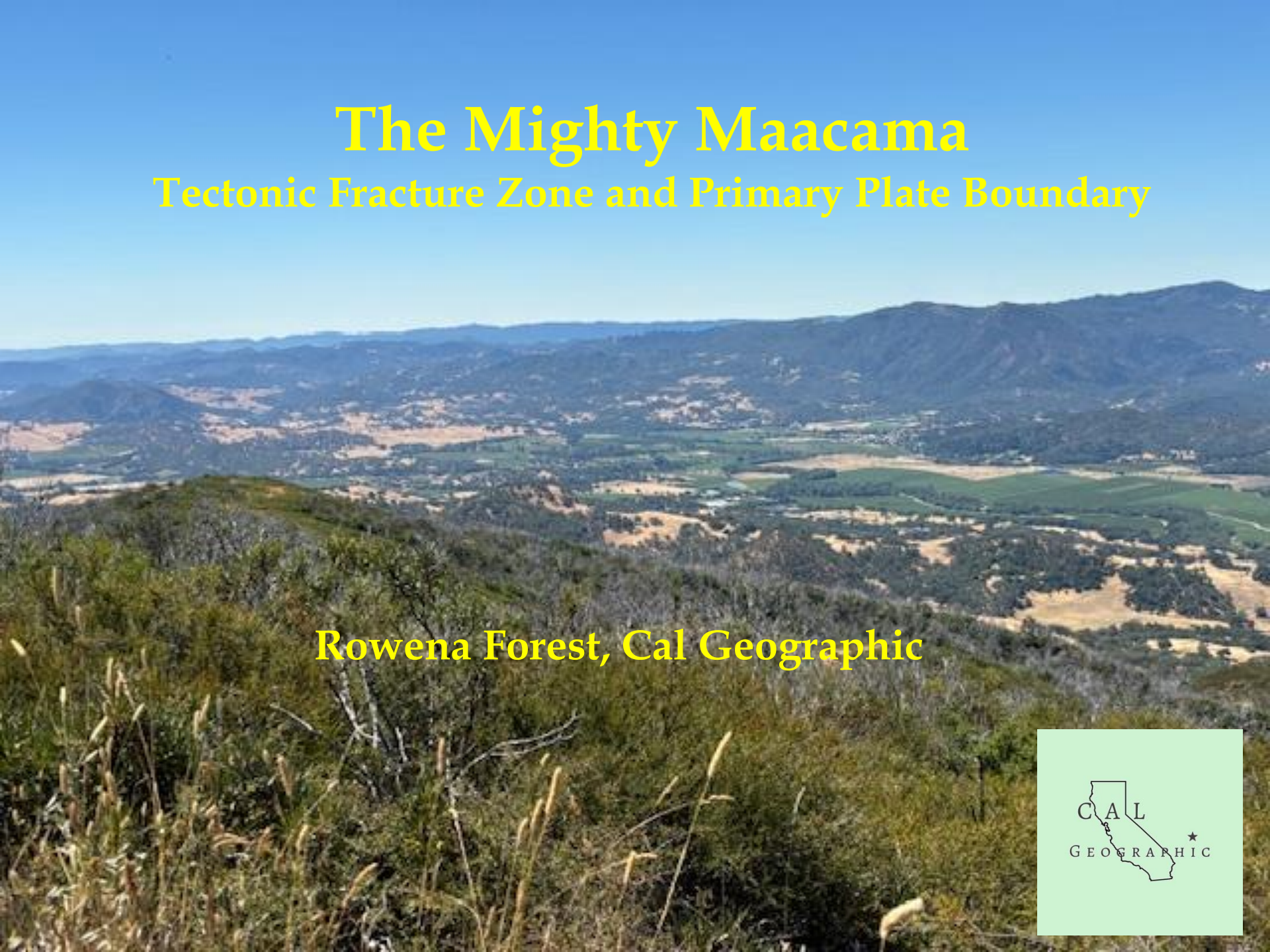
The Mighty Maacama

Tectonic Fracture Zone and Primary Plate Boundary



Rowena Forest, Cal Geographic

CAL GEOGRAPHIC

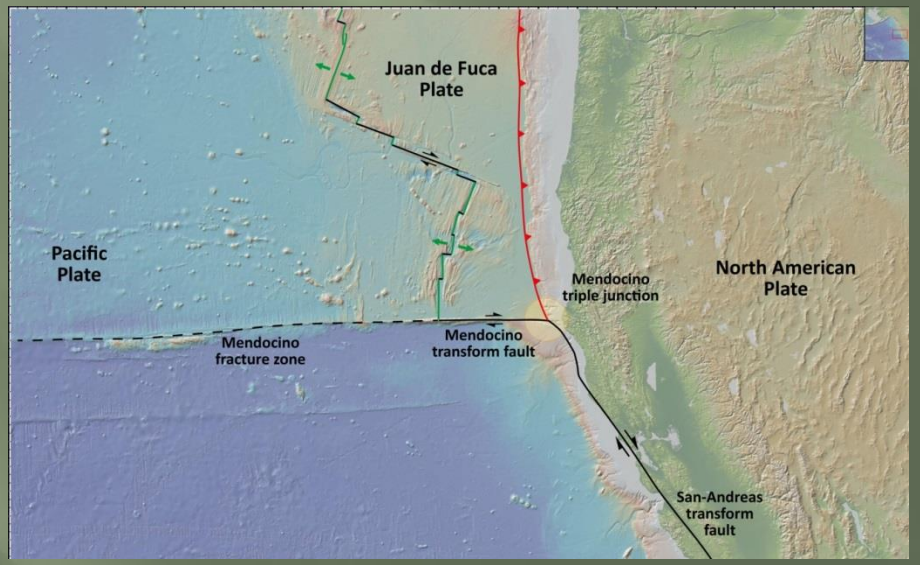
Mendocino Triple Junction

- **Point of convergence of three tectonic plates ~20 miles west of Cape Mendocino**

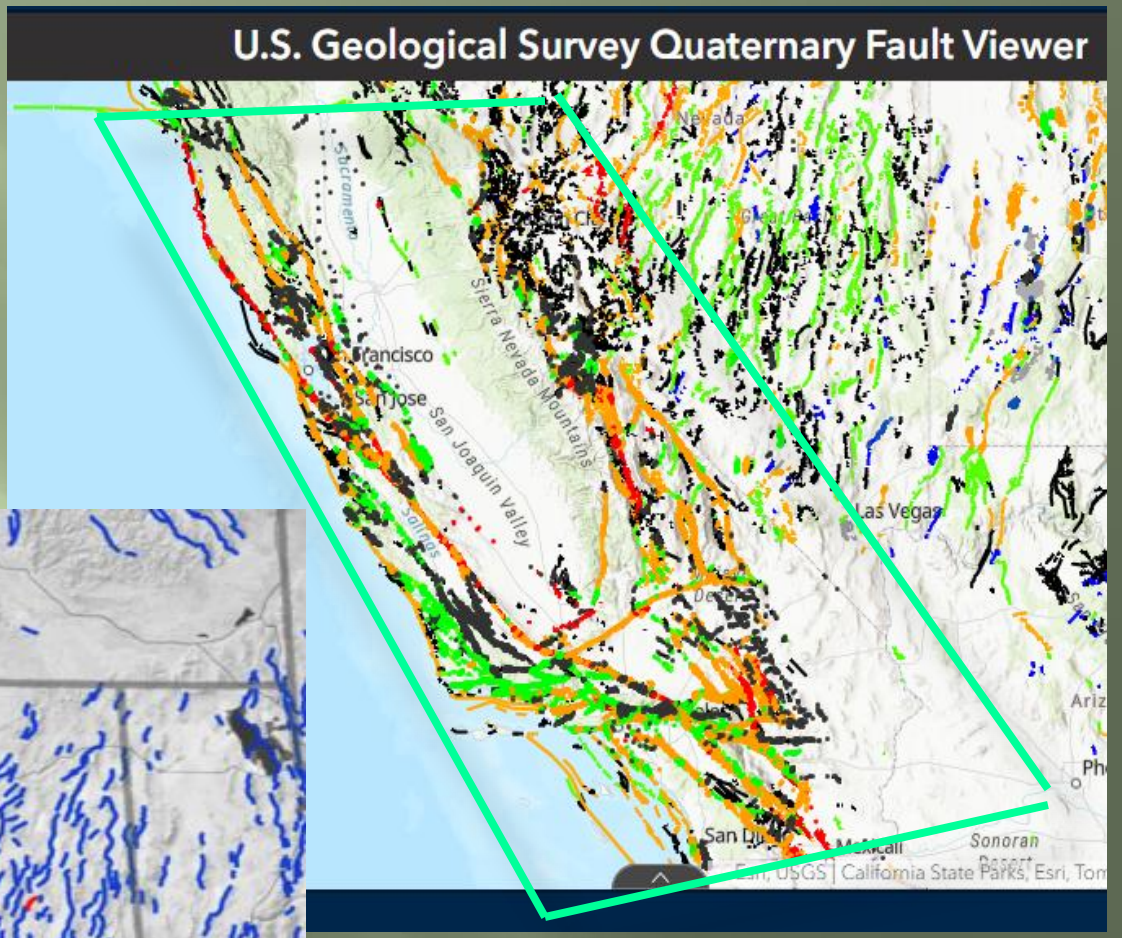
- **<u>Plates:</u> Juan de Fuca/Gorda, Pacific, North American**

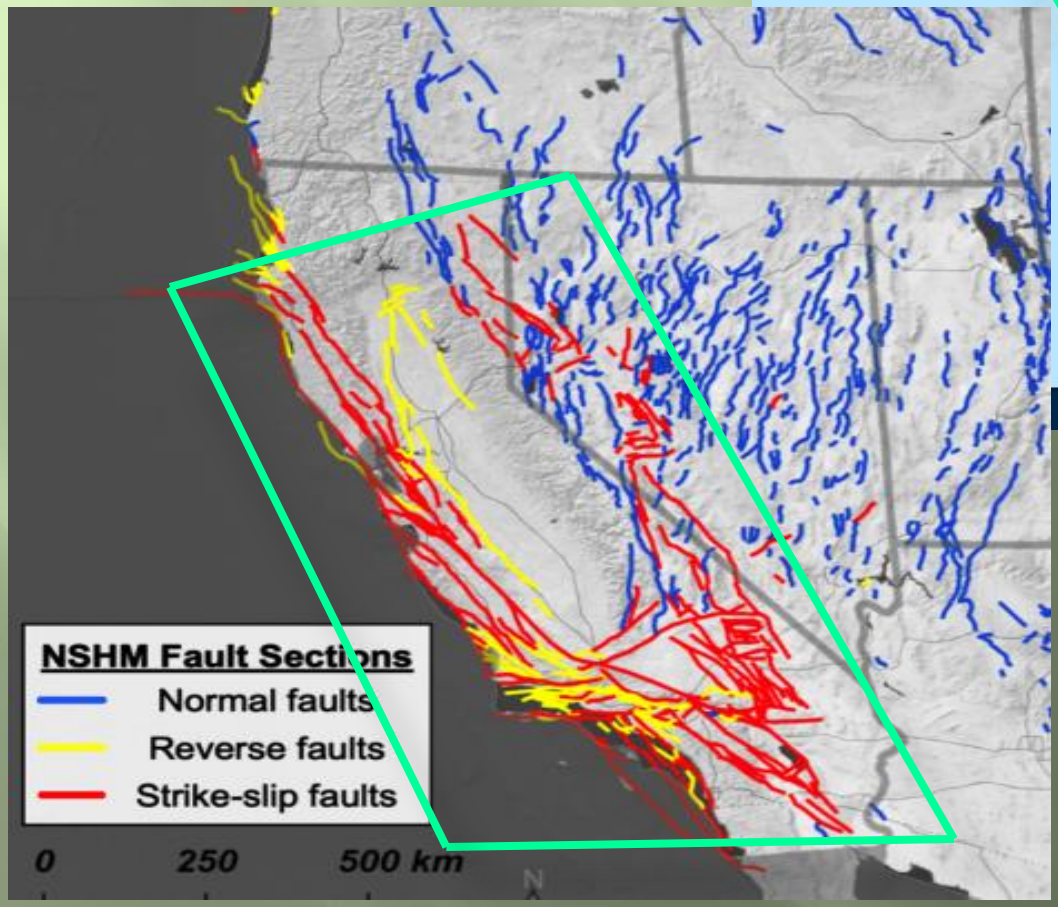
- **<u>Boundaries:</u> Cascadia Subduction Zone, San Andreas Fault, Mendocino Fracture Zone**

- **<u>Complex multi-component mechanics</u>: subduction, northwest migration/lengthening, compression, melting, thinning, and thickening of earth's crust**



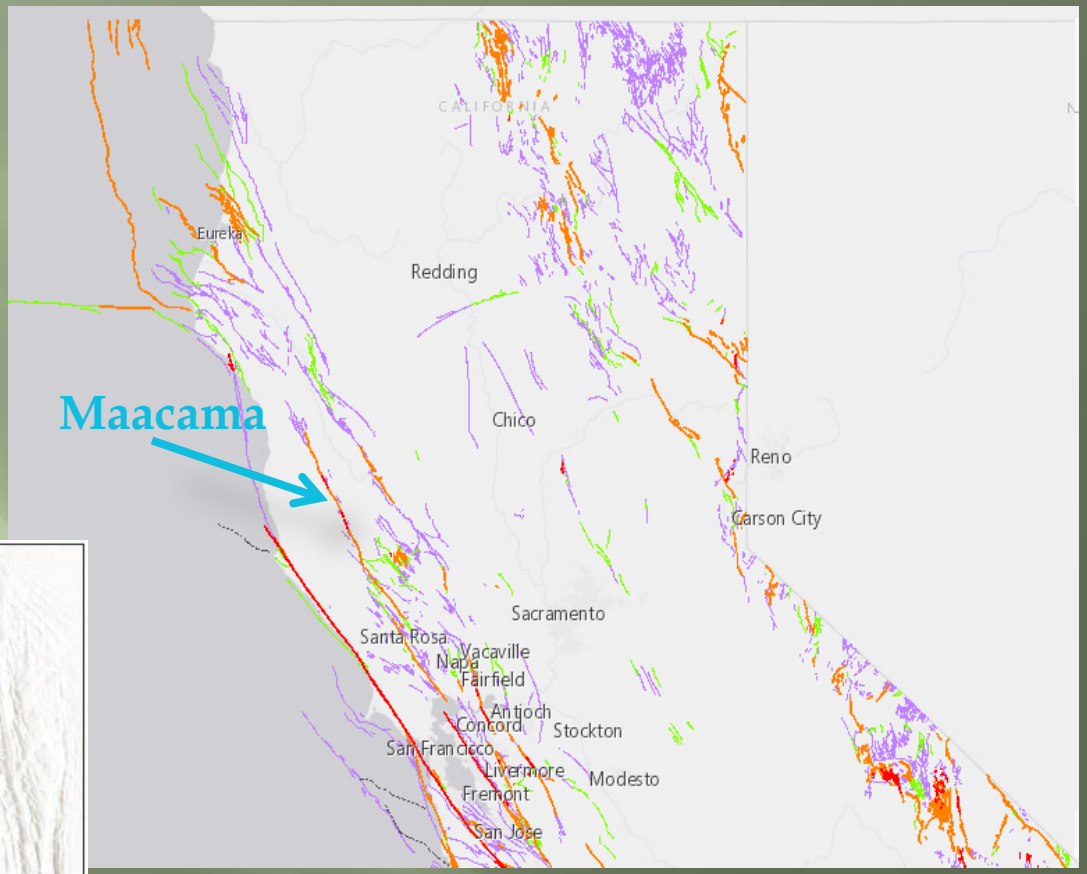
San Andreas Fault System

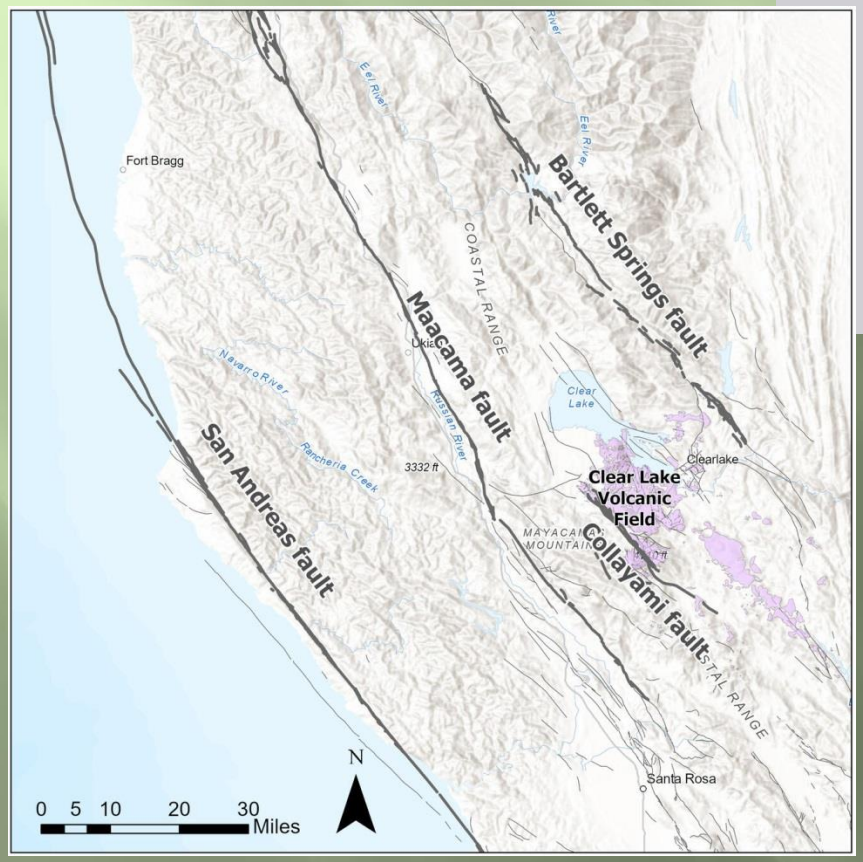




- **Transform Plate Boundary and Fault System/Fracture Zone**
- **Young-ish: ~30 Ma – Farallon plate subduction and Pacific Plate contact**
- **Accommodates horizontal/oblique transverse motion of the Pacific and North American Plates**

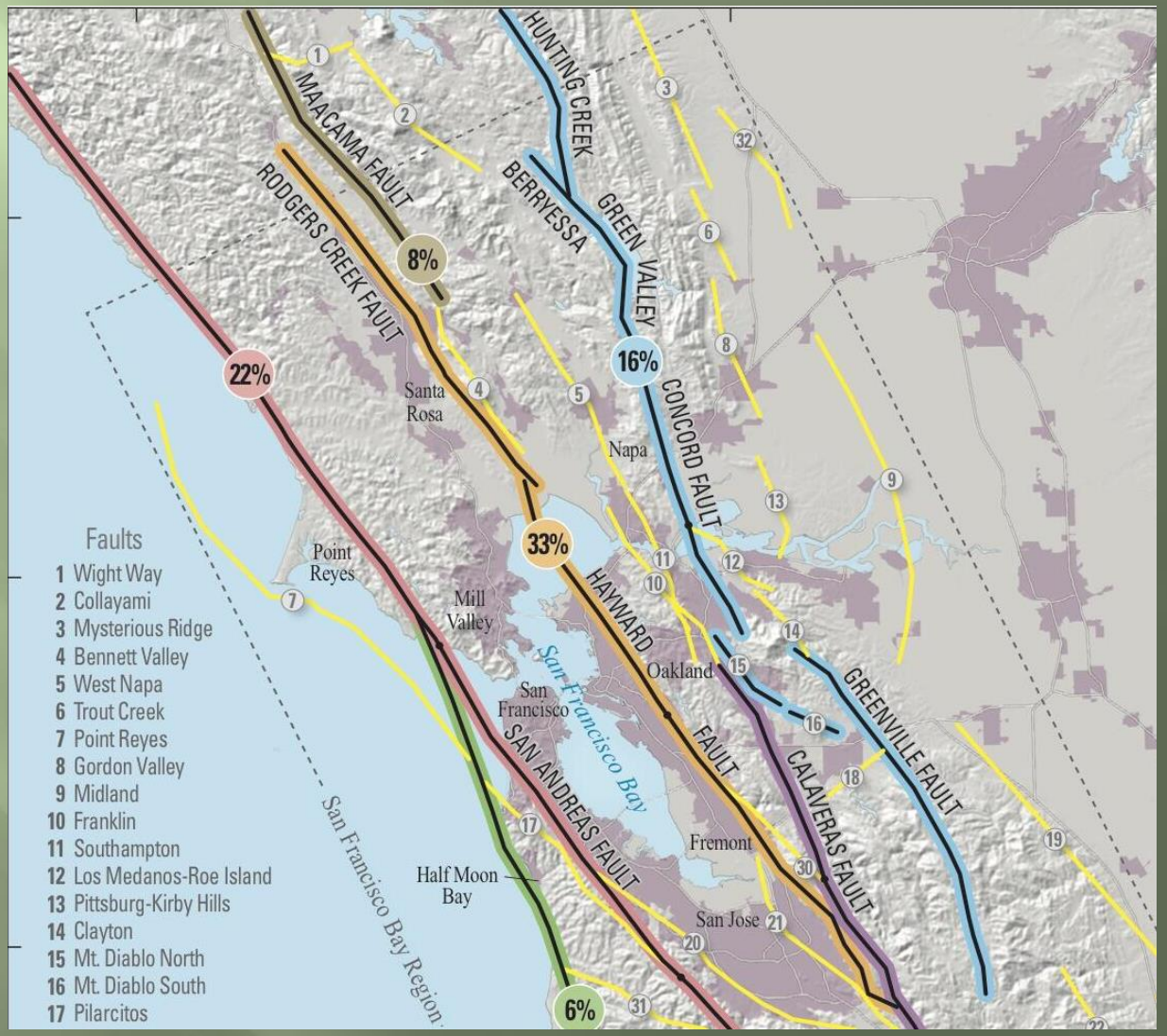
Maacama Fault and Hayward System





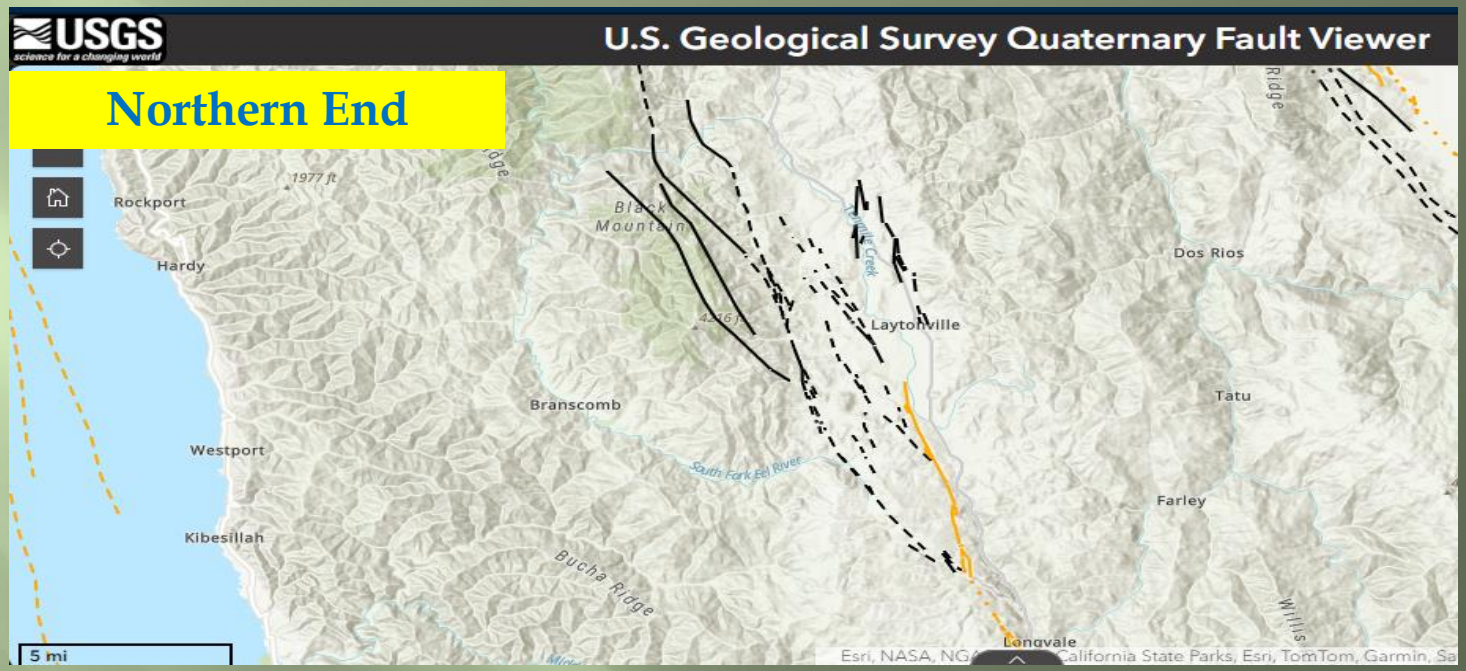
- ~3-6 Ma – northernmost and youngest branch of Hayward Fault System
- Formed as northeast jump off of Rodgers Creek Fault with shifting motion of migrating MTJ and extension of SAF system
- Pull apart basins, 5-8mm/yr displacement
- Evolving, volatile, complex

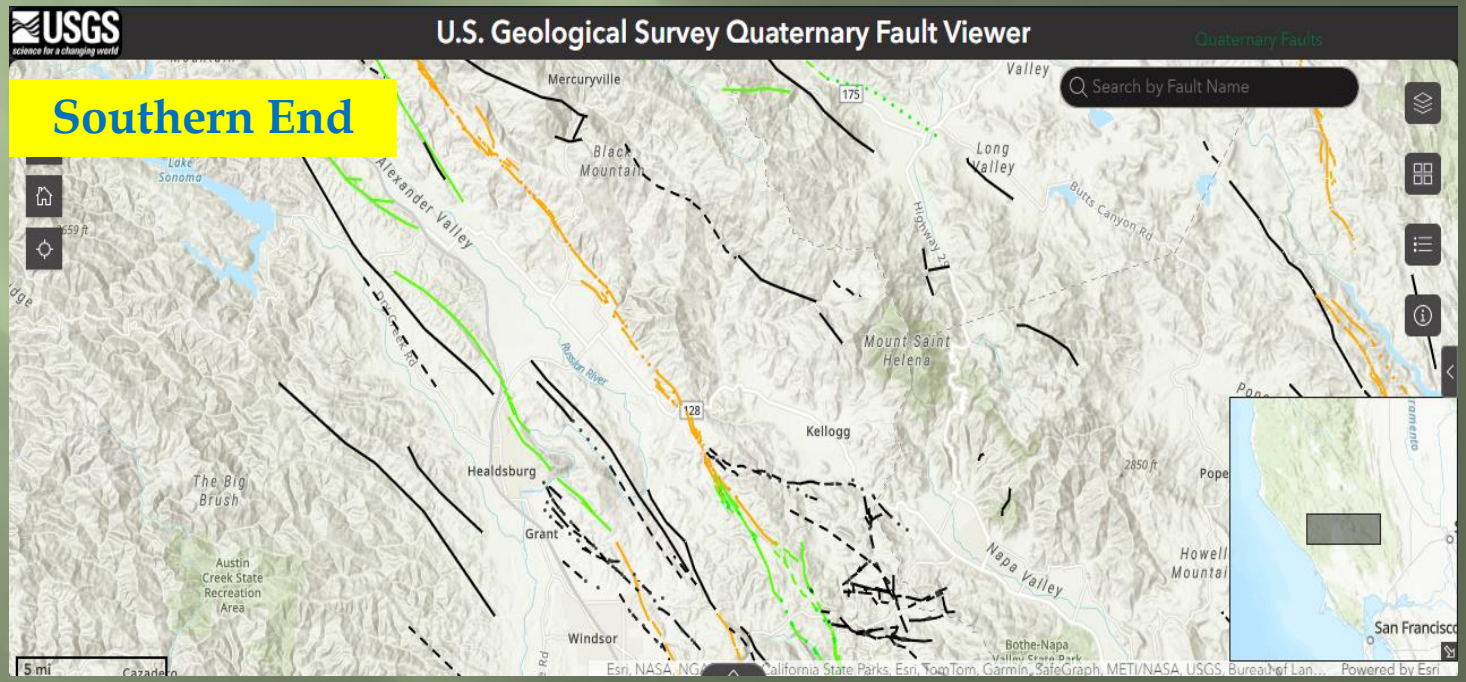
Maacama Fault and Hayward System



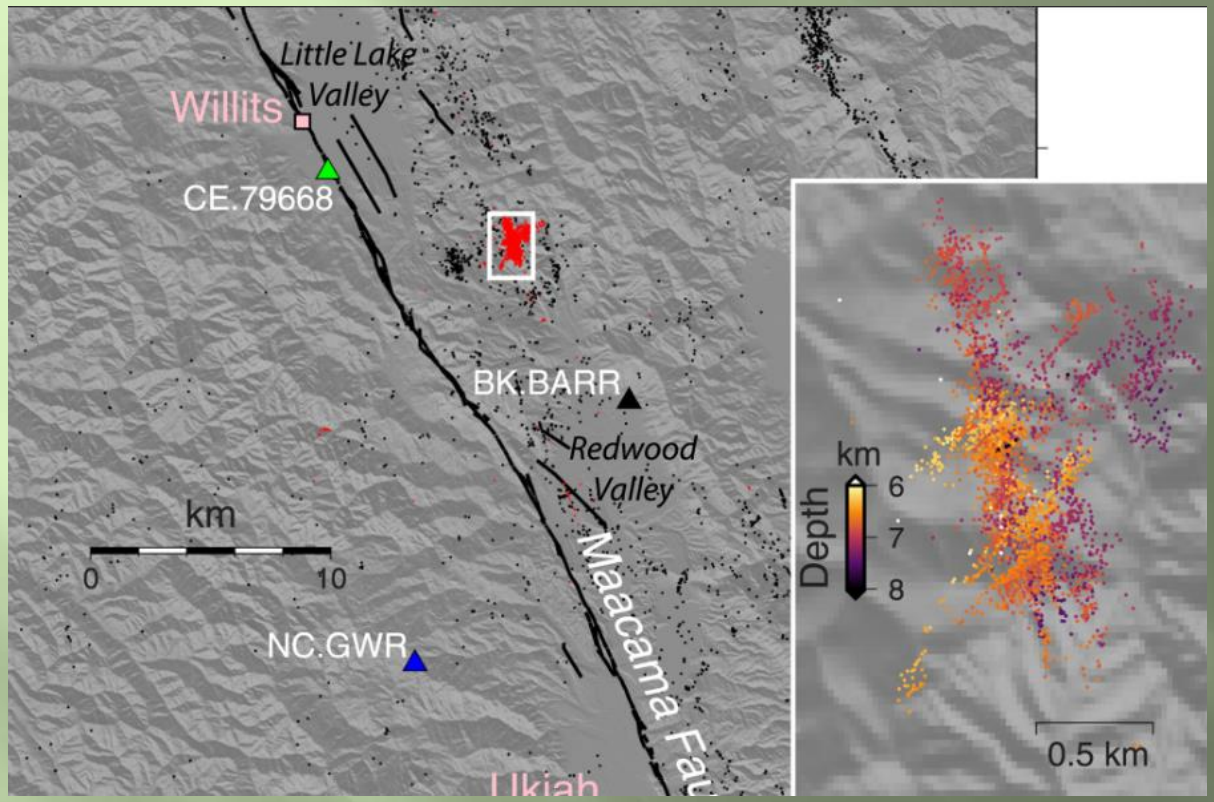
Maacama Fracture Zone

- **Splintered fracture network of fault strands radiating out from a mainstem fault**
- **The Maacama is so fractured that the vast majority of fault strands associated with it have yet to be identified**
- **Strands/faults are identified with seismic activity, or with topographic evidence as tectonic landforms**





Maacama Fracture Zone



- **Swarms of small earthquakes and interlocking faults can be so numerous that they form what is known as a *mesh*, or a *fracture mesh***

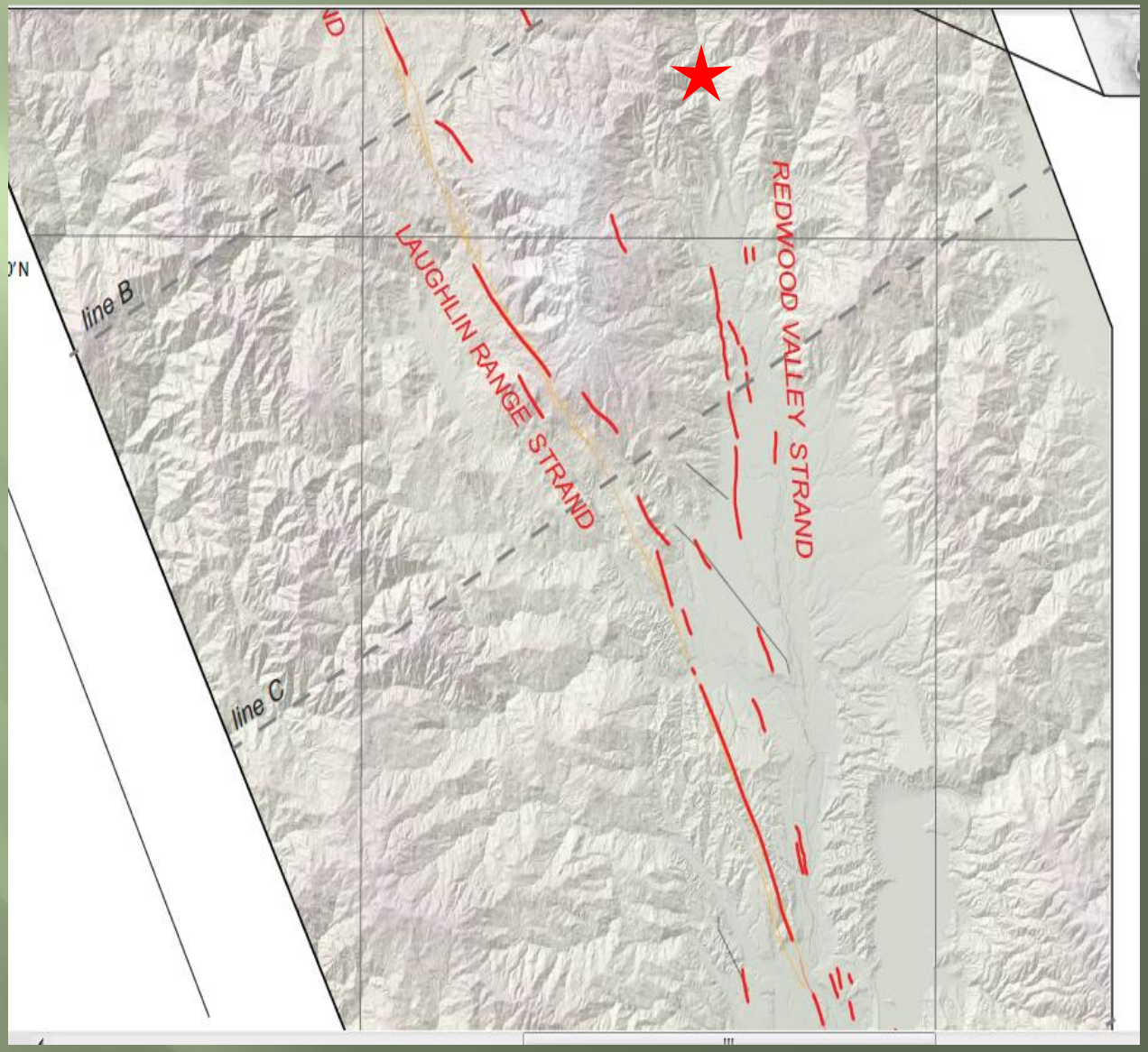
- **Earthquake swarm in active seismic zone between Redwood Valley and Willits, 2020**

Recent work resolves an earthquake swarm that initiated on the Maacama Fault but activated an en echelon network of conjugate faults that define a fracture mesh, which demonstrates that deformation is more complex than a single throughgoing fault (Shelly et al., 2023).

Maacama Fracture Zone

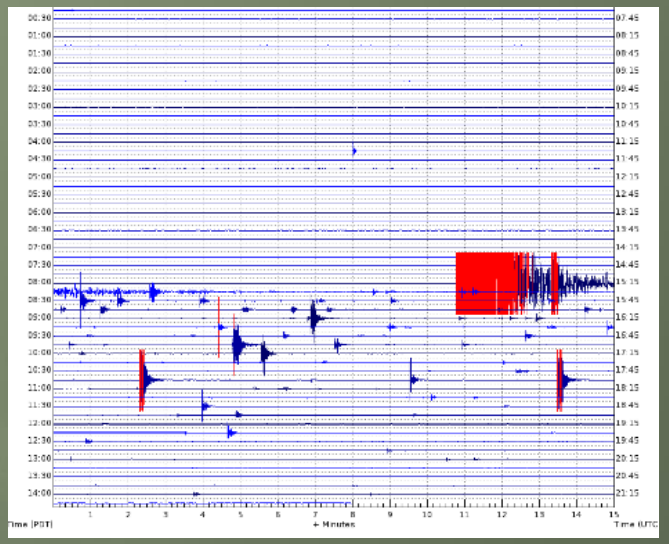
Redwood Valley Fault Strand

- "New" major segment of the Maacama Fault and Fracture Zone identified in 2021
- June earthquake will instigate identity of new strands

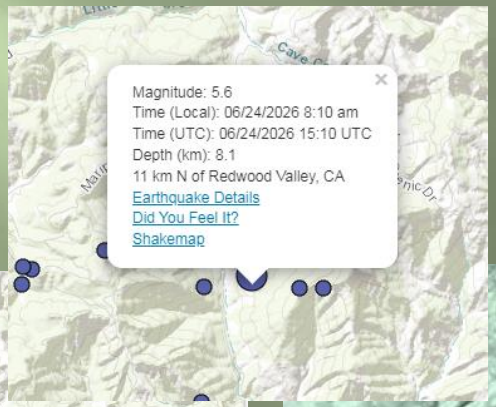


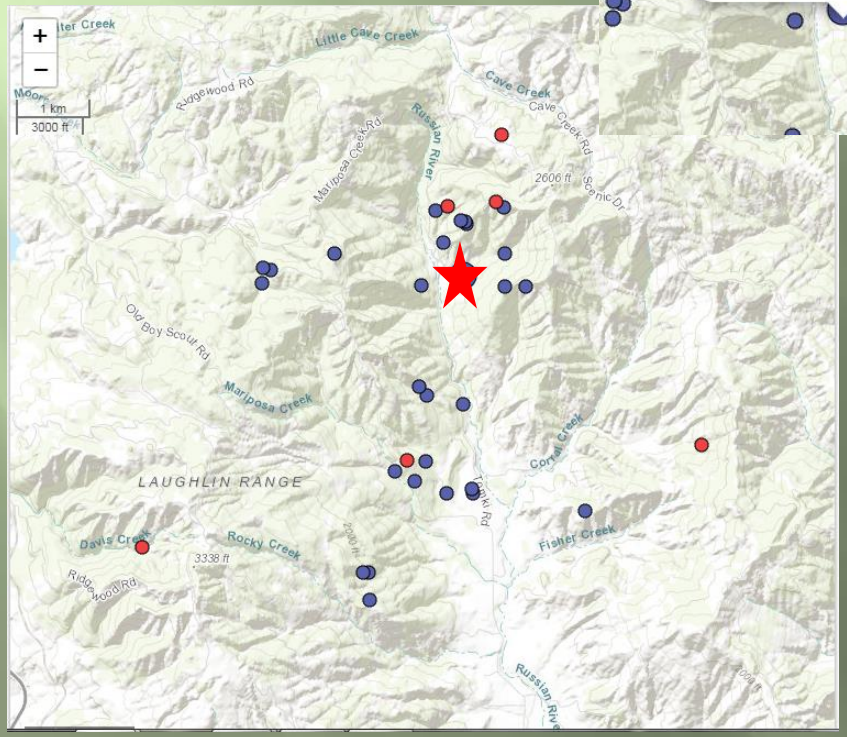
June 24, 2026 Earthquake on the Maacama Fracture Zone

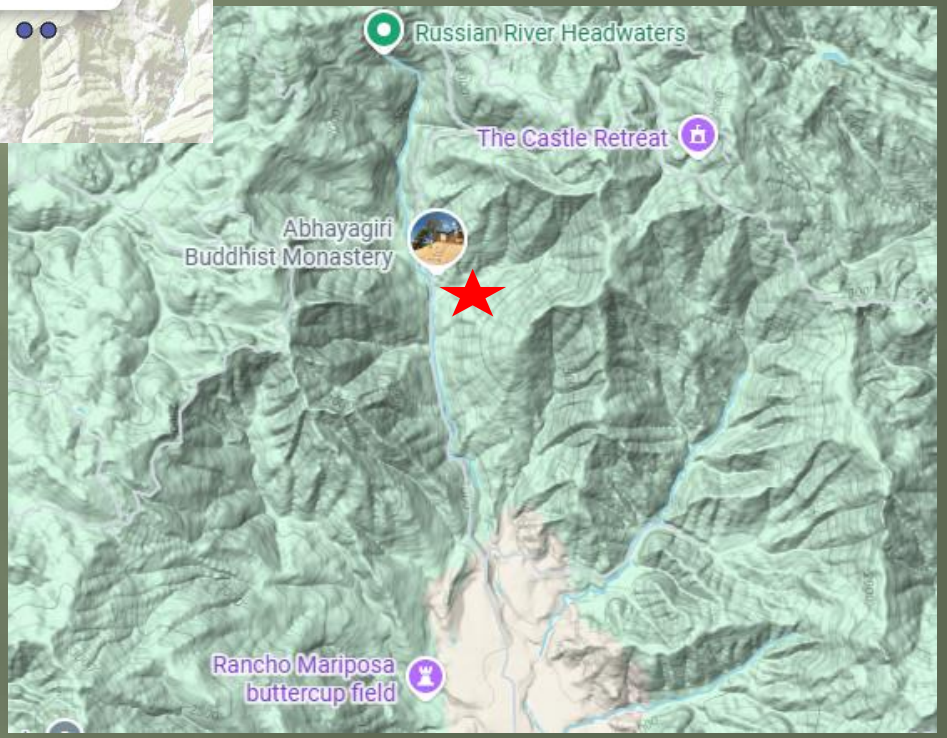
- **Largest earthquake recorded on the Maacama**
- **Magnitude 5.6 on previously unknown fault strand in upper Redwood Valley**
- **35 aftershocks >1.3 within six hours of quake**



Earthquake reading from the seismic monitoring site at Cow Mountain







Primary Plate Boundary and Deep Tectonic Shear Zone

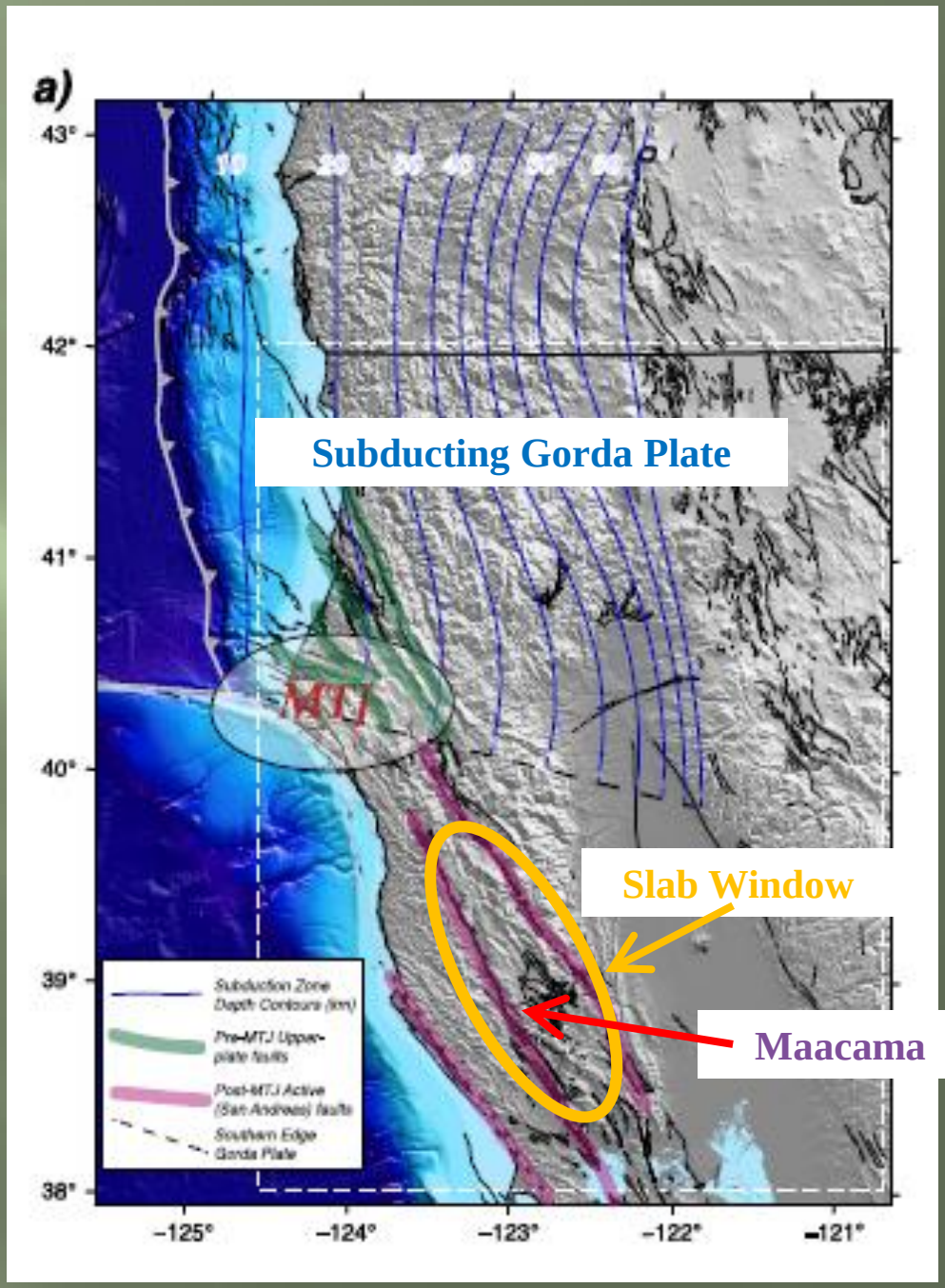
- The Maacama Fracture Zone (MFZ) is the primary Plate boundary between the North American and Pacific Plates in Northern CA

- The MFZ is a deep sheer zone that reaches down into the lower lithosphere

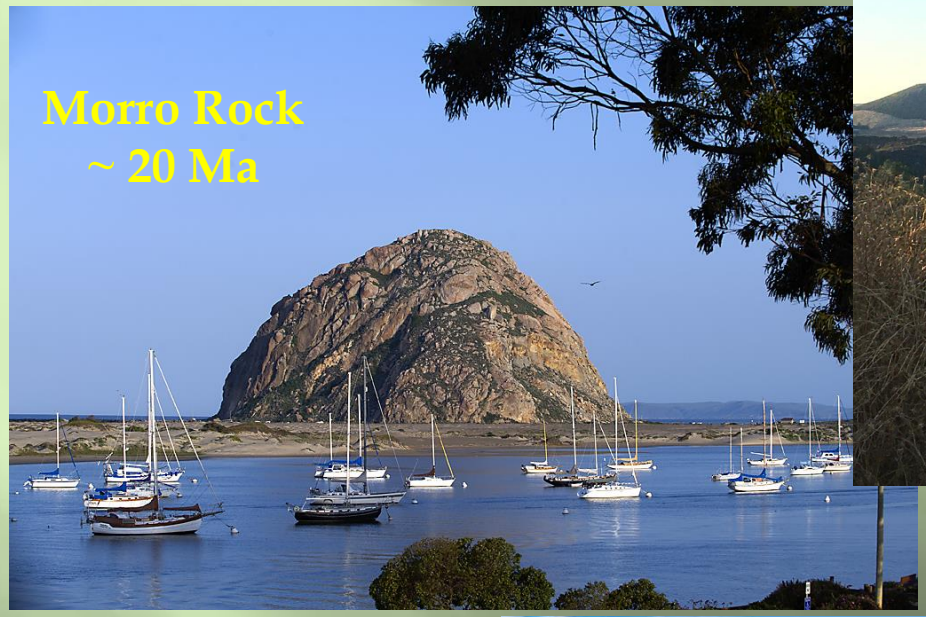
- The MFZ also creates a boundary with the Slab Window - an area of thinner crust that allows asthenospheric material/magma to upwell closer to the surface of the earth

- The Slab Window forms as the migrating Mendocino Triple Junction (MTJ) overtakes the edge of the subducting Gorda Plate and severs it, which leaves a gap/window beneath the earths crust just southeast of the MTJ

- Do we see influence of the Slab Window on the landscape?

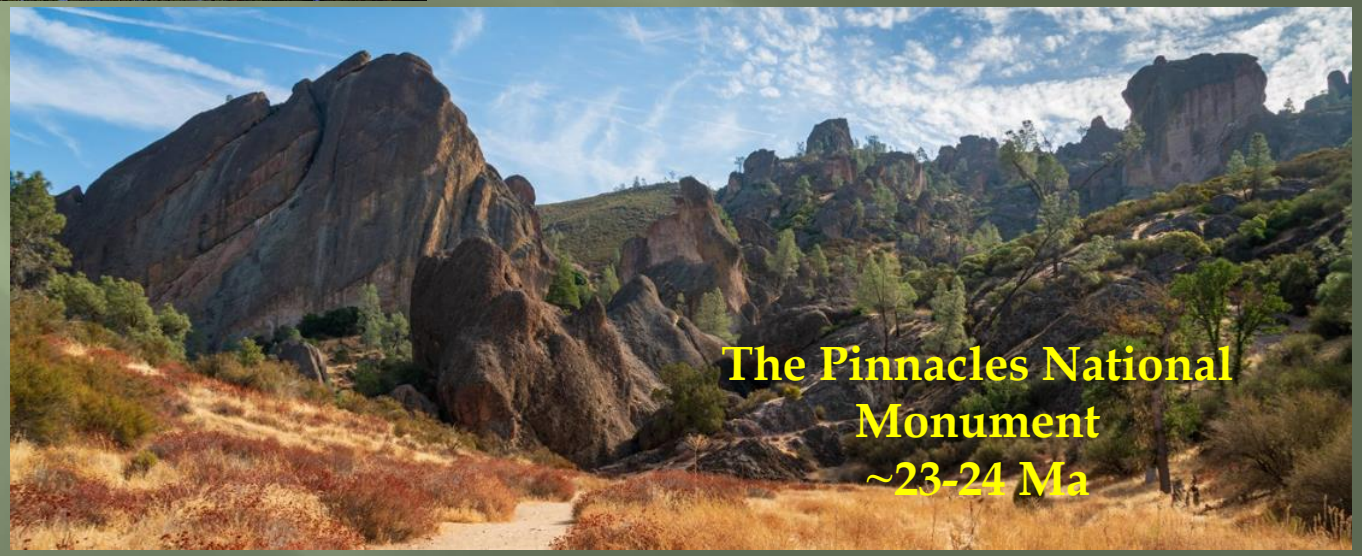


Yes!



- Migrating MTJ and Slab Window leave trail of volcanic landforms throughout Coast Ranges from ~27 Ma to present, S to N

- Current Slab Window activity: Napa, Lake, &Mendocino Counties



Slab Window Geothermal and Hydrothermal Activity

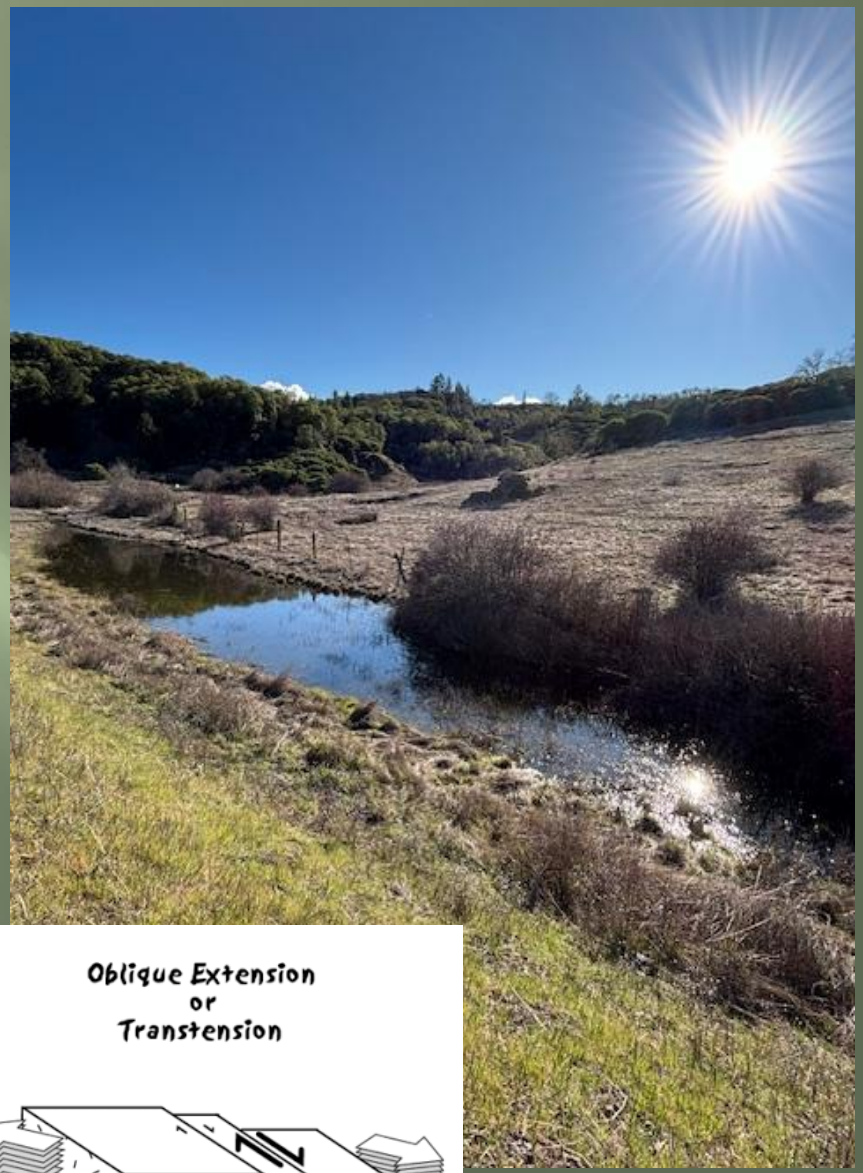
Geysers and hot springs of Napa, Lake, & Mendocino Counties

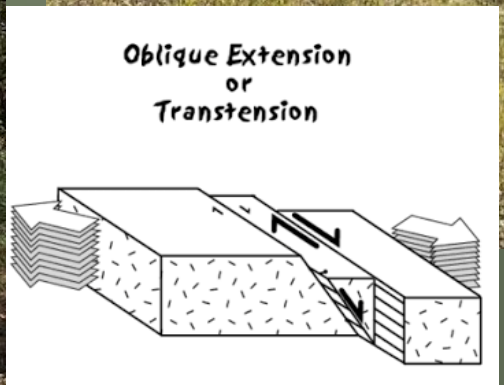
Tectonic Landforms of the MFZ Transtension

- **Regions of extension or transtension within tranform tectonic fault zones**

- **Basins can form when each side of a transverse fault is pulling away from itself, or two adjacent transform faults are moving away from each other – stretching the middle ground like taffy**

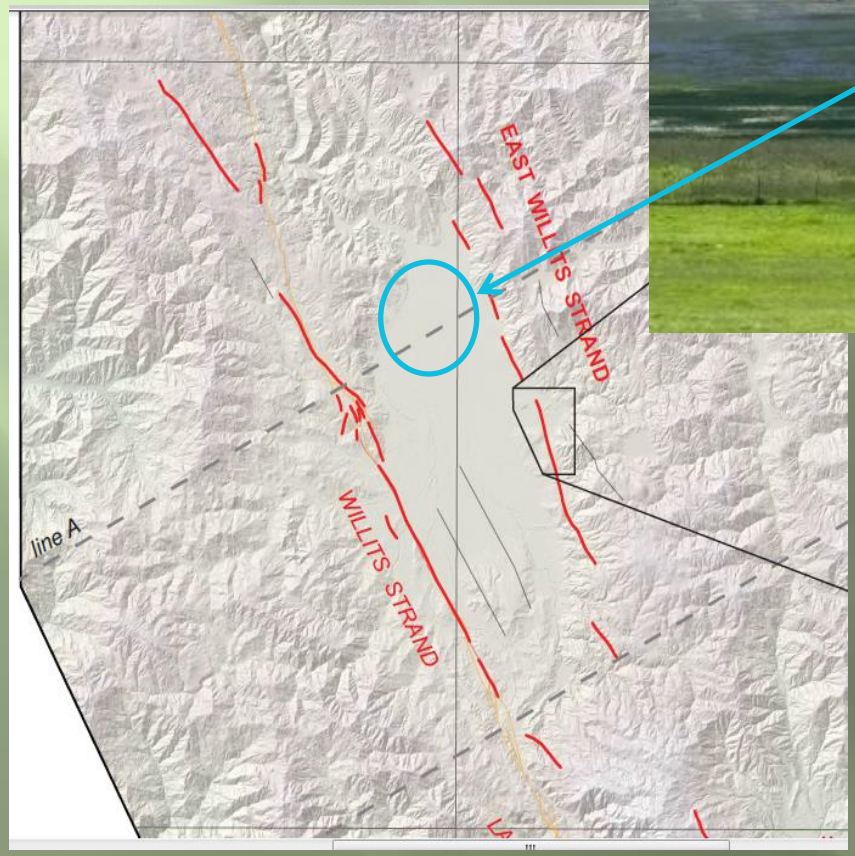
- **Creates transtensional pull-apart basins, such as sag ponds or larger basins such as the Santa Rosa Plain, Anderson Valley, or Little Lake Valley**





Tectonic Landforms of the MFZ Transtension

Willits Bypass Wetlands Mitigation Lands with Blue Camas Lily bloom



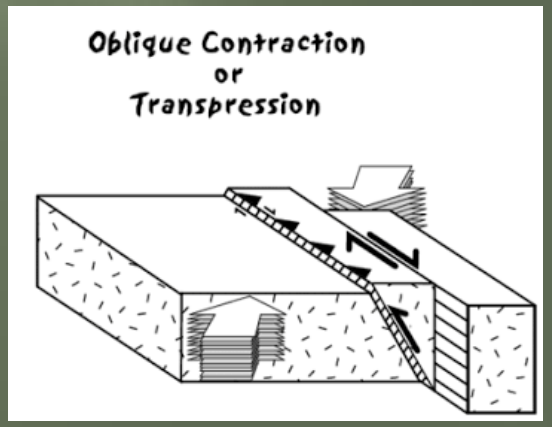
- Little Lake Valley transtensional basin formed as the Willits strands and East Willits strands of MFZ create extension between them and a pull-apart basin

Tectonic Landforms of the MFZ Transpression

• Mechanics of oblique transform fault system involves a lot of collision as the plates grind past and into each other

• This compression, or *transpression*, creates uplift of the land and compressional landforms

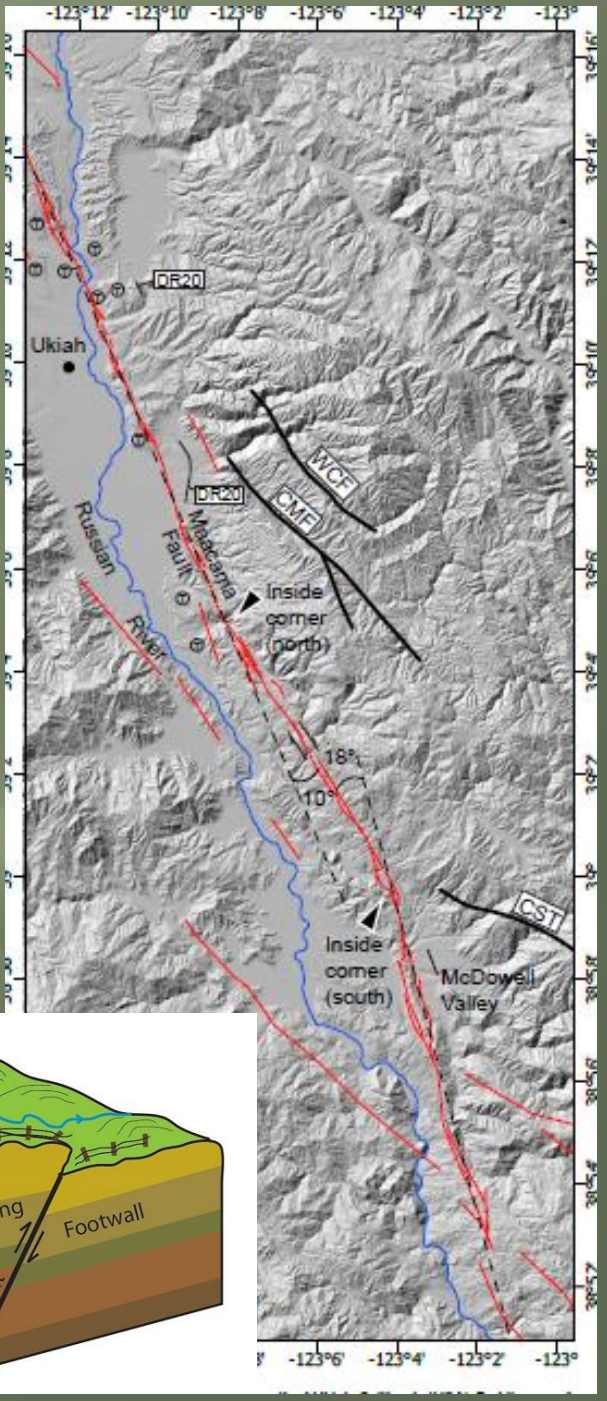
Transpression ridges along strands of the MFZ near Sanel Valley

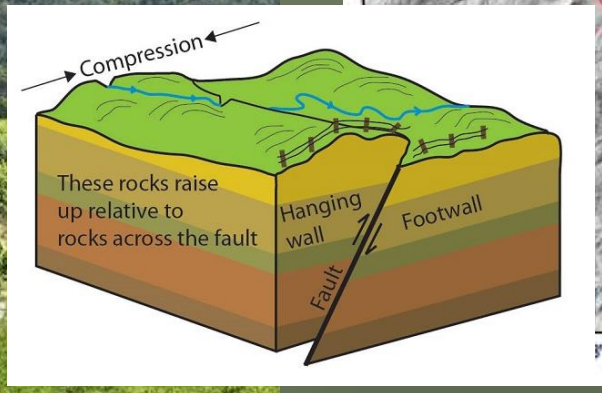


Tectonic Landforms of the MFZ
Transpression - Thrust Faults

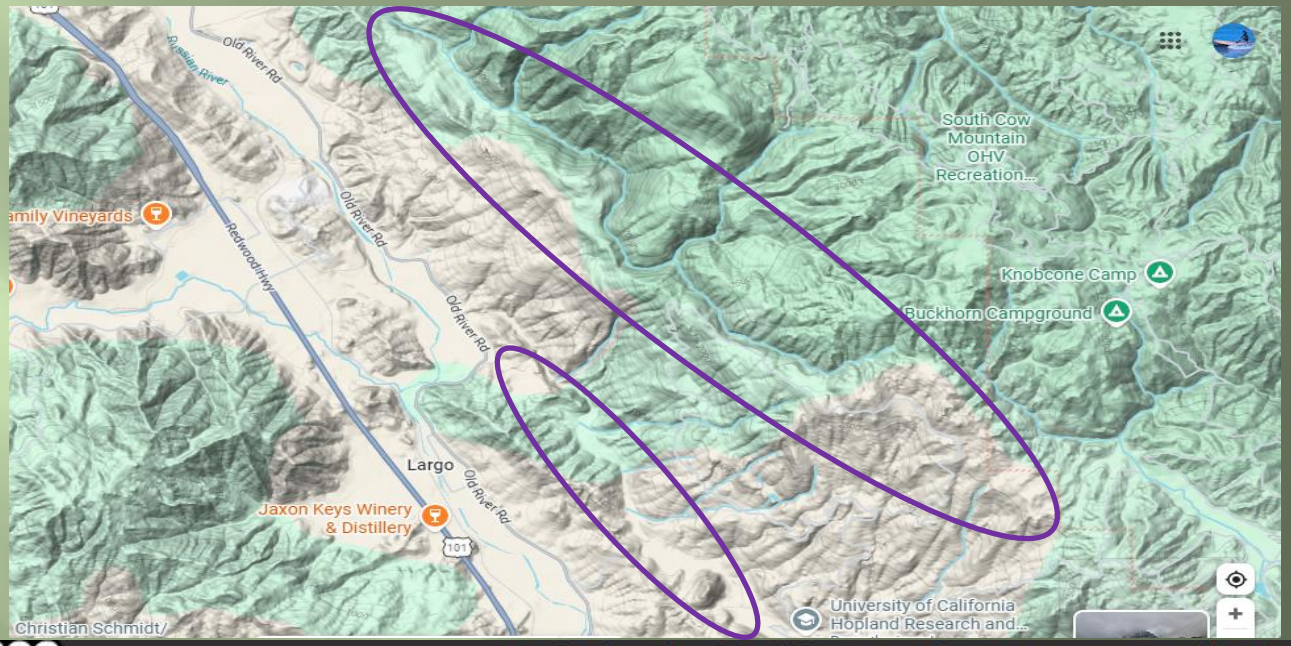
- **Transpressional forces in a transform system also create numerous thrust faults when one side of a landmass compresses into and thrusts over another**

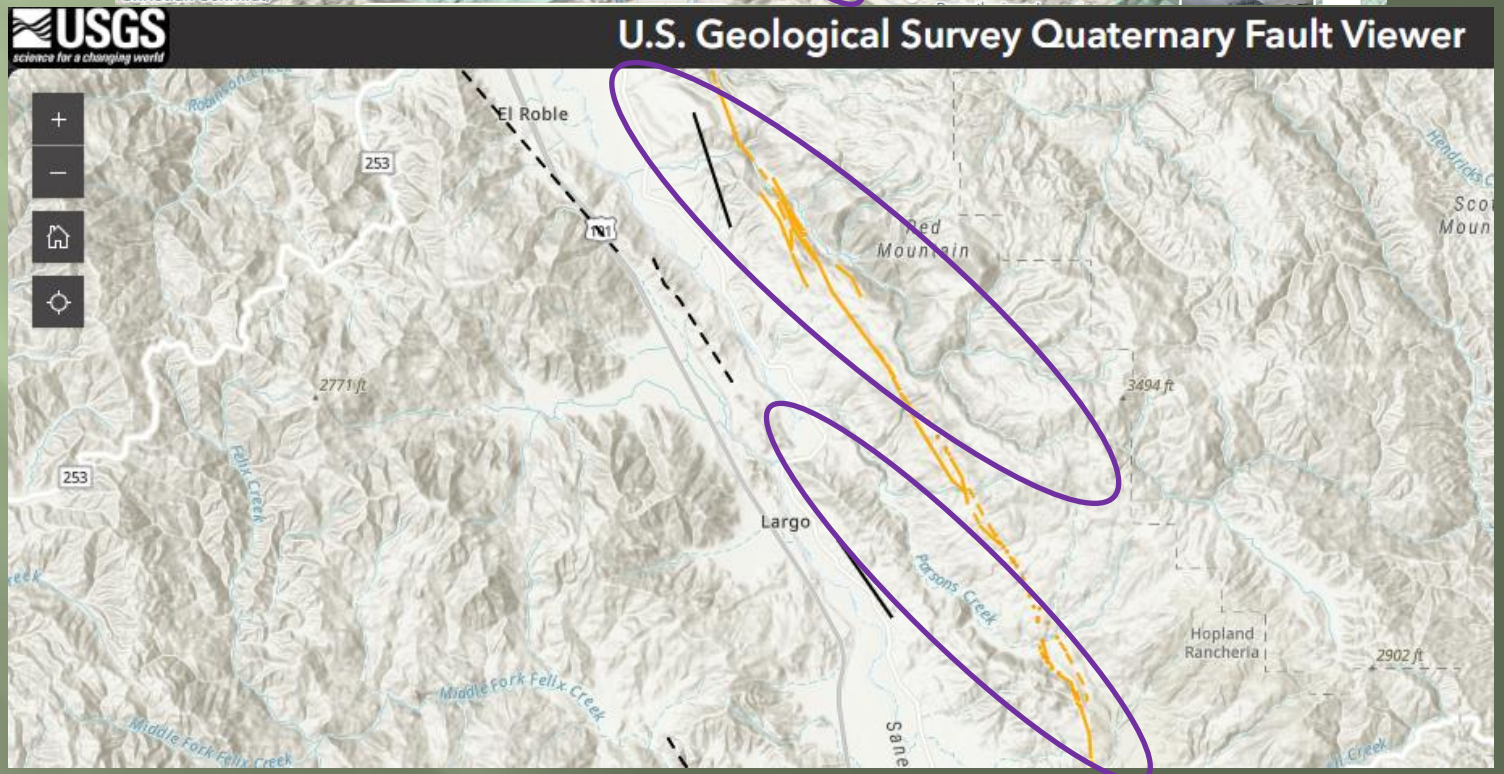
- **Thrust faults, and fold and thrust belts are primary contributors to the formation and uplift of the steepest slopes and ridgelines throughout Mendocino and the north Coast Ranges.**





Morrison Creek Thrust and Parsons Creek Thrust

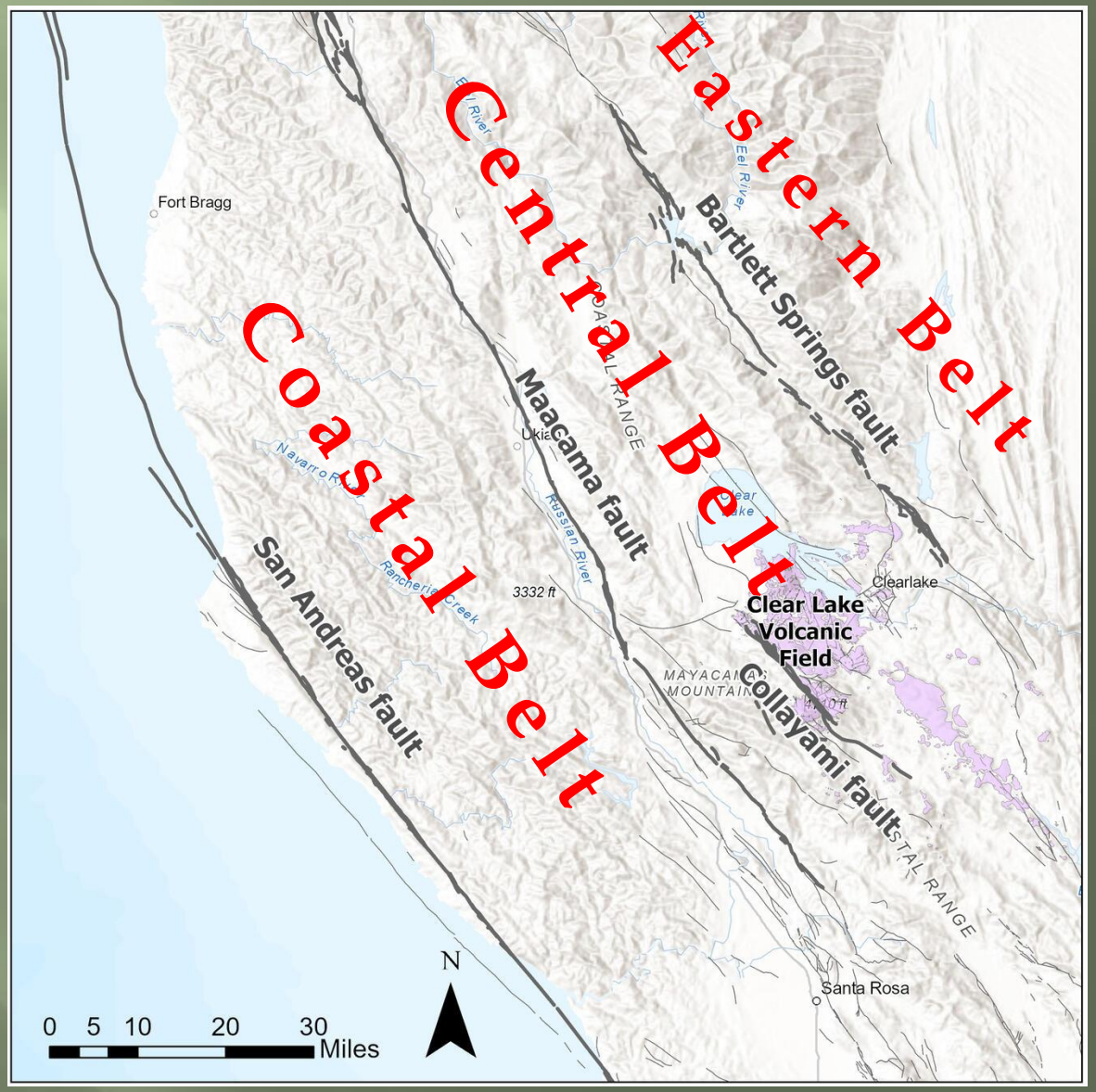




Creeks running laterally *along* (not down) the steep slopes of Red Mountain atop uplifting compression ridges of thrust faults

Franciscan Complex Geologic Belts of the North Coast Ranges

- Three distinct belts of Franciscan Complex geologic units
- Increasing in age from west to east
- The Maacama Fracture Zone forms the border between the Coastal Belt and Central Belt, along with the Coast Range Thrust



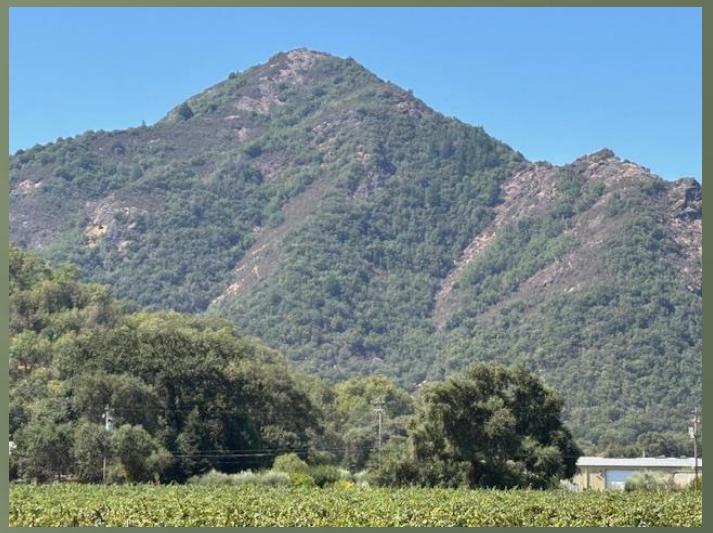
Franciscan Complex Geologic Belts of the North Coast Ranges

- The Coastal, Central and Eastern Belts of the Franciscan Complex formed as the accretionary wedge prism of the Mesozoic era subduction of the Farallon plate beneath the North American plate

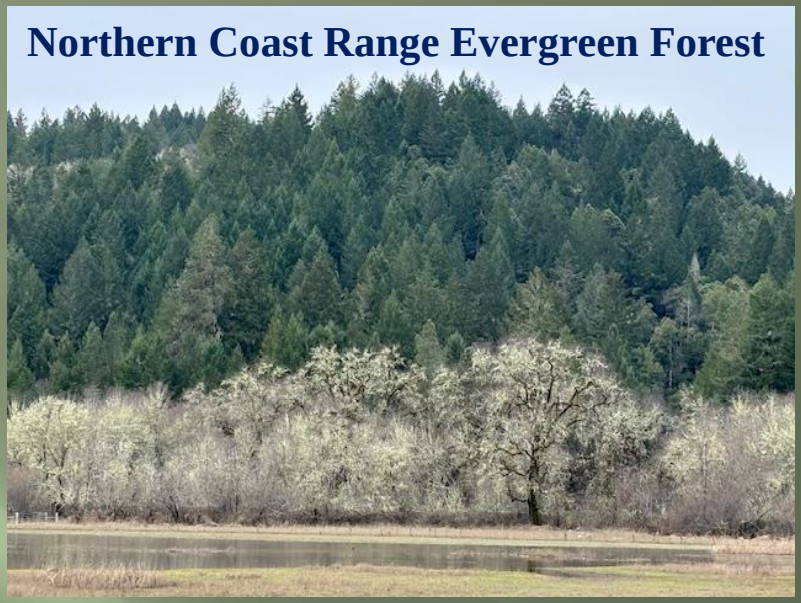
- The foothills of the Coastal Belt can be seen to the west of the Maacama Fracture Zone, and the foothills of the Central Belt can be seen to the east of it

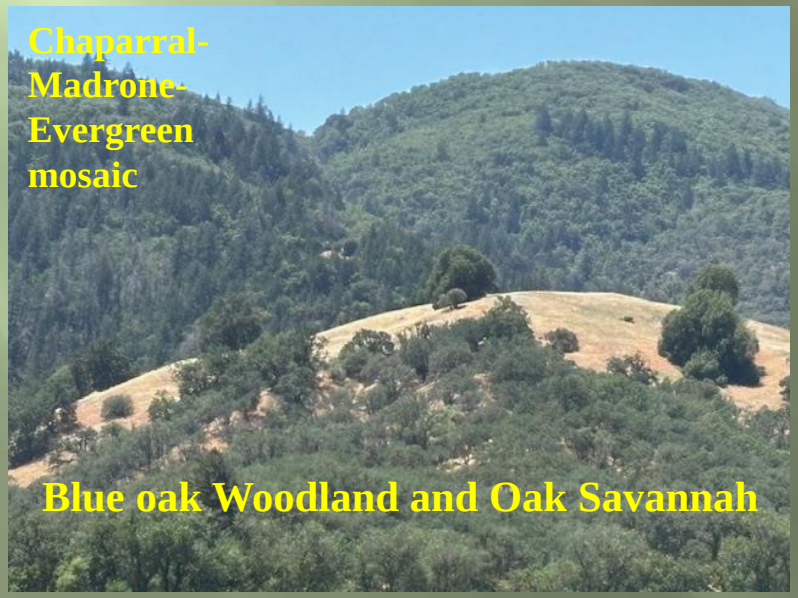
Coastal Belt Foothills Geology and Geomorphology

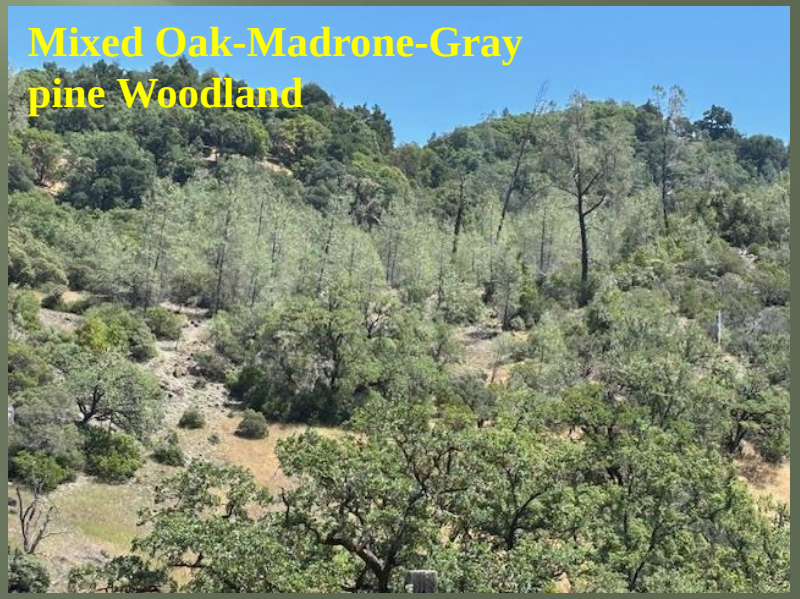
- West side of the Maacama "central valleys"/101 Corridor
- Youngest of the three Franciscan Complex geologic Belts
- Rumply erodible serpentinite landscapes, and steeply rolling and repeated angular landforms of fold and thrust belts



Coastal Belt Foothills Ecosystem Mosaic

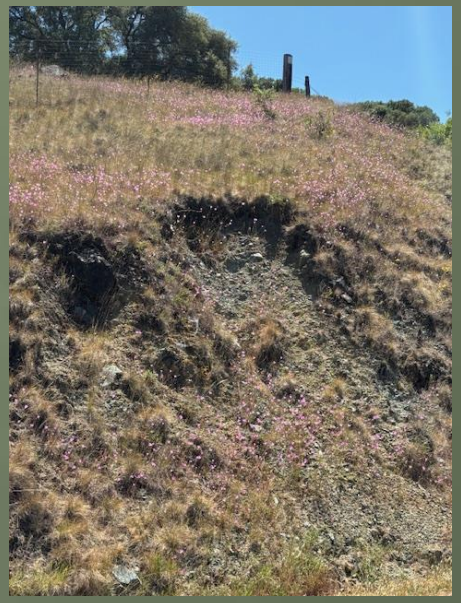


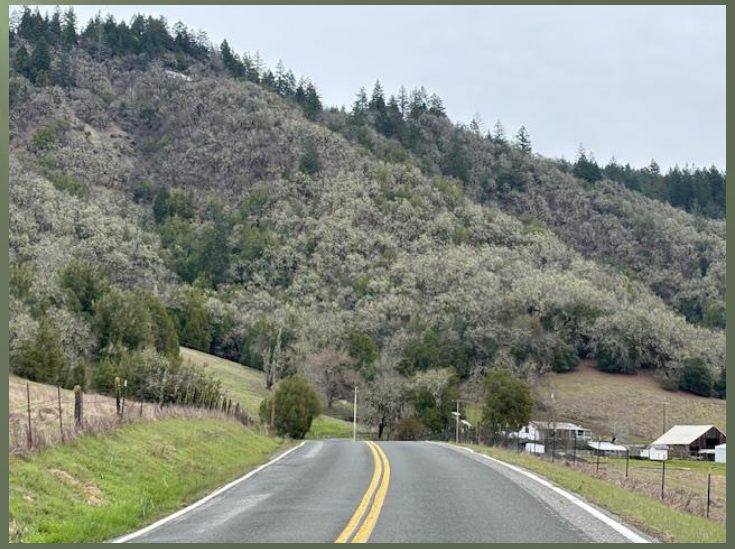




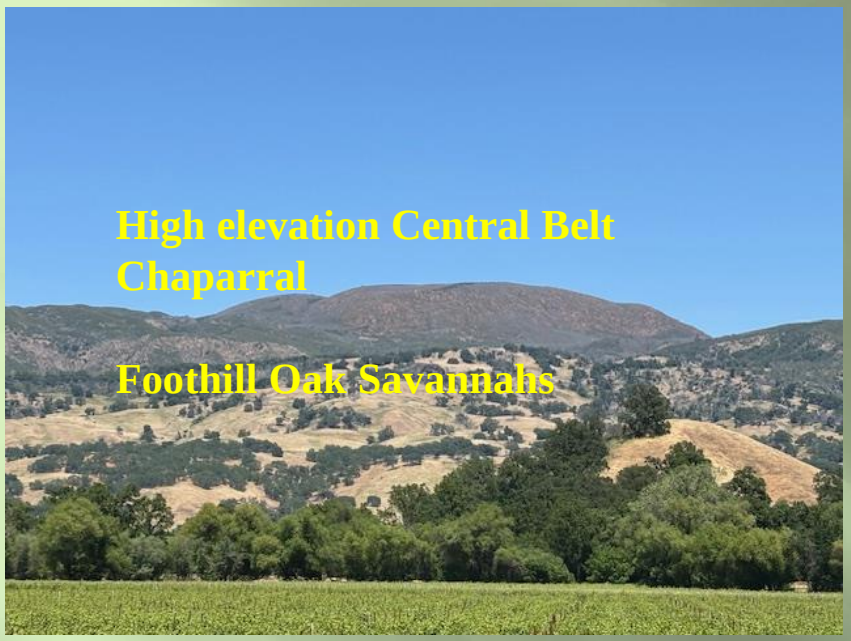
Central Belt Foothills Geology and Geomorphology

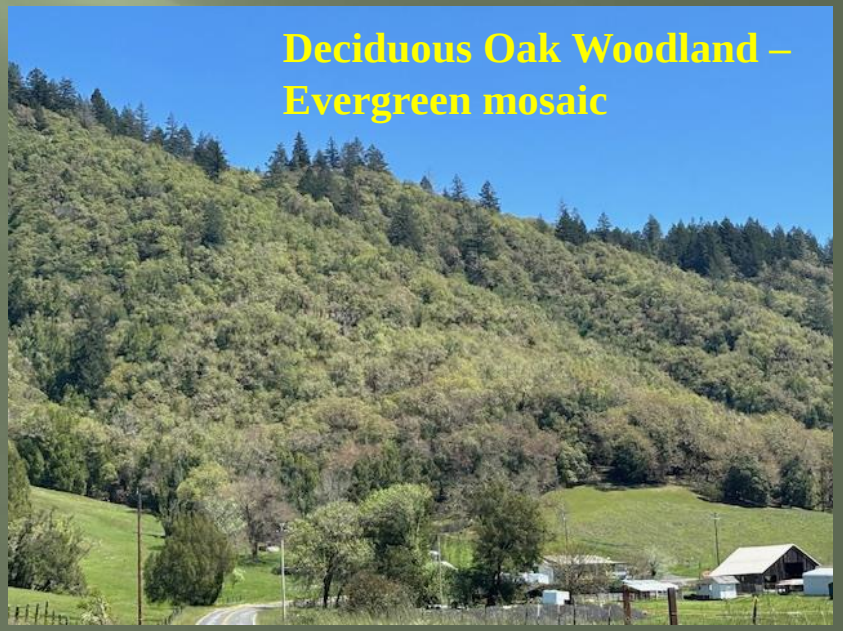
- East side of the Maacama "central valleys"/101 Corridor
- Older and moderately metamorphosed Franciscan Complex geologic units
- Massive blocky compressional ridges and mountains rapidly uplifting along thrust belts





Central Belt Foothills Ecosystem Mosaic





Birding hotspots and geographic info within the Central Belt, Coastal Belt and Maacama Fracture Zone

Peregrine Audubon Society

a California chapter of the National Audubon Society

- Home
- Events
- Sightings
- Links
- Officers
- Join
- Donate

Places to Bird in Inland Mendocino County

The links below include details and directions for inland Mendocino county's best birding sites. Good luck and have fun!

Be sure to post any rarities on Mendobirds.

1. Riverside Park
2. Ukiah Waste Water Treatment Plant
3. BLM Cow Mountain Recreation Area
4. Montgomery Woods State Reserve
5. Lake Mendocino
6. Potter Valley/Eel River
7. Covelo/Round Valley
8. Mendocino National Forest

https://www.peregrineaudubon.org/spots.html

Fault Creep in Downtown Willits

- Creep is steady aseismic movement and displacement along a tectonic fault
- Creep occurs along an estimated 80% of the Maacama Fault
- Visible in urban or built environment: pavement, structures along the creeping strand of fault
- Creep theories applicable to MFZ: friable geologic environment (serpentinites etc); presence of high pressure fluids/gasses/magma within the fracture zone

Effects of fault creep on historic home in Willits – the Maacama bisects the property diagonally through the front porch

≡ The Willits News

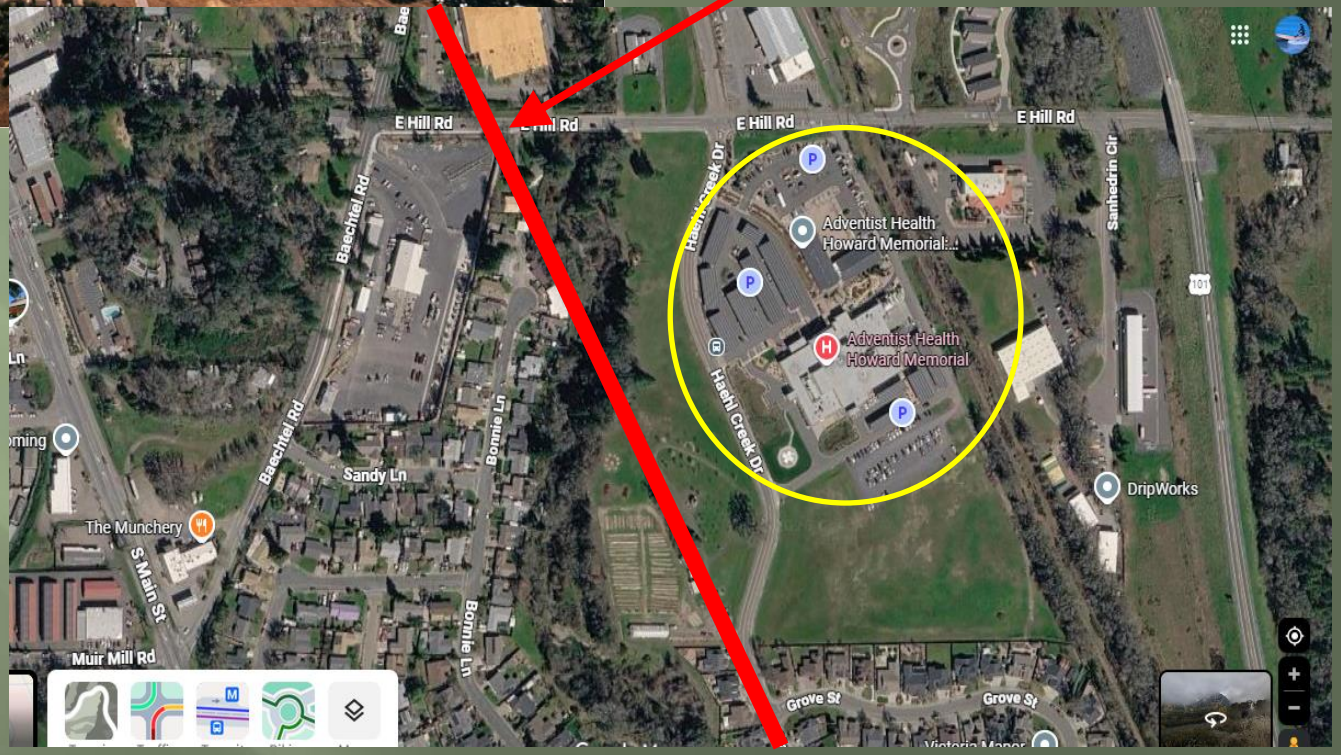
Willits should be prepared for big earthquake,...

NEWS

Willits should be prepared for big earthquake, says expert

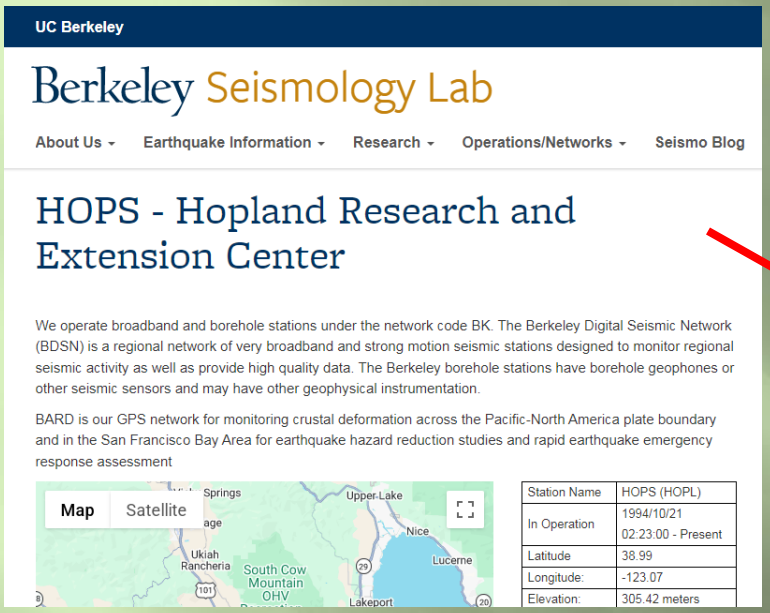
Ojeda, 2017

Maacama Fault

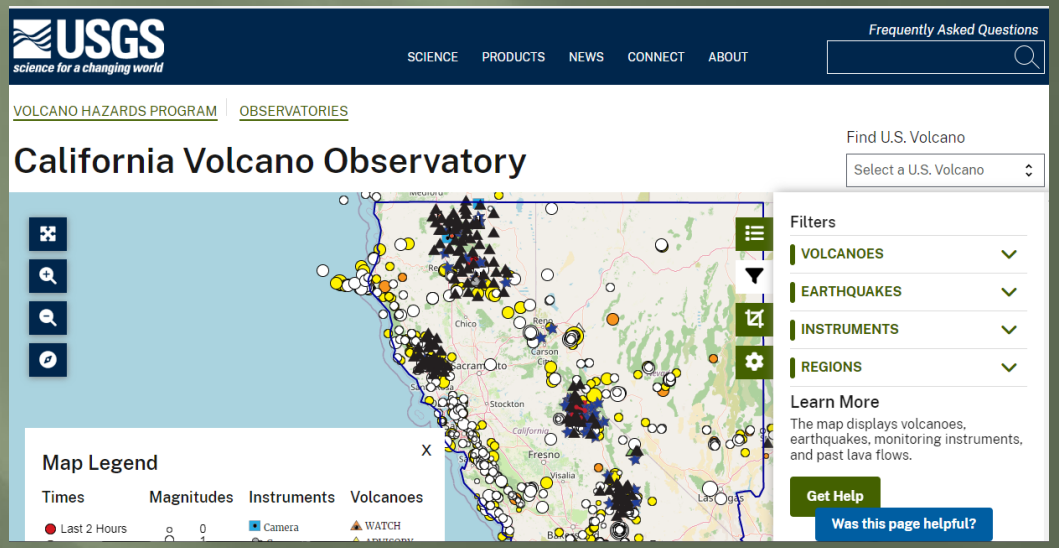


Today – Adventist Hospital and expanded subdivisions constructed on the Maacama fault

Resources for Past and Current Earthquakes Tracking



https://earthquakes.berkeley.edu/station_book/hops.html



https://www.usgs.gov/california-volcano-observatory

Thank You!

https://calgeographic.com/

Field Trips:

- Upcoming field trips are listed on Cal Geographic
- MFZ field trip possibilities?: UC Hopland Center fault and sag ponds, Downtown Willits fault creep walkabout, Redwood Valley tectonic foothills/Frey foothills

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