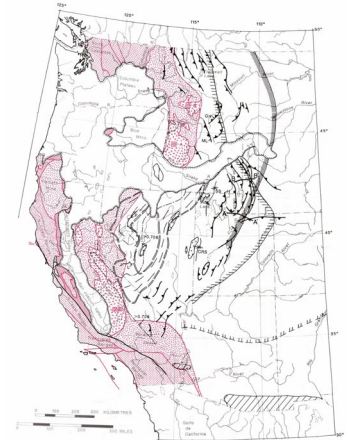


LATE JURASSIC TO LATE CRETACEOUS

Reading:
GNAM volume G3, Chapter 5

Topics

- Eastern and central Cordillera
- Western Cordillera



Eastern and Central Cordillera

- Cordilleran fold and thrust belt
- Foreland basin
- Hinterland

Plate Interior

- Foreland Deformation
 - Foreland fold and thrust belt and related basin system
- Foreland Basin Deposits
 - Aeolian deposits (Navajo ss.) followed by marine incursion (Morrison Fm.)

Three Deformation Belts

- Luning Fencemaker Thrust (Nevada)
- Sevier Belt
- Hinterland Belt (Willow Creek Allochthon)

Foreland Basin Deposits

- Fluvial Morrison Formation with conglomerate wedges
- Deposited on top of earlier aeolian deposits of Navajo ss.
- Represents erosion from a western orogenic highland onto an extensive eastern foreland basin

Fold And Thrust Belt

- Geometry and Displacements
- Timing of Thrusts

Timing of Thrusts

- 100 Ma to 50 Ma (older in the west)
- Classic stacked shingle structure
 - Structurally oldest faults are highest
 - Carried eastward piggy back on younger faults

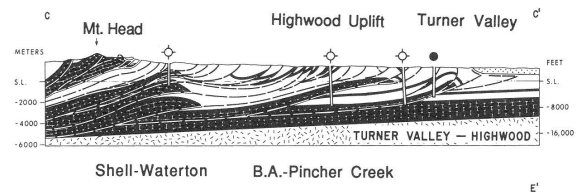
Foreland Basin

- **Interpretation**
- **Early Jurassic**
- **Late Jurassic**

Geometry and Displacements

- Proterozoic and Paleozoic geocline
- East vergent
- Thin-skinned
- E limit is Wasatch line or hinge line
- Shortening is about 50%
- Basal decollement
 - Steps down section from E to W
- Cretaceous to Precambrian sediments

Foreland Thrust Belt

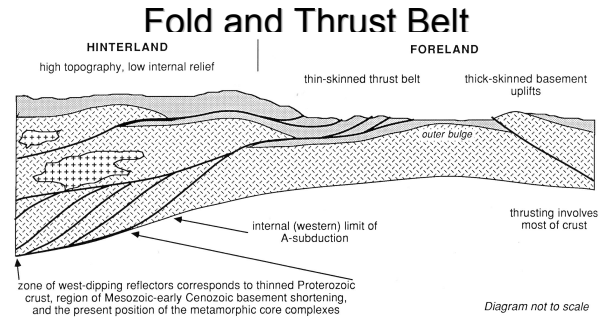


Interpretation

- Began in late Jurassic
- Culminated in Cretaceous
- Extended from S Nevada into Canada
- Asymmetric
 - Thickest near uplift
 - Feathered toward the east
 - Up to 10 km thick

Interpretation

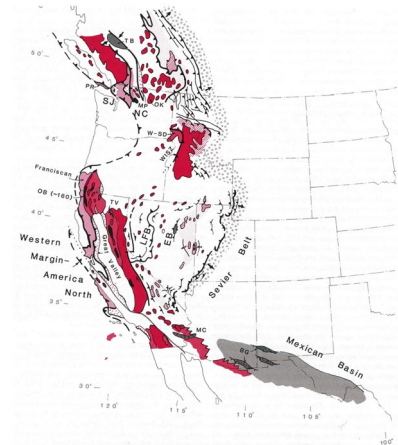
- Basin responded to crustal loading
 - Loading caused by thrusting
 - Deposition occurred in the basins
- Broadly distributed flexure
 - Elastic deformation
 - Low to moderate thermal gradients



Early Jurassic

- Vast epeiric seaway
- Shallow marine and sub aerial deposits
 - Derived from the continental interior

Middle Jurassic-Late Cretaceous



Late Jurassic

- Non-marine deposits spread eastward
 - Shale, sandstone, and conglomerate
- Epeiric sea retreated
 - Northward into Canada
 - Southward into Mexico
- Swamp deposits spread eastward
 - Form an alluvial plain

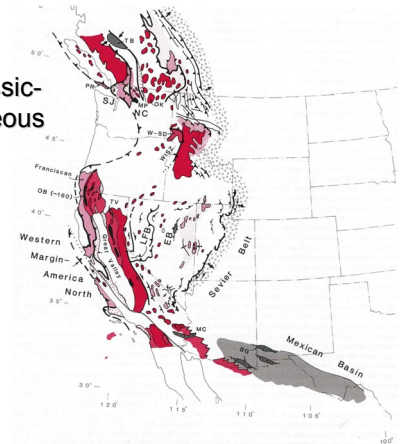
Hinterland

- Thrust systems rooted in the west
- Metamorphic core complexes
 - Late Jurassic and early Cretaceous age
 - Located in the western thrust belt
- 90 to 100 Ma plutons
 - Coextensive with the Sevier thrust belt

Upper Jurassic to Upper Cretaceous

- Bisbee Group
- McCoy Mountain Formation

Middle Jurassic-Late Cretaceous



Transtensional Disruption

- Bisbee Basin
 - Rift Sediments (Glance Conglomerate, 2 Km)
- McCoy Basin
 - Volcaniclastic Rocks (3 Km)
- Sinistral Faults (Sonora)
- Independence Dike Swarm (Rift Related)

Bisbee Group

- Southern Arizona and SW New Mexico
- Deposits are 3 Km thick
- Basal conglomerates
- Overlain by volcanics (150 Ma)
- Overlain by shallow marine/non-marine sediments
- Related to failed rift & opening of the Gulf of Mexico

McCoy Mountain Formation

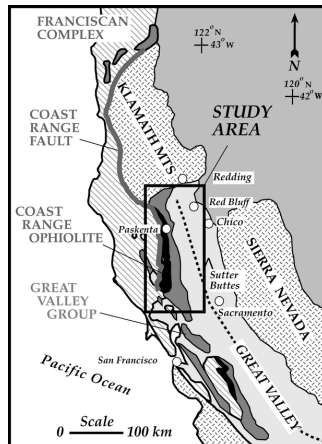
- Deposits are 7 km thick
- Deformed and metamorphosed
- Lower quartzose to volcaniclastic section
- Overlain by upper Cretaceous arkoses

Western Cordillera

- Structural tectonic groups
- Sierra Nevada Batholith
 - A. Roots of the magmatic arc
- Great valley sequence
 - Sedimentary fill of the forearc basin
- Franciscan complex
 - Subduction complex
 - Deformed and metamorphosed ocean floor, trench, and continental slope materials

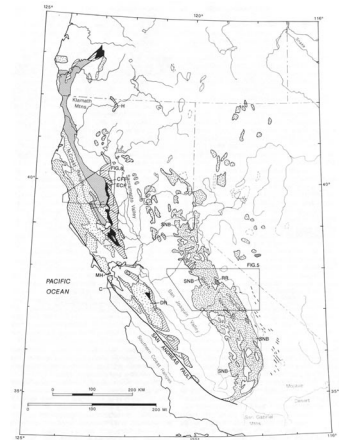
Western Belt Map

- Sierra Nevada batholith
- Great Valley Group
- Franciscan Fm.



Sierra Nevada Batholith

- Plutons
- Framework Rocks



Plutons

- Upper Jurassic to Cretaceous age
- Main batholith
- Scattered stocks & plutons
- Amalgam of plutons & comagmatic suites
- Region displaced ~ 200 km westward
 - Post emplacement extension in the Great Basin

Framework Rocks

- Generally strike northwards
- Southern part
 - Cordilleran miogeocline
 - Precambrian and Paleozoic strata
- Northern part
 - Subduction complexes
 - Paleozoic arc-related terranes

Framework Rocks

- Mojave area
 - Precambrian basement
- Klamath complex basement
 - Overlapping nappes of back arc terranes
- Nevada
 - Accreted arc terranes
 - Continental shelf sediments

Ages in Sierra Nevada

- U-Th are the best ages
- K-Ar dates represent cooling ages
- Sierra Nevada ages are younger eastward
 - Western part has 150 Ma to 130 Ma plutons
 - Western foothills mafic belt is at 130-115 Ma
 - Eastern part is 110-80 ma

Ages of Other Plutons

- Mojave Desert 100-75 Ma
- NW Nevada 105-80 Ma
- Klamath Mountains 150-130 Ma
- Idaho Batholith 95-75 Ma

Eastward Trends

- Increasing SiO₂
- Increasing K₂O
- Sr isotope ratios reflect basement
 - Accreted arc sequences in east
 - Cratonic assemblages in west

Deformation

- Volcanic complexes strongly deformed
 - Synkinematic folding
- Deformation and metamorphism
 - Affected a hinterland
 - Softened by plutonism

Petrology

- Lower Cretaceous Plutons
 - More Mafic Than Late Cretaceous
- Older Plutons Are Tonalites
- Concentric Zoning
- Sheared and Foliated Outer Contacts
- Dominant Composition Is Granodiorite

Volcanism

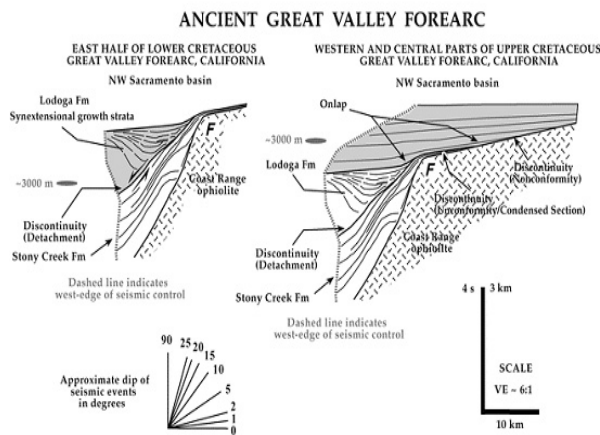
- Andalusite in contact metamorphic rx
 - Indicate shallow (<10 km) depths of intrusion
- Roof pendants
 - Preserve sub aerial volcanic rocks
 - Ritter range pendant caldera complex

Origin

- Magmatic arc formed at a convergent plate boundary
- Comparable to the subvolcanic zones of active convergent margins
 - Andean type volcanism
- Nearly continuous record of convergence
 - Entire western coast of North America

Great Valley Group

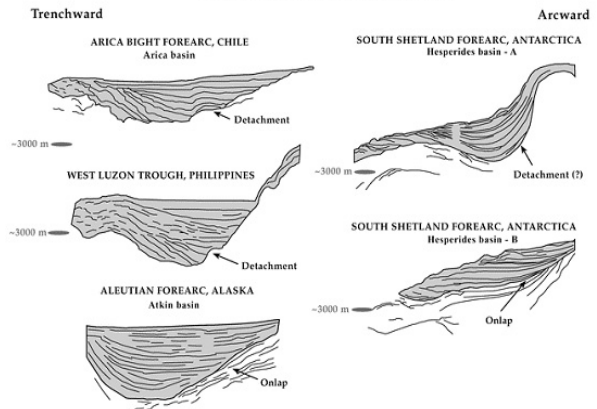
- Terrigenous clastic sequence
 - Sandstone, mudstone, and conglomerate
- Overlies diverse basement terranes
- Sierra foothills
 - Eastward thinning sedimentary wedge
 - Rests upon:
 - Mafic, intermediate, and felsic plutonic rocks
 - Low-grade metamorphic rocks



Asymmetric Syncline

- NW trend
- Coast Ranges - 15 km section
- Diablo Range - 8-10 km section
- Folding can't explain distribution & structure
- Perhaps faulting or erosion are involved
- Some may be strike-slip (left lateral)

MODERN PACIFIC FOREARCS



Coast Range

- Jurassic ophiolites
- Overlying sedimentary and volcanic rocks
- Marks the extinction of the late Jurassic magmatic arc and related ophiolites
- Inception of a new forearc basin and magmatic arc
- Represented by Great Valley Group & Sierra Nevada Batholith

Sedimentology and Petrology

- Proportion of lithic clasts decrease upward while feldspar increases
- Temporally changing provenance
- Late Jurassic
 - Supracrustal rocks were the main source
 - Includes some ophiolites
- Cretaceous
 - Volcanic arc to the east provided clasts
- Represents progressive unroofing of plutonic system

Paleogeography

- Accumulated in a forearc or outer-arc basin
- Sierra Nevada magmatic arc to the east
- Similar to modern Sunda-Java forearc basin
- Sedimentation outlasted the magmatic arc

Initial Franciscan Deposits

- Local Deposition Began in Late Jurassic
- Washington (Pickett Peak Fm)
 - Basalt, Argillite, Clastics
- South Oregon (Otter Point Complex)
 - Volcaniclastics, Basalts, Submarine Pyroclastics

Three Main Packages within the Franciscan

- Eastern Belt
- Central Belt
- Coastal Belt

The Franciscan Complex

- Lithologically Heterogeneous
- Three Main Packages

Lithologically Heterogeneous

- Clastic sediments, basalt, chert, and metamorphic rocks
- Late Jurassic to Paleocene age
- Separated from the GVS by faults
- Noted for blueschist and eclogite
- Highly deformed (chaotic) and faulted

Eastern Belt

- East-dipping thrust sheets with blueschists
- Protoliths of sandstone, mudstone, and basalt
- Radiometric age is difficult to determine

Central Belt

- Mélange with outliers of eastern belt rocks
- Many units are laterally displaced
- Small exotic blocks
 - High-grade metamorphic rocks
 - Includes blueschists and eclogites
 - High P, low T
- Fragments of deeply-buried oceanic crust
- Fragments of tropical limestones

Coastal Belt

- Sandstone-mudstone turbidites
- Imbricate, east-dipping thrusts
- Boundary with the GVS
 - Partly Neogene low-angle normal faults
 - Indicates extension

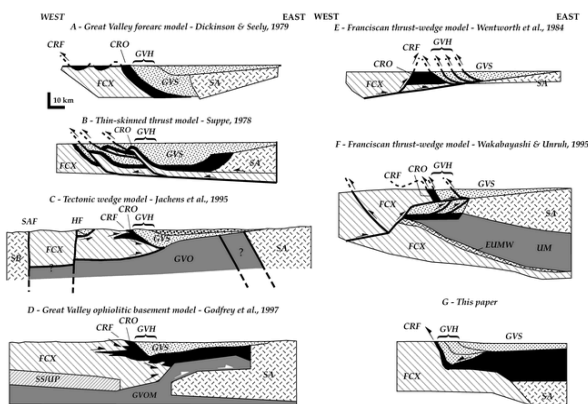
Origin

- Franciscan was material scraped off a subducted "pacific" plate slab
- Developed during the late Jurassic to Cretaceous
- Remaining questions
 - How were deep parts of the subducted slab brought to the surface?
 - What was the mechanisms for the large lateral displacements?

Tectonic Models for Franciscan

- Oblique plate convergence
- Fragments of an oceanic arc traveled thousands of km on top of subducted plates

TECTONIC MODELS OF THE CALIFORNIA COAST RANGES AND GREAT VALLEY FOREARC BASIN



Displaced Terranes

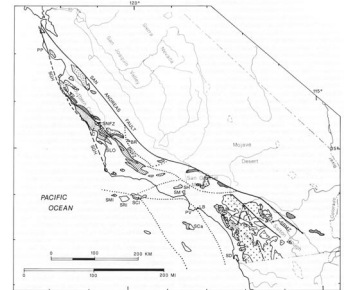
- The Sierra Nevada and Great Valley Group
 - Formed in their present location along the edge of the north American Plate
- Parts of underlying Franciscan Complex
 - Likewise formed in place
- Many rock units to the west
 - Were transported northward &
 - Emplaced in the latest Cretaceous or Tertiary

Displaced Terranes of California

- Salinian composite terrane (E of SNFZ)
- Sur-Opispo composite terrane (W)
- Tujunga terrane (San Gabriel Mts.)
 - Pelona-Orocopia Schists
- Cretaceous Plutons

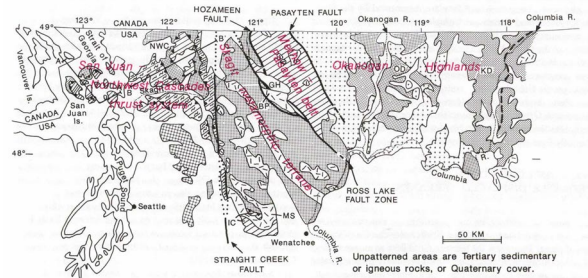
Displaced Terranes of California

- Salinian terrane
- Sur-Obispo terrane
- Tujunga terrane
- Peninsular Ranges



Composite Terranes of Washington

- San Juan nappe terrane
- Skagit metamorphic terrane
- Methow-Payson sequence
- Okanogan Highlands



- San Juan Islands, WA
- North Cascades, WA
- Okanogan Region, WA
- Coastal SW Oregon

Review - Triassic to Jurassic

