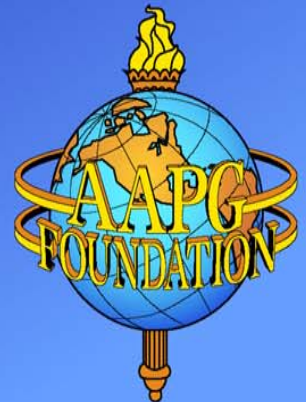


Evolutionary Model For Convergent Margins Facing Large Ocean Basins: Mesozoic Baja California, Mexico

Cathy Busby
Department of Geological Sciences
University of California
Santa Barbara, CA



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Petroleum Geologists and Cathy Busby.**

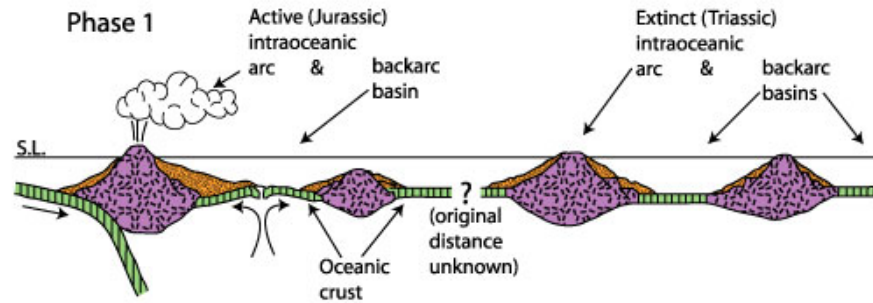
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Cathy Busby.**



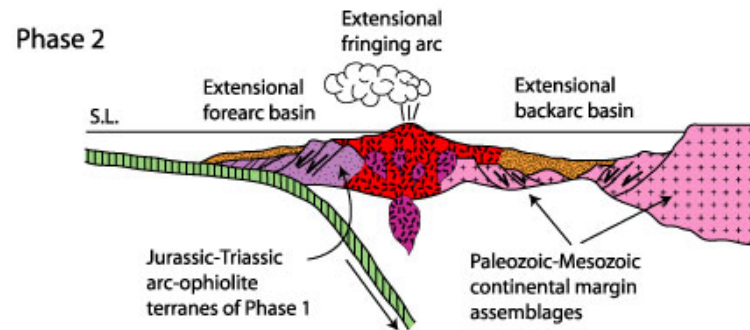




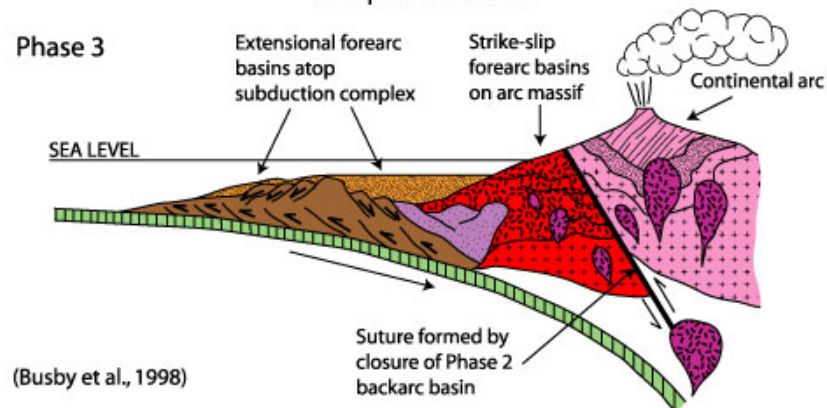
Strongly Extensional Arc



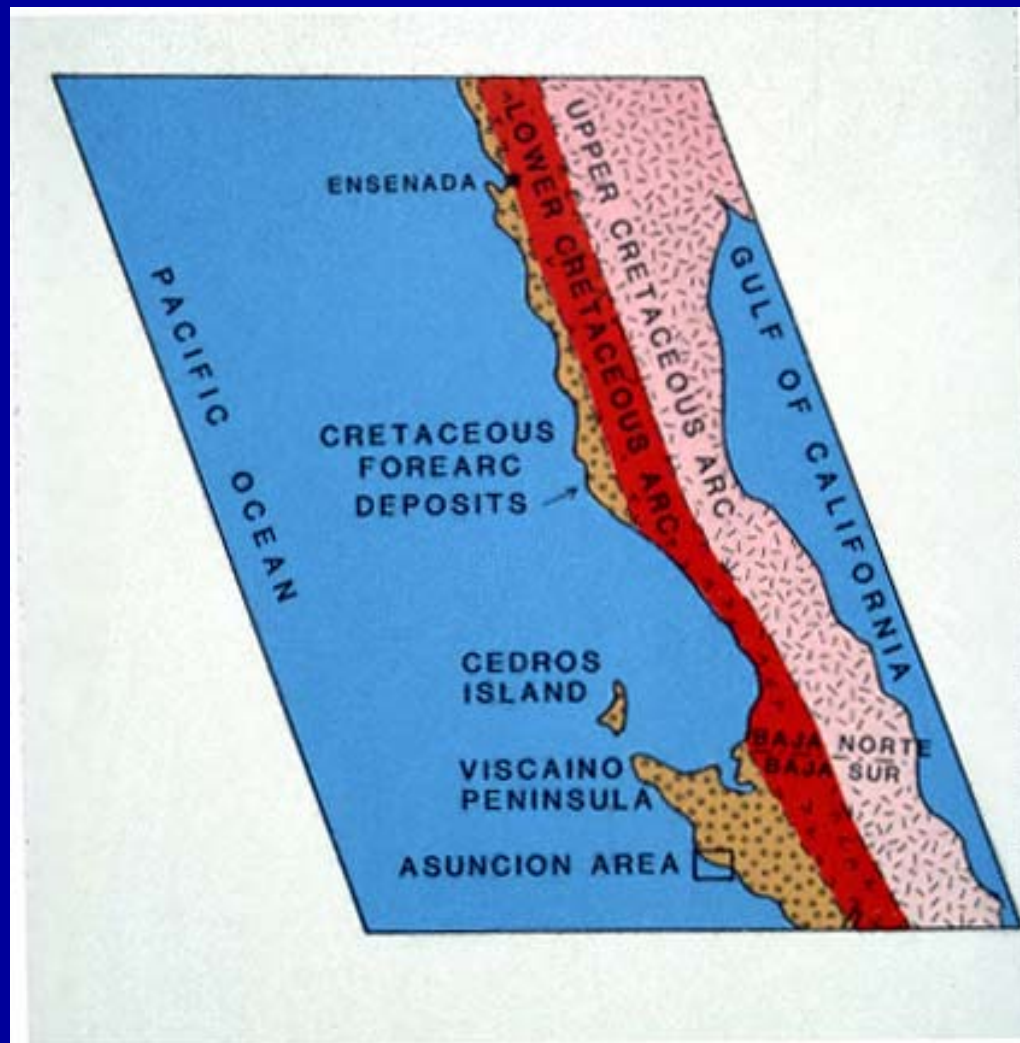
Moderately Extensional Arc



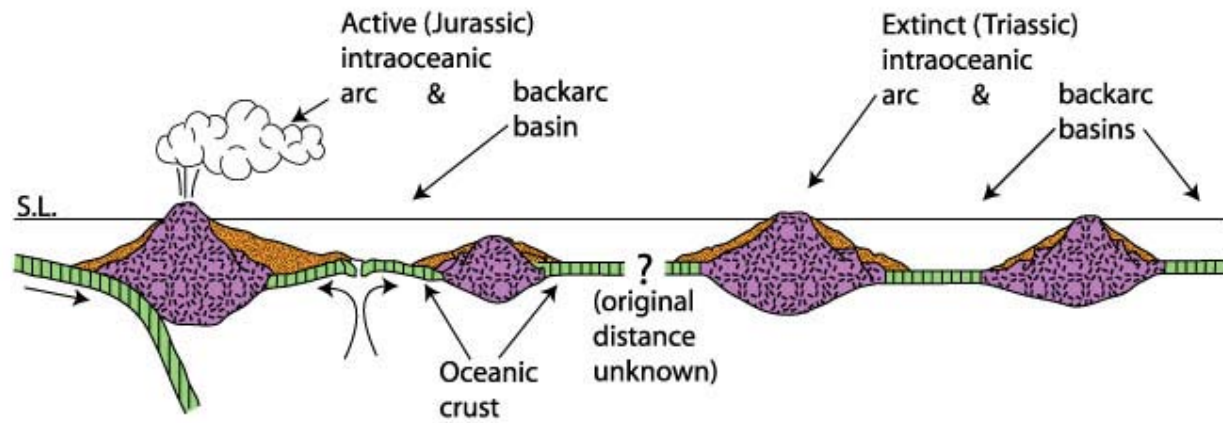
Compressional Arc



(Busby et al., 1998)



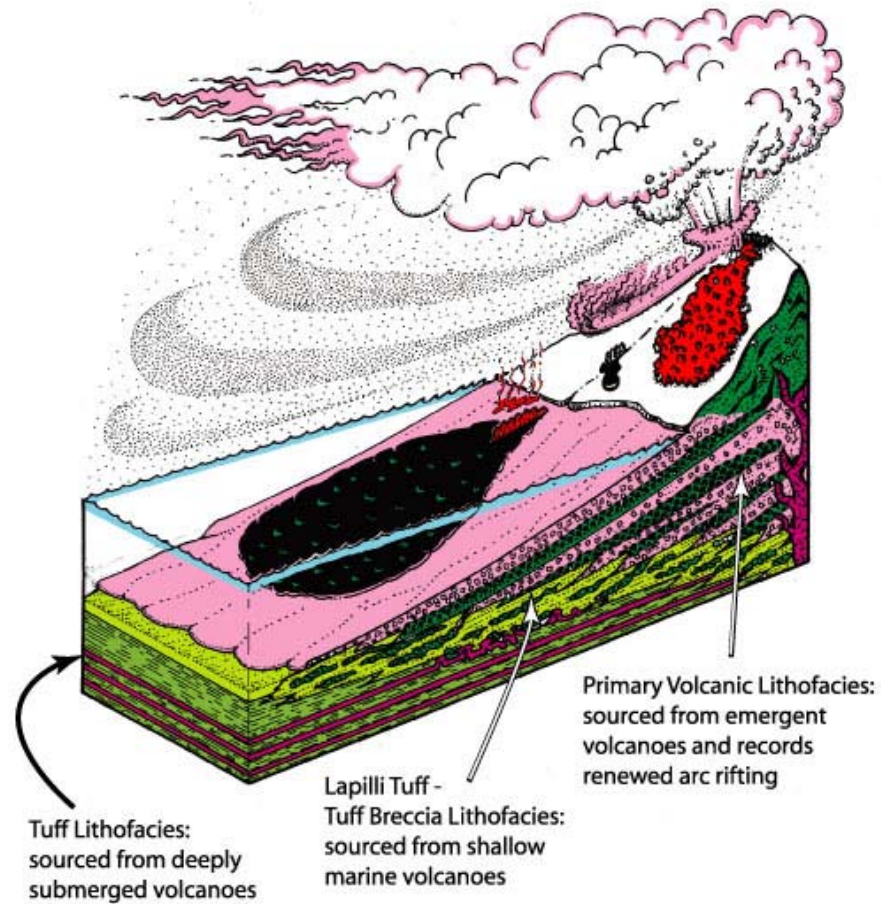
Phase 1: Strongly Extensional Arc

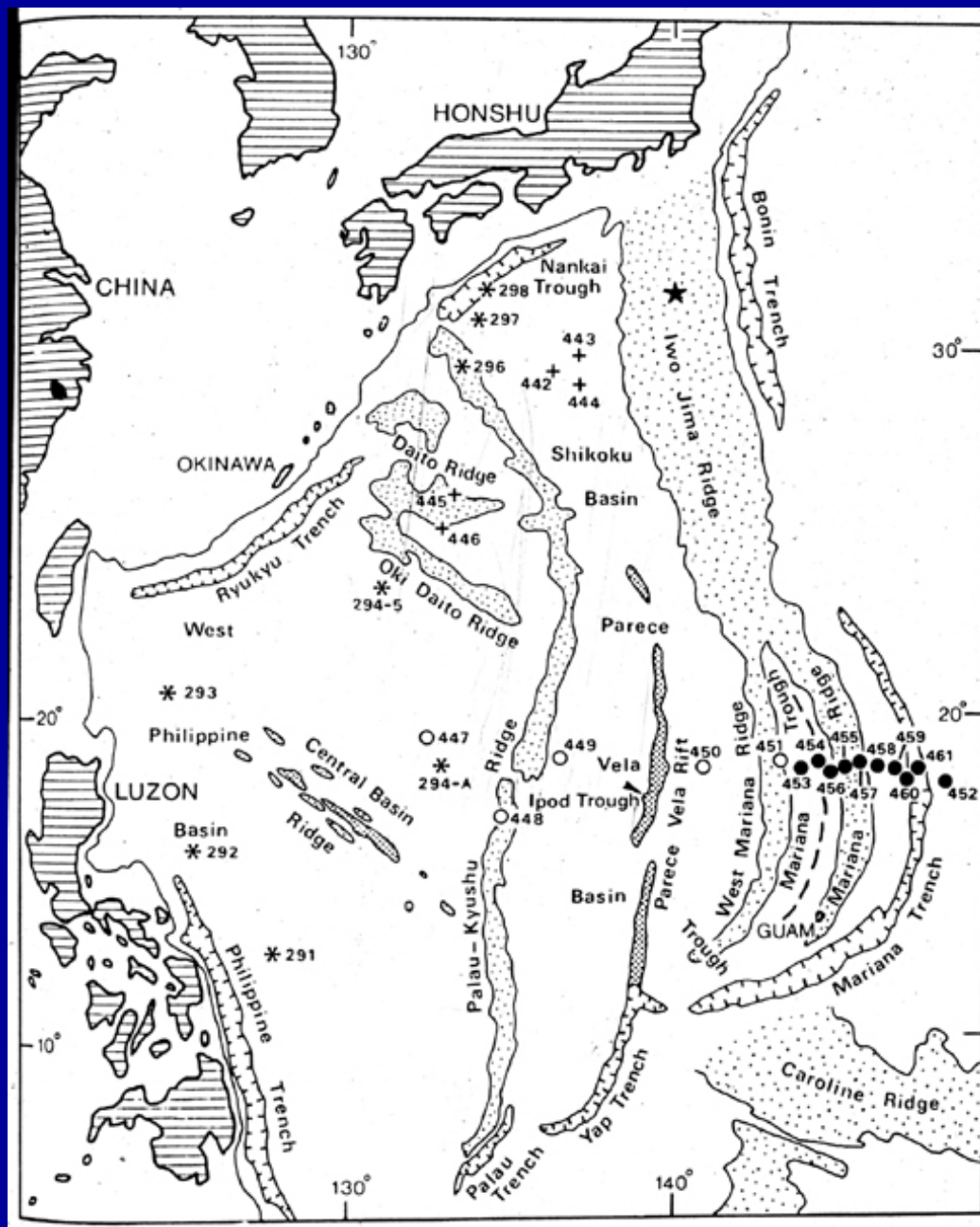


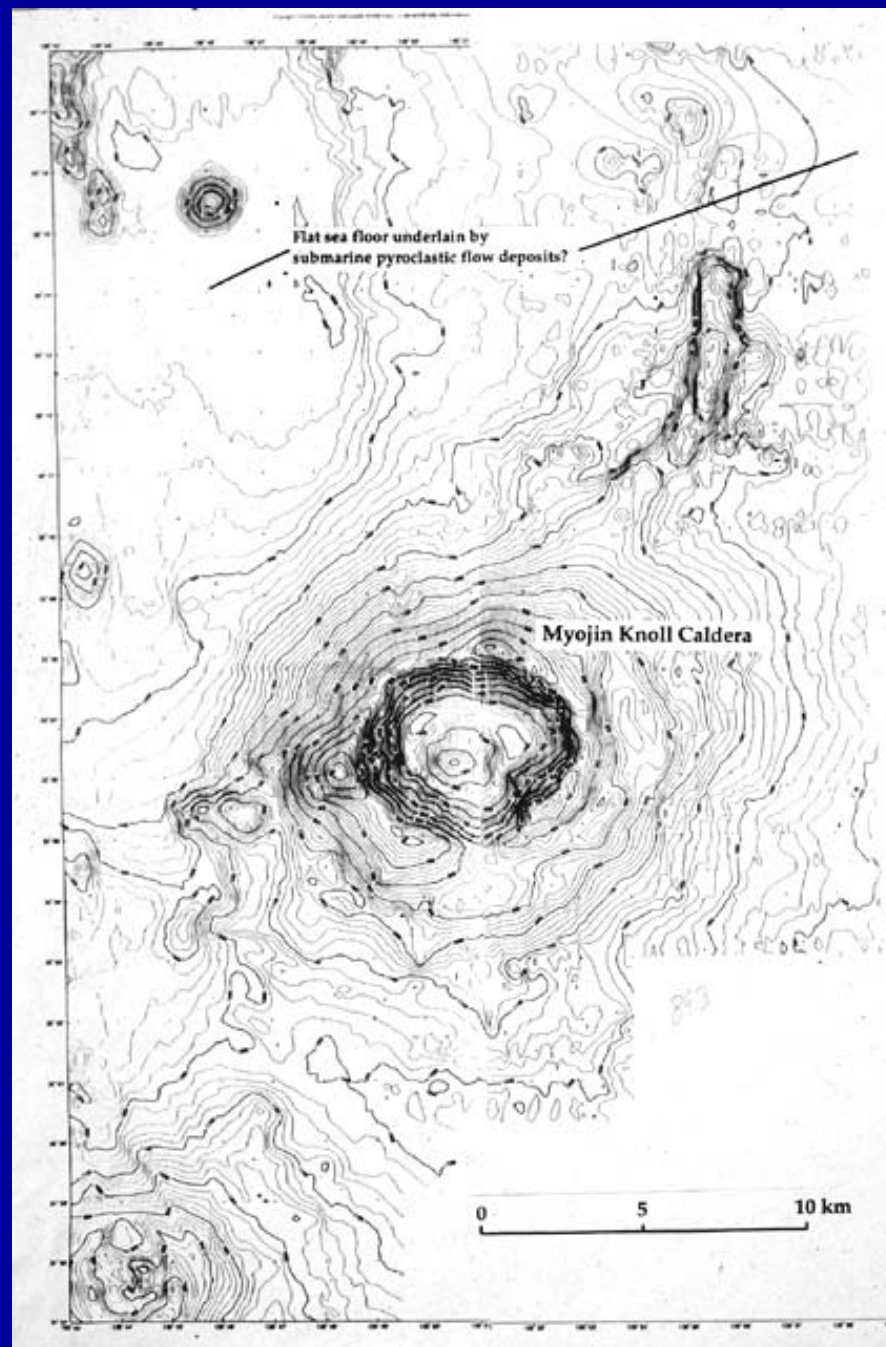
(Busby et al., 1998)

PROGRADATIONAL BACKARC APRON

Deep marine pyroclastic wedge builds from growing arc onto rifted arc crust and "steaming" oceanic crust (Busby-Spera, 1988)

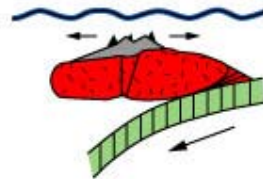






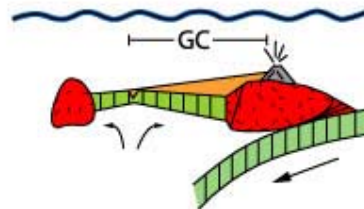
Backarc Apron Tectonic Model, Gran Canon Formation

(modified from Critelli, Marsaglia and Busby, 2002)



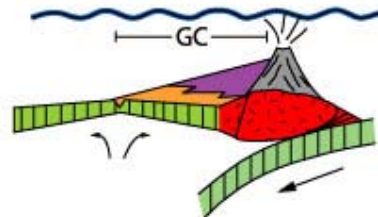
I. Rifting of oceanic arc basement

Choyal Formation



II. Nascent backarc basin
(Cedros Island ophiolite, ~173 Ma)
behind a deeply-submerged
nascent oceanic arc

Tuff Lithofacies

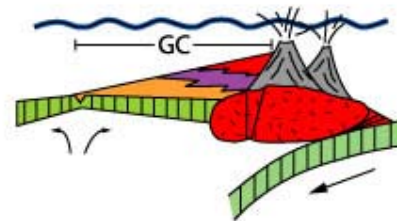


III. Growth of oceanic arc
toward sea level and
continued backarc spreading

Lapilli tuff - Tuff breccia Lithofacies

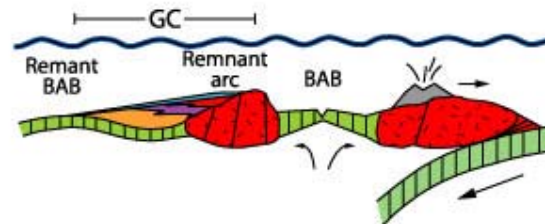
Backarc Apron Tectonic Model, Gran Canon Formation

(modified from Critelli, Marsaglia and Busby, 2002)



IV. Backarc spreading center
migrates too far from subducting
slab, leading to renewed arc rifting

Primary Volcanic Lithofacies,
~164 Ma



V. Rifting succeeds, isolating
backarc apron from active
volcanoes; it is blanketed
with thin cover of sand

Epiclastic Lithofacies



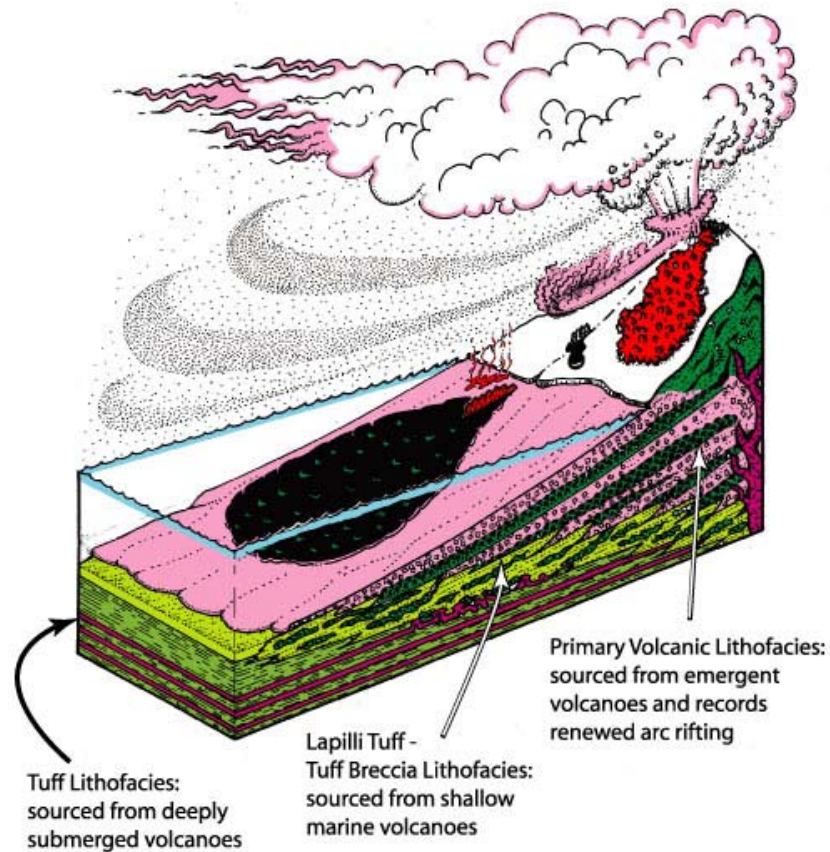




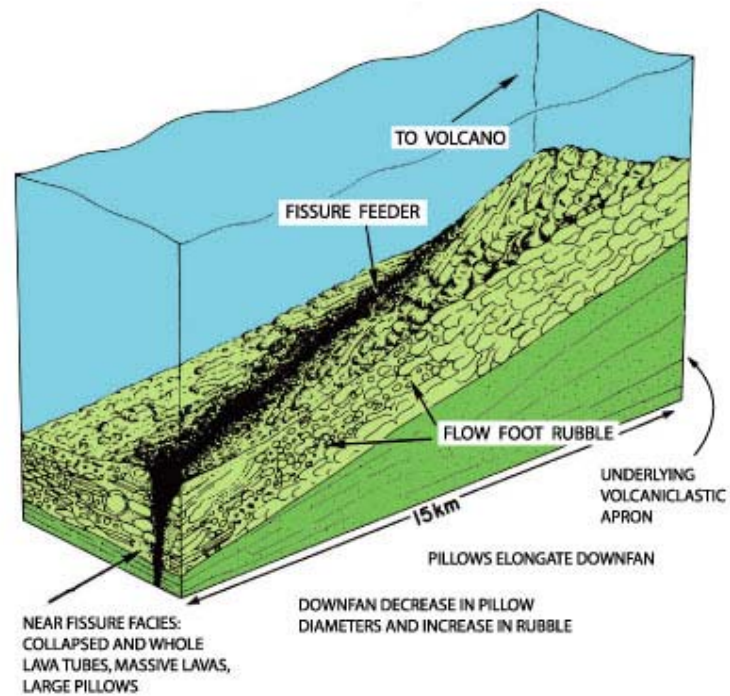


PROGRADATIONAL BACKARC APRON

Deep marine pyroclastic wedge builds from growing arc onto rifted arc crust and "steaming" oceanic crust (Busby-Spera, 1988)



Progradational Backarc Apron:
Primary Volcanic Lithofacies
records renewed arc rifting



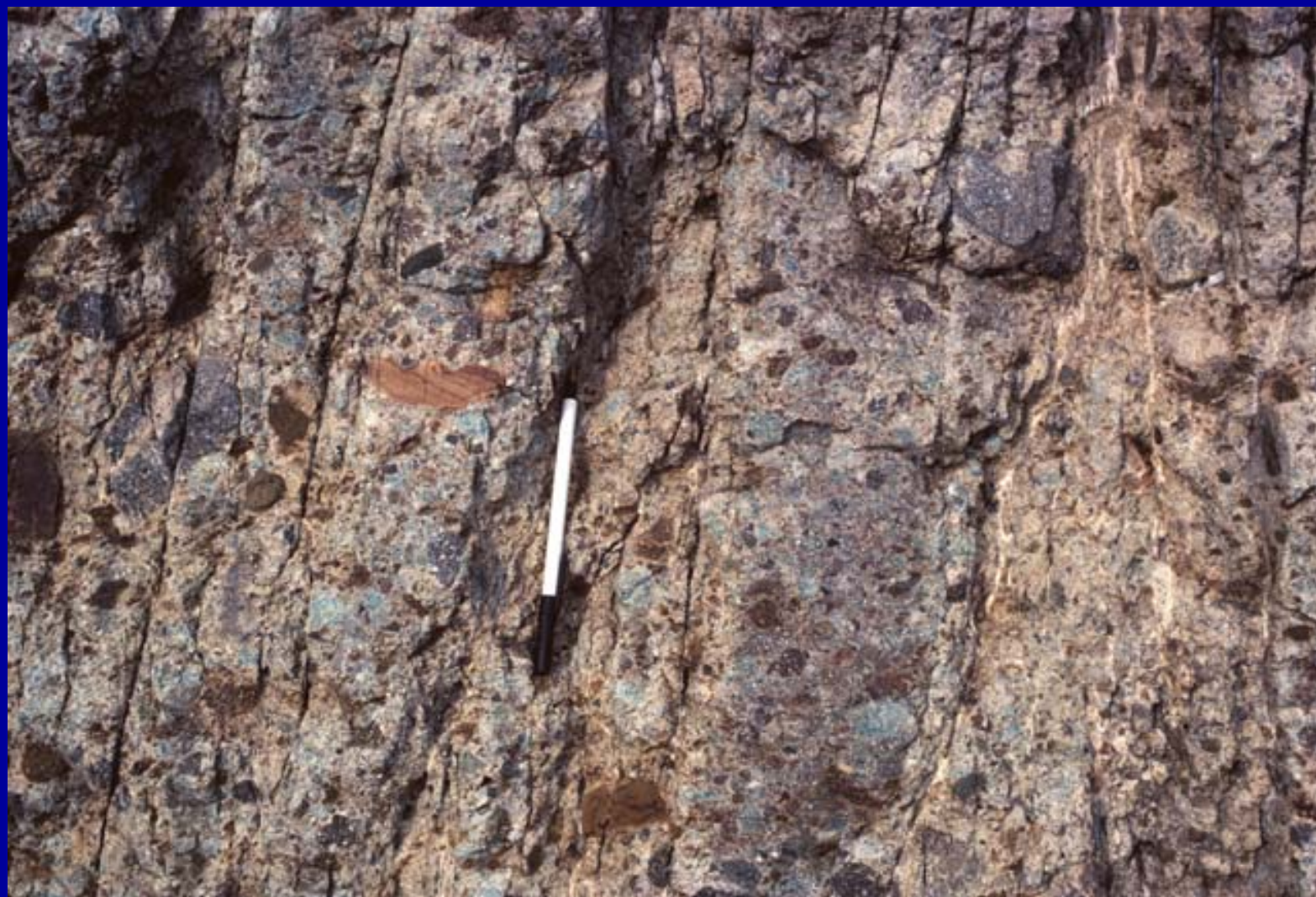
(Busby-Spera, 1987)





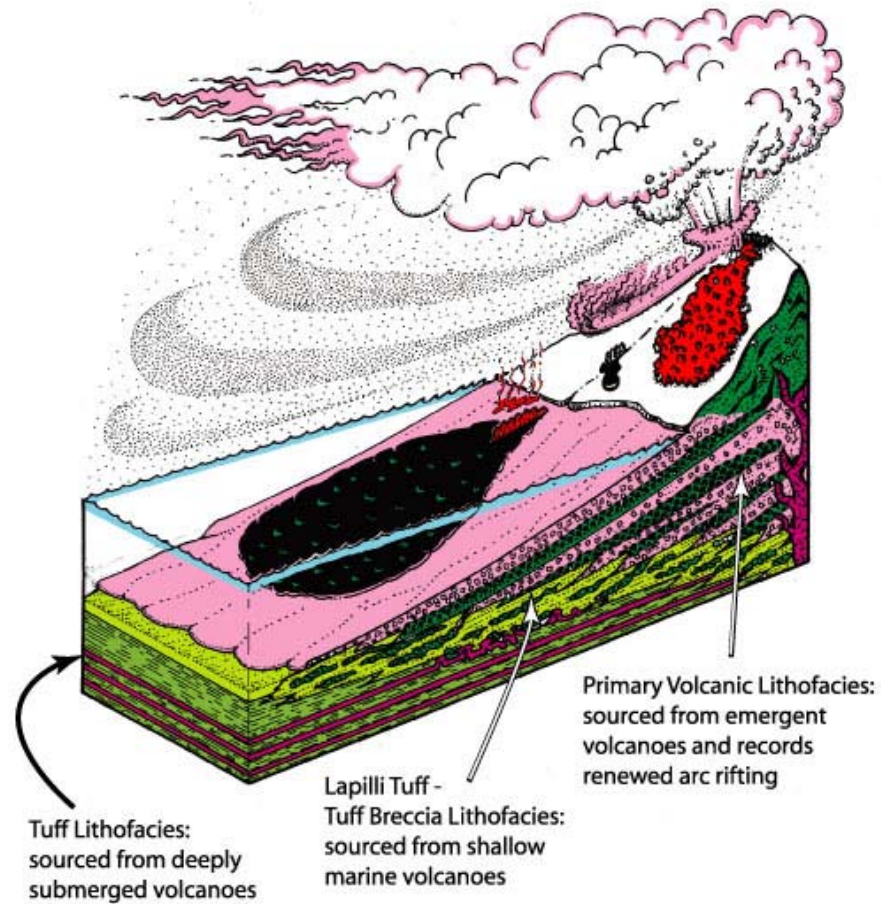




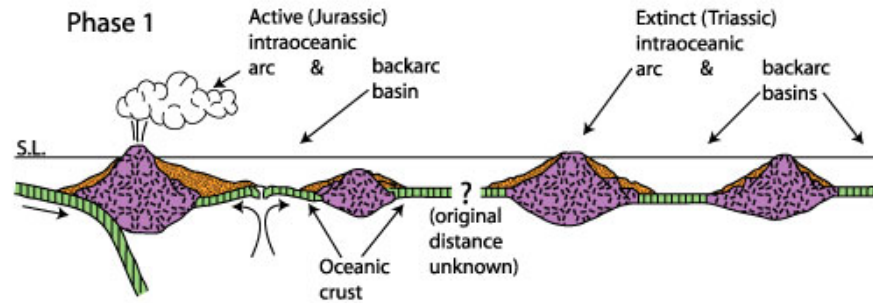


PROGRADATIONAL BACKARC APRON

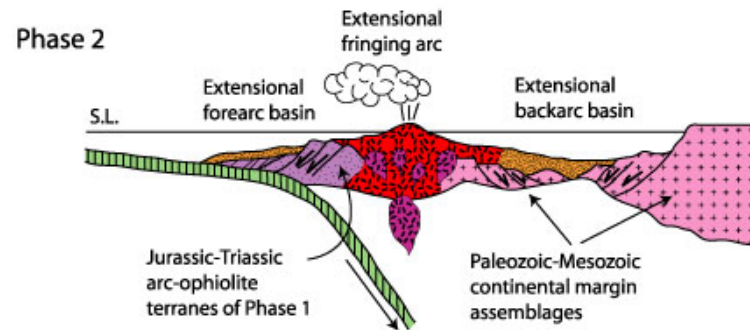
Deep marine pyroclastic wedge builds from growing arc onto rifted arc crust and "steaming" oceanic crust (Busby-Spera, 1988)



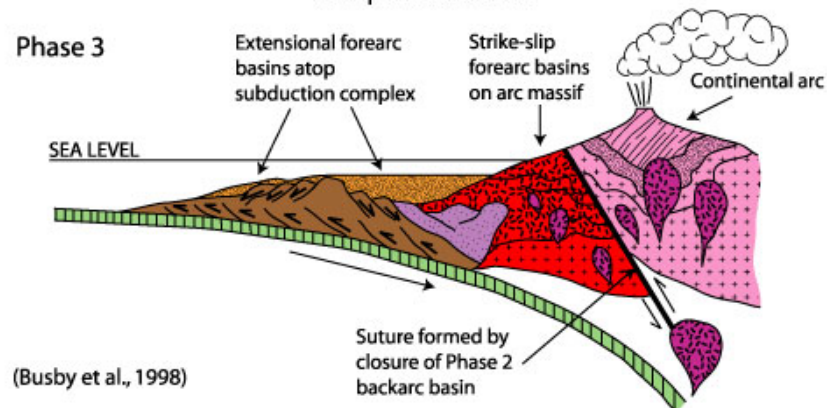
Strongly Extensional Arc



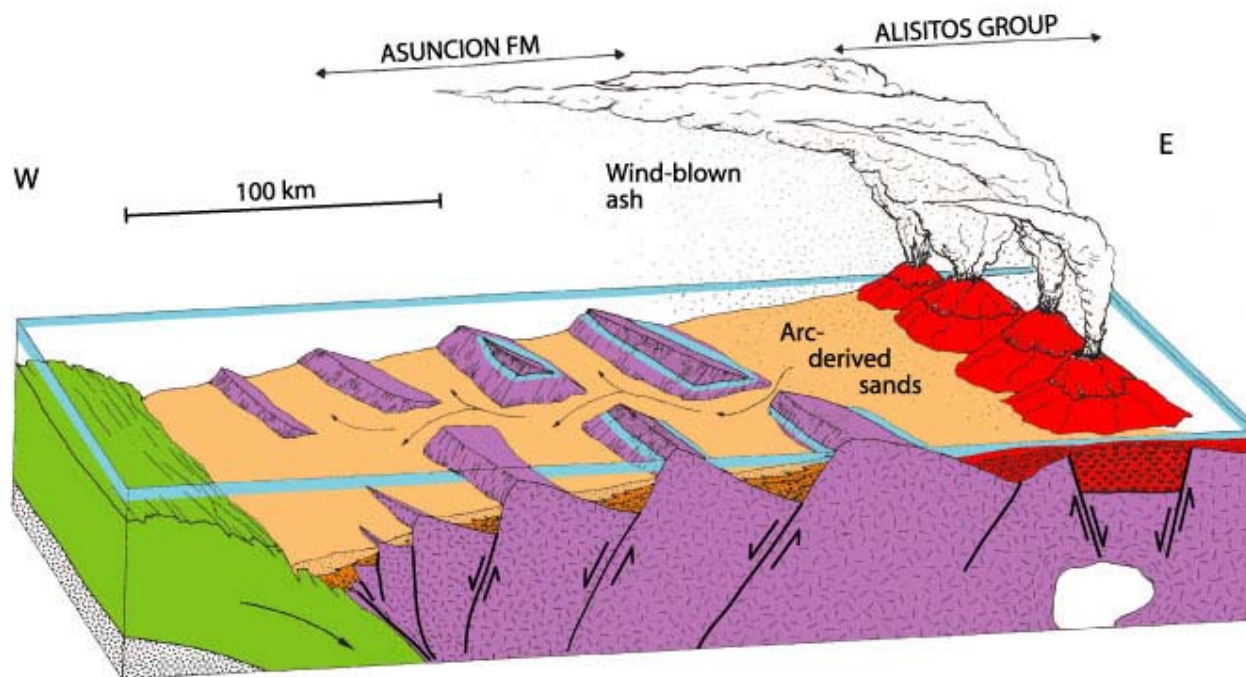
Moderately Extensional Arc



Compressional Arc



(Busby et al., 1998)



Phase 2 Extensional Arc and Extensional Forearc Basin
(Busby et al., 1998)

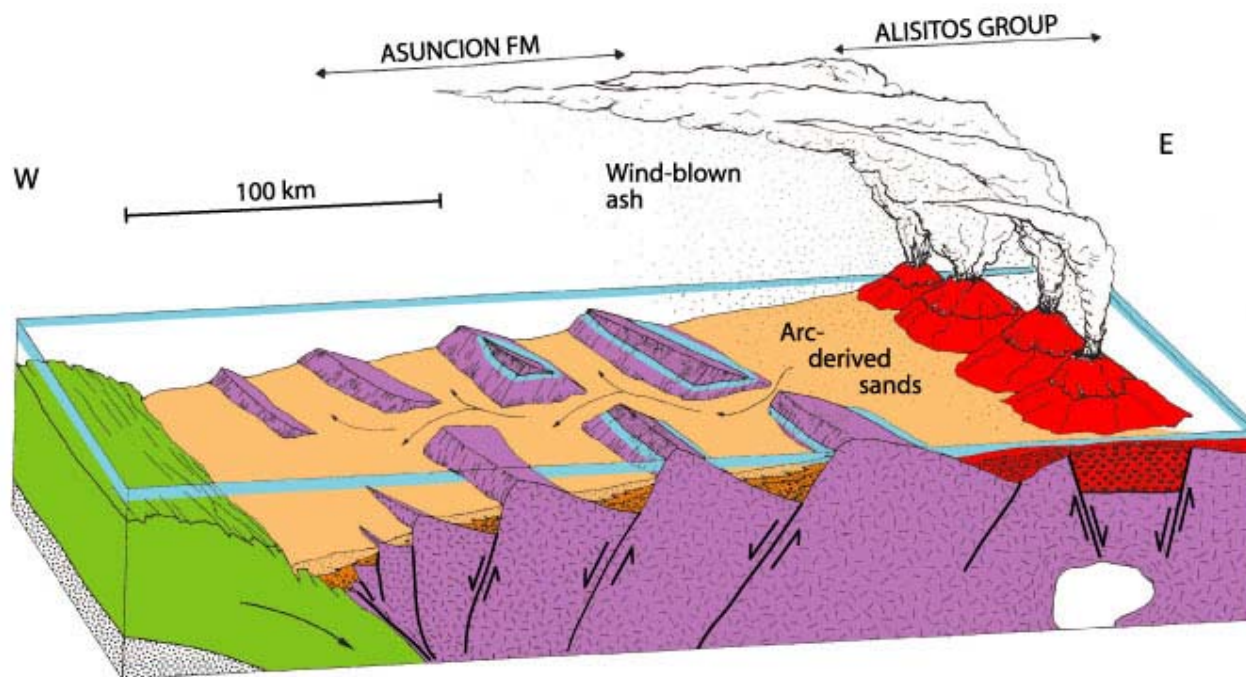
Cretaceous Alisitos arc, western Peninsular Ranges:

I. EXTENSIONAL OCEANIC ARC

Intermediate to silicic explosive volcanism, culminating in caldera-forming ignimbrite eruptions

II. RIFTED OCEANIC ARC

Mafic effusive and hydroclastic rocks and widespread dike swarms

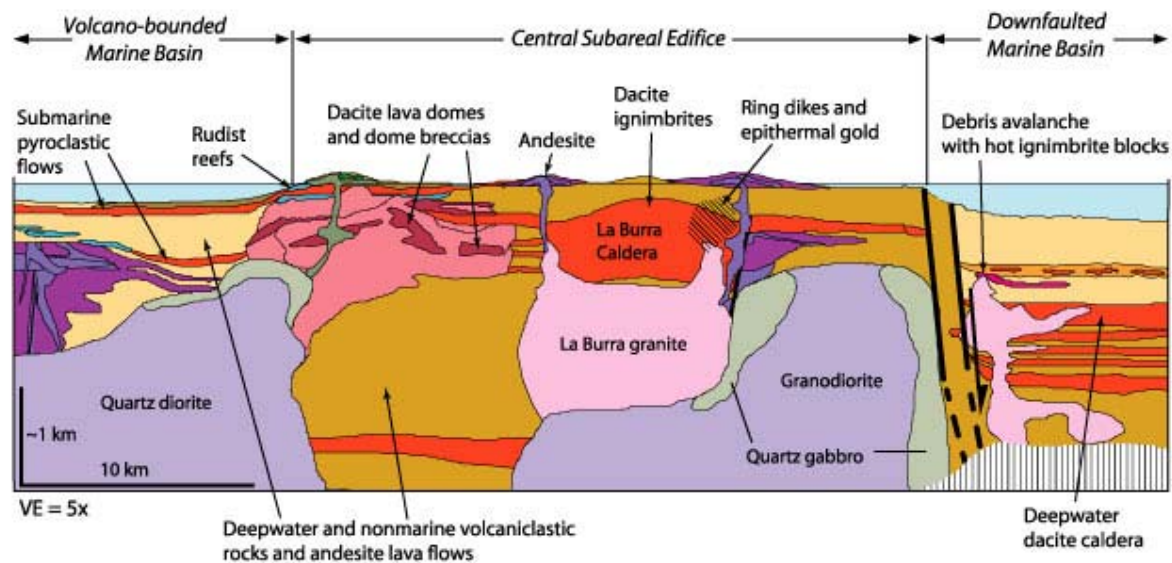


Phase 2 Extensional Arc and Extensional Forearc Basin

(Busby et al., 1998)

Extensional Oceanic Arc (Alisitos Group)

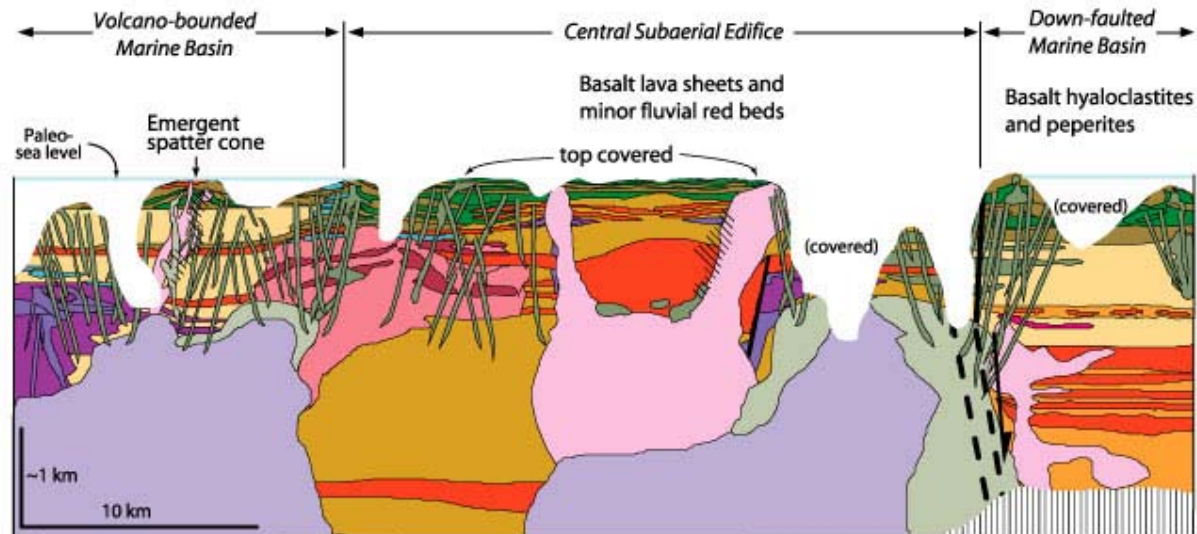
Time Slice 1: Normal faulting, high rates of subsidence (1 km/my), and ignimbrite calderas



(Adams and Busby, 1998)

Extensional Oceanic Arc (Alisitos Group)

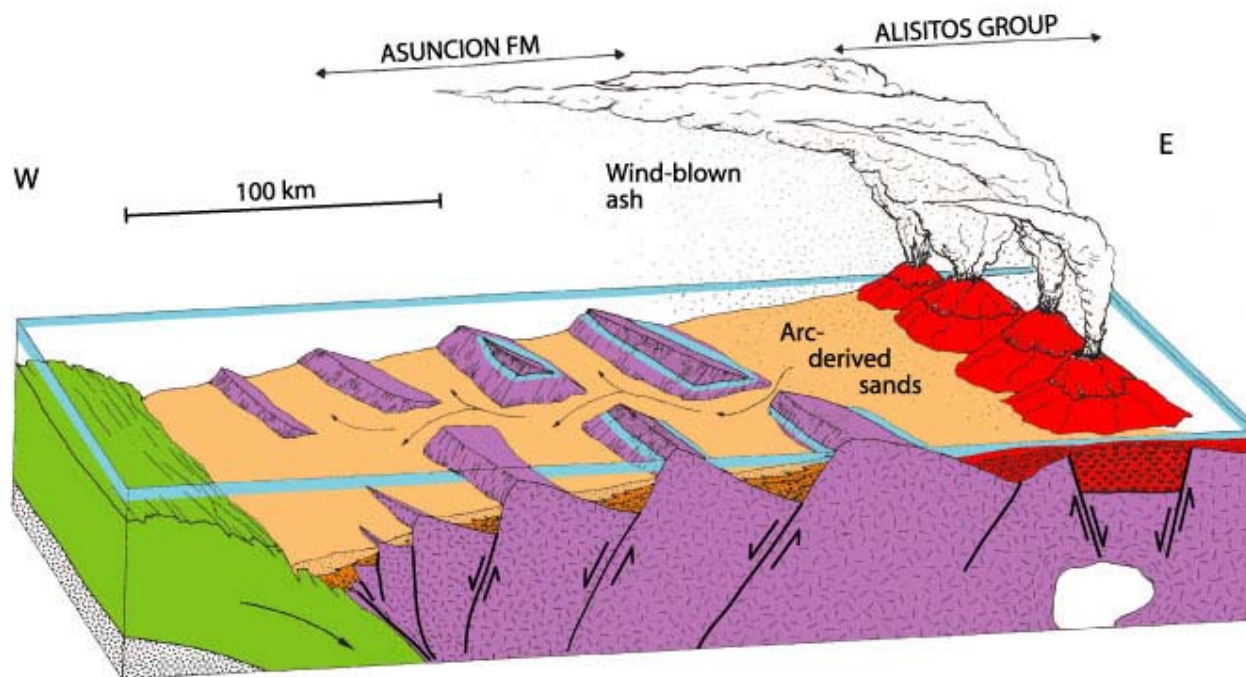
Time Slice 2: Arc rifting, mafic diking, and outpouring of basalts



True (scaled) cross-section with 5X vertical exaggeration. Top covered. (Adams and Busby, 1998)

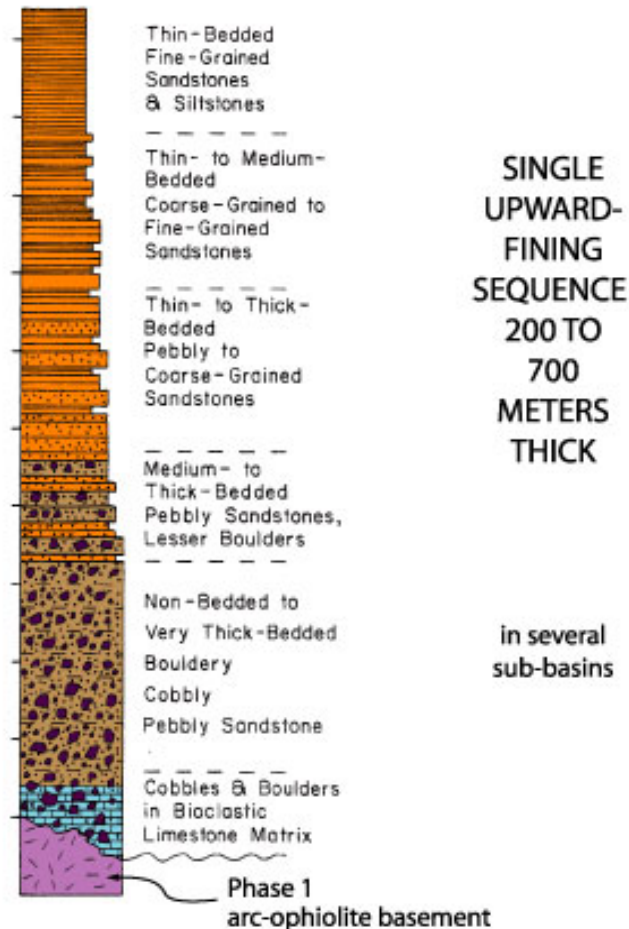


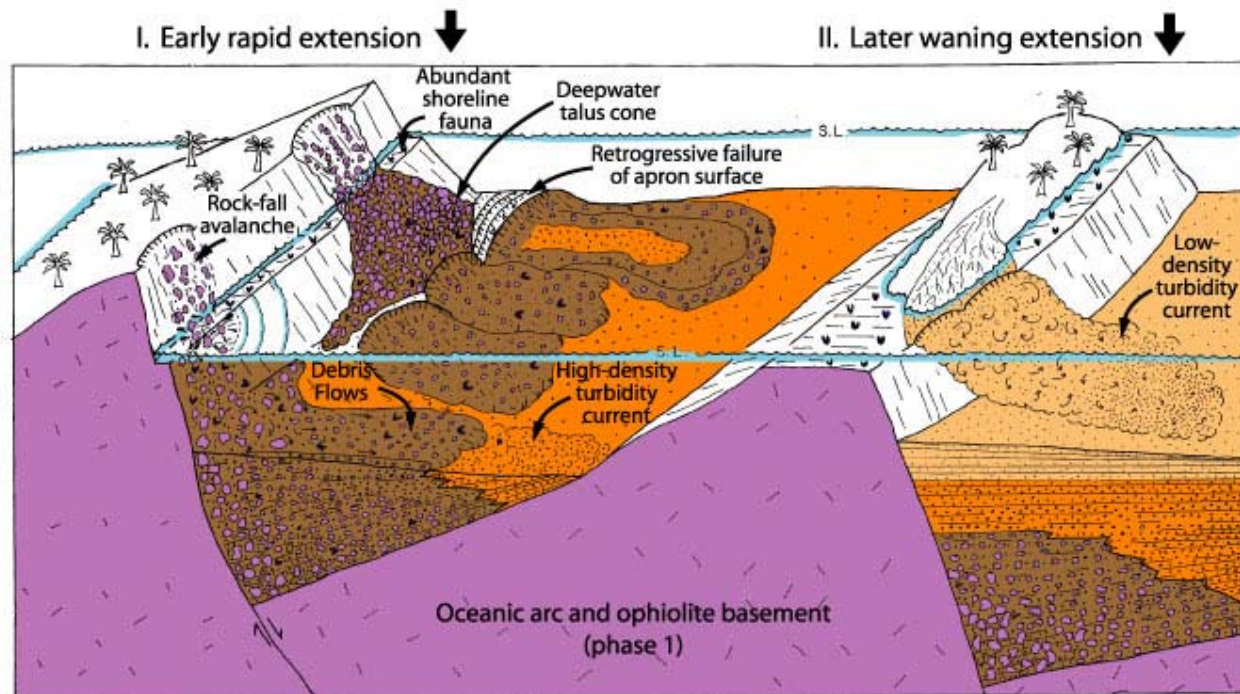




Phase 2 Extensional Arc and Extensional Forearc Basin
(Busby et al., 1998)

Extensional Forearc, Phase 2 Early Cretaceous Asuncion Formation, Vizcaino Peninsula (Busby-Spera and Boles, 1986)





I. Screen cones build directly from coastal fault scarps onto graben floors at bathyal water depths

II. Fine-grained turbidite wedge shed from eroded horst blocks

Extensional Forearc slope Apron Deposits of Phase Two

(Busby-Spera and Boles, 1986)



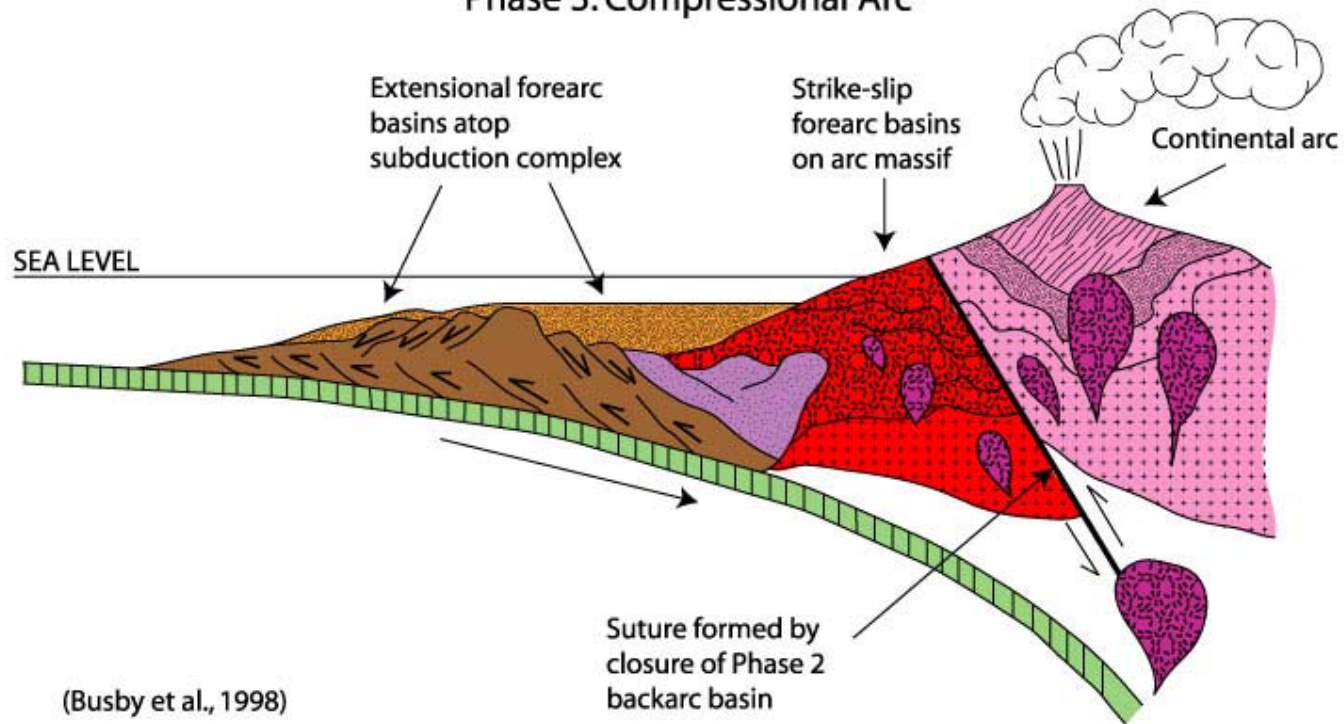




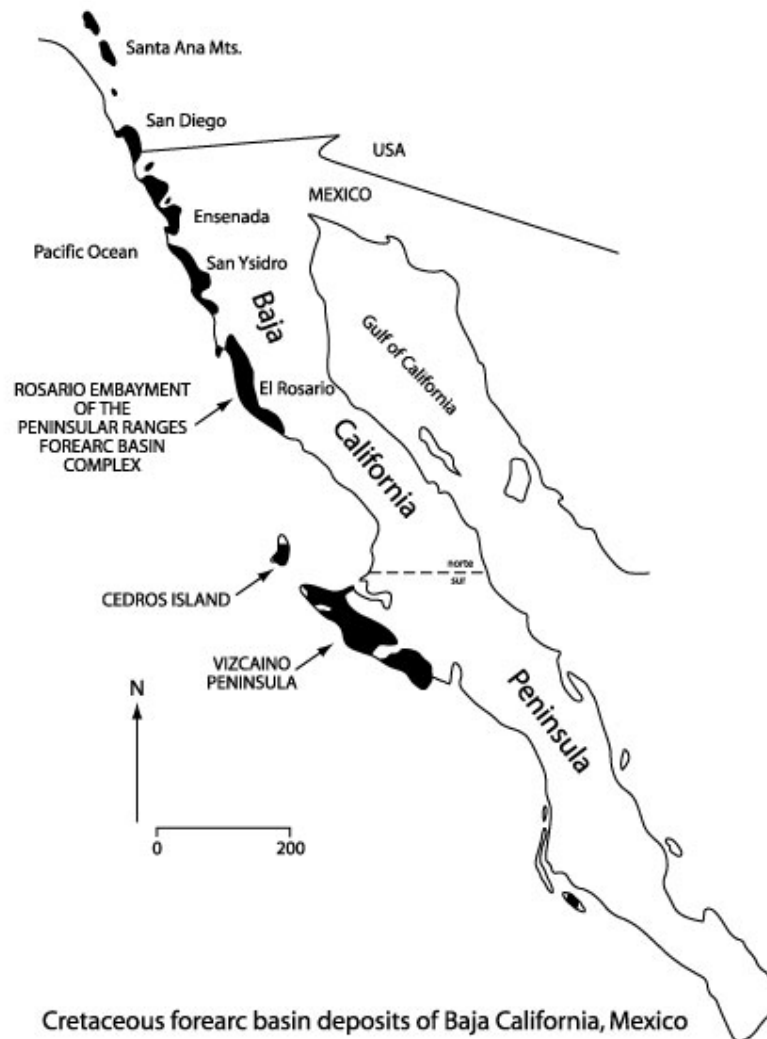




Phase 3: Compressional Arc

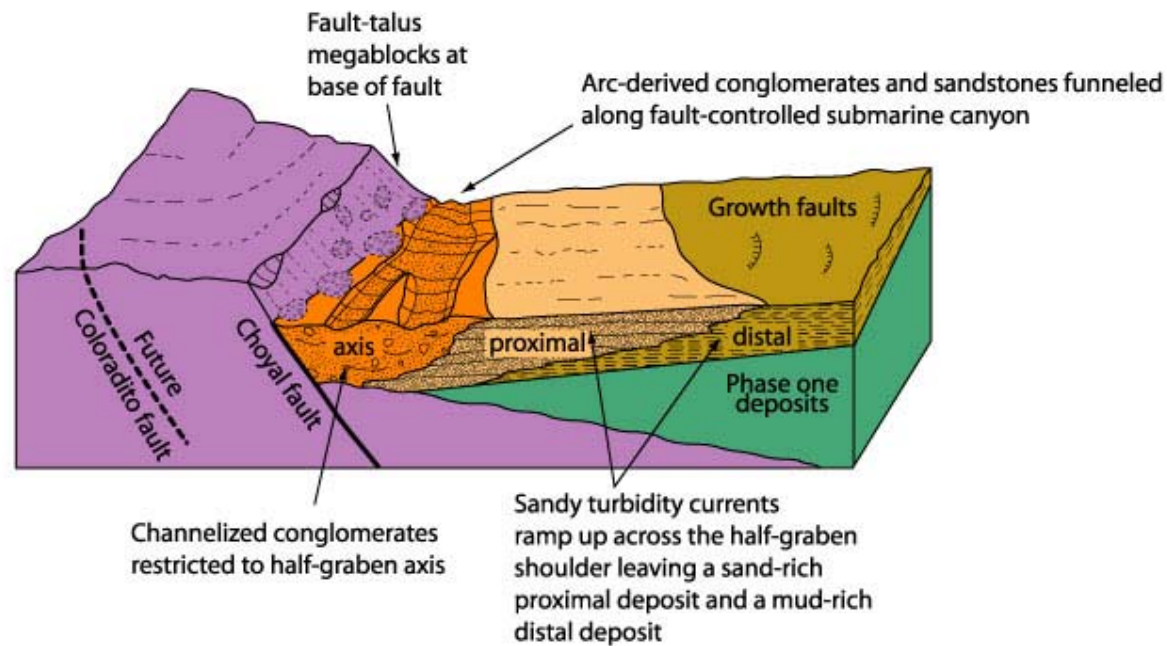


(Busby et al., 1998)





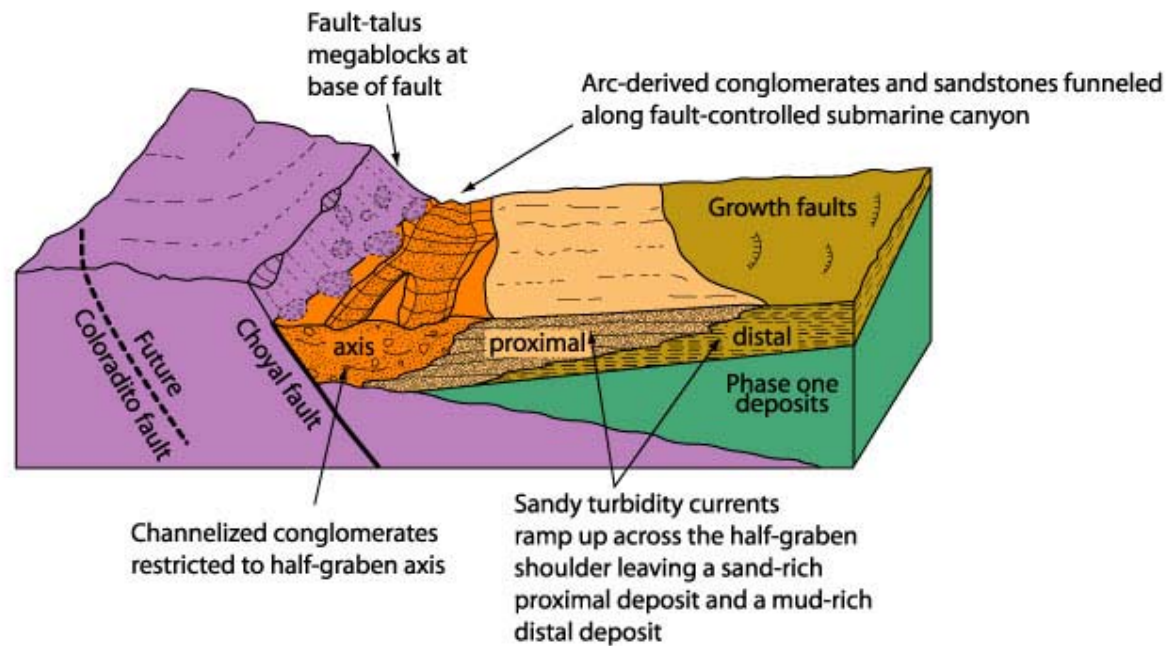




I. EXTENSIONAL FOREARC BASIN ATOP SUBDUCTION COMPLEX

(Smith and Busby, 1993)

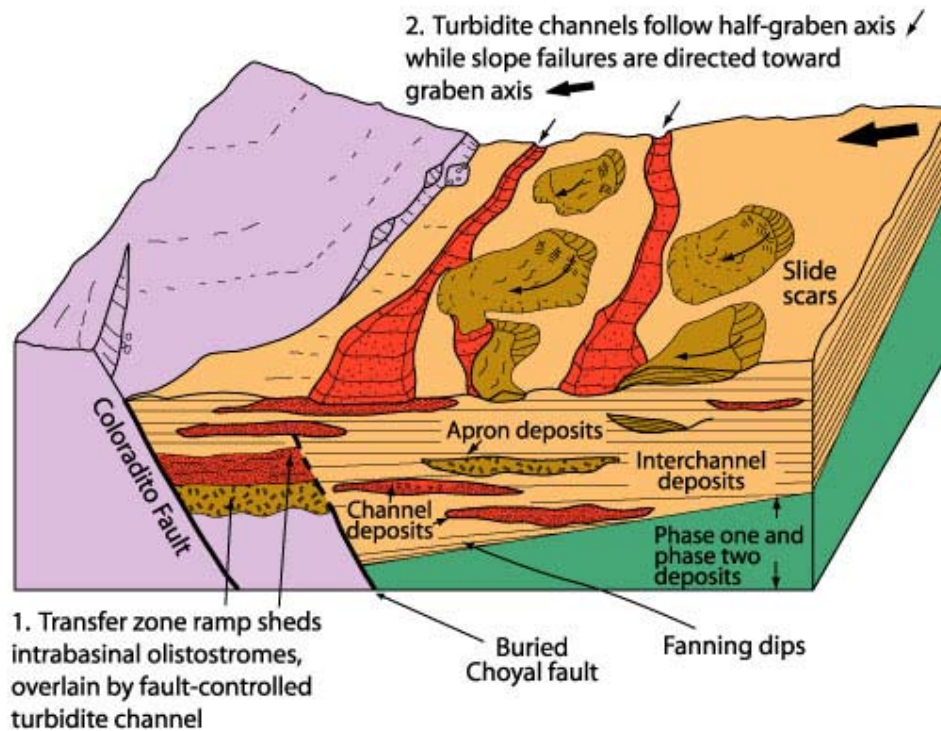




I. EXTENSIONAL FOREARC BASIN ATOP SUBDUCTION COMPLEX

(Smith and Busby, 1993)

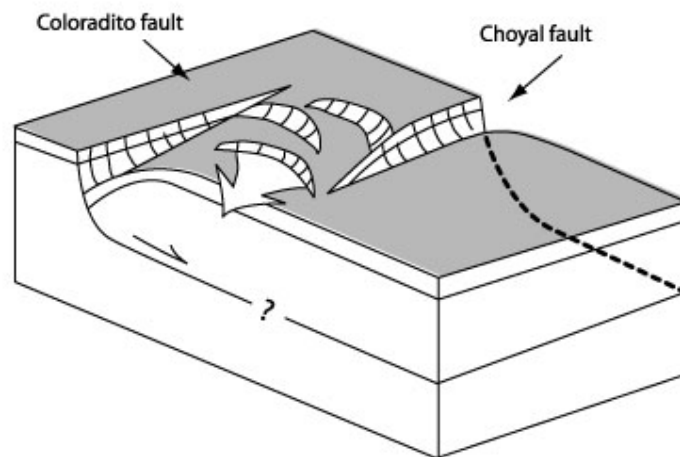




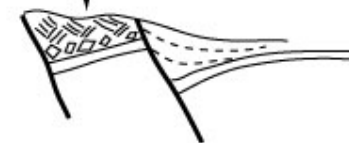
II. EXTENSIONAL FOREARC BASIN ATOP SUBDUCTION COMPLEX

(Smith and Busby, 1993)

Growth of Coloradito fault *en echelon* with Choyal fault
produces transfer zone ramp that sheds olistostrome



INTRABASINAL
OLISTOSTROME
UNIT



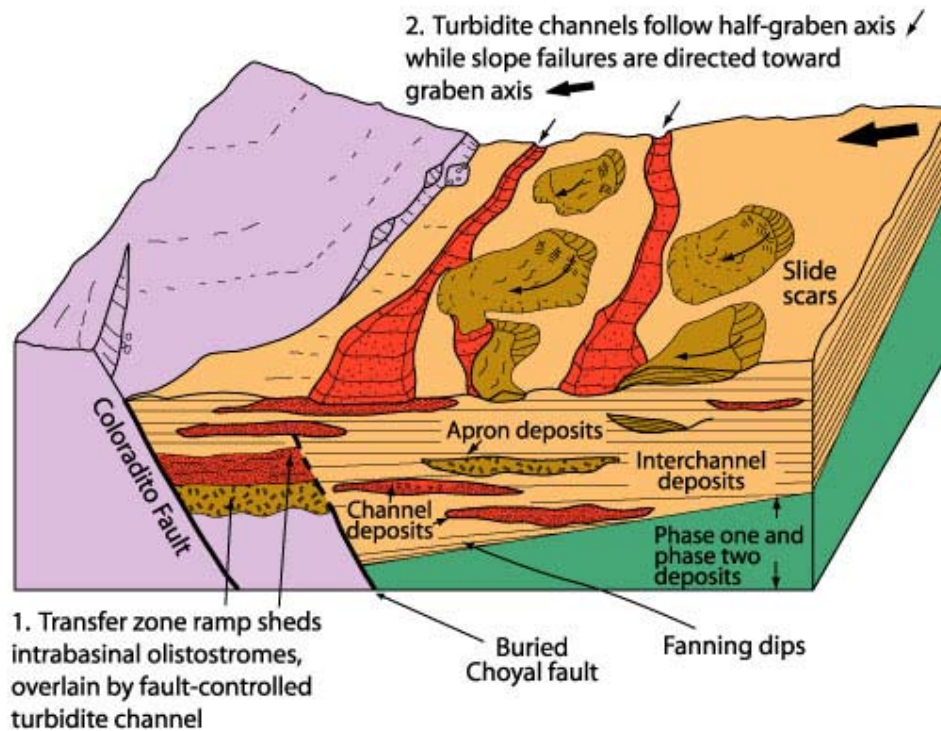
(Smith and Busby, 1993)









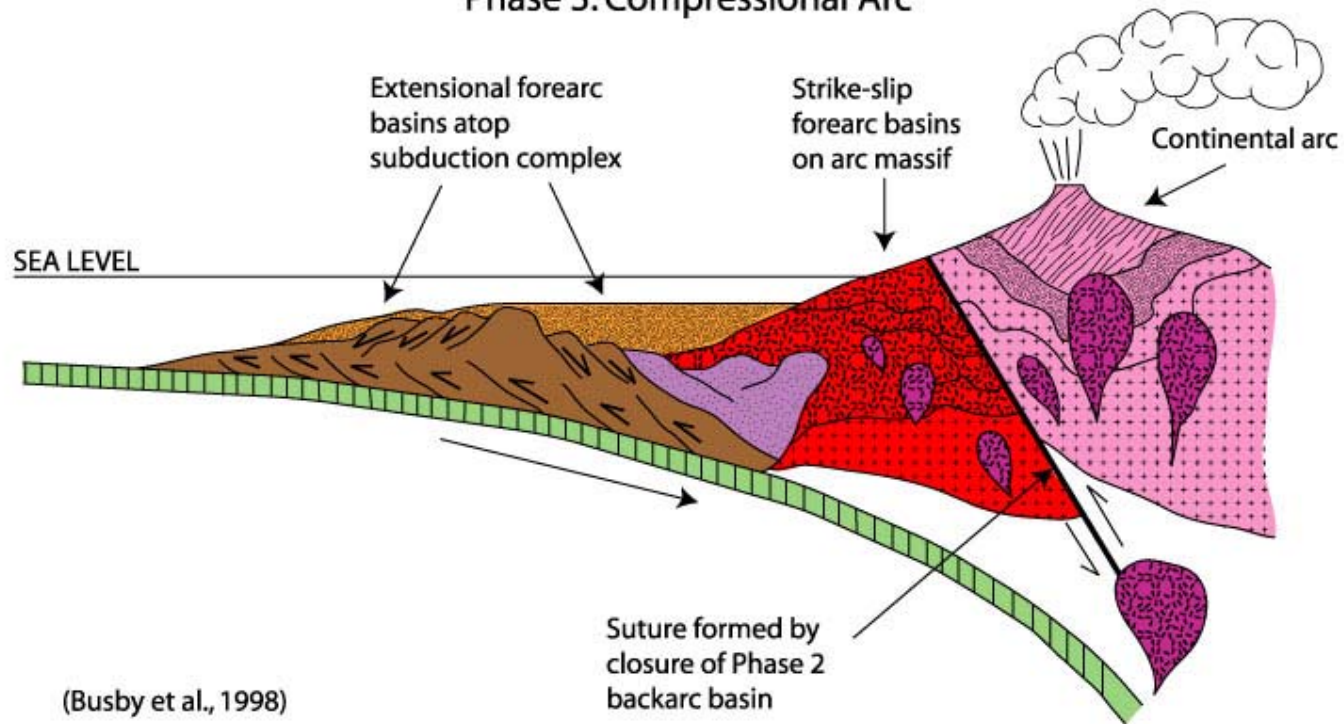


II. EXTENSIONAL FOREARC BASIN ATOP SUBDUCTION COMPLEX

(Smith and Busby, 1993)

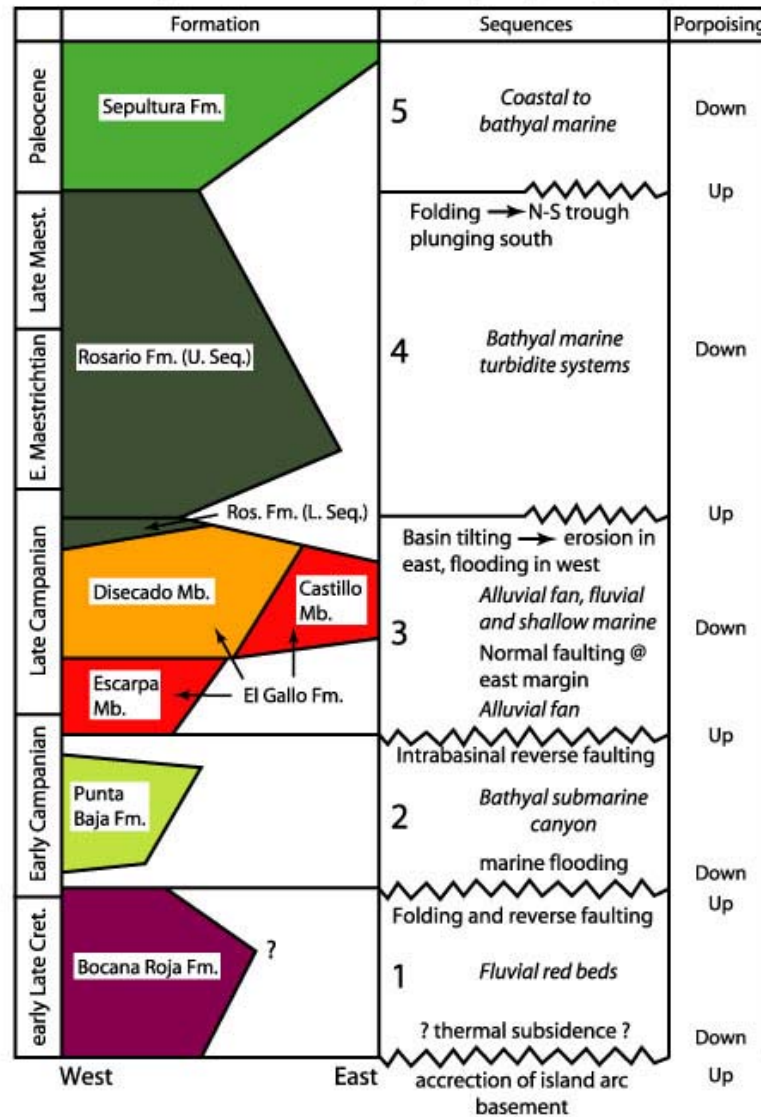


Phase 3: Compressional Arc

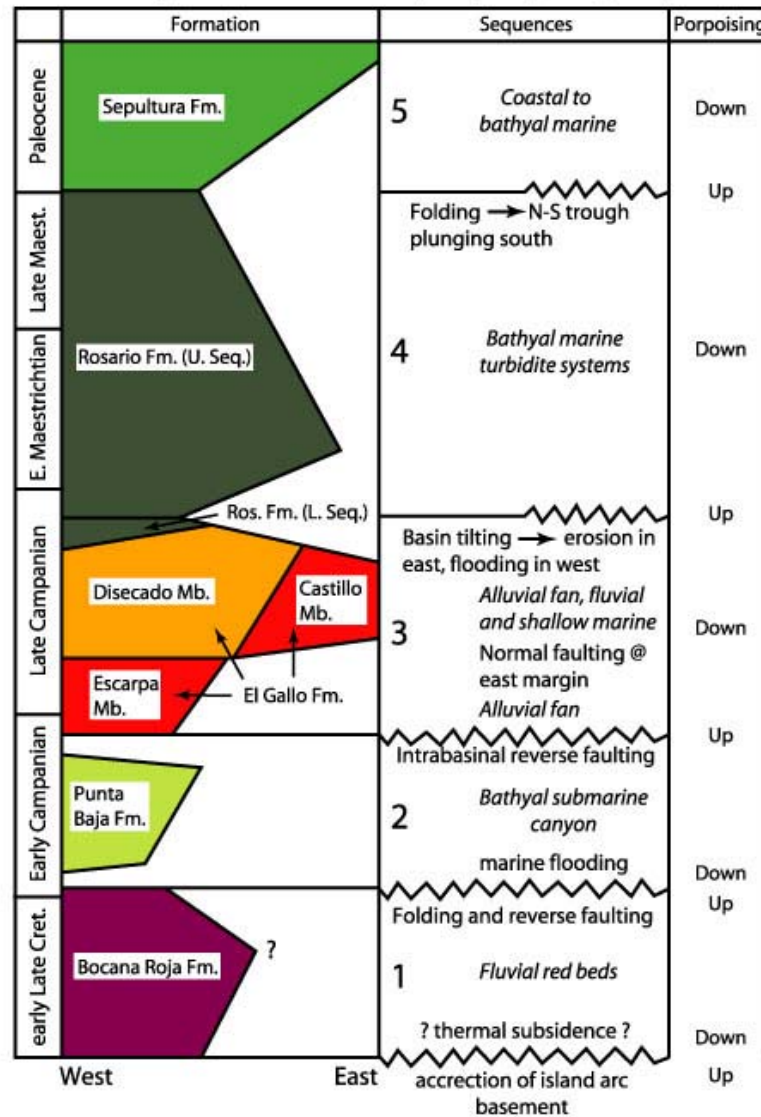


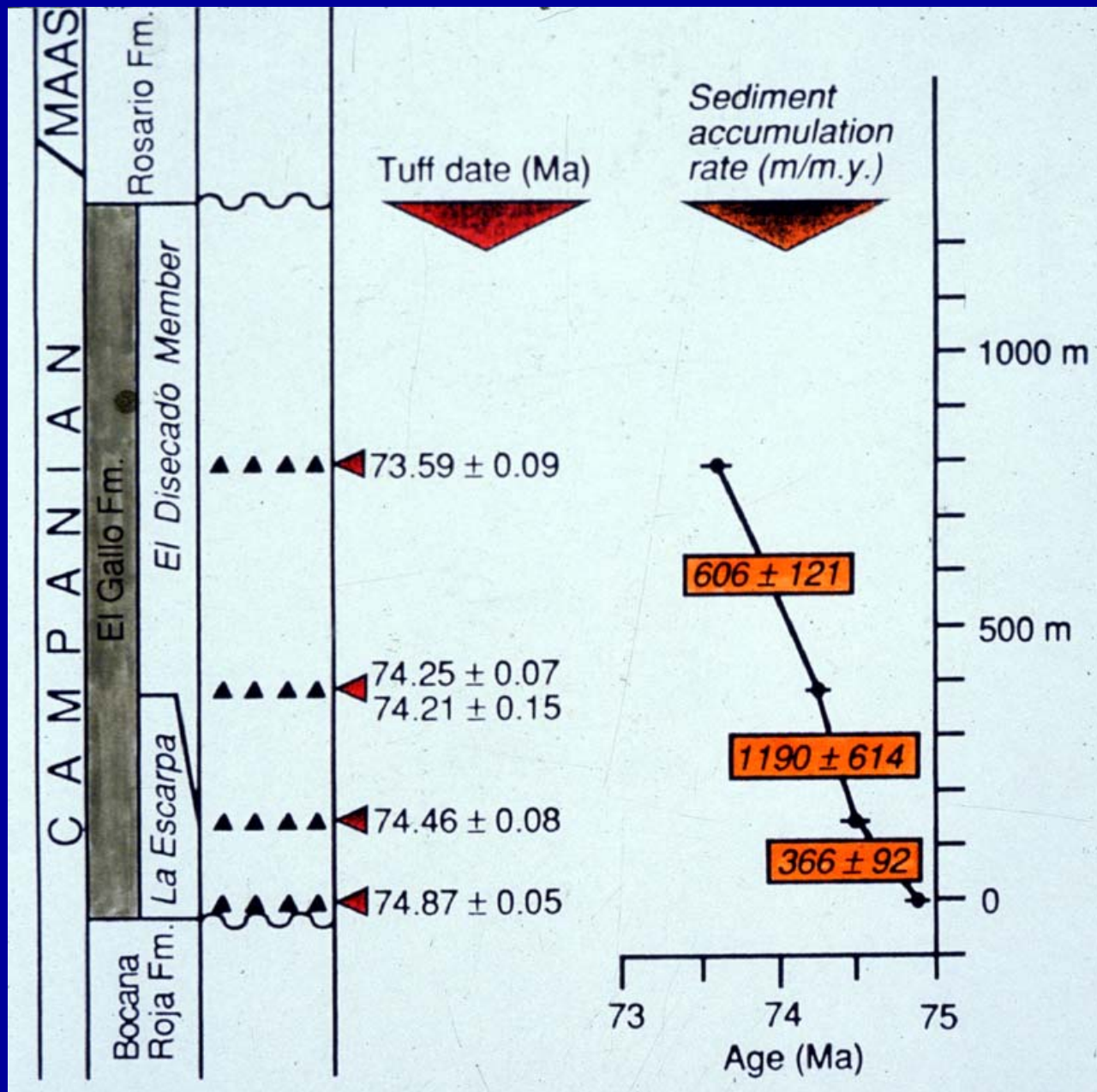
(Busby et al., 1998)

Sequence Stratigraphy of the Rosario Embayment of the Peninsular Ranges Forearc Basin Complex (Busby et al., 1998)



Sequence Stratigraphy of the Rosario Embayment of the Peninsular Ranges Forearc Basin Complex (Busby et al., 1998)

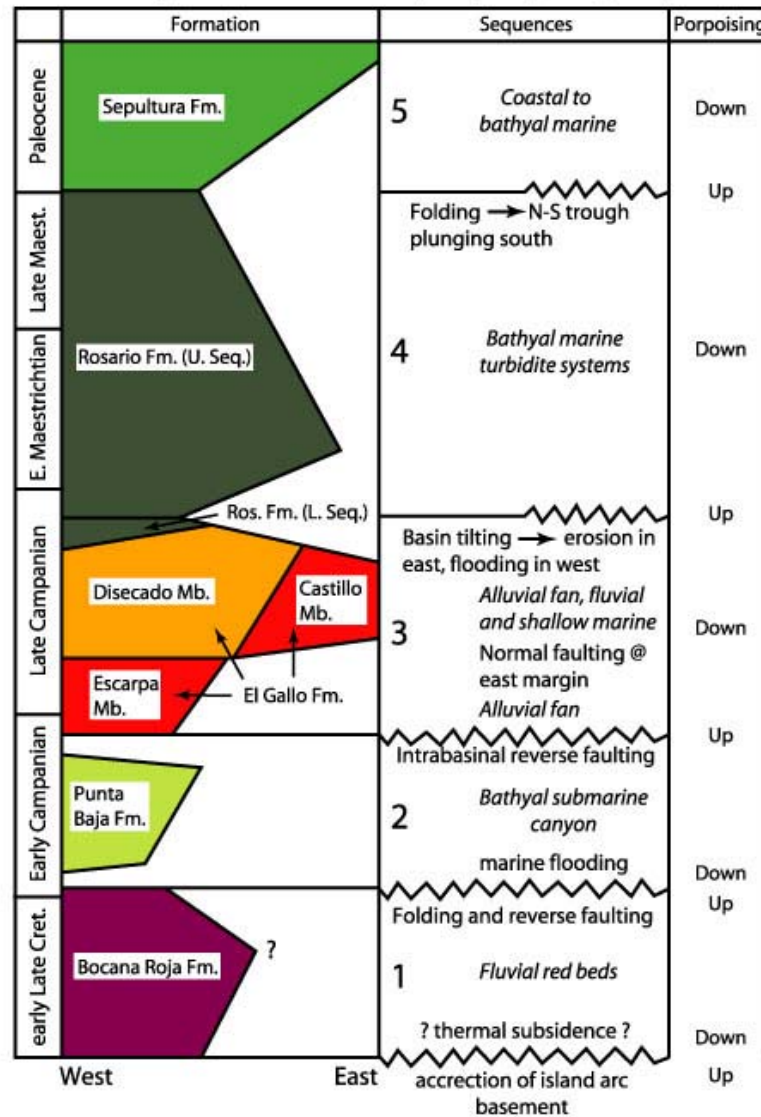




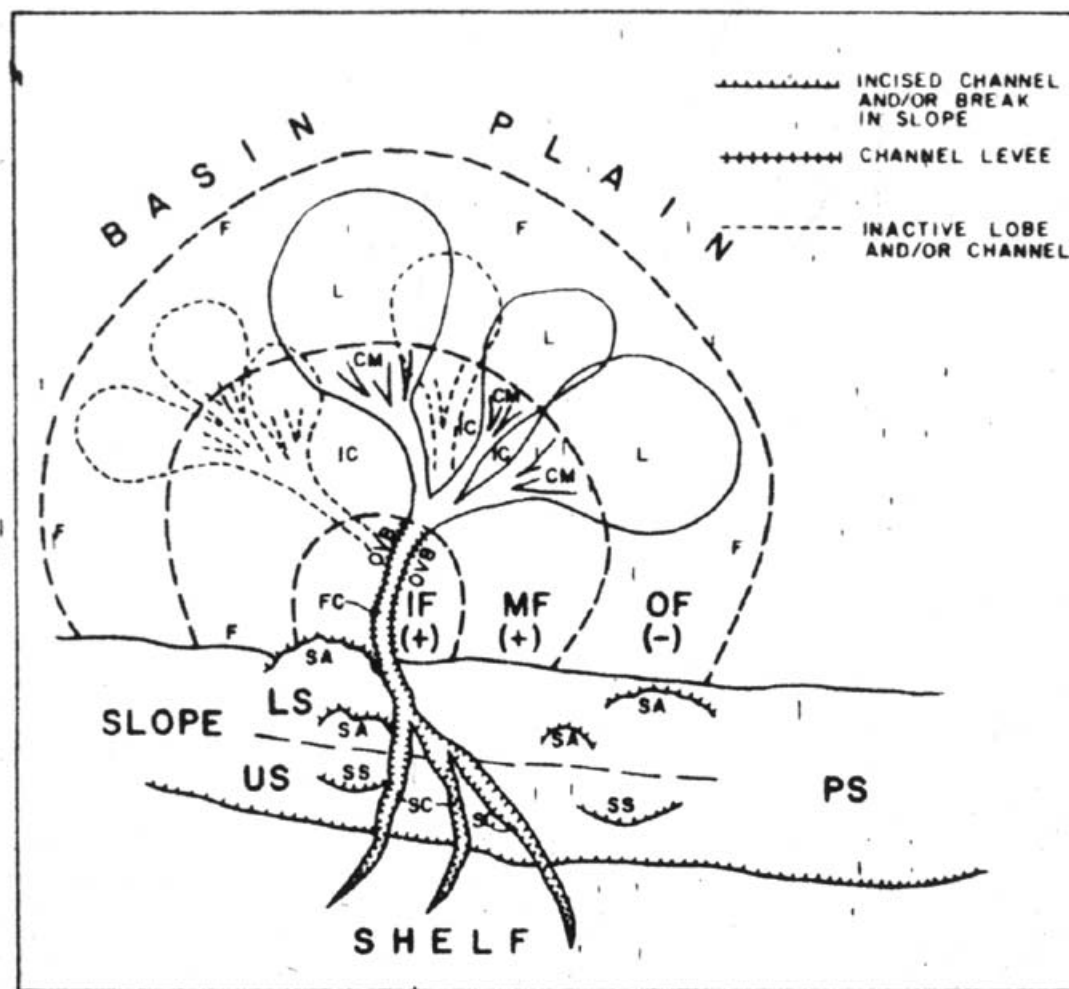




Sequence Stratigraphy of the Rosario Embayment of the Peninsular Ranges Forearc Basin Complex (Busby et al., 1998)



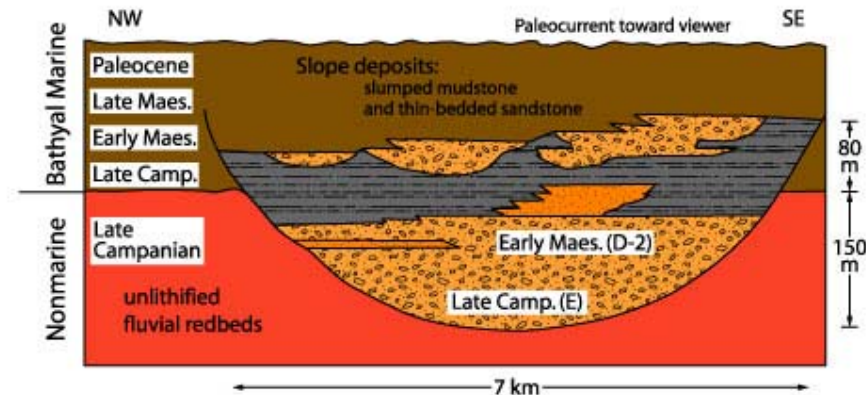
Ingersoll, 1979



San Carlos submarine canyon, Rosario Group,
Peninsular Ranges forearc basin complex

(Morris and Busby-Spera, 1988)

- Erosively-based feature filled with bathyal marine deposits
- Canyon fill bound laterally by contemporaneous slope deposits



- Unlithified redbeds downdropped >1 km and eroded by turbidity currents
- *Lower conglomerate - sandstone unit*: amalgamated channels, intraformational slide blocks 100m long, and giant load structures
- *Middle mudstone - sandstone unit*: aggrading turbidite channel with traction structures; slumps in mudstones indicate high axial gradients
- *Upper conglomerate - sandstone unit*: more isolated channels, migrate S.E. with time

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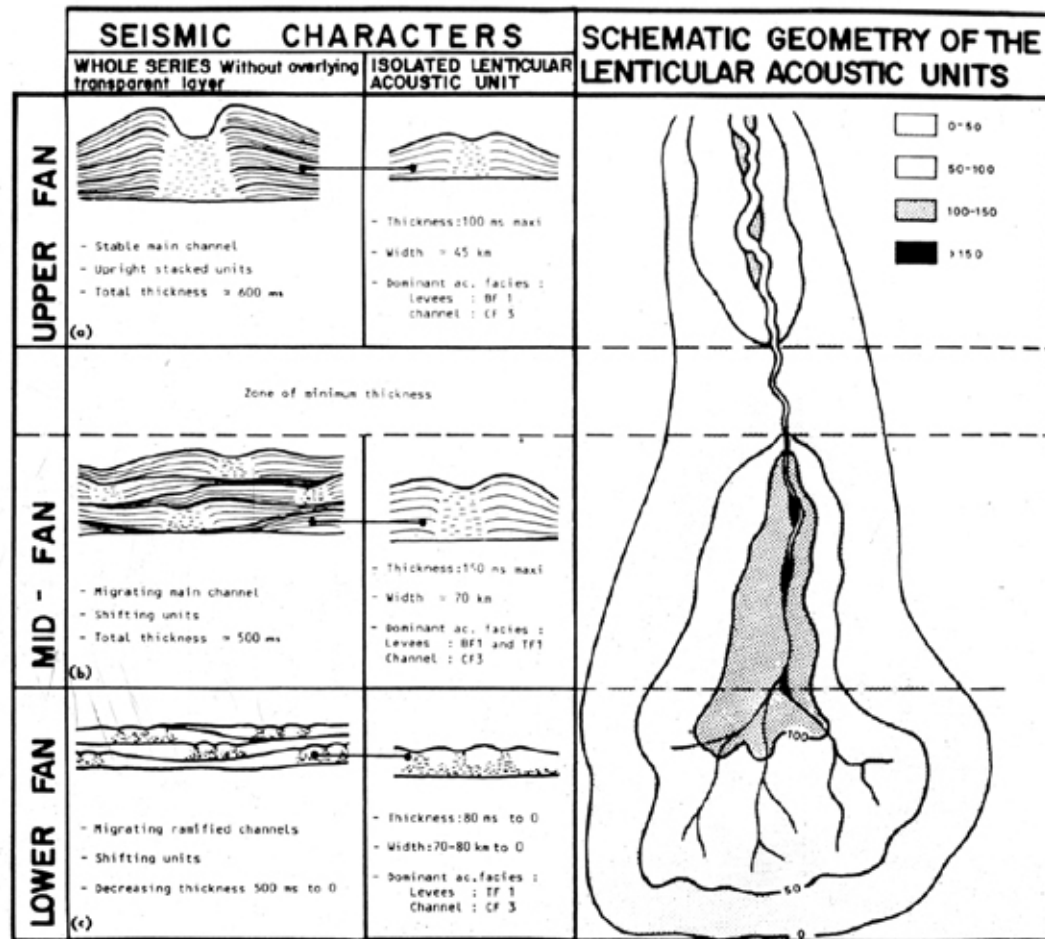
A·A·P·G BULLETIN



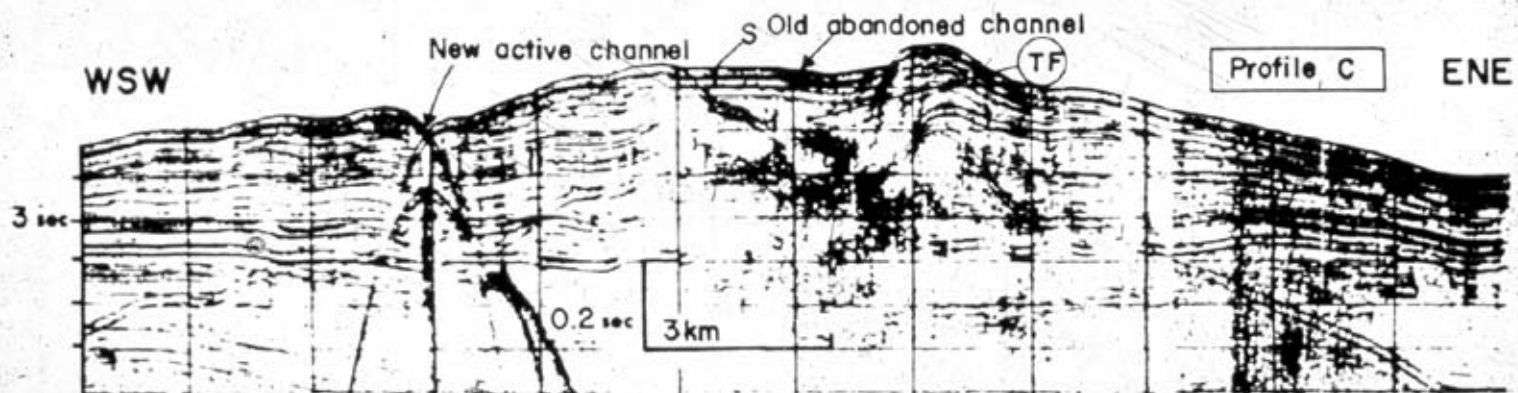
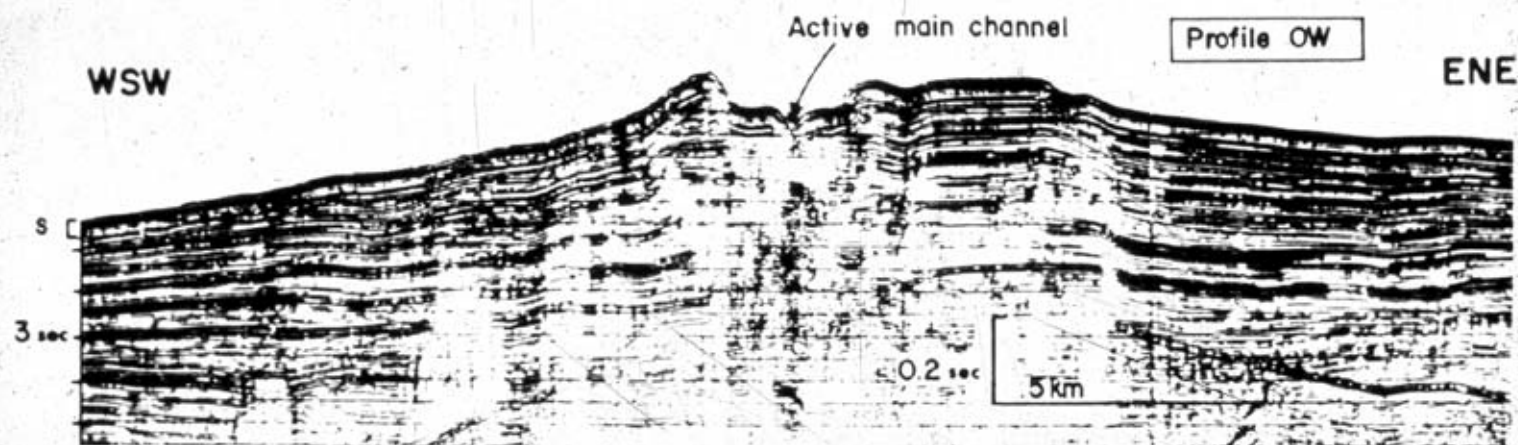




Droz and Bellaiche, 1985



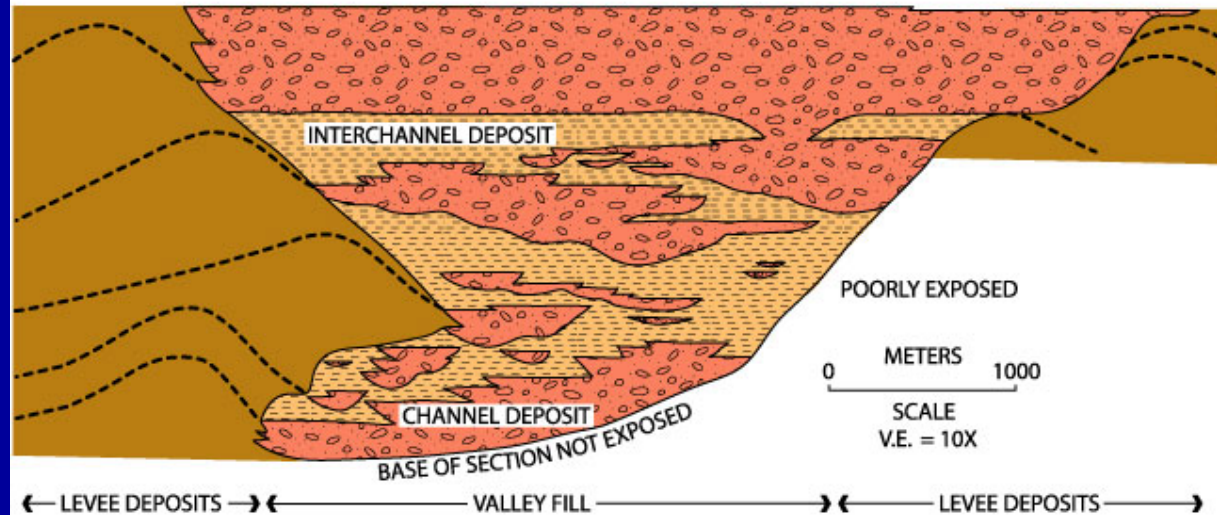
Droz and Bellaiche, 1985



DEEPWATER VALLEY-LEVEE COMPLEX

(Morris and Busby-Spera, 1990)

Aggradation of valley confined by levees leads to vertical stacking of channel (and interchannel) deposits

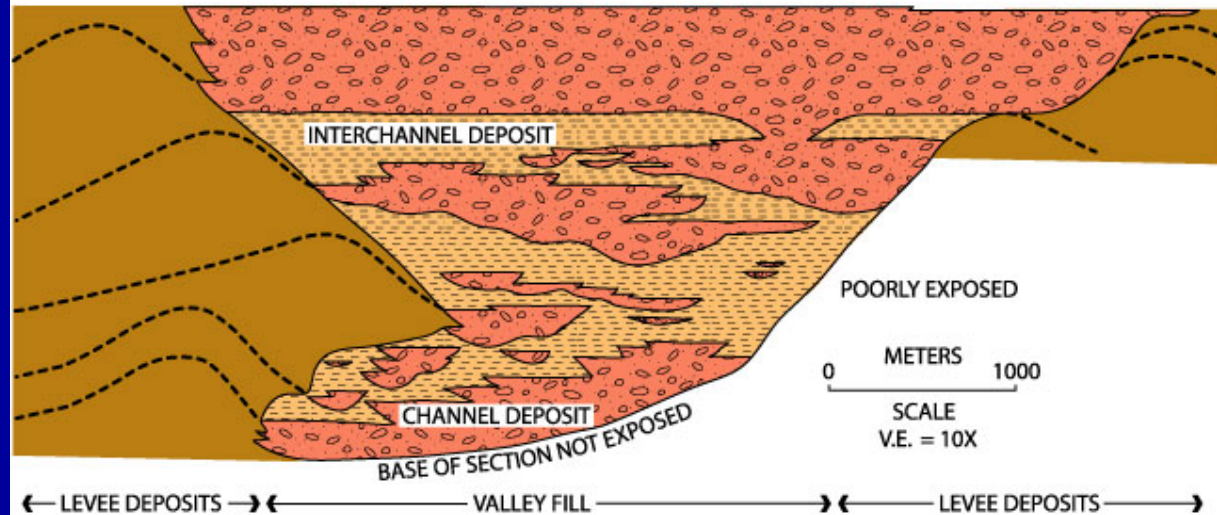




DEEPWATER VALLEY-LEVEE COMPLEX

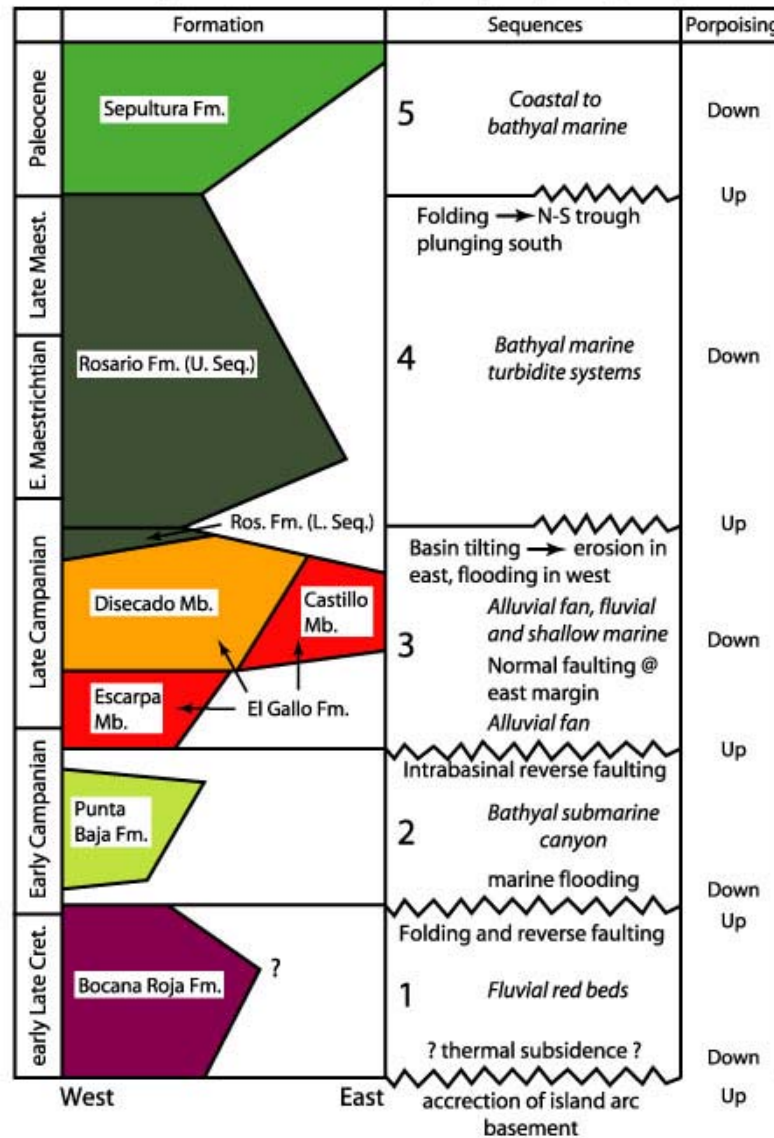
(Morris and Busby-Spera, 1990)

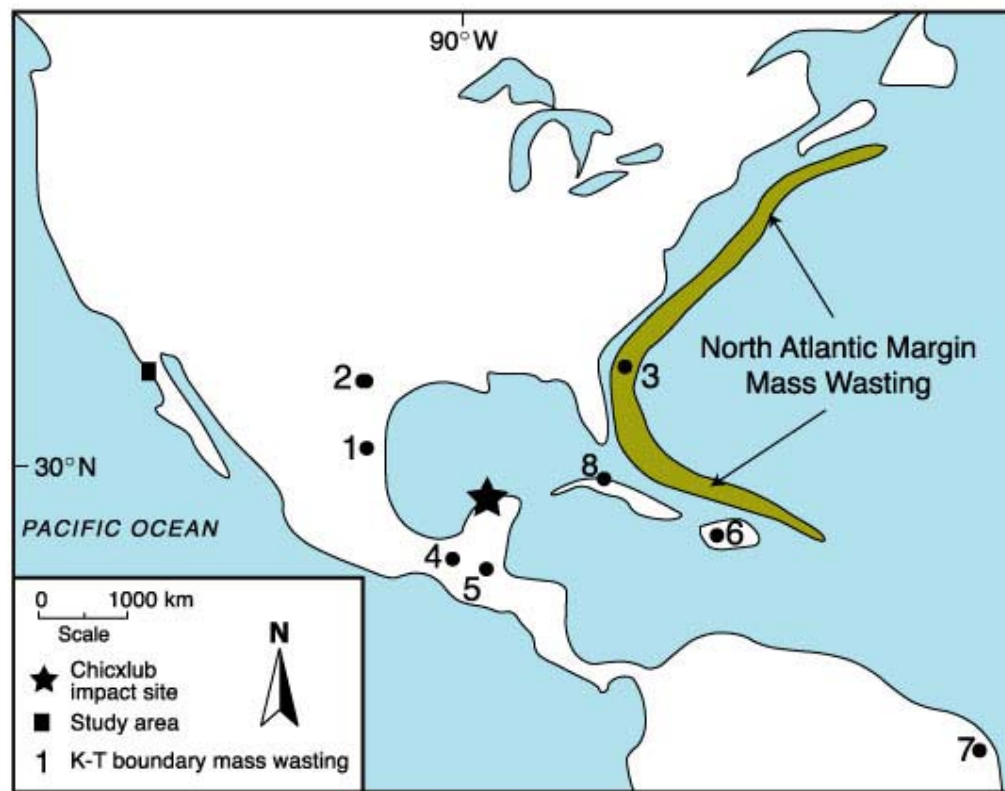
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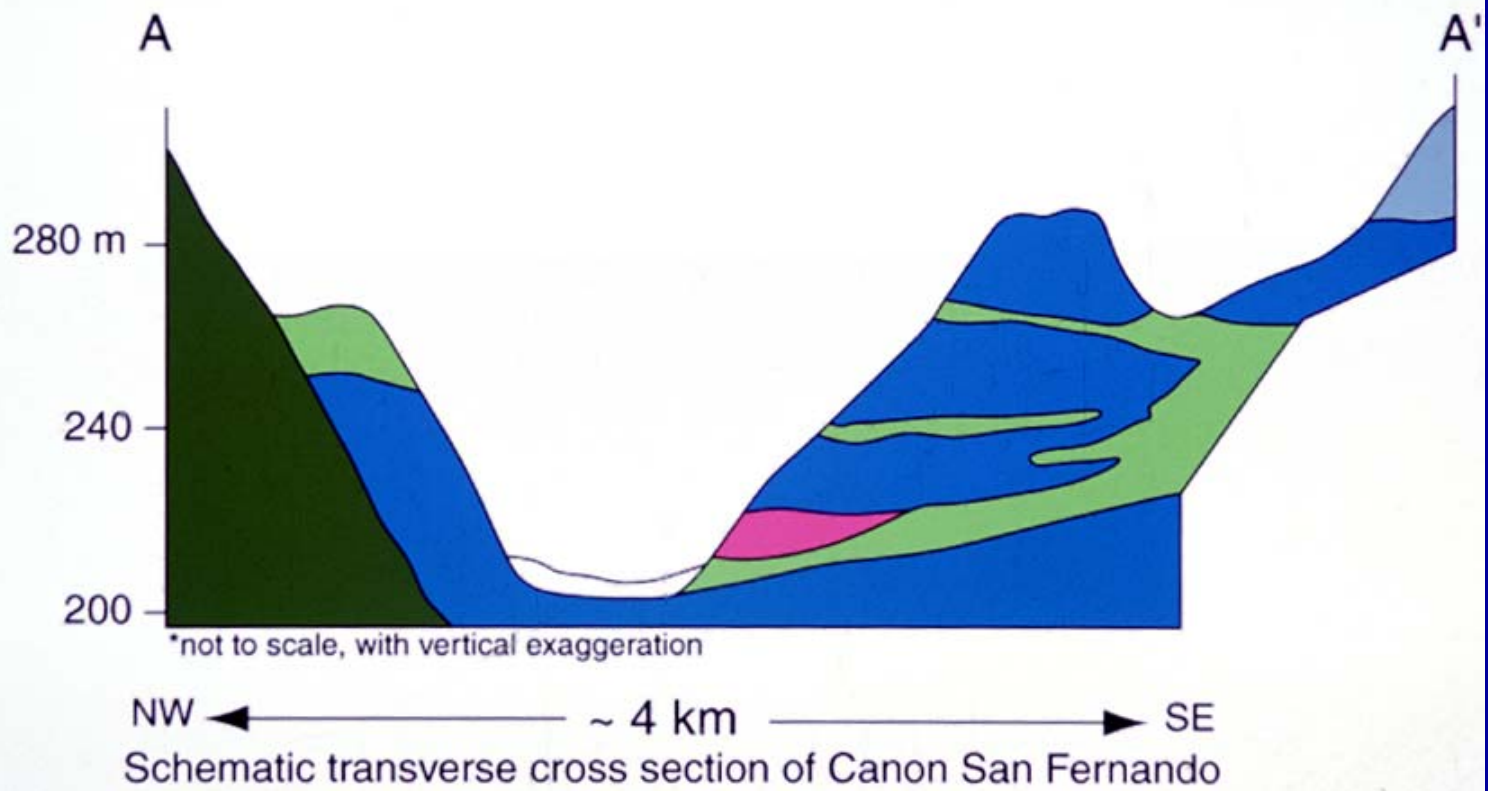


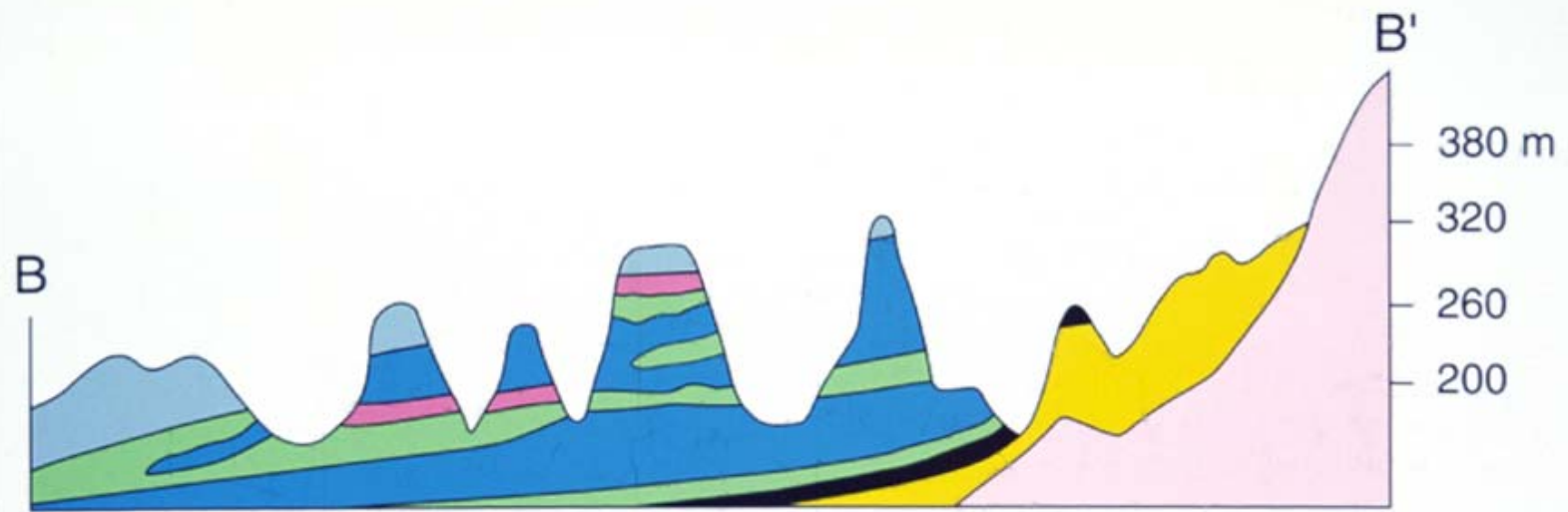


Sequence Stratigraphy of the Rosario Embayment of the Peninsular Ranges Forearc Basin Complex (Busby et al., 1998)







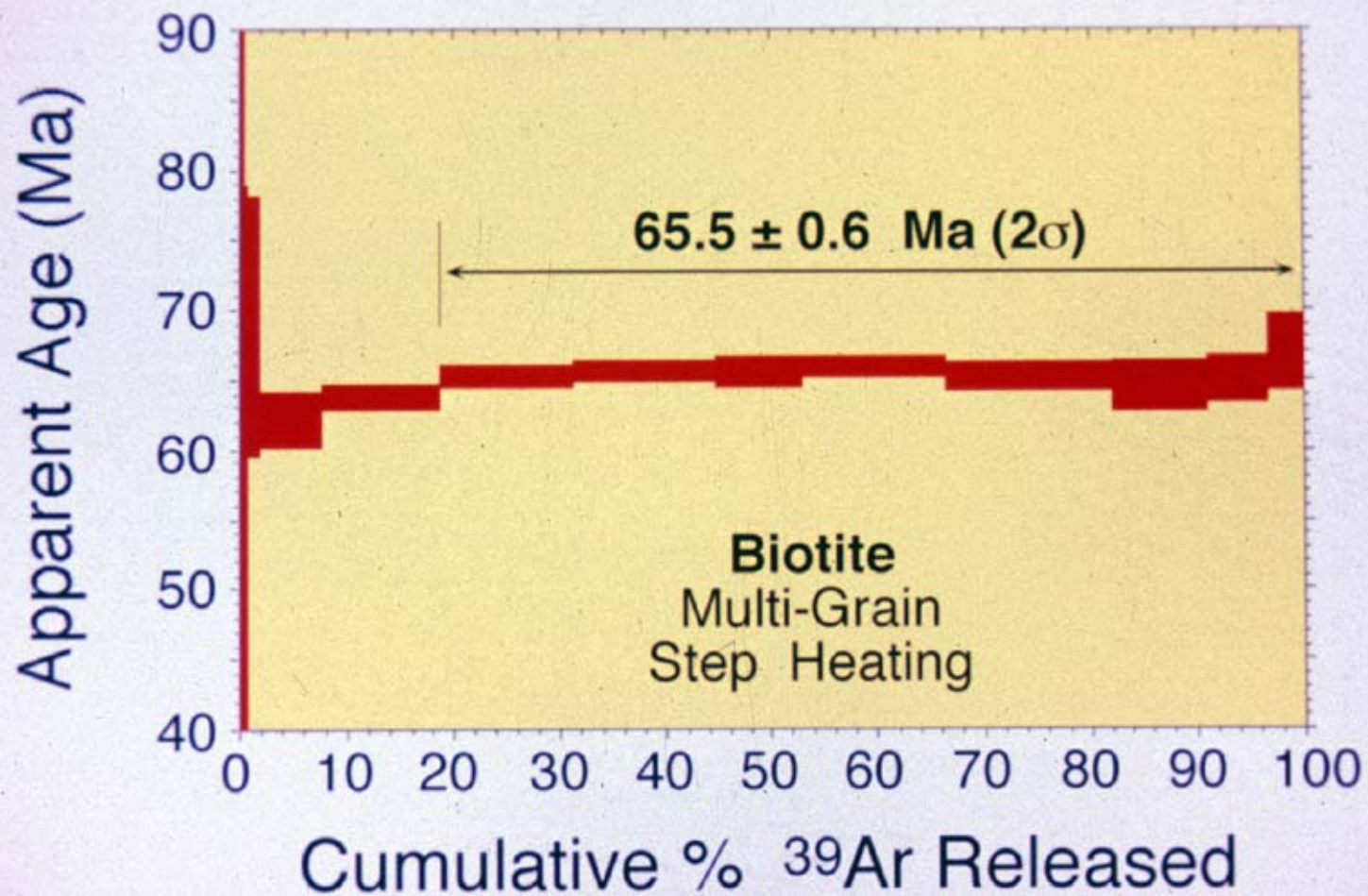


*not to scale, with vertical exaggeration

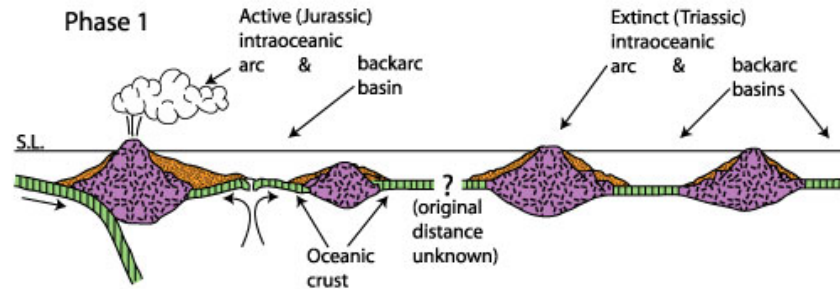
SW ← ~ 10 km → NE

Schematic longitudinal cross section of Canon San Fernando

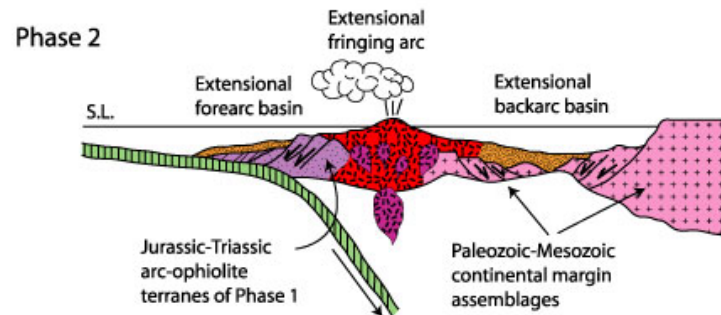




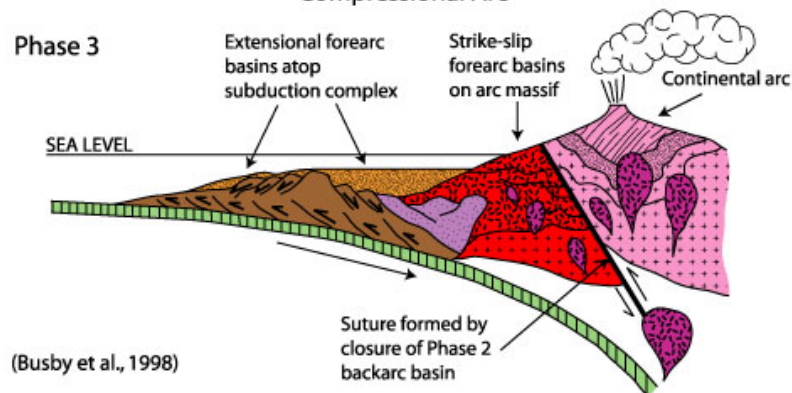
Strongly Extensional Arc



Moderately Extensional Arc



Compressional Arc



(Busby et al., 1998)

