SCEC Community Rheology Model Workshop 2023

SESSION 1

THE IMPORTANCE OF SHEAR ZONES FOR THE CRM

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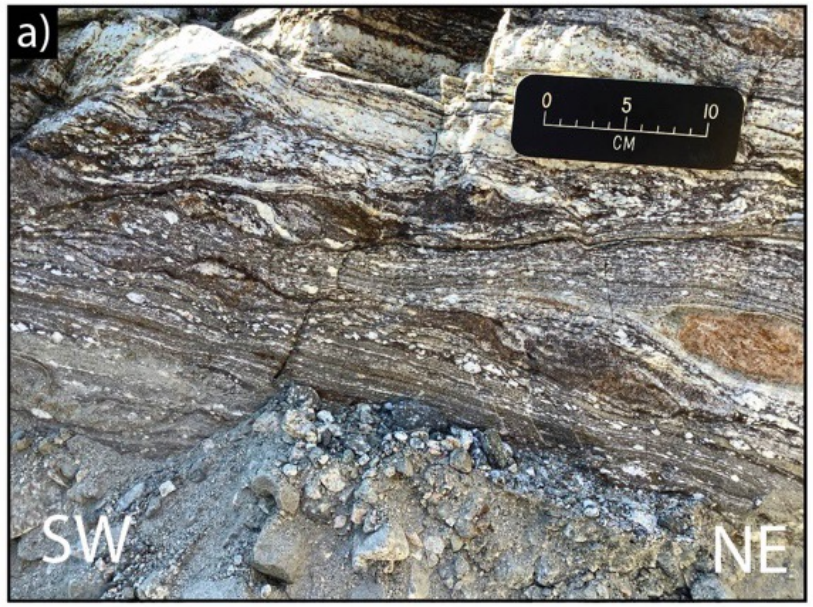
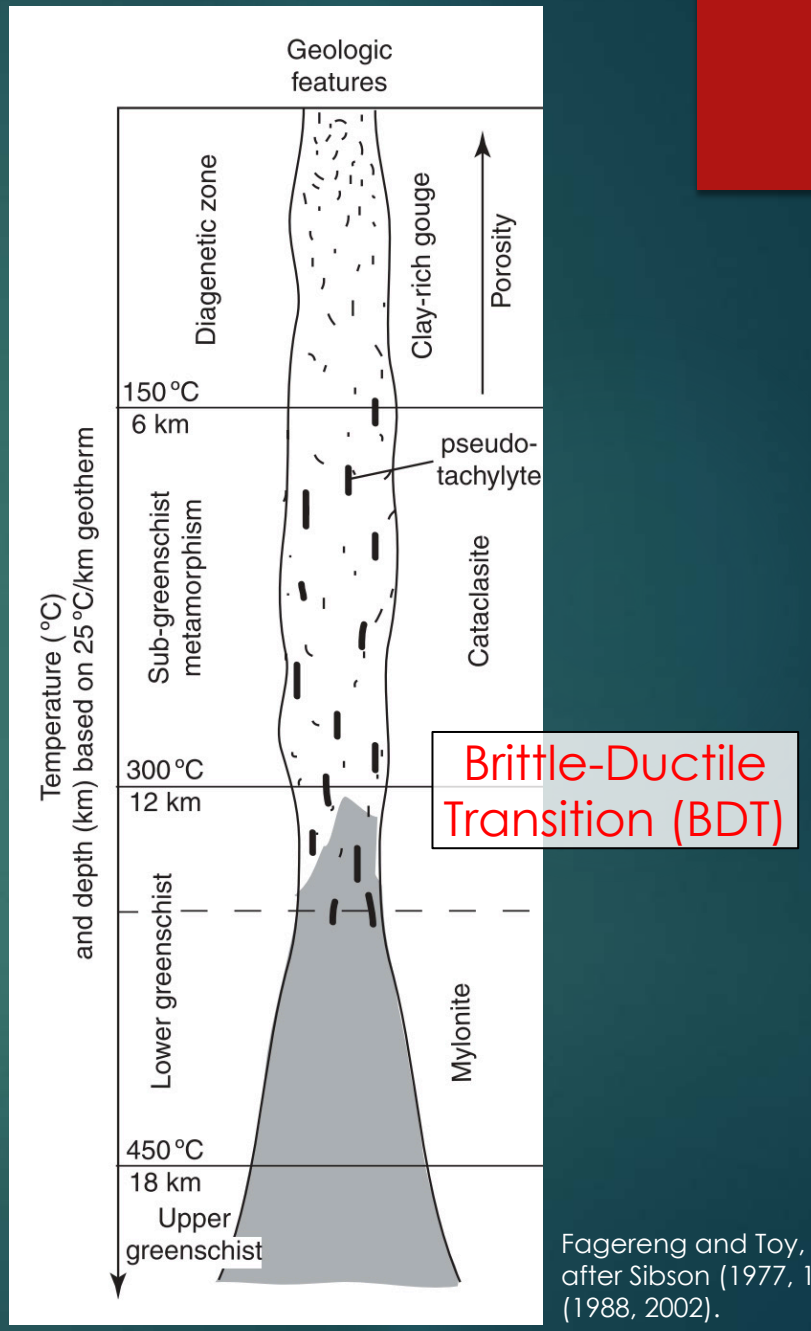


SCEC

AN NSF+USGS CENTER

SCEC's CRM Research Priorities

- Generate flow laws and/or guidance for the **rheology of ductile shear zones**
- Generate flow laws or guidance for addressing **transient rheology**
- Add **brittle-plastic rheology** to the CRM (upper crust, sediments, shear zones)
- Define a workflow for connecting results of GF viewer queries to the code RHEOL_GUI



Fagereng and Toy, 2011; modified after Sibson (1977, 1983); Scholtz (1988, 2002).

SoCal shear zones contain key data for CRM Research Priorities:

- Generate flow laws and/or guidance for the **rheology of ductile shear zones**
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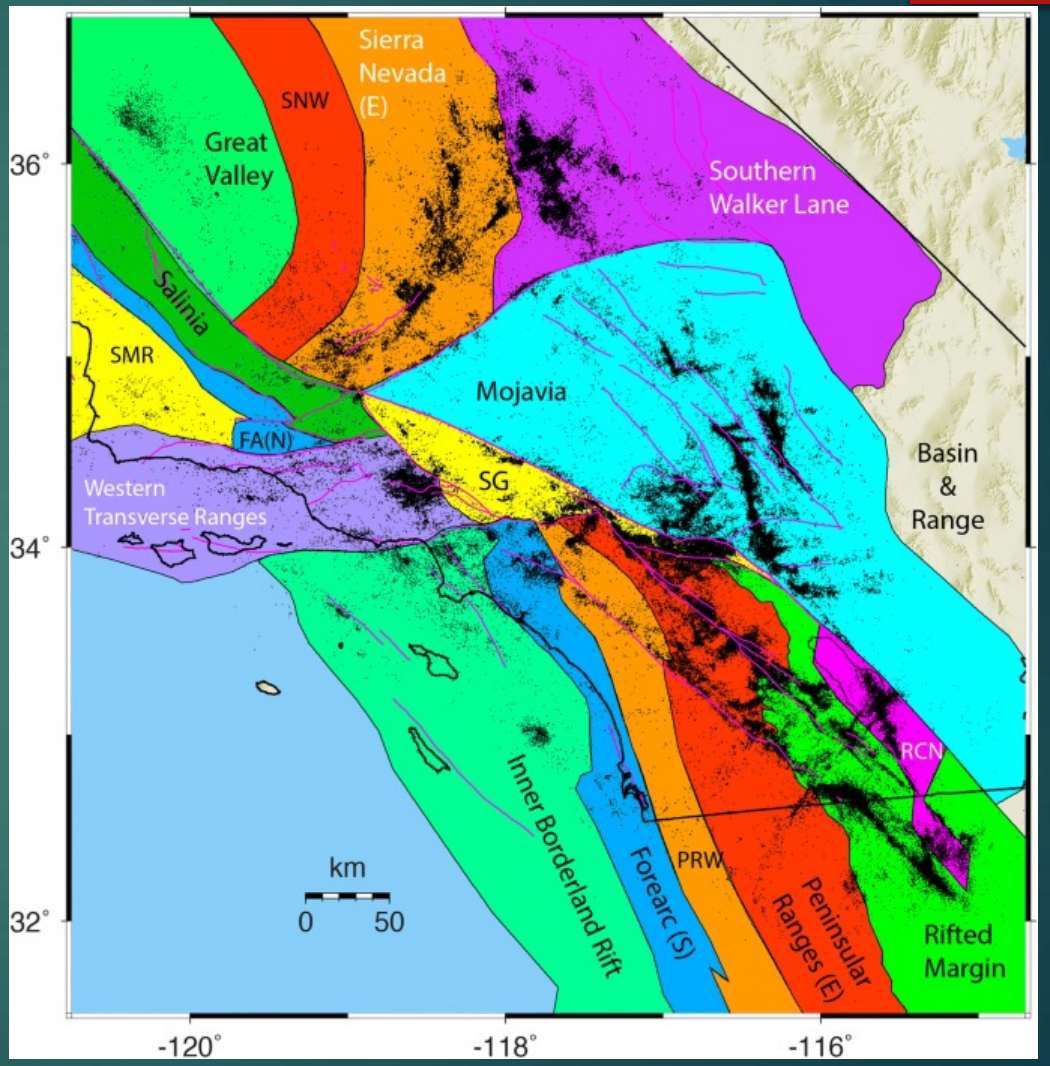
- Shear zone host rock composition + deformation mechanisms + shear zone width
- Shear zones record transient events (melt infiltration, pseudotachylyte)
- Shear zone mylonites and co-eval pseudotachylytes record brittle-plastic rheology

CRM's Lithotectonic Block Model

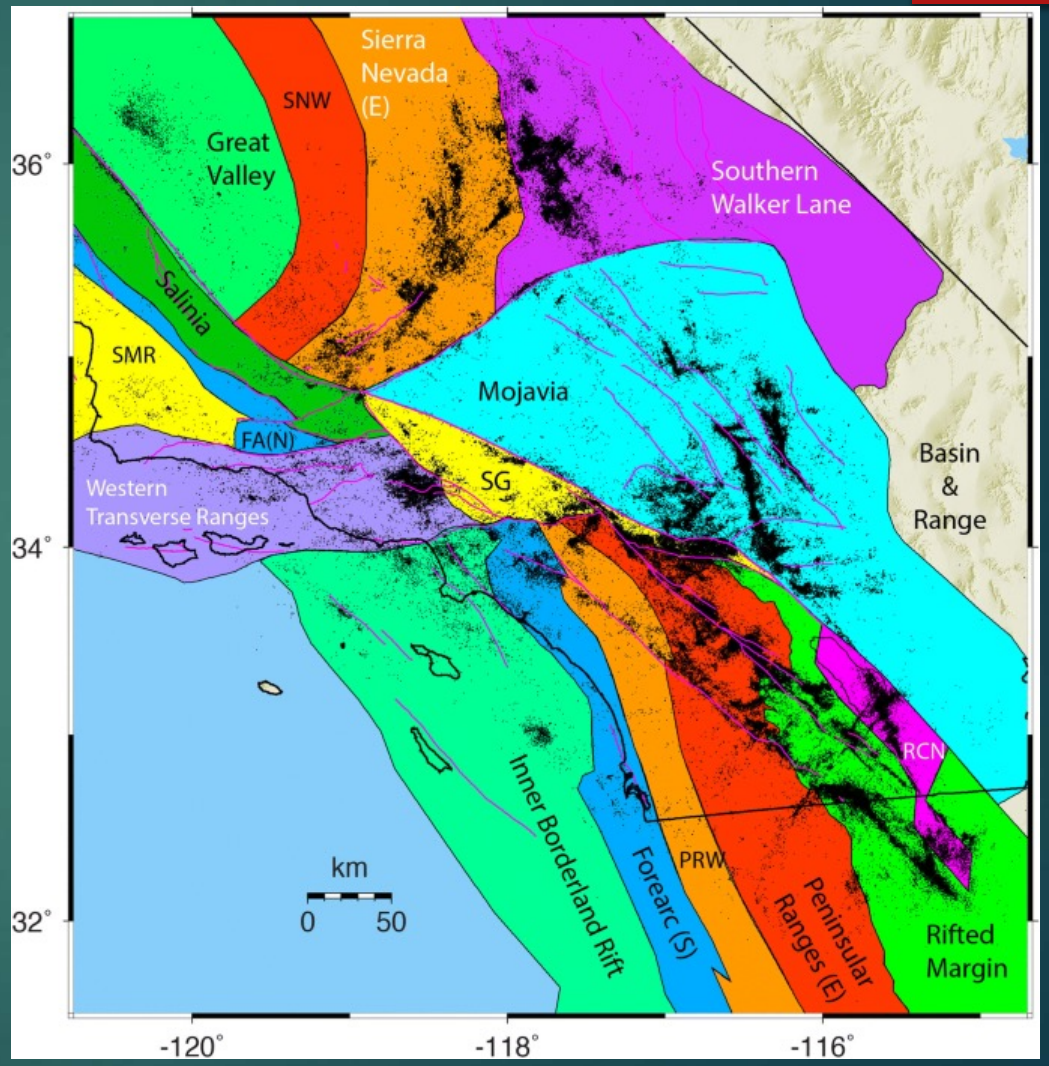
- Inherited tectonic fabric from evolution of Pacific-North America plate boundary
- Blocks have distinctive compositional affinity
- Not all blocks are fault-bounded
- *CRM has to account for both compositional changes and ductile shear zones beneath faults– these may be decoupled*
- *Shear zones are insightful for this specific challenge*



Hauksson and Meier, 2019
Oskin et al., 2016

Lithotectonic Block Model

- Lots of different shear zones…which are best?
- Late Cretaceous intra-arc shear zones are a good analog for shear zones under faults of SAF system
- Expose middle and lower crust
- Pre-existing ductile shear zone fabrics guide development of major brittle faults of the San Andreas Fault system



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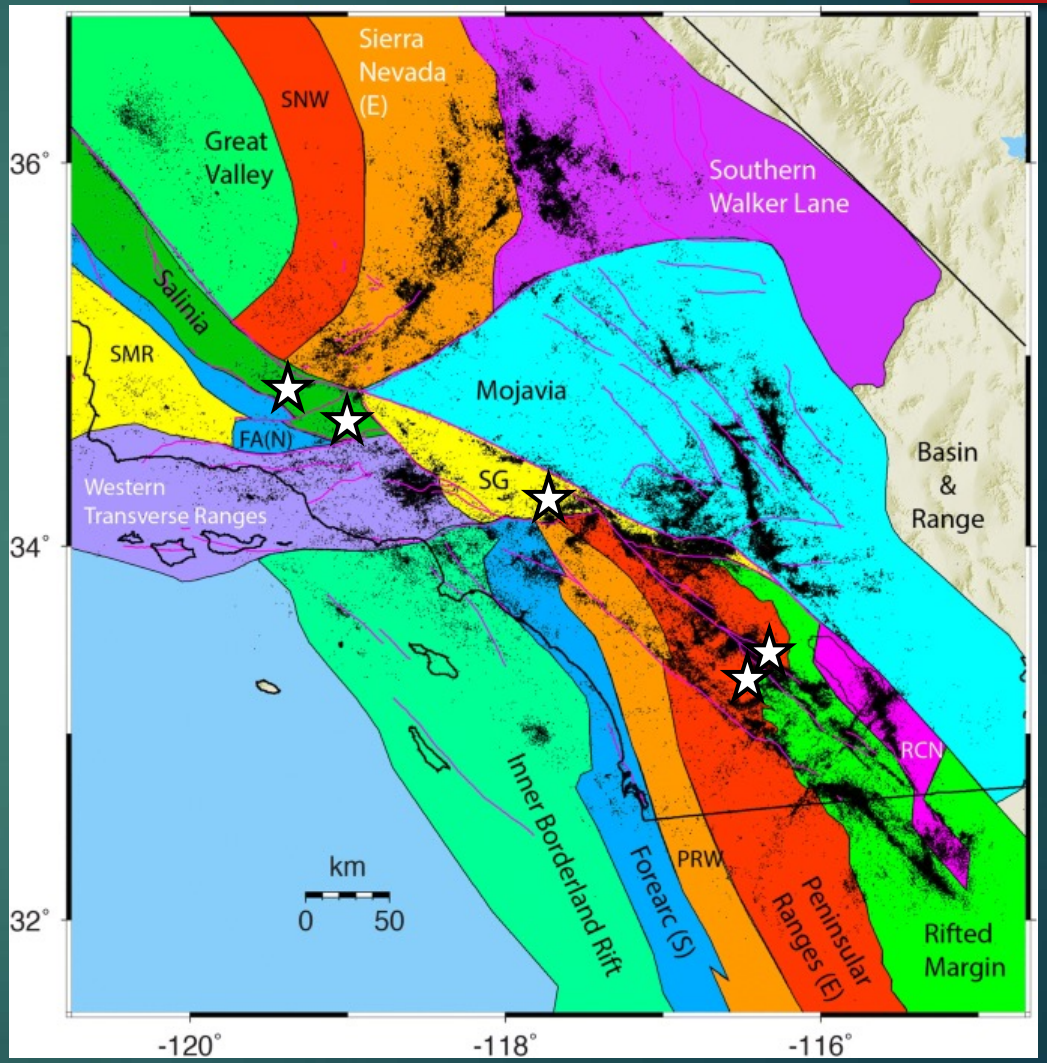
Where are shear zones relative to the Lithotectonic Block Model?

- **Salinia Block (or is it San Gabriel Block?)**
  - Tumamait Shear Zone
  - Alamo Mountain/Piru Creek Shear Zone
- **San Gabriel Block**
  - Cucamonga Shear Zone*
  - Black Belt Shear Zone*
- **Peninsular Ranges (E)**
  - Eastern Peninsular Ranges Mylonite Zone (3 components)

*field trip tomorrow



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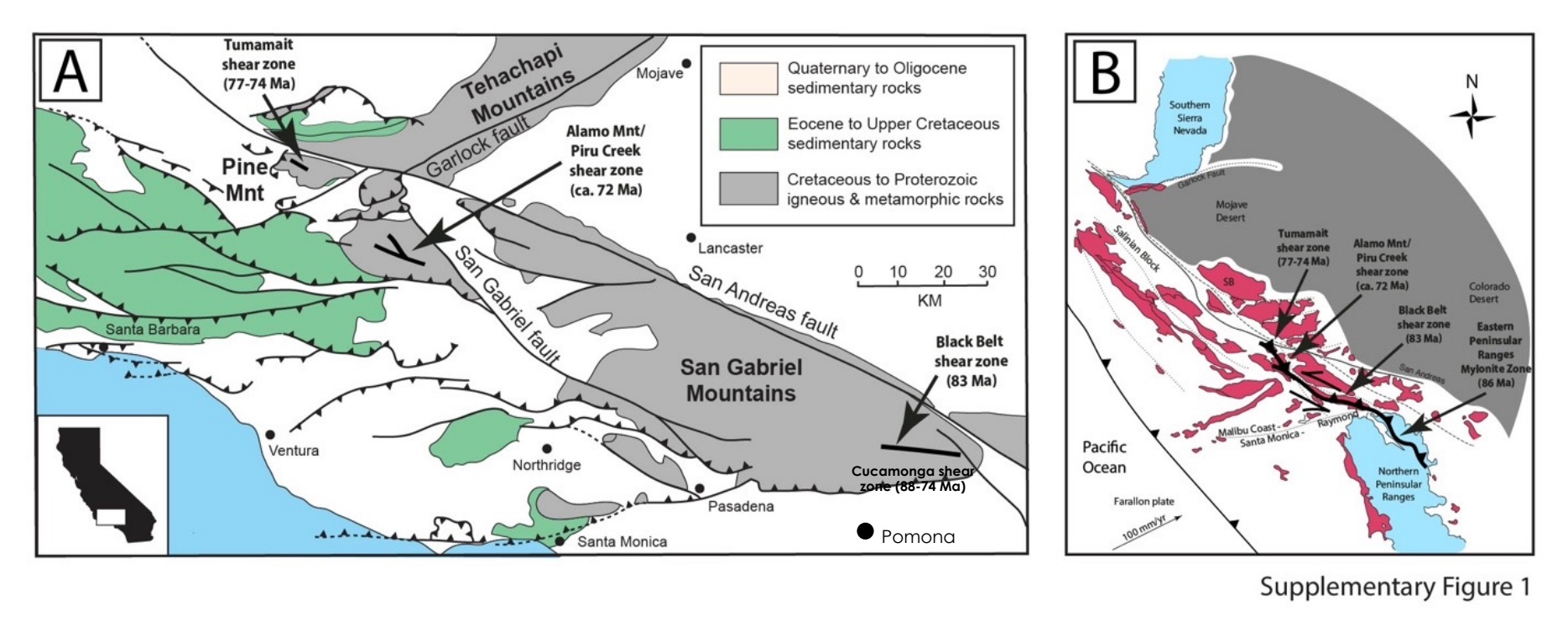
Late Cretaceous Shear Zones



Supplementary Figure 1

Schwartz et al., in revision for *Nature Communications*

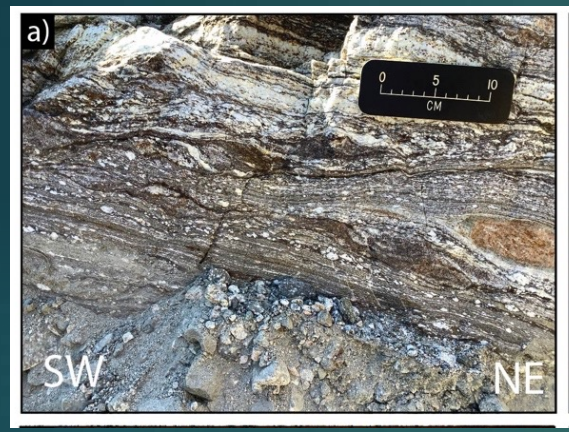
The Late Cretaceous shear zones get progressively older towards the south

Top-to-SW, oblique sinistral-reverse sense of shear

- **Offset by modern SAF**
- **Continuous intra-arc shear zone in Late Cretaceous**

Late Cretaceous Shear Zones

Cucamonga SZ
migmatitic paragneiss



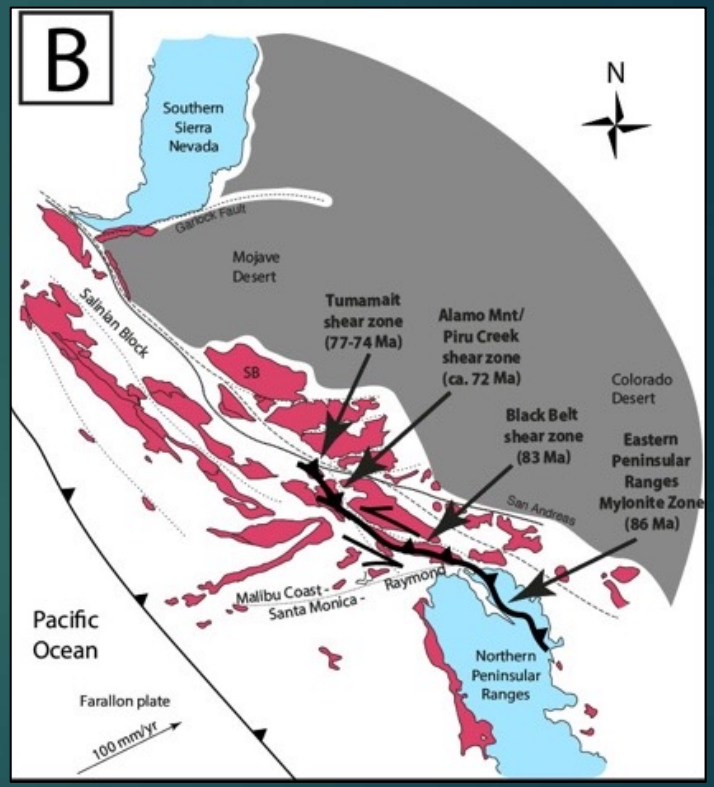
Black Belt SZ
tonalite

Black Belt SZ
tonalite

Tumamait SZ
granite

Eastern Peninsular Ranges SZ
granodiorite

EPR SZ
granodiorite



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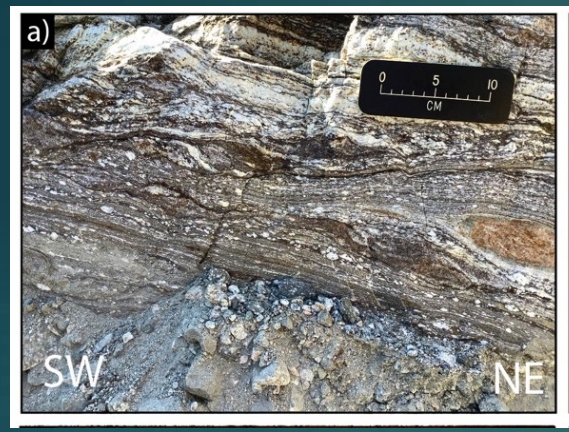
Late Cretaceous Shear Zones

Cucamonga SZ
migmatitic paragneiss



Black Belt SZ
tonalite

Black Belt SZ
tonalite

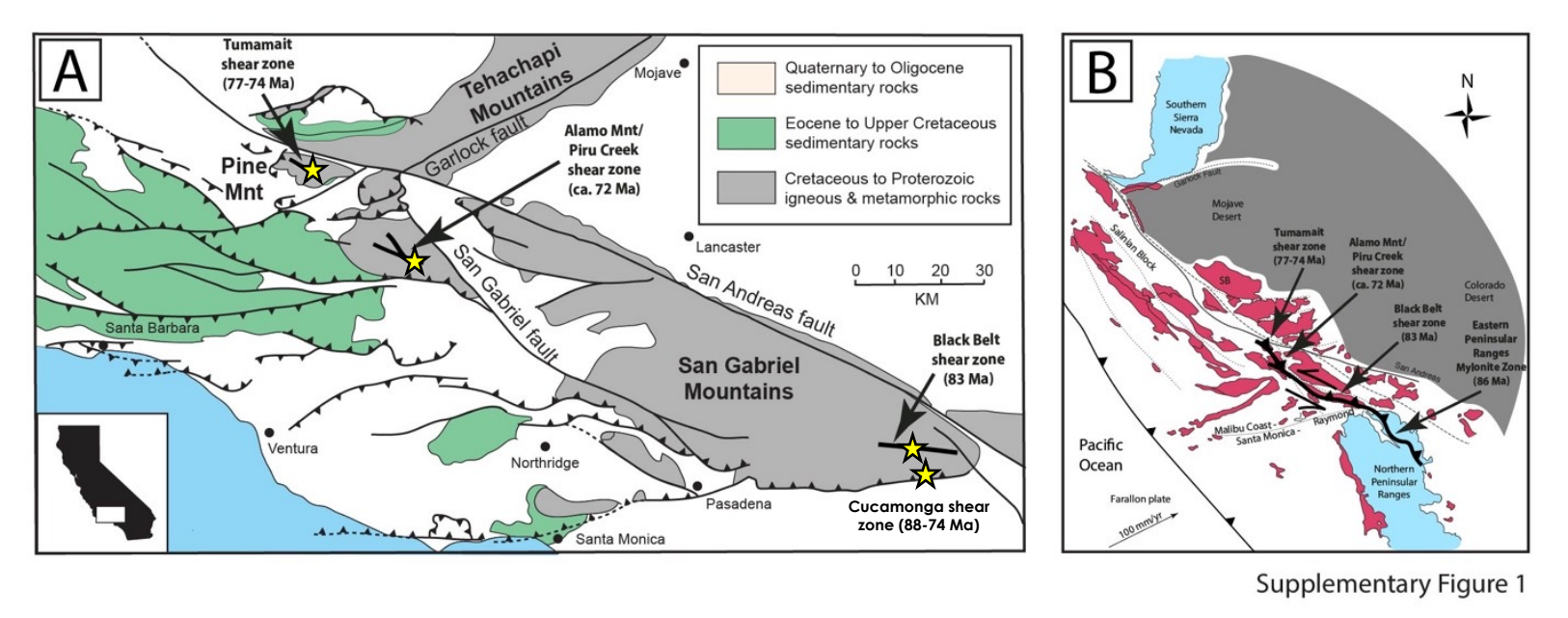
Tumamait SZ
granite

Eastern Peninsular Ranges SZ
granodiorite

EPR SZ
granodiorite

- **Ductile Shear Zone Rheology**
  - Lower crust (garnet gneiss)
  - Middle crust (tonalite, granodiorite, granite)
  - Width of SZ
  - How is strain localized
  - Deformation mechanisms
- **Transient Rheology**
  - Melt (migmatite, pst)
  - Earthquakes (pst)
  - Need constraints on time; geochronology and petrochronology
- **Brittle-Plastic Rheology**
  - Melt (migmatite, pst)
  - Earthquakes (pst)
  - Constraints on timing of fabric development through petrochronology

Late Cretaceous Shear Zones



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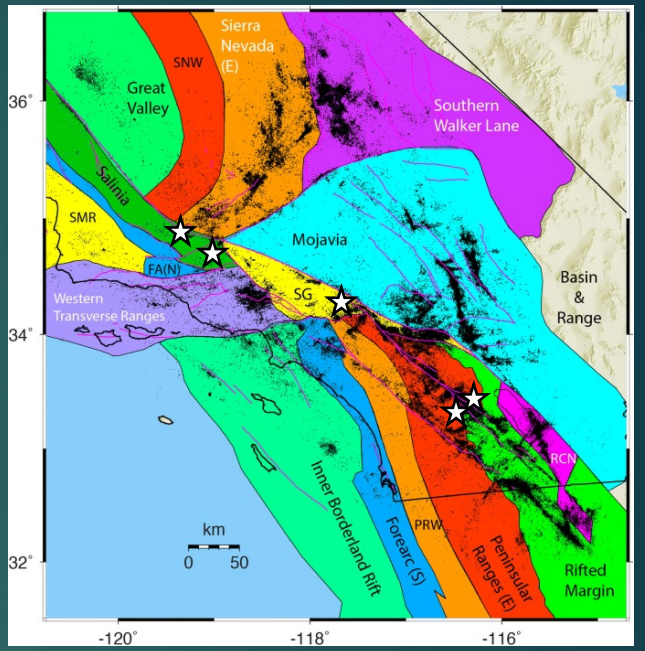

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- **Basement geology needs to inform Lithotectonic Block Model**
- **Regional scale of Late Cretaceous intra-arc shear zone raises questions about block affinity**
- **Requires re-examination of role of PORC schists in these blocks**