Complex Deformation along the Maacama Fault Zone, Part of the Young PAC-NAM Transform Boundary

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Abstract

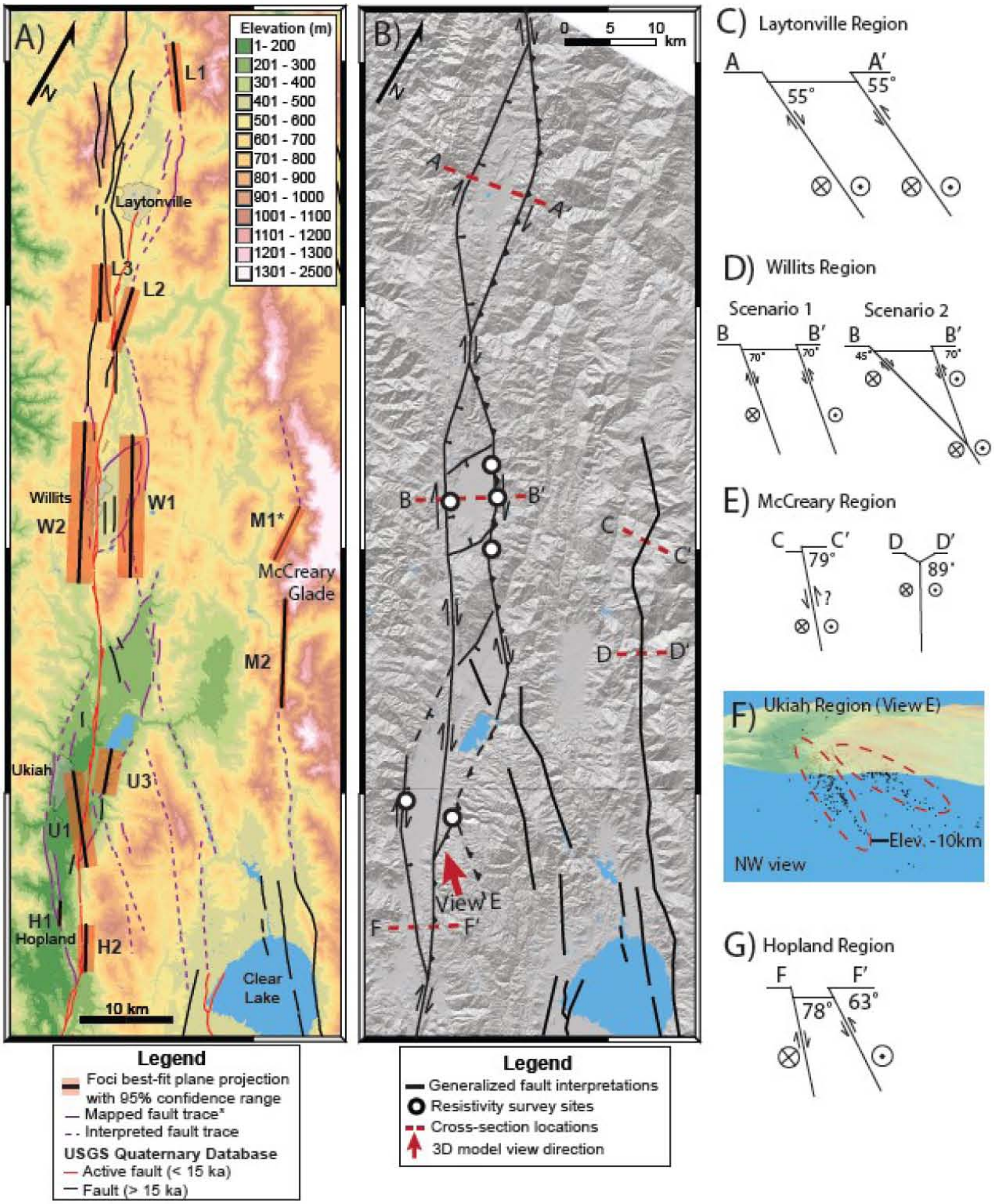
The Maacama Fault Zone (MFZ) is a relatively young, active portion of the Pacific-North American transform boundary in northern California, and is more diffuse and complex than previously assumed. The surface projection of tabular-shaped best-fit clusters of earthquake foci correlate with mapped geology and shallow resistivity profiles, and define numerous closely-spaced faults that bound rhombohedron-shaped basins interpreted to be active pull-apart basins (Figure 1 A, B).

Many of these faults have moderate to steep northeast dipping geometries with surface projections that coincide with subduction-related reverse faults outcrops (Figure 1 C-G). Modern right-lateral faults are interpreted to reactivate these reverse faults with high (Freymueller et al., 1999: ~13.9 mm/yr) displacement rates, in an area with equally high (Galehouse and Lienkaemper, 2003: 6.5 mm/yr) surface creep rates on certain fault segments. This surface creep is interpreted to be associated with weak hydrothermally altered minerals found in reactivated fault zones. Outcrops of these weak minerals outcrop along linear trends, but may not be continuous, causing a complex arrangement of creeping and seismogenic zones.

Geomorphic features such as beheaded and fish-hooked streams, which correlate with tabular surface projections of seismicity along the MFZ, indicate >8 km of cumulative dextral displacement. A smaller ~1200 m offset series of shutter ridges delineate a fault that is responsible for a portion of this displacement and indicates that fault segments generally transfer displacement and step to the right thereby permitting releasing junction kinematics required by the interpreted active pull-apart basins along the MFZ.

Understanding fault kinematics of the MFZ is necessary in order to properly assess seismic hazard in the area. The identification of more active faults will lower the apparent 7.4 mm/yr slip deficit, calculated as the difference between current geodetic and surface creep studies, but at the same time identify more active strands with their own associated hazards. Moreover, kinematics along this portion of the San Andreas Fault system may be characteristic of other young, rapid displacement continental transforms around the world.

Figure 1. *A) Digital elevation model showing surface projections of best-fit tabular clusters of earthquake foci along the Maacama Fault Zone. *Mapped fault traces are select faults from previous studies (Pampeyan et al., 1980; Upp, 1989). B) Shaded relief map with generalized faults highlighting distinct rhombohedron-shaped valleys that are bounded by faults, some of which are delineated by shallow resistivity surveys. C-G) Generalized cross-sections though fault zones at several regions along the Maacama Fault Zone, with dips determined from best-fit seismogenic clusters.*



A)
Elevation (m)
1- 200
201 - 300
301 - 400
401 - 500
501 - 600
601 - 700
701 - 800
801 - 900
901 - 1000
1001 - 1100
1101 - 1200
1201 - 1300
1301 - 2500
L1
Laytonville
L3
L2
Willits
W1
W2
M1*
McCreary Glade
M2
Ukiah
U3
U1
H1
Hopland
H2
Clear Lake
10 km
Legend
Foci best-fit plane projection with 95% confidence range
Mapped fault trace*
Interpreted fault trace
USGS Quaternary Database
Active fault (< 15 ka)
Fault (> 15 ka)
B)
0 5 10 km
A
A'
B
B'
C
C'
D
D'
View E
F
F'
Legend
Generalized fault interpretations
Resistivity survey sites
Cross-section locations
3D model view direction
C) Laytonville Region
A A'
55° 55°
D) Willits Region
Scenario 1
Scenario 2
B B' B B'
70° 70° 45° 70°
E) McCreary Region
C C' D D'
79° 89°
F) Ukiah Region (View E)
Elev. -10km
NW view
G) Hopland Region
F F'
78° 63°