Laramide Orogeny: Late Cretaceous to Early Eocene

Reading:

GSA DNAG volume 3, Ch. 6

Topics

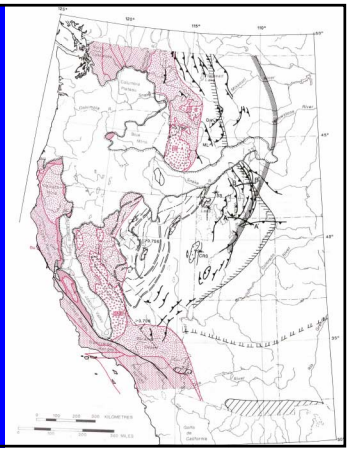
- Late Cretaceous to early Eocene
- New patterns developed
- 5 main regions
- Tectonic interpretations
- Post-Laramide events

Prior Andean Style Continental Margin

- Eastern fold and thrust belt
  - Adjacent foreland basin
- Central magmatic arc system
  - Flanking fore-arc and back-arc basins
- Accretionary complexes
  - Shifting terrains along the coast

Pre-Laramide Configuration

- Fold and thrust belt
- Magmatic arc
- Accretionary complexes



New Laramide Patterns

- Uplifted thrust-blocks on craton
  - Localized sedimentation
  - Thick sedimentary accumulation
- Local thin-skinned foreland thrusting to the west
- Prior zones of magmatism in the central region cooled
  - Uplift and erosion

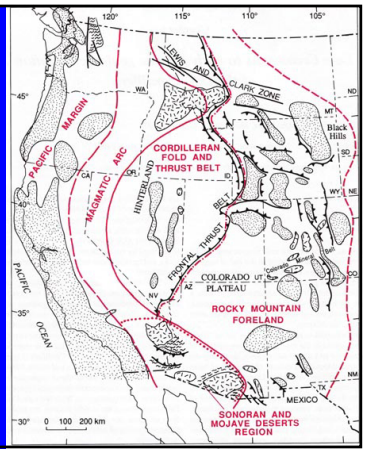
Laramide Elements

Rocky Mountain foreland

Fold and thrust belt

Magmatic arc

Pacific margin



Changing Zones of Magmatism

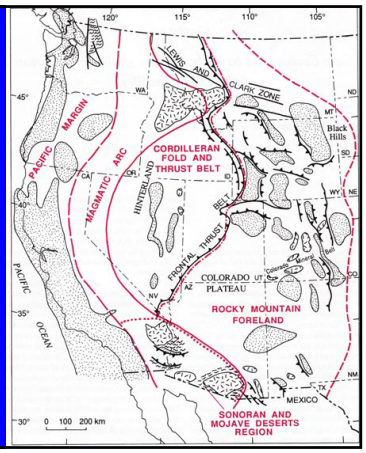
- Magmatism spread eastward
- To the south:
  - Southern California and Arizona
- To the north:
  - Idaho and Montana

Changing Magmatic Patterns

Idaho/Montana

Mohave/Arizona

Colorado Mineral Belt



Main Regions

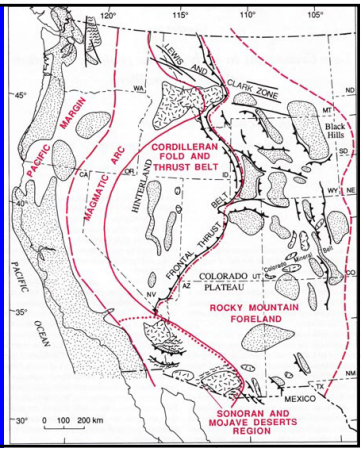
Rocky Mountain foreland

Cordilleran fold & thrust belt

Sonoran and Mojave Deserts

Magmatic arc

Pacific margin

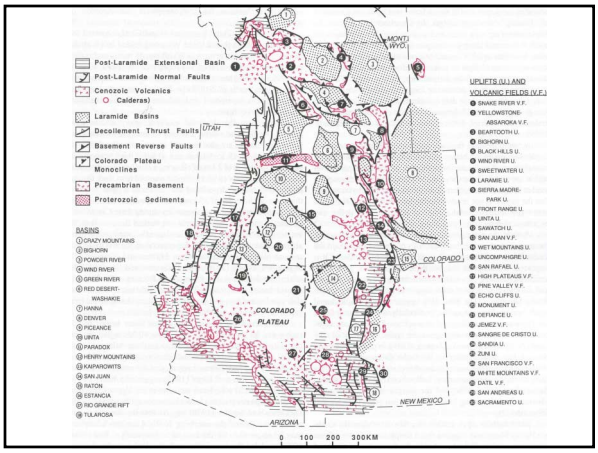


Rocky Mountain Foreland

Thick-skinned deformation

Basin sedimentation

Local magmatism



Thick-Skinned Deformation

- East of miogeocline wedge and hinge line
- Thin sedimentary cover
- Pre-fractured anisotropic cratonic basement
- Deformation localized along zones of prior weakness
- Deep-seated thrust faults

Thick-skinned Deformation

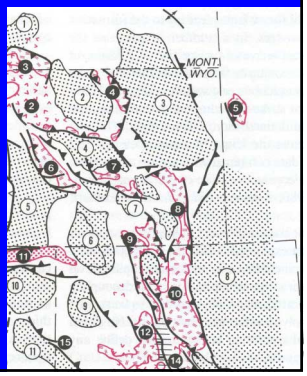
Basins bounded by medium-angle reverse faults

Uplifts ramped

Sedimentary decollement features

Bounded by conjugate thrust faults opposite uplift

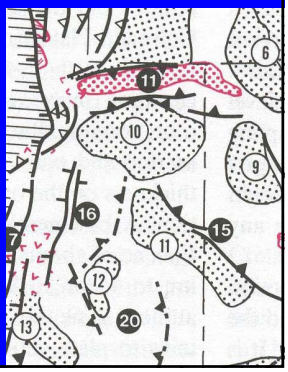
Floating basement wedges



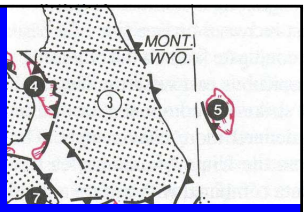
Other Features

East-west faults imply oblique or strike-slip component

Uinta Mts, Utah (11)



Thick-skinned Mechanism



Basement cored uplift is due to middle or lower crust decoupling

Mantle is not deformed beneath uplifts

Laramide anticlines are probably located above similar deep uplifts

Anticlines of the Williston Basin, edge of Black Hills

Cordilleran Fold and Thrust Belt

- Frontal thrust belt on the east
  - Thin-skinned thrusts
  - Localized by hinge line between miogeocline and craton
- Hinterland on the west
  - Thrust faults located deep in miogeoclinal sediments
  - Also in craton

Cordilleran Fold and Thrust Belt

- Cooling of western metamorphic belt during late Cretaceous
- Widespread Eocene volcanism accompanied deformation
  - Challis volcanics
  - Sanpoil volcanics

Magmatic Arc

- Central section weakly magmatic
- Main zones shifted
  - South into California and Arizona
  - North into Idaho and Montana

Local Magmatism

- SW Montana/NW Wyoming
  - Pioneer Batholith
  - Elkhorn and Adel Volcanic Fields
- Colorado Mineral Belt
  - Hypabyssal rocks
  - Monzonite to syenite
- SE Arizona and SW New Mexico
  - Calc-alkaline plutons and volcanics

Northern Magmatism

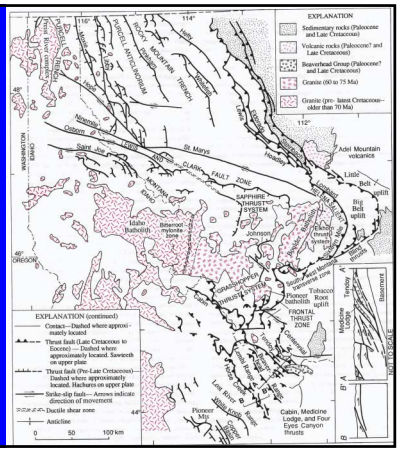
SW Montana & NW Wyoming

Idaho-Montana Porphyry Belt

Pioneer Batholith (83-67 Ma)

Elkhorn (78-73 Ma) and Adel Volcanic Fields

Laccolithic intrusions (54-45 Ma)



Core of the Cascade Range

- Granitoid plutons (75-60 Ma)
- Tonalite to Granodiorite
- Some foliated to orthogneiss
- Dextral slip

Colorado Mineral Belt

- Hypabyssal intrusions (70-50 Ma)
- Monzonite, granodiorite, syenite
- Associated ore deposits
  - Mo, Sn, W, U, Th, (Au, Ag)

Central Zone Volcanism

- Andesite volcanoes
- Older group (70-60 Ma)
- Younger group (54-44 Ma), similar to Eocene volcanism of the Challis and Absaraka volcanics to the north

Sonoran and Mojave Desert Regions

- Plutonism and metamorphism
- Calc-Alkaline composition
- Biotite and two-mica granitoids
- Porphyry copper deposits
  - Cu, Pb, Zn, (Au, Ag)
- Ductile flexure of crustal blocks

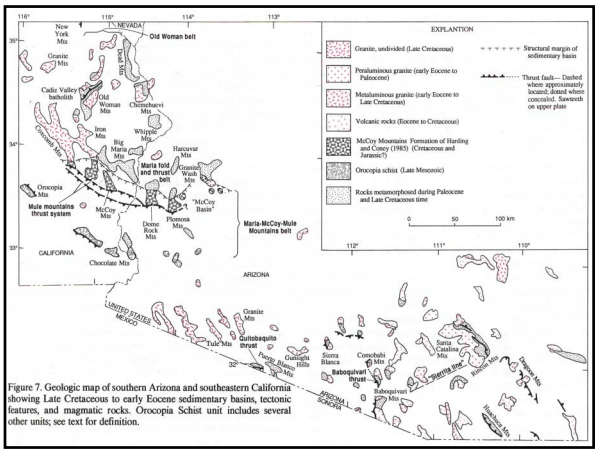


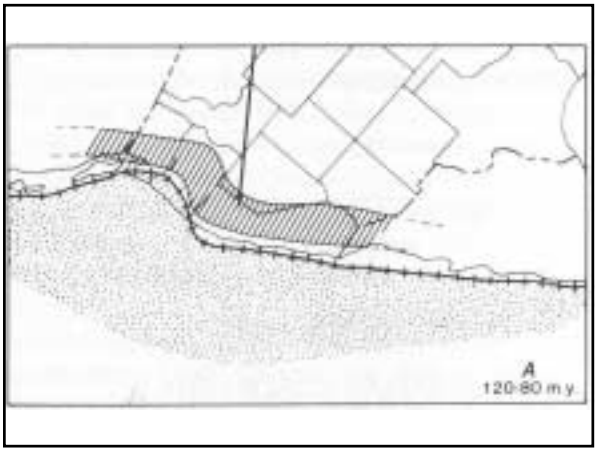
Figure 7. Geologic map of southern Arizona and southeastern California showing Late Cretaceous to early Eocene sedimentary basins, tectonic features, and magmatic rocks. Orocopia Schist unit includes several other units; see text for definition.

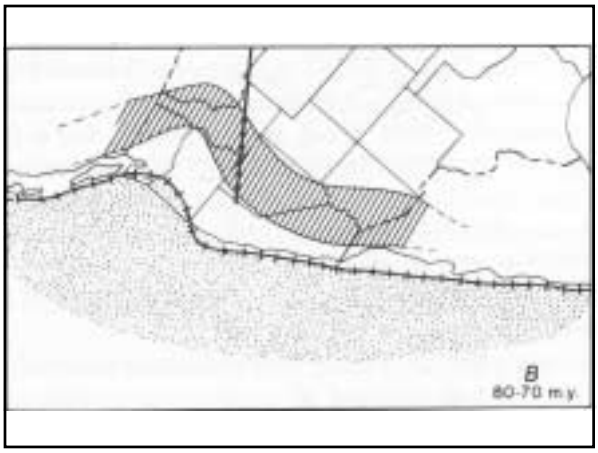
Tectonic Interpretations

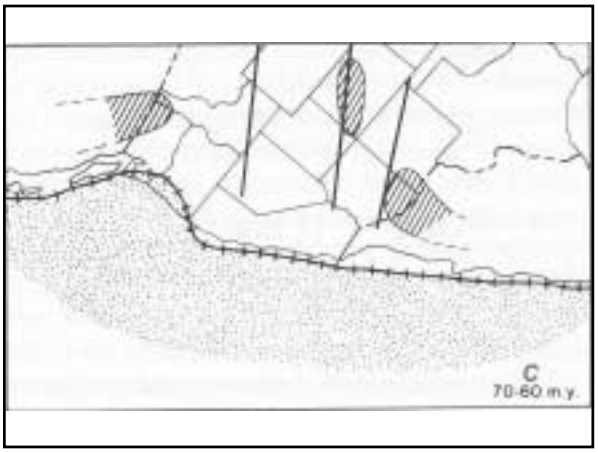
- Relatively rapid convergence
- Shallow angle of subduction
- Buoyancy of near horizontal slab
  - –Caused upward forces

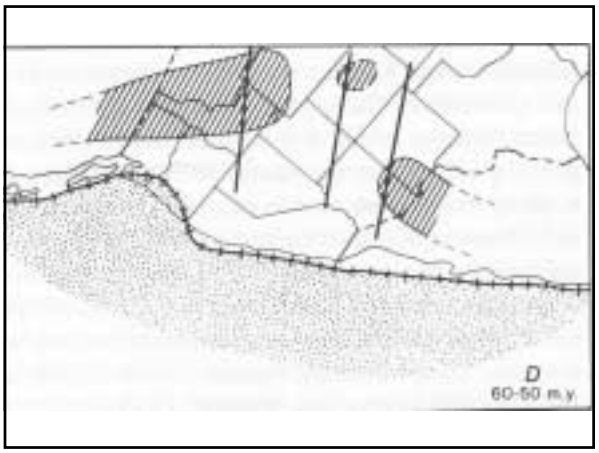
Tectonic Pattern

- Andean type continental margin
- Magmatic arc system
- Continuous subduction of the Farralon Plate

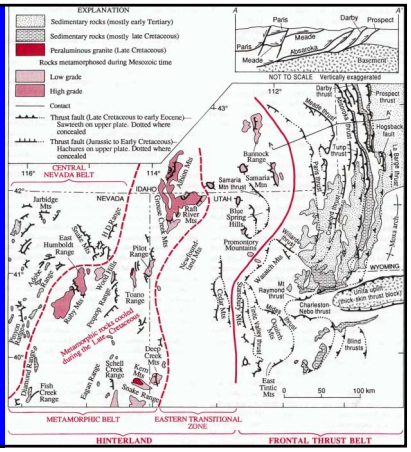








Local zones of metamorphism within the fold and thrust belt



Pacific Plate Margin

- Fore-arc basins
- Strike-slip sedimentary basins
- Accretionary tectonic slices

Late Cretaceous Margin

Basins

Allochthonous terranes

Magmatic Arcs

Metamorphic terranes

Paleocene-Eocene Basins

- Puget Sound
- Olympic Mountains
- North Cascades
- Blue Mountains
- Klamath Mountains
- Franciscan Fm.
- Great Valley
- Southern California

Paleogeography Late Cretaceous

- Okanogan Highlands
- Klamath uplands
- Franciscan Terrane
- Great Valley Foreland
- Salinian Terrane
- Transverse Ranges
- Peninsular Ranges

Paleogeography Paleocene-Eocene

- Extinct magmatic arc
- Olympic Peninsula
- Clarno Basin
- Tyee forearc basin
- Salinian Terrane
- Sur-Obispo Terrane
- Transverse Ranges
- California Borderland

Post-Laramide Events

- Major zones of extension
- Normal faulting overprint
- Thick calc-alkaline volcanic sections
- Localized sedimentary basins
- Major strike-slip faulting