

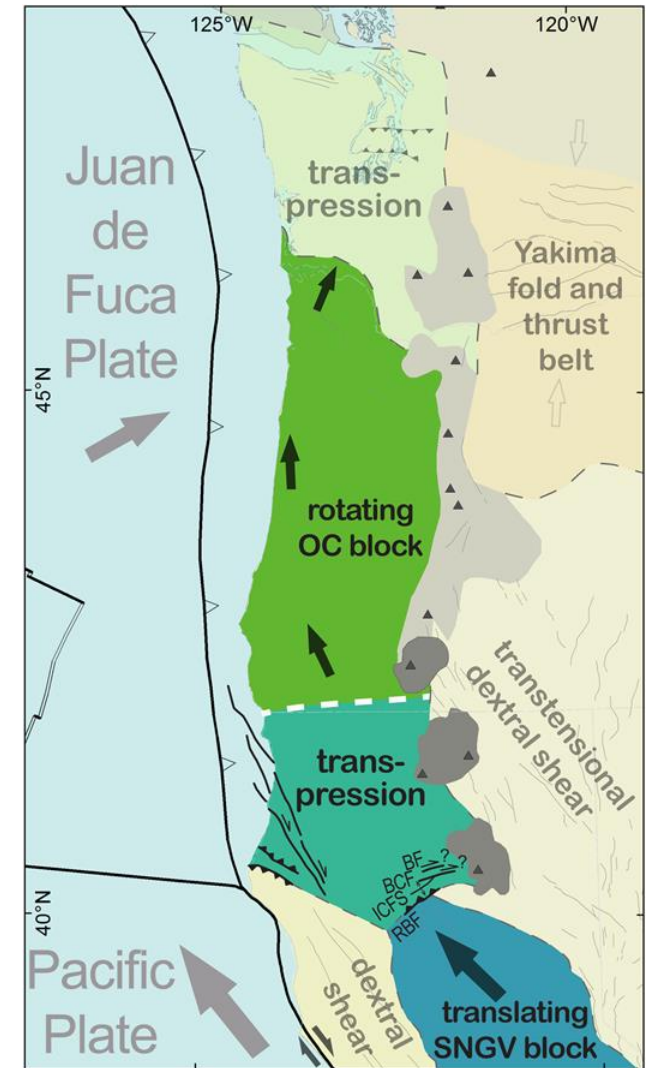
The Mendocino Triple Junction: Faulting Complexity Onshore and Offshore

Kathryn Materna¹, with contributions from:
Will Yeck², David Shelly², Fred Pollitz², Jessica Murray²,
Dara Goldberg², Jason Patton³



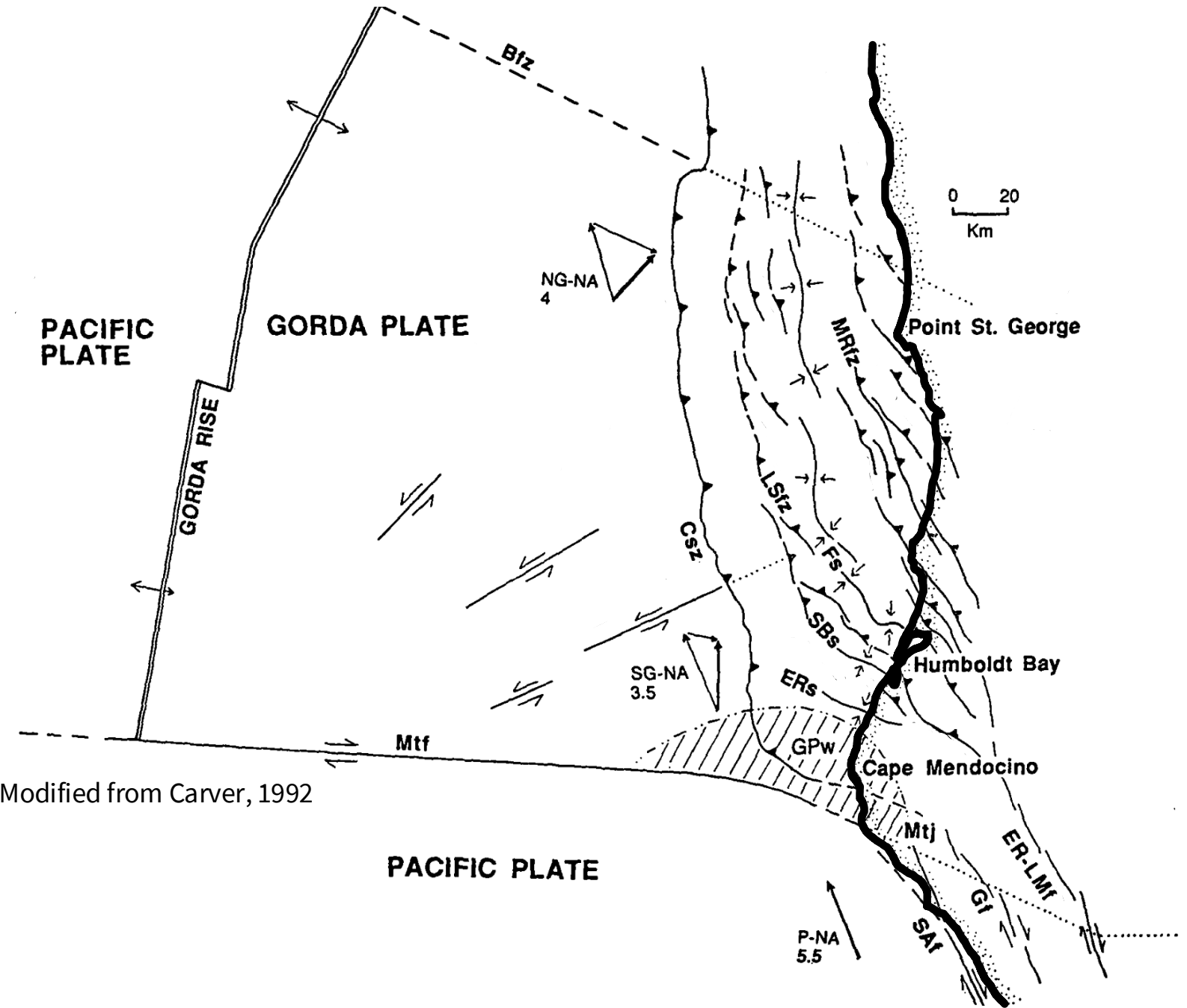
Talk Outline

- MTJ components
- Parallels to Special Fault Study Areas
- Open questions:
 - Implications of vertical deformation across timescales
 - Strain partitioning across the triple junction
 - Rupture behavior in an interconnected system
 - Fault geometry
- Future opportunities in seismology, geodesy, etc.
- Opportunities at the CRESCENT and SCEC border



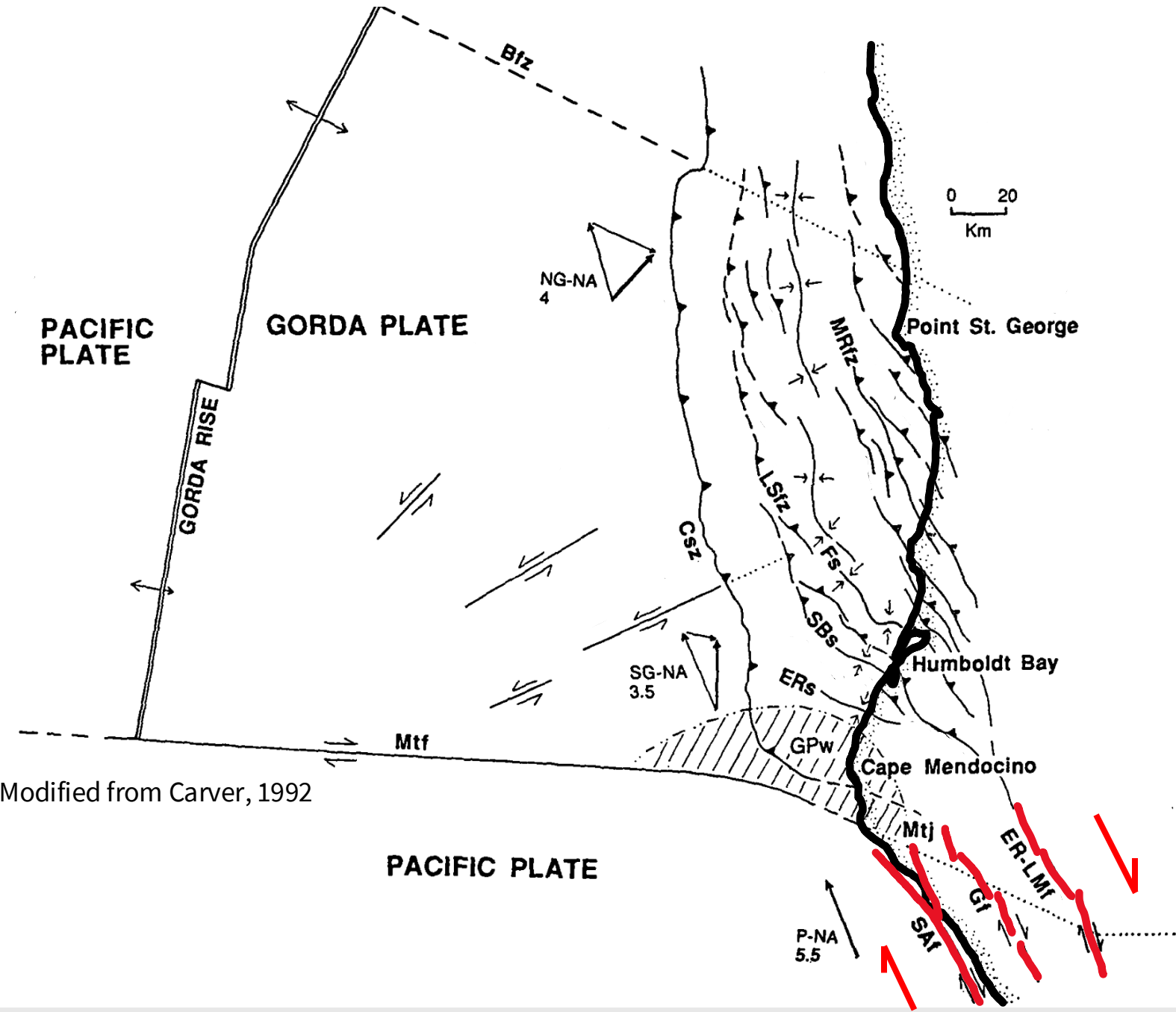
Angster et al., 2020

MTJ Components



Modified from Carver, 1992

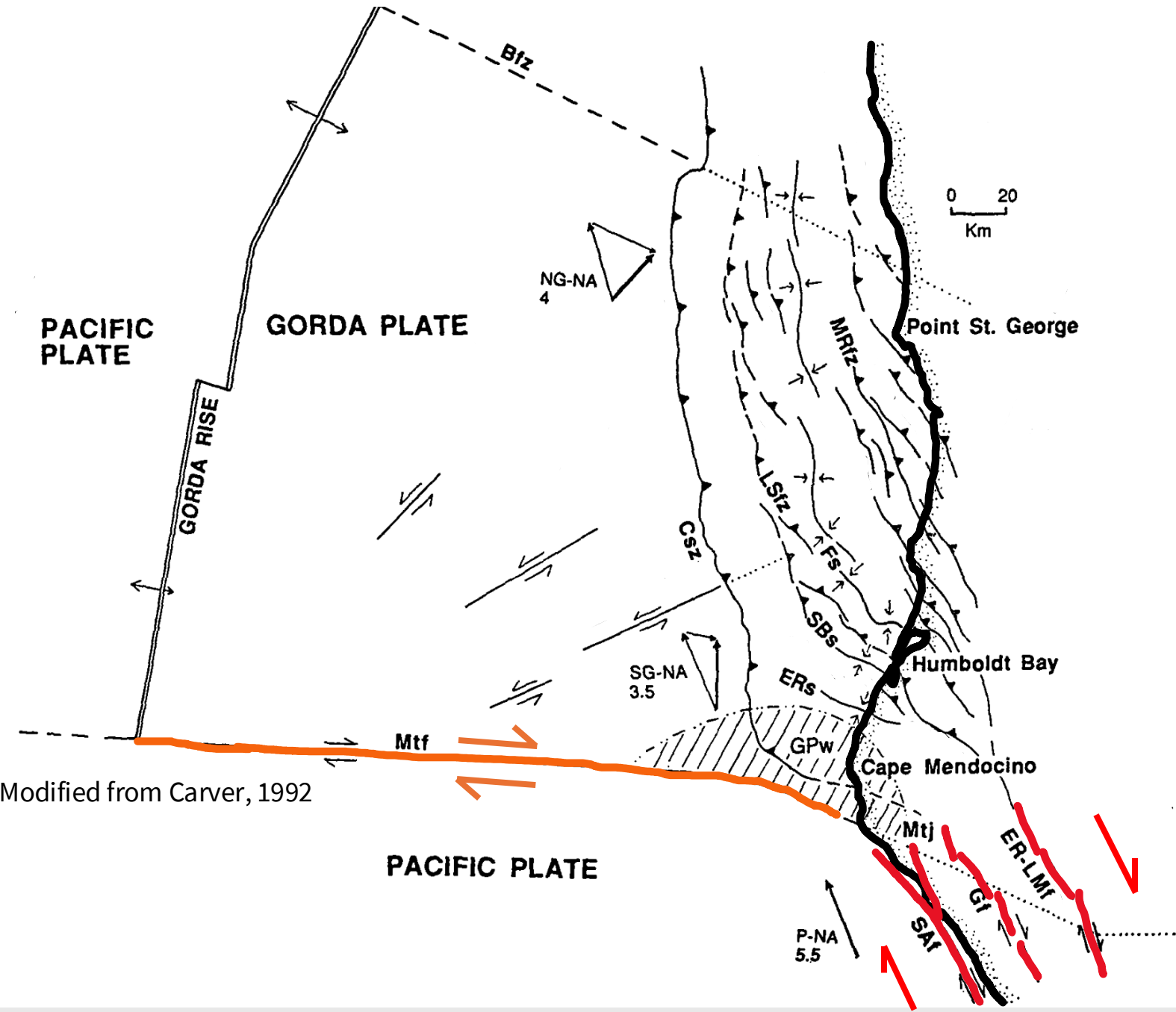
MTJ Components



Modified from Carver, 1992

1. SAF-parallel Strike-slip
~40 mm/yr

MTJ Components



2. MFZ Strike-slip

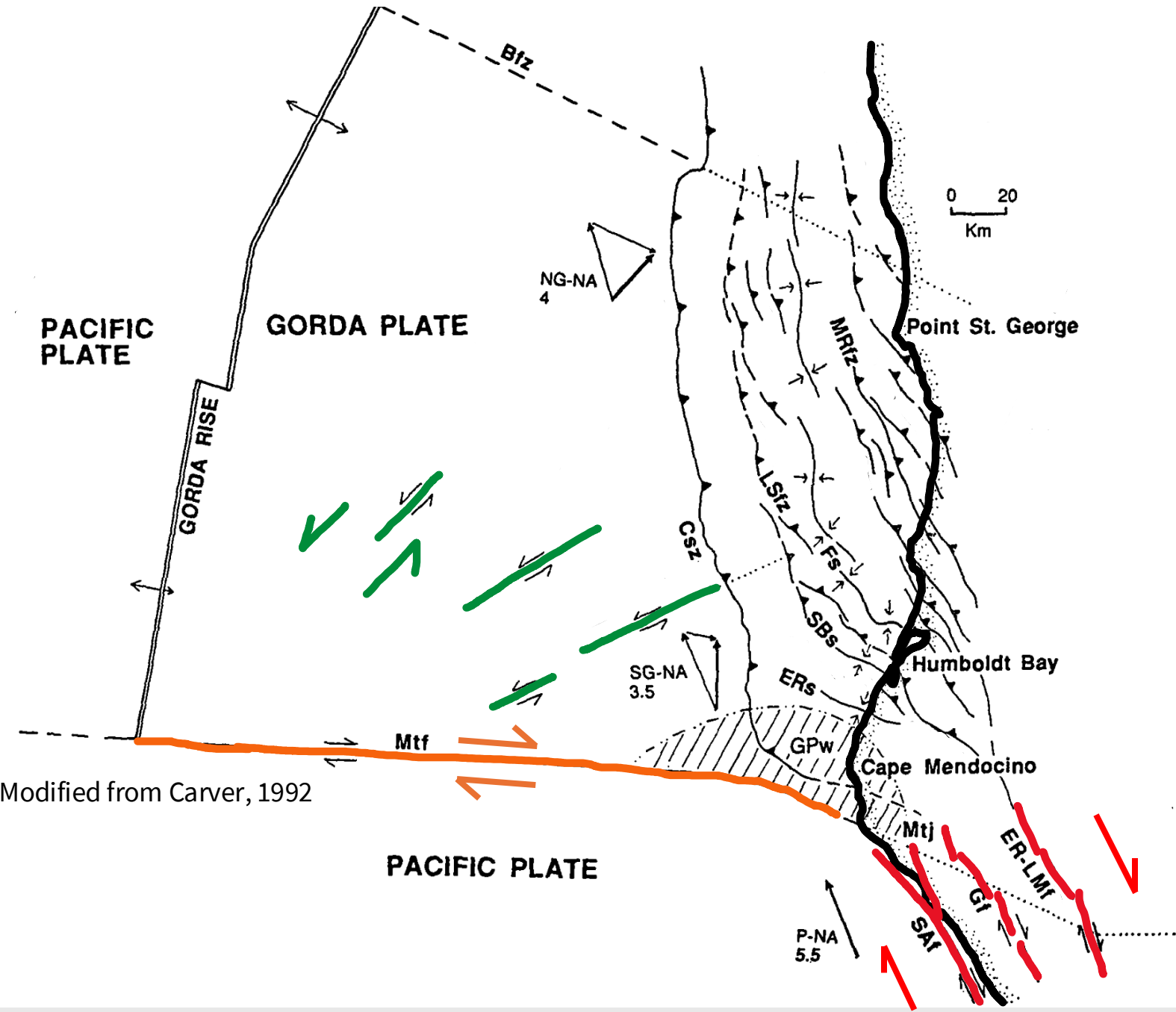
~44 mm/yr

1. SAF-parallel Strike-slip

~40 mm/yr

Modified from Carver, 1992

MTJ Components



3. Gorda Intra-plate

?? mm/yr

2. MFZ Strike-slip

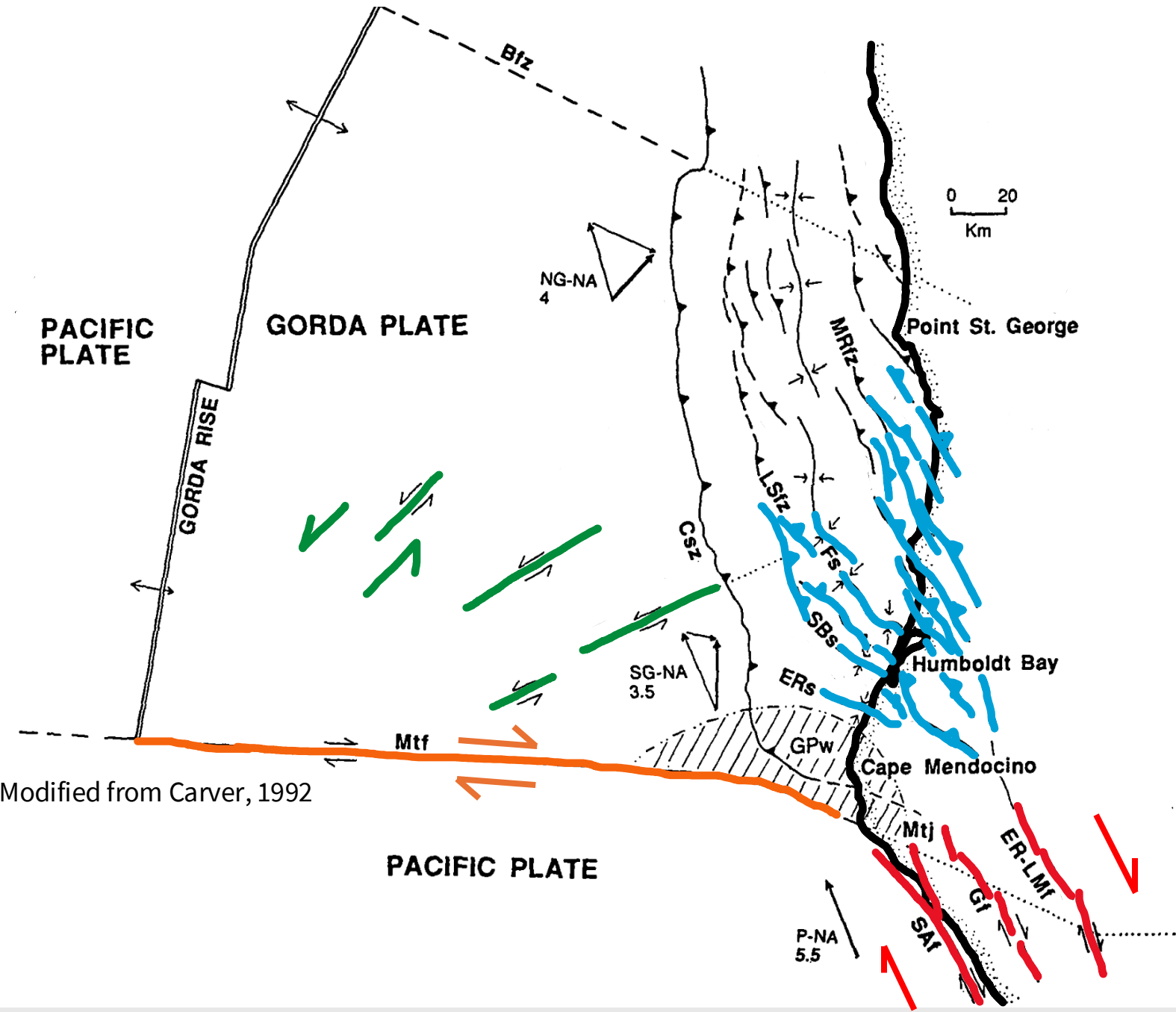
~44 mm/yr

1. SAF-parallel Strike-slip

~40 mm/yr

Modified from Carver, 1992

MTJ Components



4. Forearc oblique faulting

?? mm/yr

3. Gorda Intra-plate

?? mm/yr

2. MFZ Strike-slip

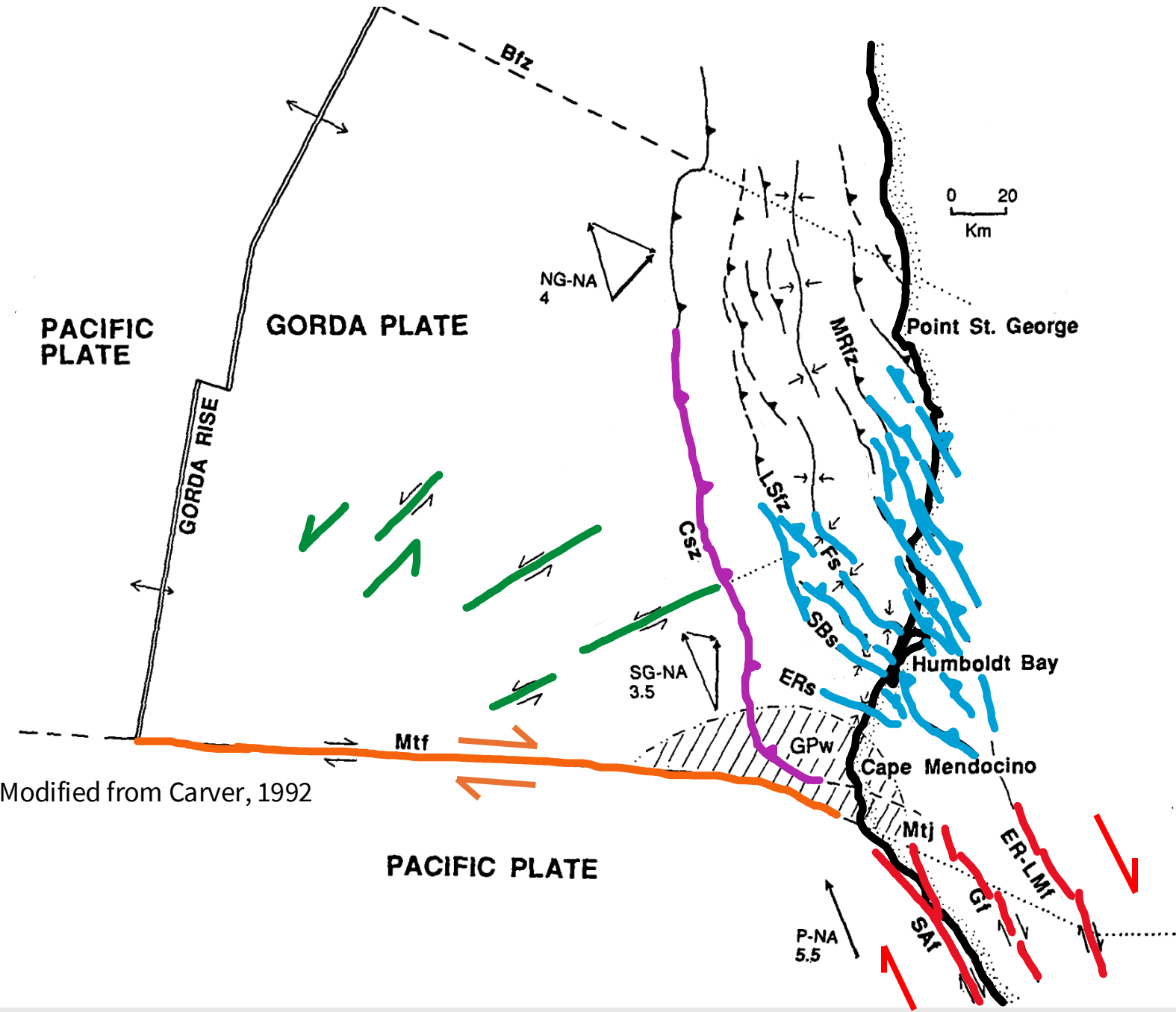
~44 mm/yr

1. SAF-parallel Strike-slip

~40 mm/yr

Modified from Carver, 1992

MTJ Components

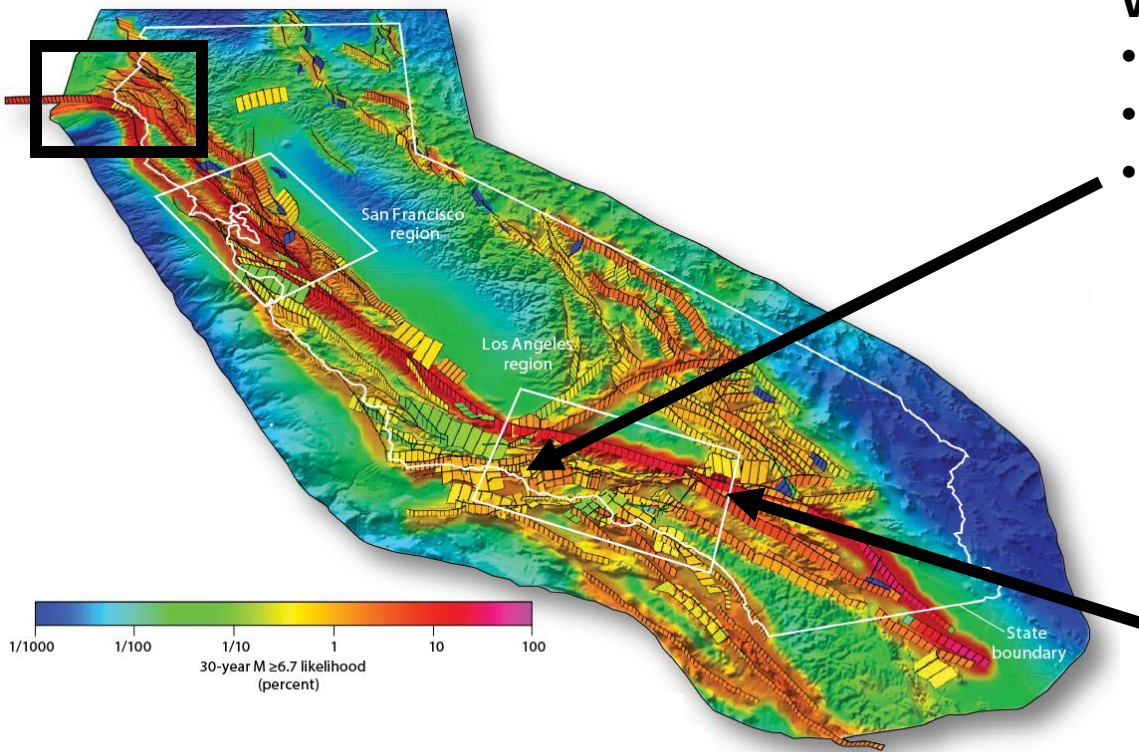


- 5. CSZ convergence**
~31 mm/yr
- 4. Forearc oblique faulting**
?? mm/yr
- 3. Gorda Intra-plate**
?? mm/yr
- 2. MFZ Strike-slip**
~44 mm/yr
- 1. SAF-parallel Strike-slip**
~40 mm/yr

Parallels to Special Fault Study Areas

UCERF3

Uniform California Earthquake Rupture Forecast (Version 3)

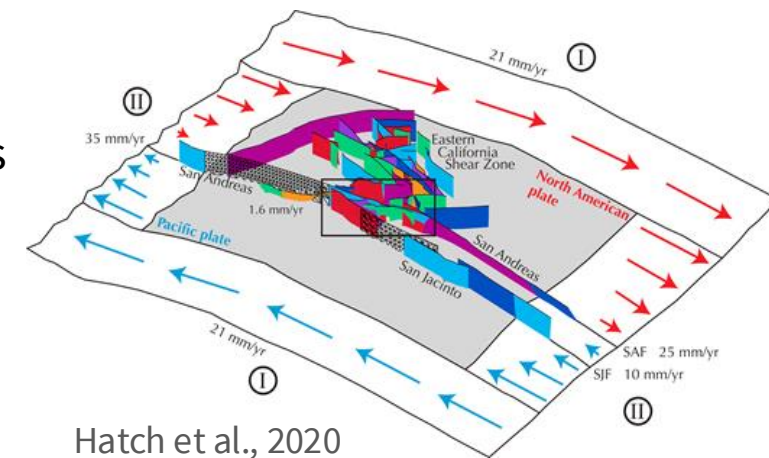
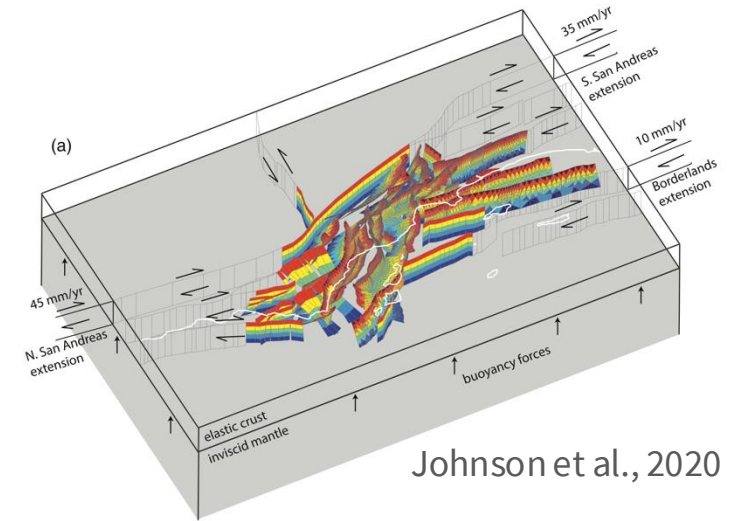


Ventura:

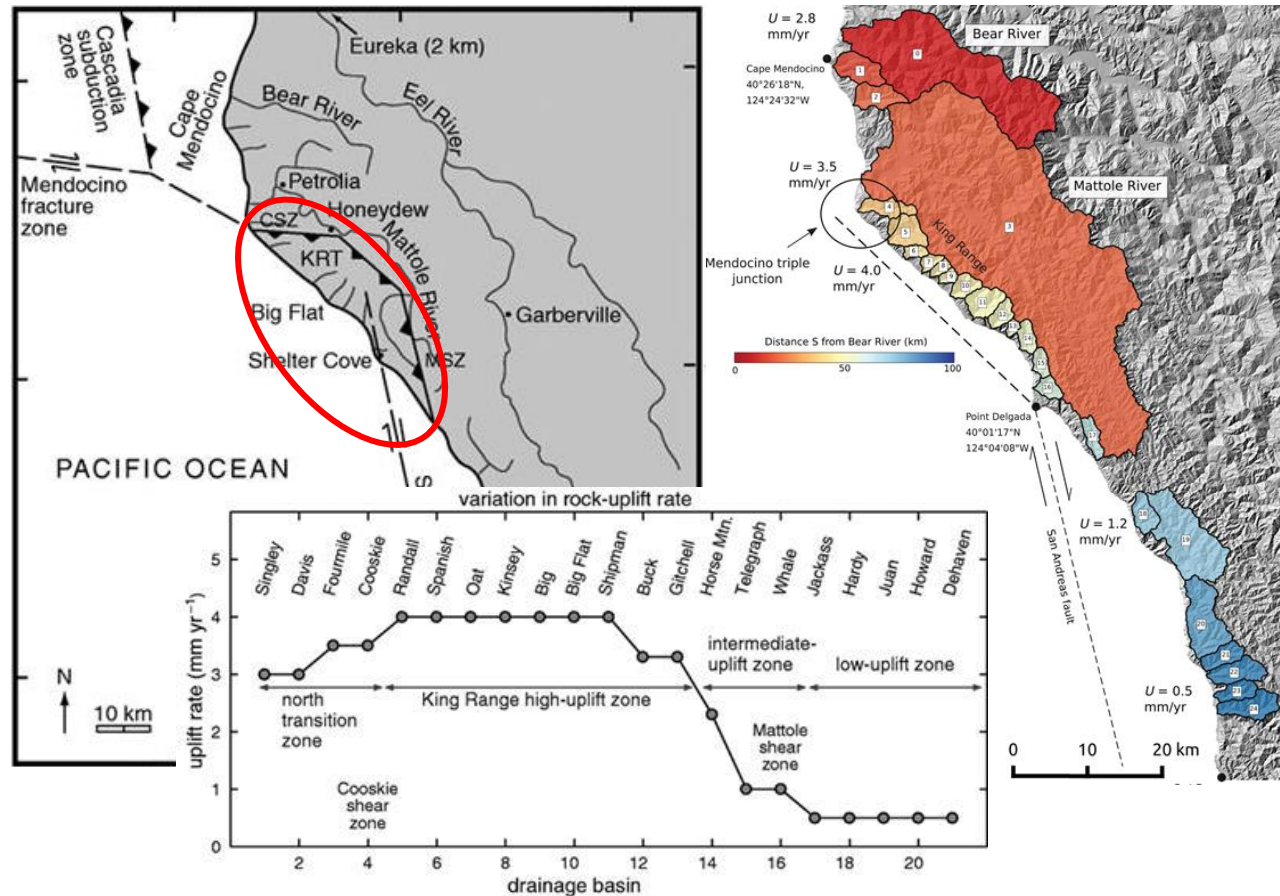
- Terrace uplift at ~4 mm/yr
- Active folds growing
- Tsunami potential

San Gorgonio Pass:

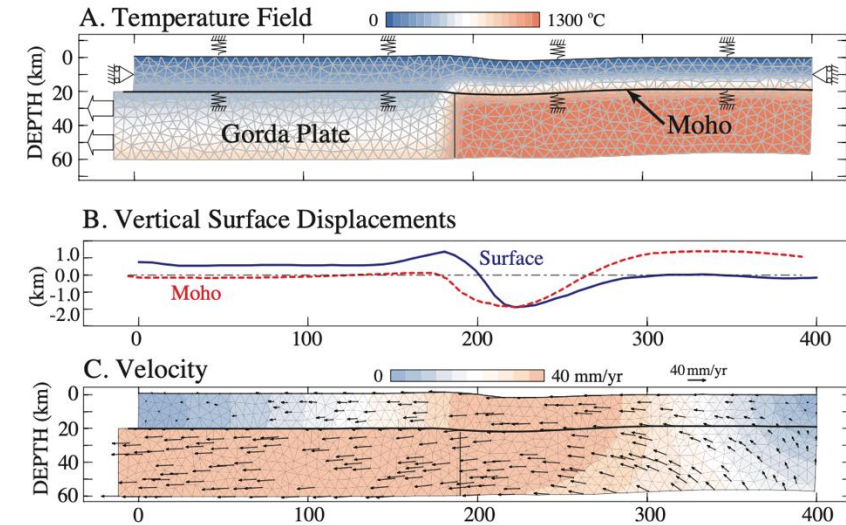
- Slip partitioning kinematics at fault junction
- Dynamic rupture interactions



1) What are the implications of high uplift rates at MTJ?



Merritts and Bull, 1989; Snyder et al., 2000; Clubb et al., 2020



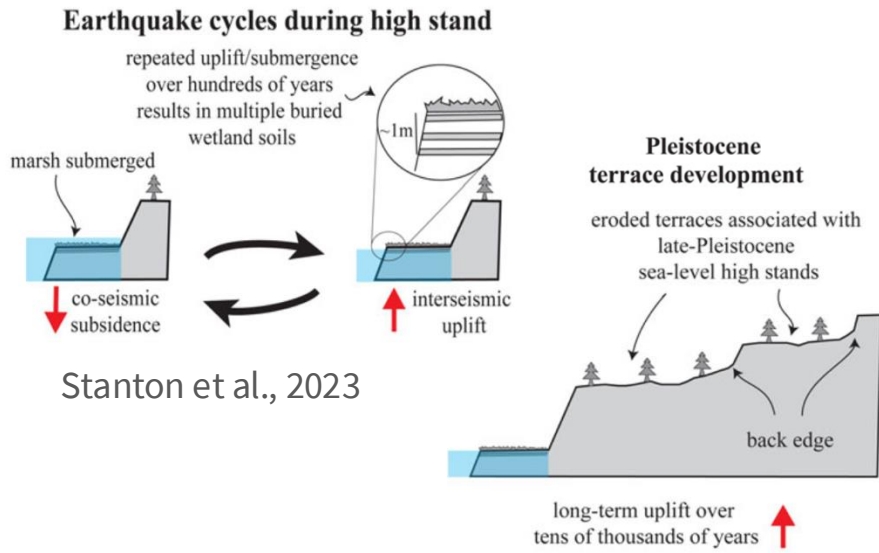
Furlong & Govers, 1999

Key Points:

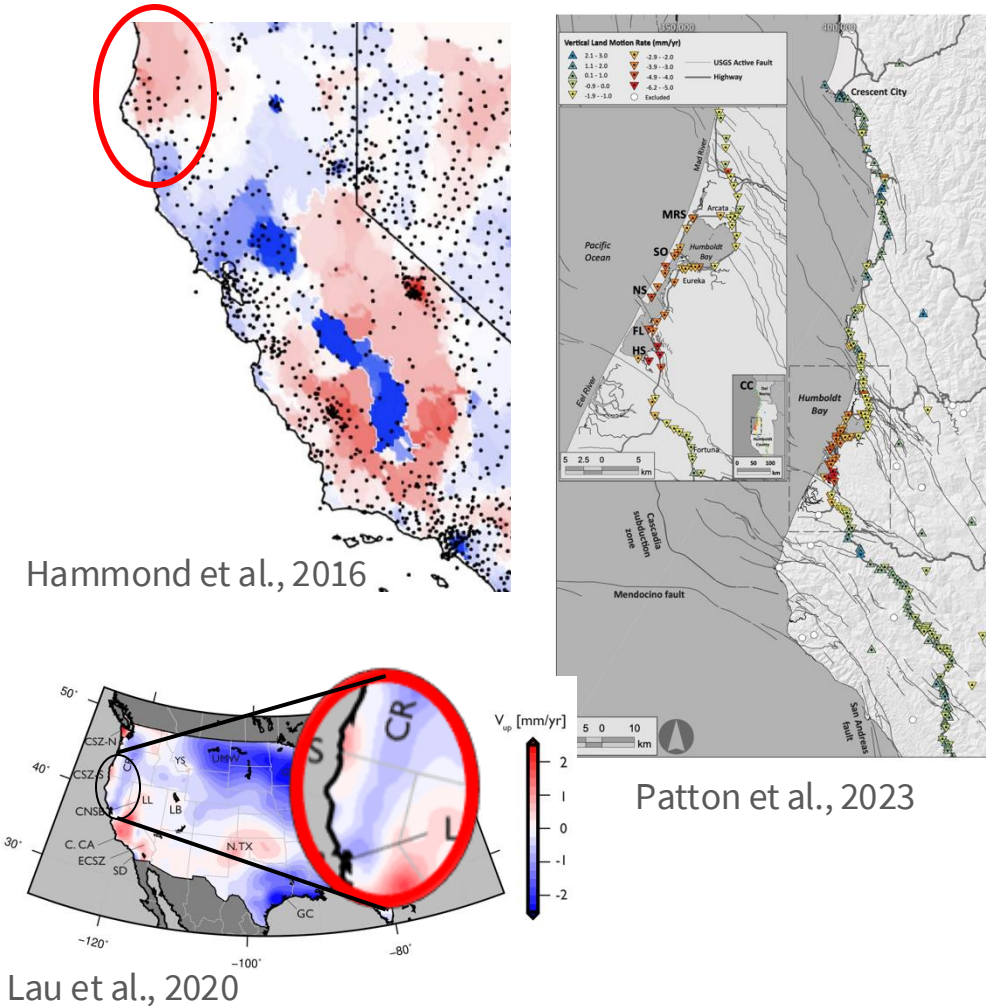
- MTJ Quaternary uplift rates among highest in US, ~ 4 mm/yr in King Range.
- Consistent with geomorphic evidence from channel steepness and hillslope geometry.
- Uplift pulse moving northward via “Mendocino Crustal Conveyor”.

1) What are the implications of high uplift rates at MTJ?

Quaternary (100ka)



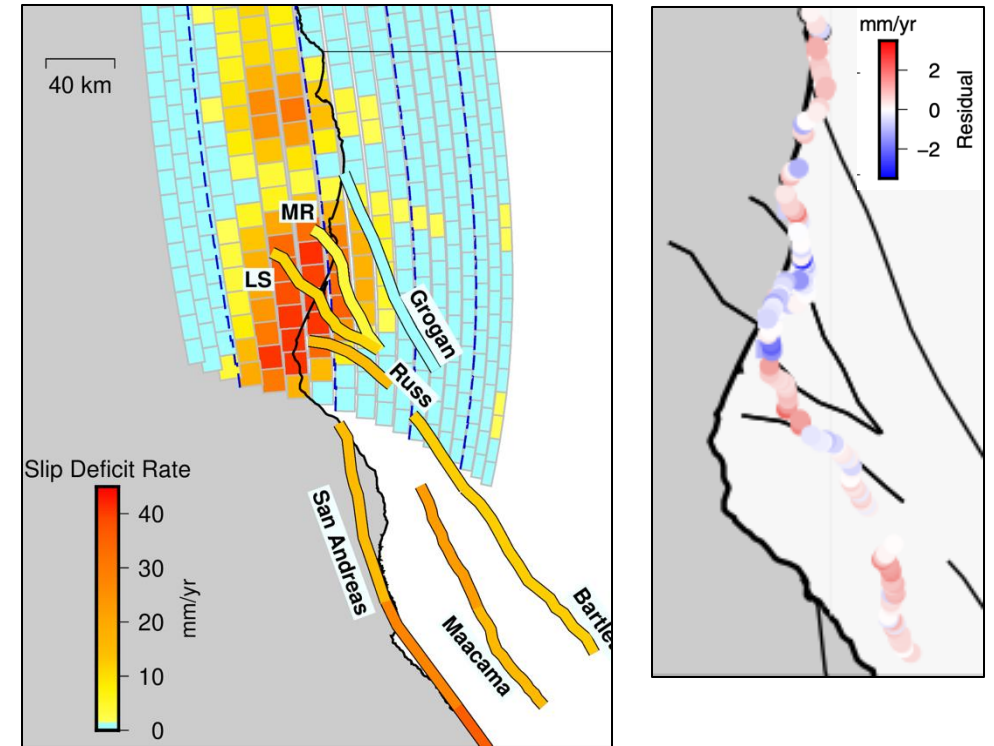
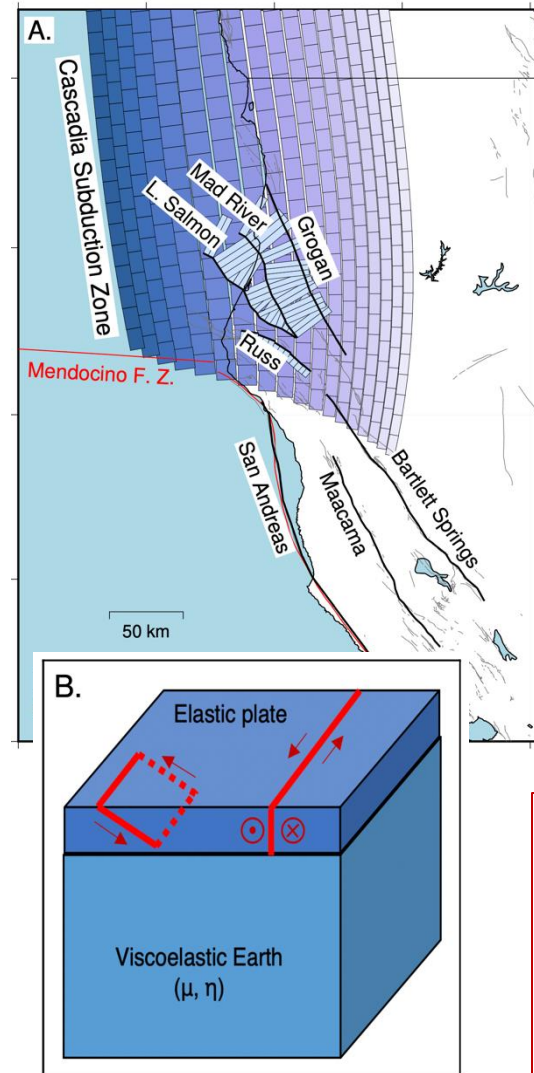
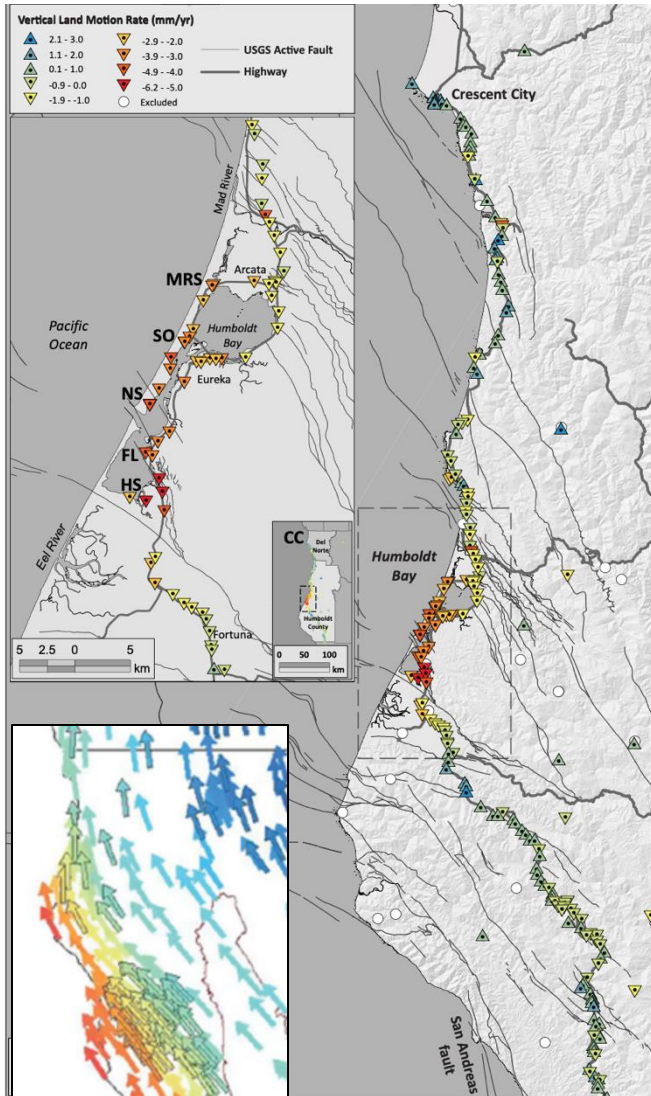
Decadal (1930s-present)



Key Points:

- How does the budget of vertical deformation produce uplift over many earthquake cycles?
- Geodetic uplift contains earthquake cycle effects, groundwater loading, GIA, sedimentation processes.

Modeling 3D interseismic velocity field with VE model



Key Findings:

- Combination of megathrust coupling (80%) and oblique slip-deficit on forearc faults (20%) accommodates convergence, reproduces interseismic subsidence at HB.
- SAF system ~45 mm/yr total

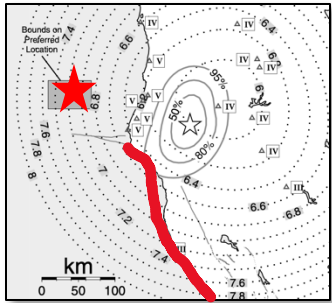
3) What types of dynamic fault interactions occur at MTJ?

Weird Aftershocks

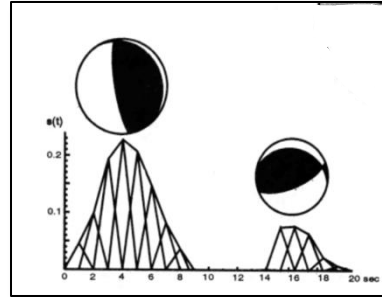
Multiple Sub-Events

Triggered slip or coupling

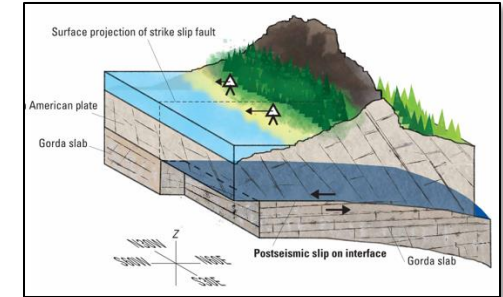
1906 S.F. Mw7.8



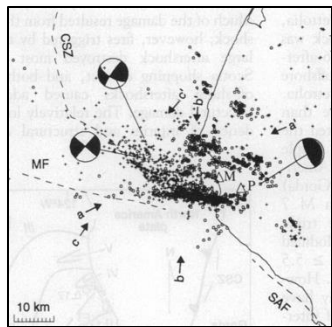
1992 Petrolia Mw7.2



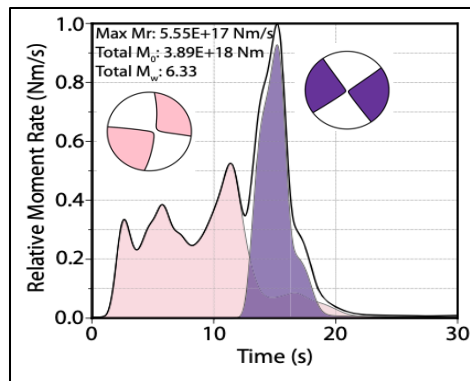
2022 Ferndale Mw6.4



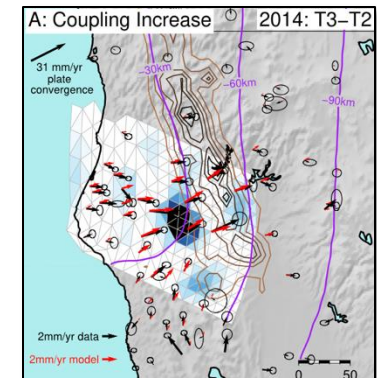
1992 Petrolia Mw7.2



2021 Ferndale Mw6.4



2014 Gorda Mw6.5

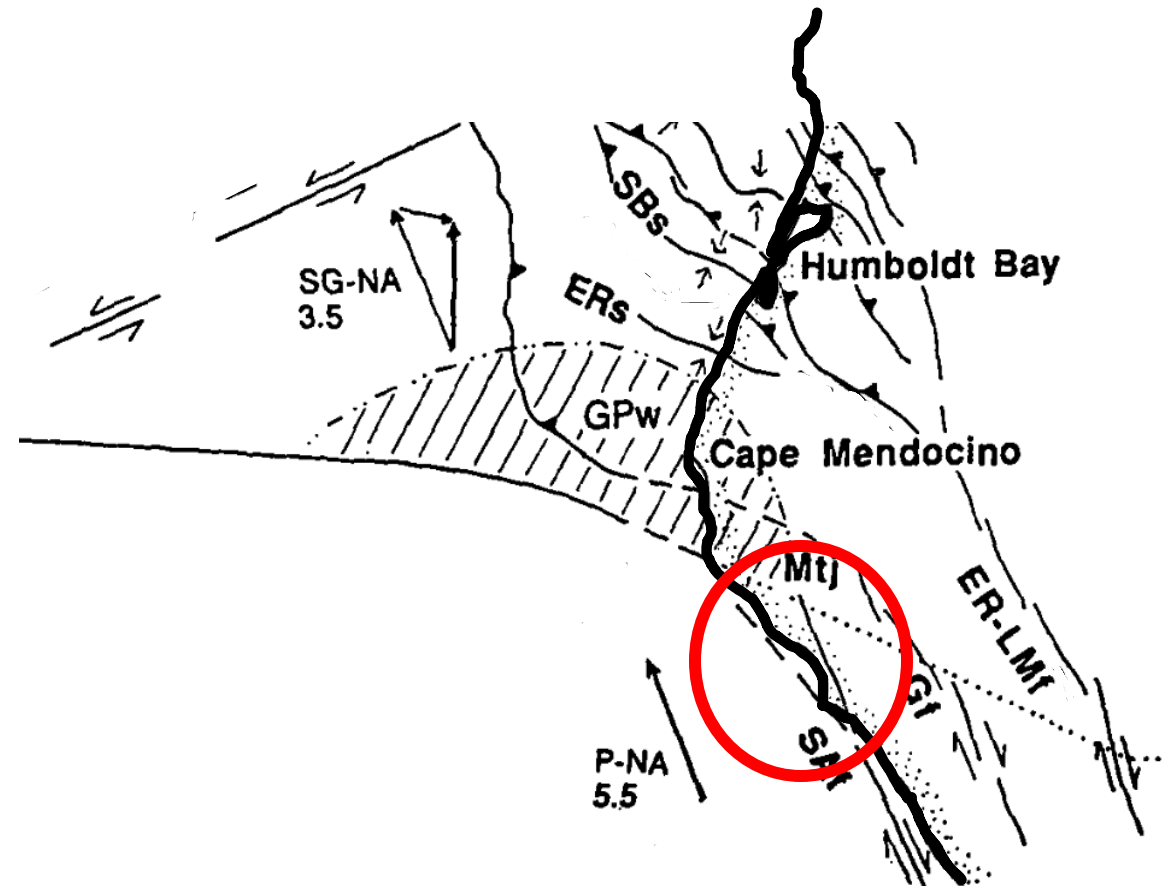
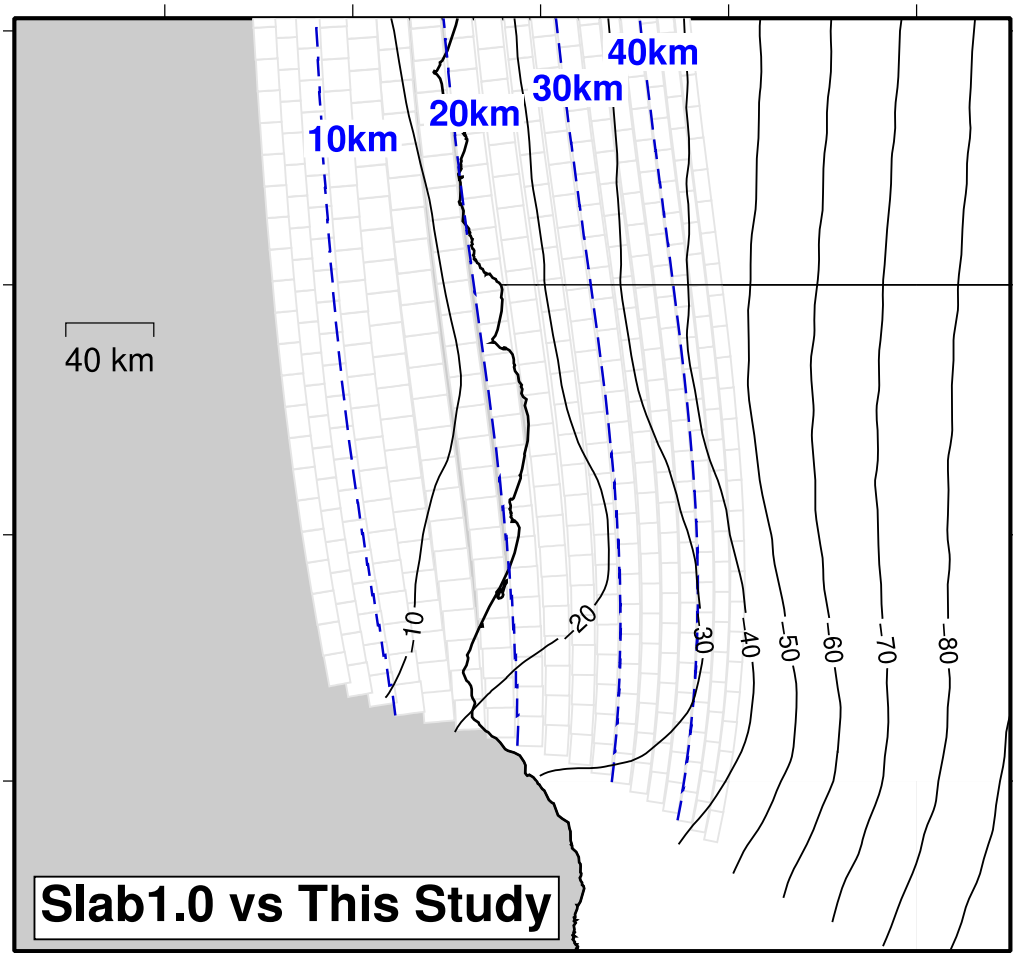


Meltzner & Wald, 2003;
Oppenheimer et al., 1993

Hagerty & Schwartz, 1997;
Yeck, Shelly, Materna et al., 2023

Shelly, Goldberg et al., 2024;
Materna et al., 2019

4) Geometry: where even is the SAF? And CSZ?

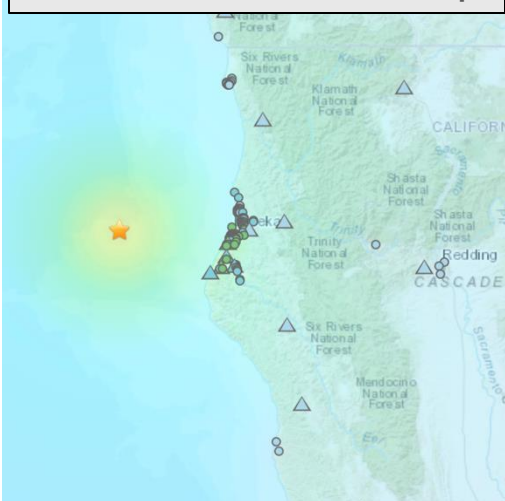


Modified from Carver, 1992

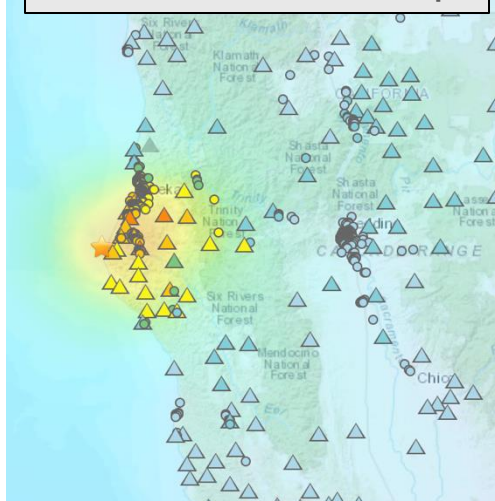
Opportunities: what can new datasets tell us about MTJ?

- EEW System expansion → new opportunities to understand rupture characteristics, wave propagation, extreme ground motion, velocity model
- DAS offers high-resolution imaging, which could help understand low-slip-rate or seismically quiet faults
- Geodetic imaging improvements in past decade

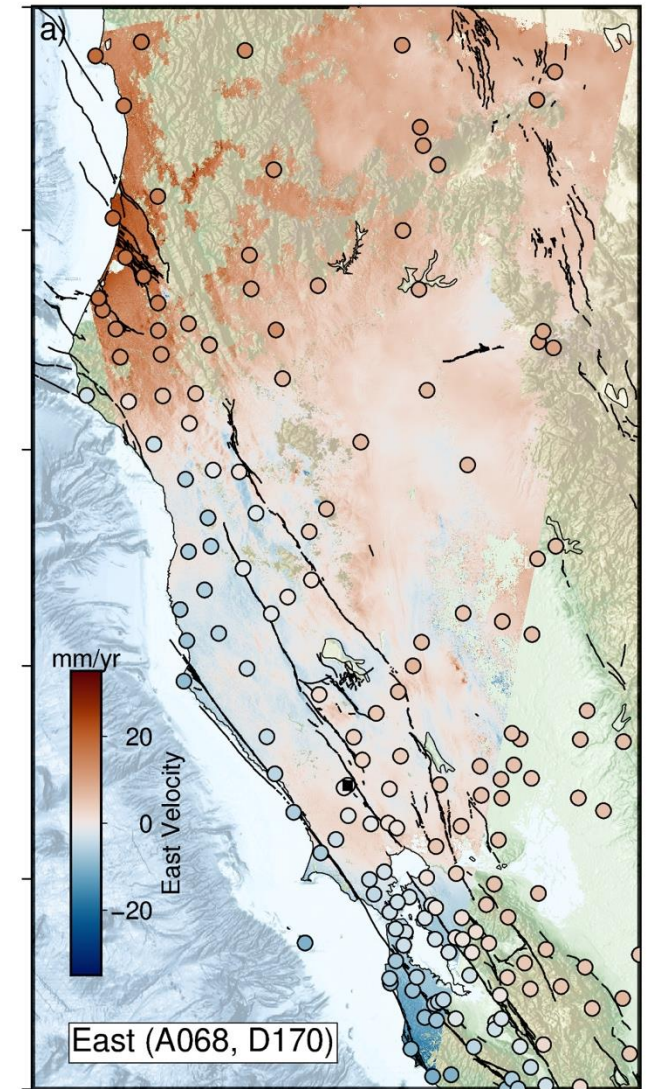
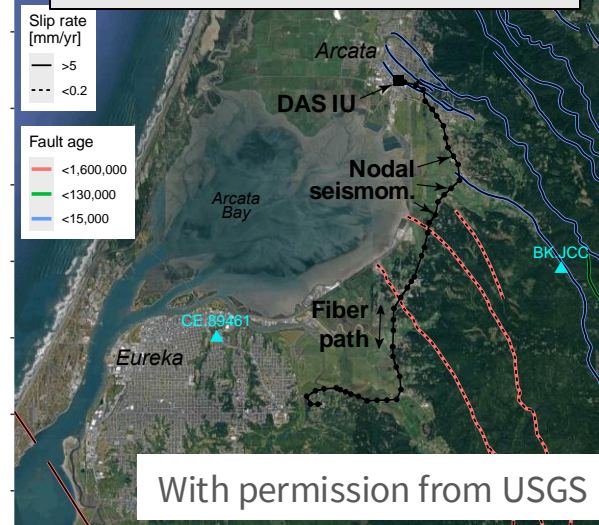
March 2014 Shakemap



Dec 2022 Shakemap



Dec 2022 Deployment



Lindsay et al., in prep.

Summary and broader discussion questions

- Key questions and opportunities:
 - Implications of vertical deformation across timescales
 - Strain partitioning across the triple junction
 - Rupture behavior and fault interactions in an interconnected system
 - Fault geometry of major and minor structures
- Opportunities for future collaboration with CRESCENT

