fault Zone, UC Berkeley, Modified from UC Berkeley Grounds and Buildings map, 1897
N
0 200 400 Feet
Contours below 400 feet: 4 ft. intervals
Contours above 400 feet: 8 ft. intervals
Blackberry Creek
CALIFORNIA MEMORIAL STADIUM
PIEDMONT WAY
GAYLEY ROAD
CYCLOTRON ROAD
HEARST AVE
PLACE
A
A'
B
C
D
D'
E
bc
oc
sr
sc
ec
rs
t
Explanation
bc beheaded channel: Channel cut off from its source by lateral offset
oc offset channel: Deflection of a channel due to lateral offset
sr shutter ridge: Fault-displaced ridge that deflects natural drainage
sc stream capture: Capture of flow by secondary stream
ec en echelon cracks in pavement
rs racked structure: Deformation of structures due to lateral offset
t fault exposed in trench
Channel from original 1897 mapping
Channel (this study)
East trace of Hayward fault: Dashed where approximately located After Harding Lawson Associates, 1988; Williams, 1990
West trace of Hayward fault. After Harding Lawson Associates, 1988; Williams, 1990; Lienkaemper, 1992
Fault scarp
Slide scar

Figure 1.



Tm Moraga Formation

To Orinda Formation

Kgv Great Valley Group

JKf Franciscan Complex

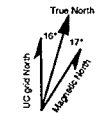
Contact, showing dip
Long-dashed where approximately located; short-dashed where gradational or inferred.

Fault, showing dip
Long-dashed where approximately located; short-dashed where inferred, dotted where concealed; queried where probable; double-queried where hypothetical. Small, bold numbers along the Hayward Fault match observation notes.

Strike and dip of beds

Boundary of Lawrence Berkeley Laboratory

authors: Preston Holland - LBL geology
Patrick Williams - Hayward Fault
original drawing date: 12/1/94
latest revision date: 2/7/95



APPROXIMATE MEAN DECLINATION, 1969

SCALE 1:9000

0 500 1000ft

CONTOUR INTERVAL 10 FEET
UNIVERSITY OF CALIFORNIA DATUM

Figure 2.

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