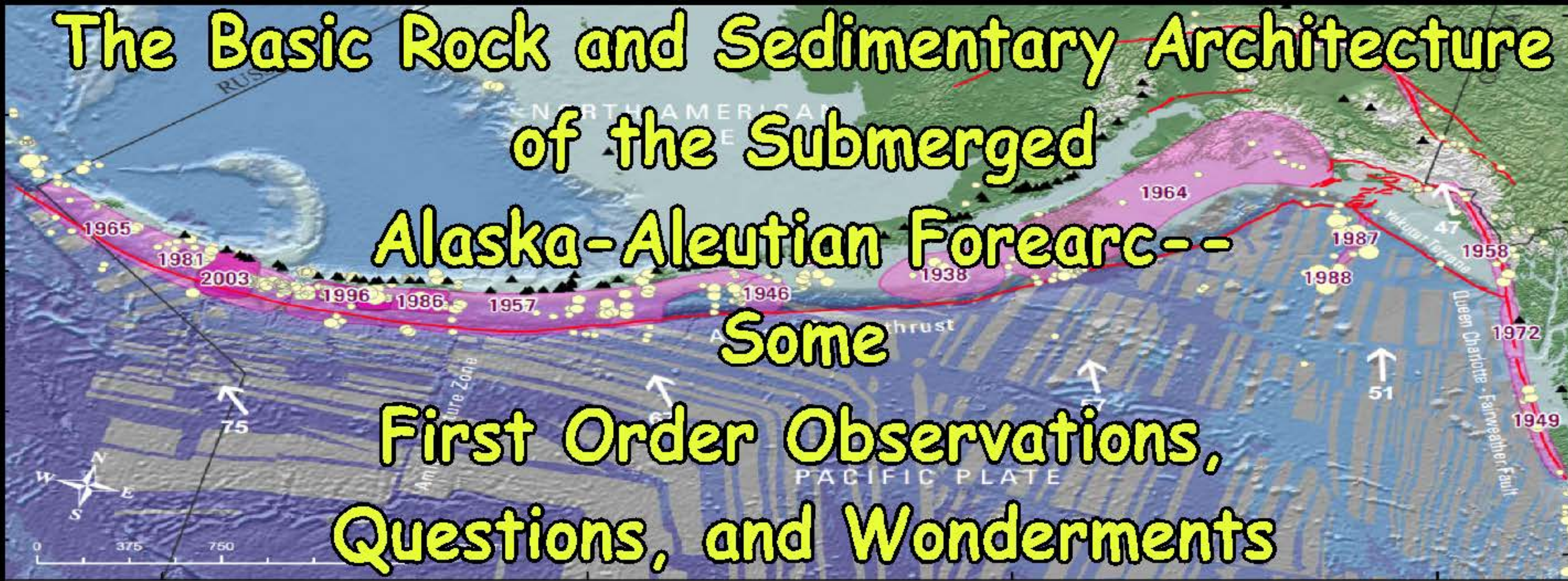
GeoPRISM-Alaska

The Basic Rock and Sedimentary Architecture of the Submerged Alaska-Aleutian Forearc-- Some First Order Observations, Questions, and Wonderments



1) The Rock Fabric of the Submerged Alaska Forearc

2) The Rock Fabric and Birthing of the Aleutian Arc Massif

3) Forecasting the Future Occurrence of Great and Giant Megathrust Ruptures

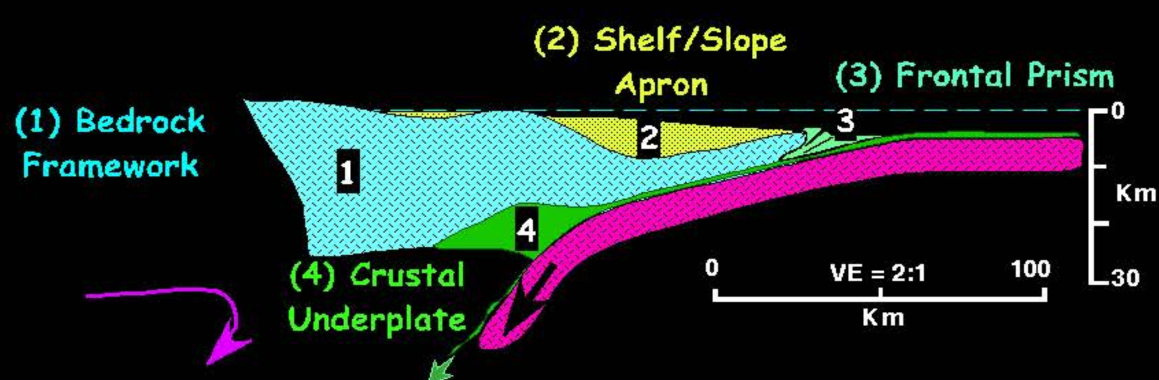
Dave Scholl

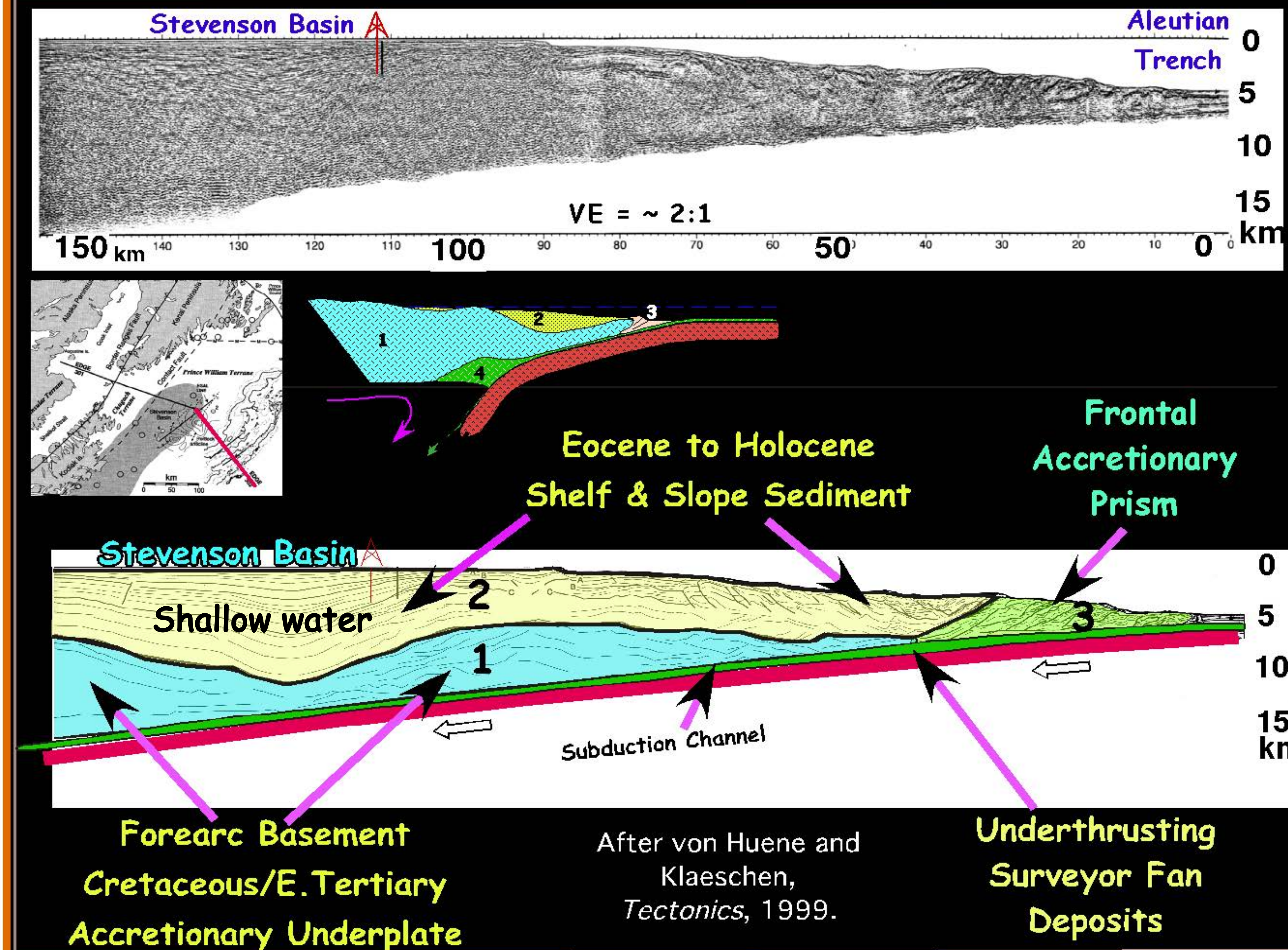
University of Alaska Fairbanks & USGS, Menlo Park, CA

Basic Rock and Sedimentary Architecture of the Submerged Alaskan Forearc

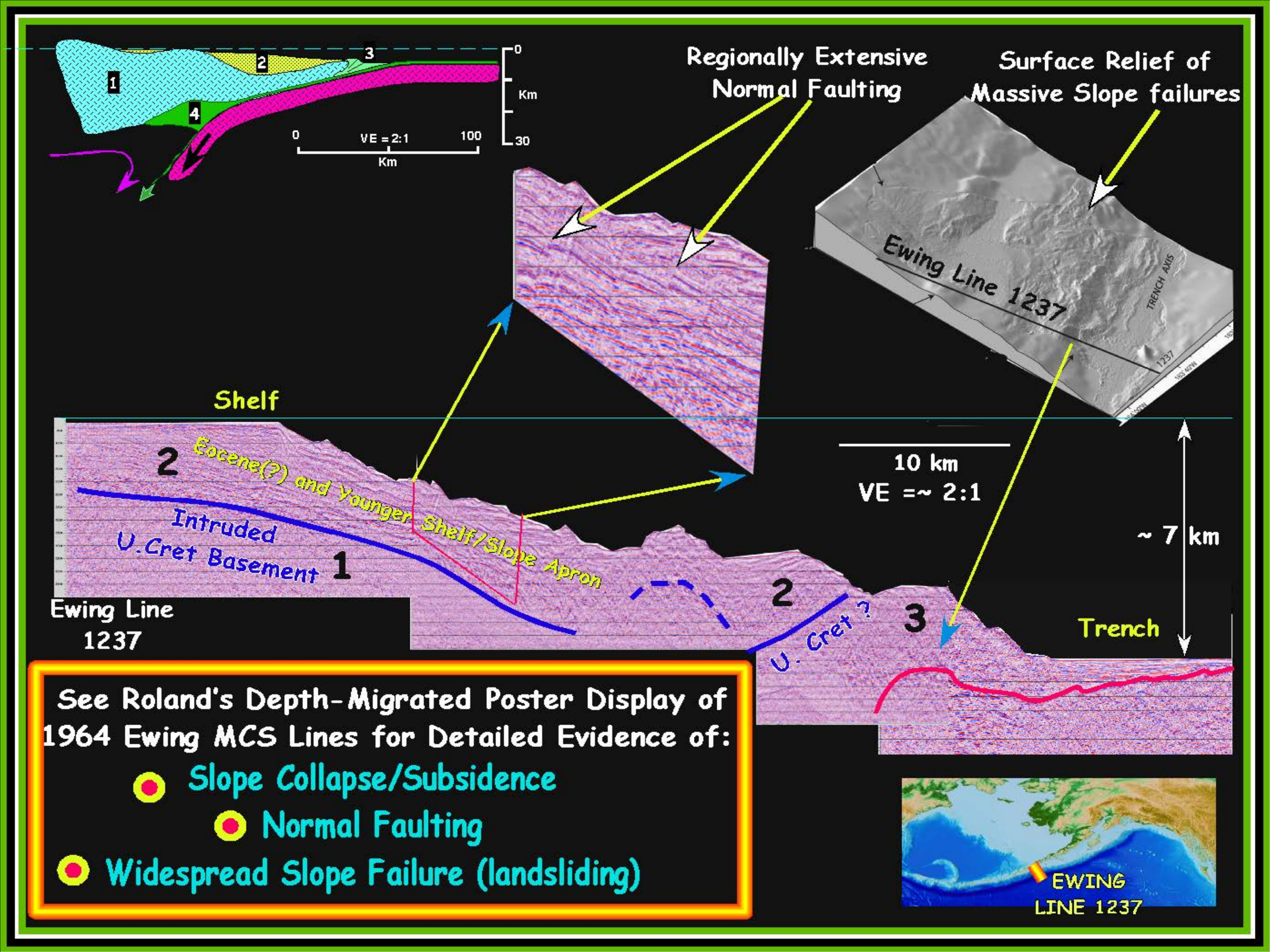
A View brought to you

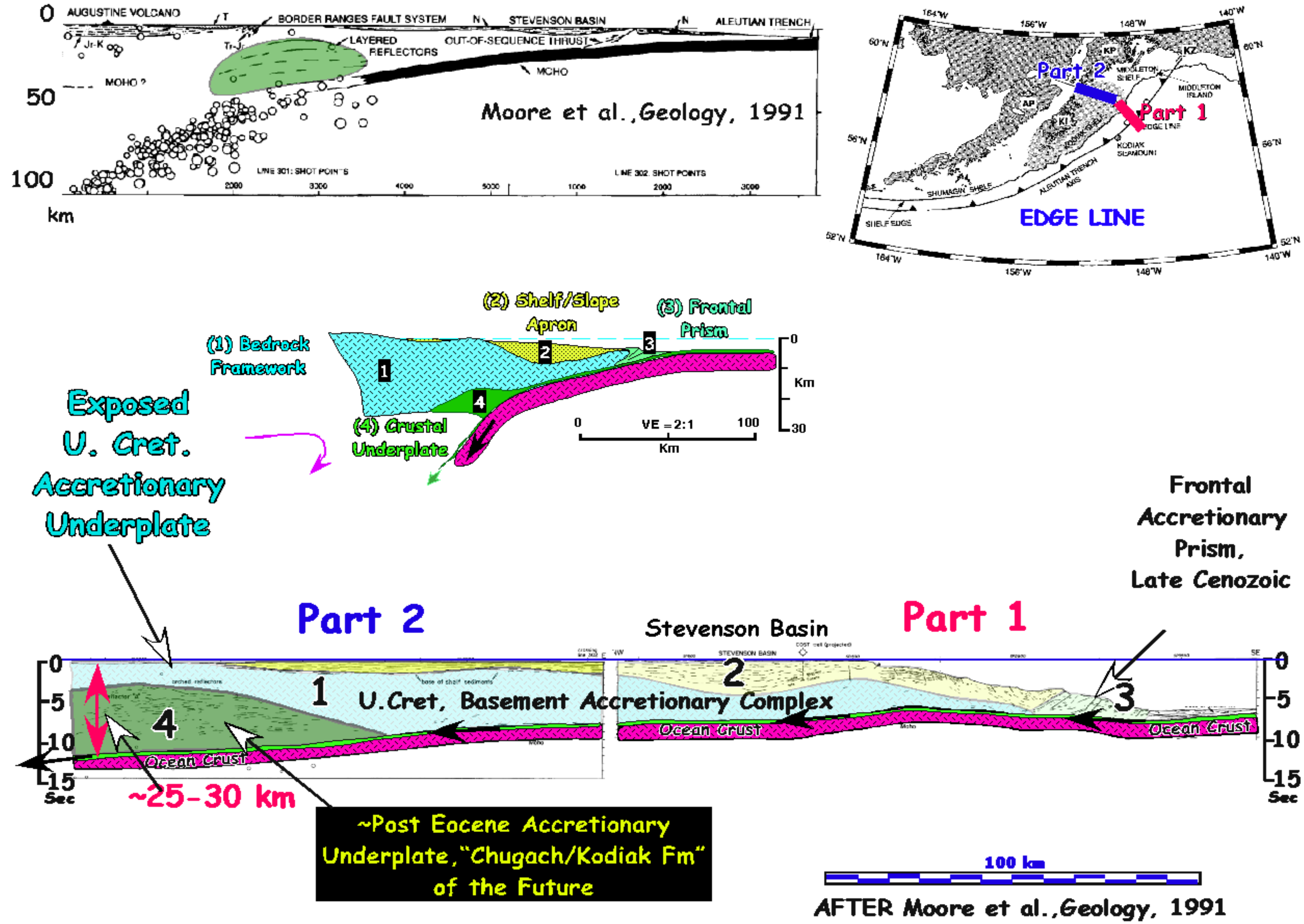
by Roland von Huene, Dave Scholl, and Holly Ryan



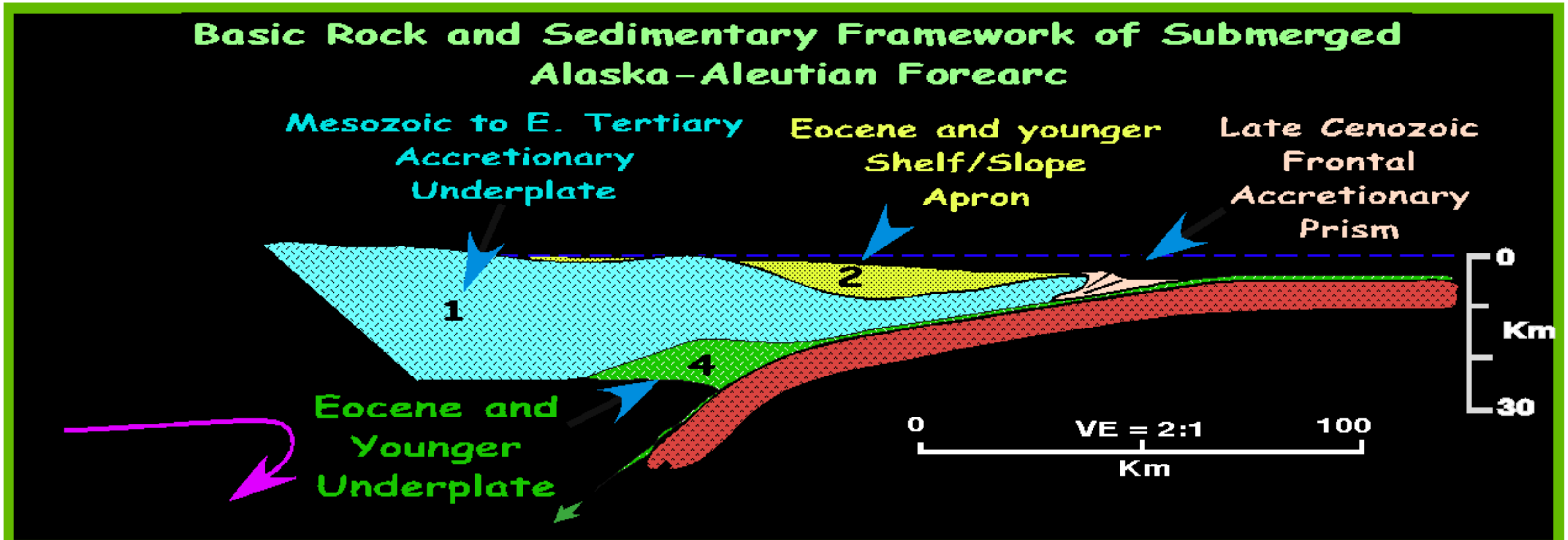


After von Huene and Klaeschen, *Tectonics*, 1999.


1
2
3
4
0
Km
30
0
VE = 2:1
100
Km
Regionally Extensive
Normal Faulting
Surface Relief of
Massive Slope failures
Ewing Line 1237
TRENCH AXIS
Shelf
2
Eocene(?) and Younger Shelf/Slope Apron
Intruded
U.Cret Basement
1
10 km
VE =~ 2:1
~ 7 km
2
U. Cret ?
3
Trench
Ewing Line
1237
See Roland's Depth-Migrated Poster Display of
1964 Ewing MCS Lines for Detailed Evidence of:
Slope Collapse/Subsidence
Normal Faulting
Widespread Slope Failure (landsliding)
EWING
LINE 1237



0
AUGUSTINE VOLCANO
BORDER RANGES FAULT SYSTEM
STEVENSON BASIN
ALEUTIAN TRENCH
LAYERED REFLECTORS
OUT-OF-SEQUENCE THRUST
MOHO ?
MOHO
50
100
km
Moore et al.,Geology, 1991
LINE 301: SHOT POINTS
LINE 302: SHOT POINTS
Part 2
Part 1
KODIAK SEAMOUNT
MIDDLETON ISLAND
SHUMAGIN SHELF
ALEUTIAN TRENCH AXIS
SHELF EDGE
EDGE LINE
(1) Bedrock Framework
(2) Shelf/Slope Apron
(3) Frontal Prism
(4) Crustal Underplate
Km
VE = 2:1
0
100
30
Exposed U. Cret. Accretionary Underplate
Frontal Accretionary Prism, Late Cenozoic
Part 2
Stevenson Basin
Part 1
1
2
3
4
U.Cret. Basement Accretionary Complex
Ocean Crust
Ocean Crust
Ocean Crust
0
5
10
15
Sec
~25-30 km
~Post Eocene Accretionary Underplate, "Chugach/Kodiak Fm" of the Future
100 km
AFTER Moore et al.,Geology, 1991



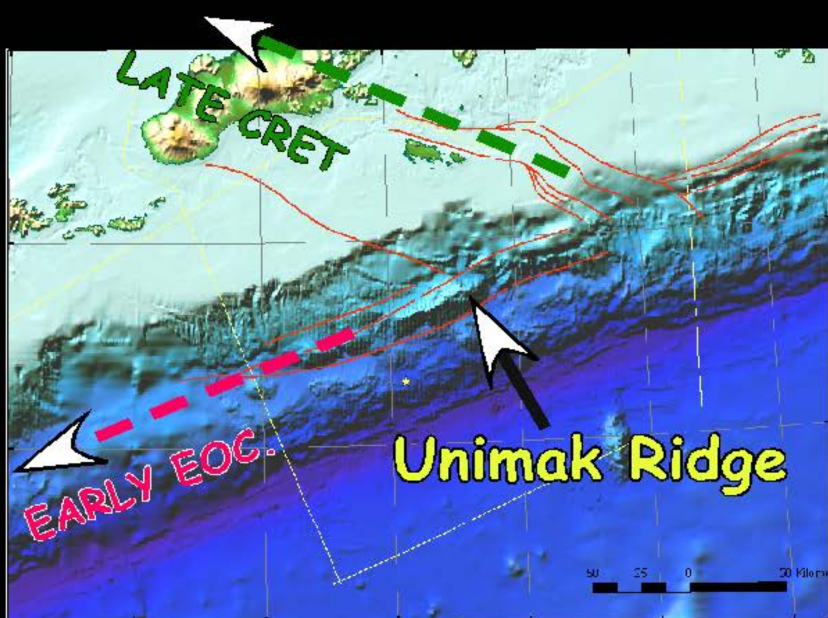
OBSERVATIONS

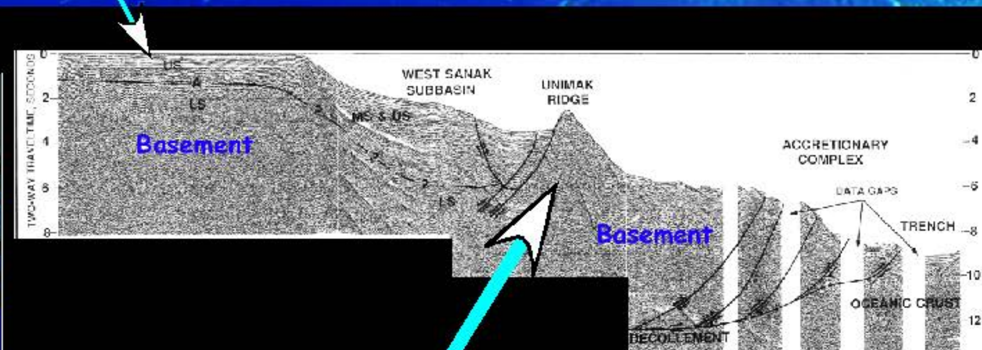
The Submerged Forearc Is Being Constructively Thickened by Underplating to landward (Yin)

The Submerged Forearc is Being Destructively Thinned and Truncated to Seaward (Yang)

WONDERMENTS

- What Is the Cenozoic Volumetric Balance Between Crustal Loss to Seaward and Growth to landward?
- What Subduction Zone Circumstances Conditioned the Net Growth that Produced the Massive Accretionary Underplates of the L. Cret. & E. Tert?

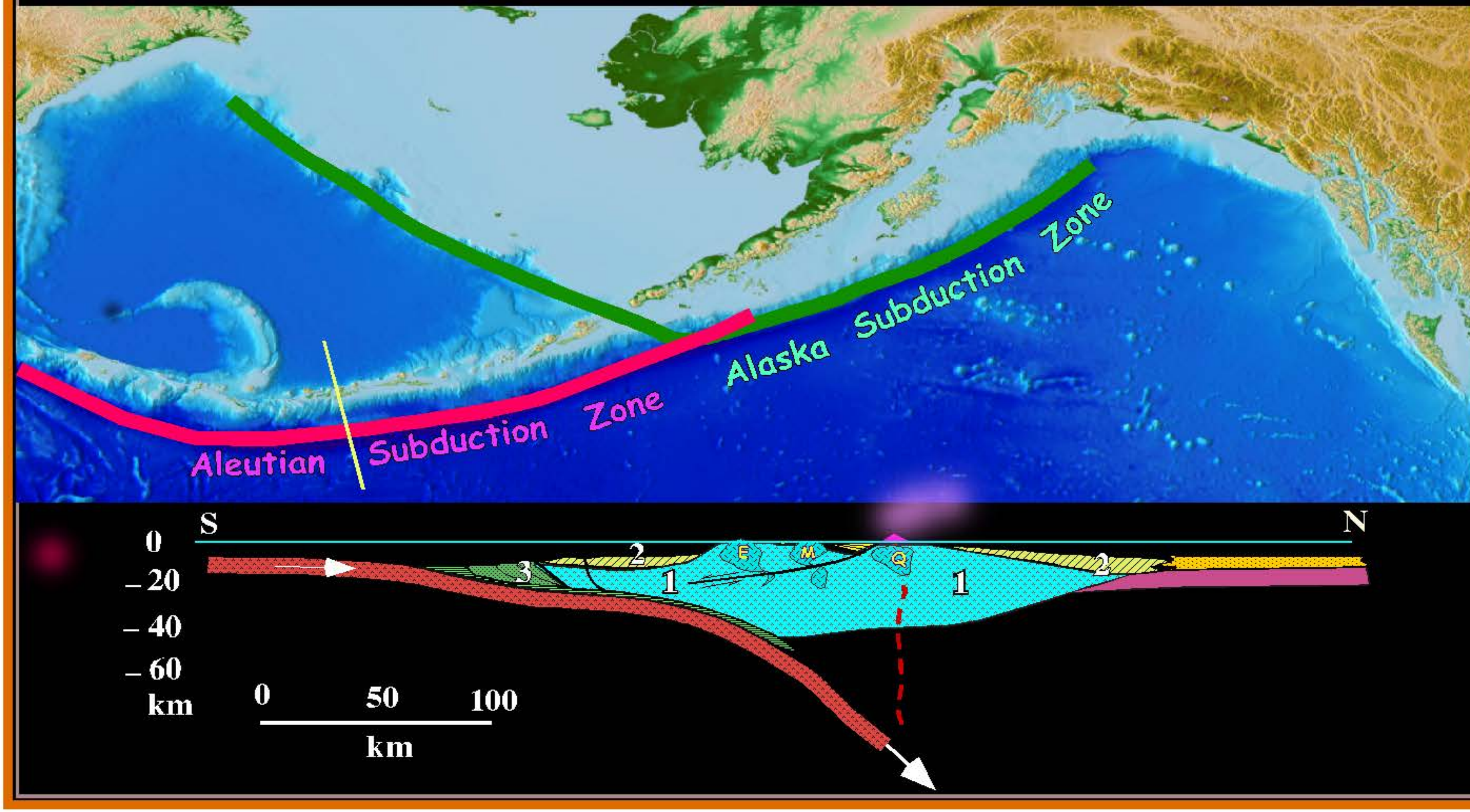


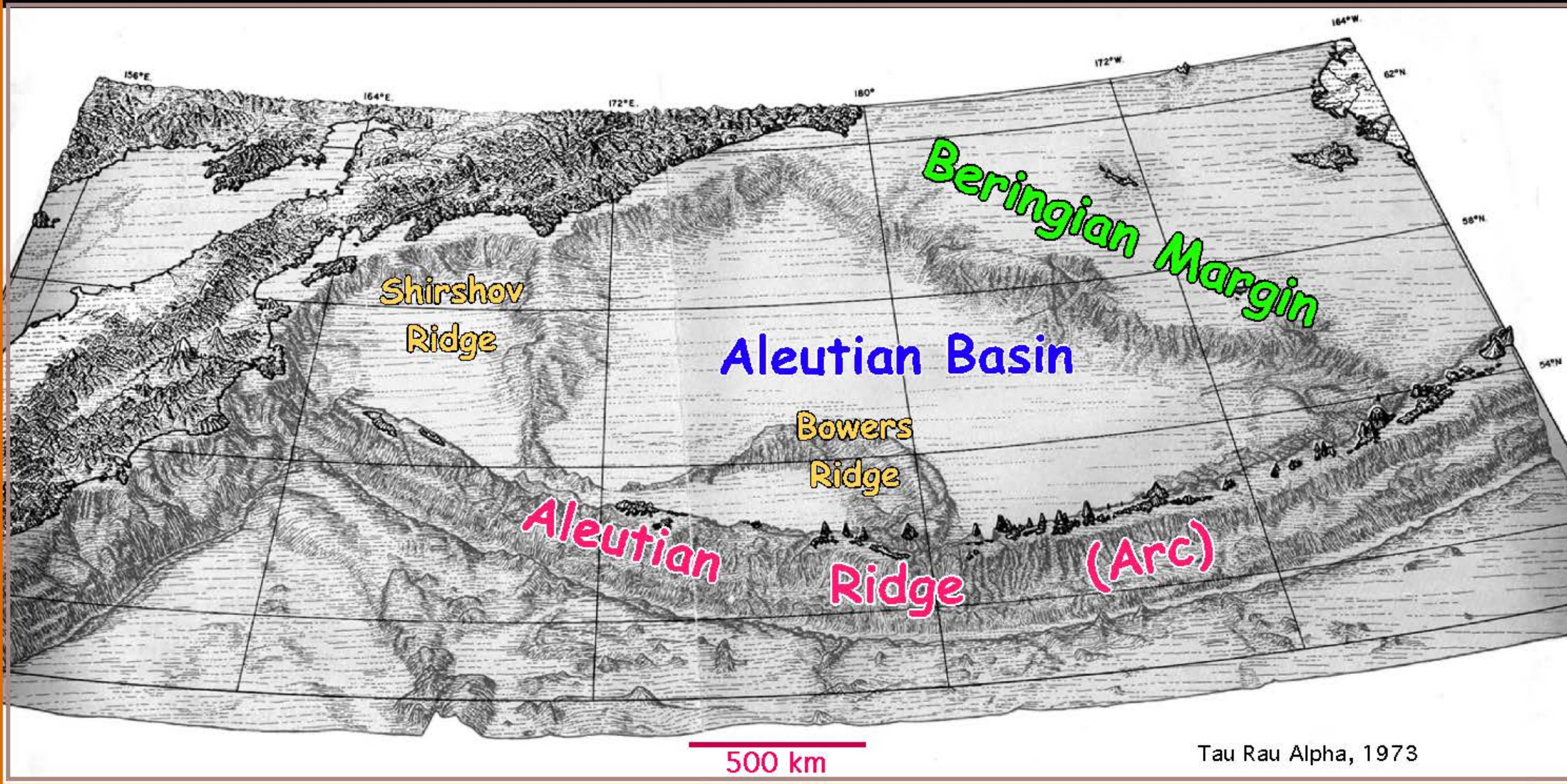


Is Eocene(?) Unimak Ridge the Eastern End of the Aleutian Arc Massif?

Birthing and the Rock and Sedimentary Architecture of the Aleutian Arc Masssif

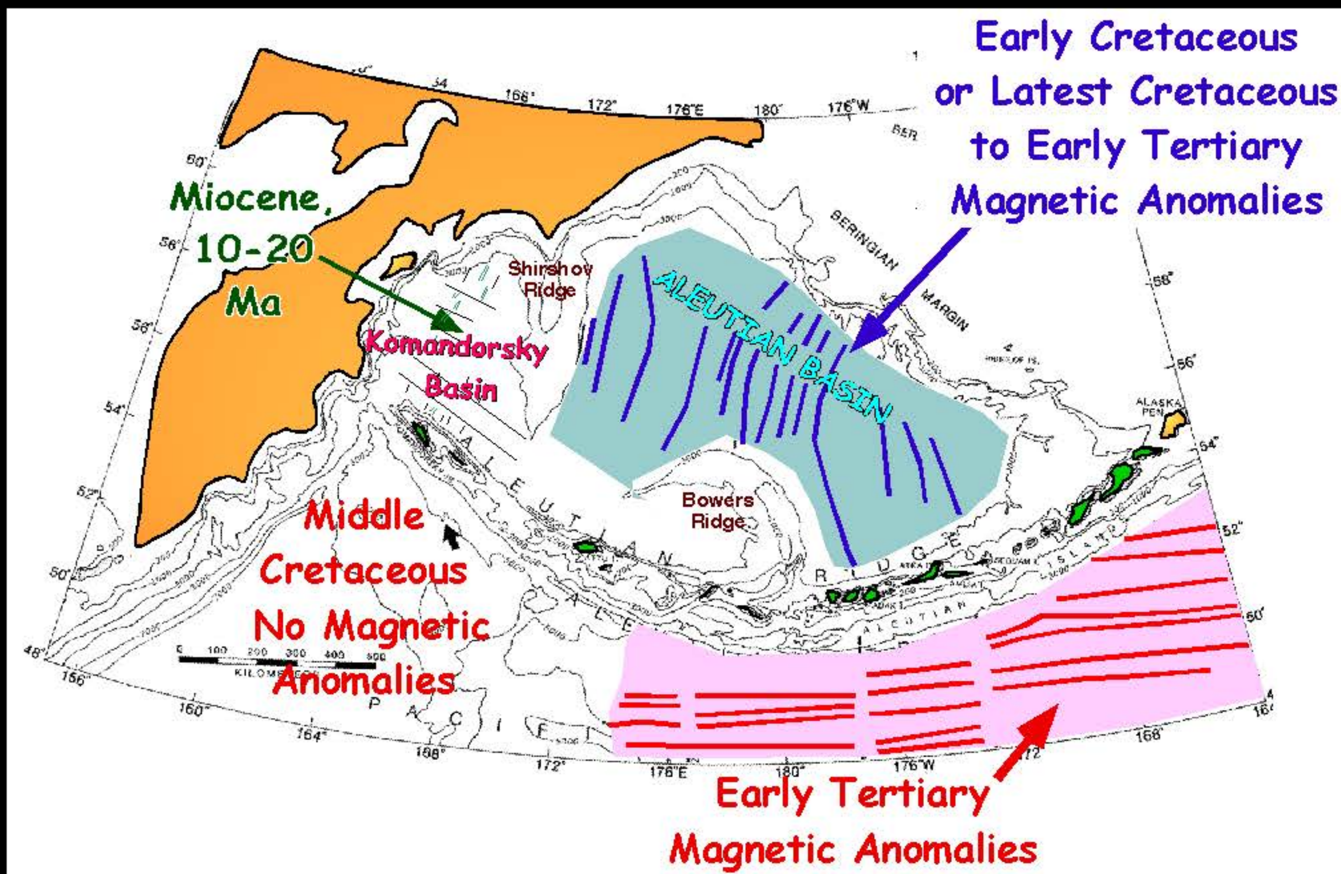
A View Brought to You by Dave Scholl and Holly Ryan





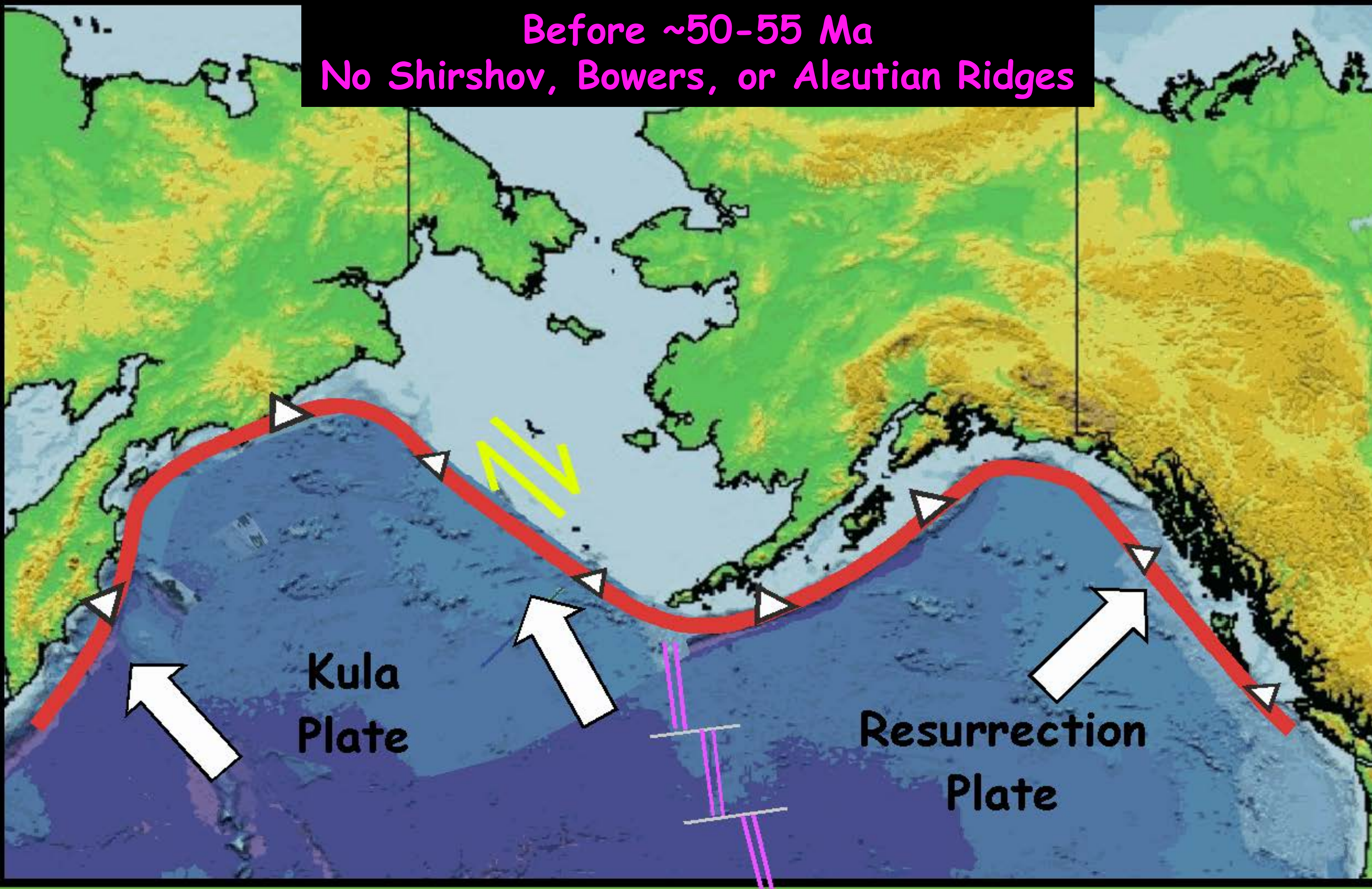
Major Physiographic Elements Associated with the Aleutian Ridge or Arc

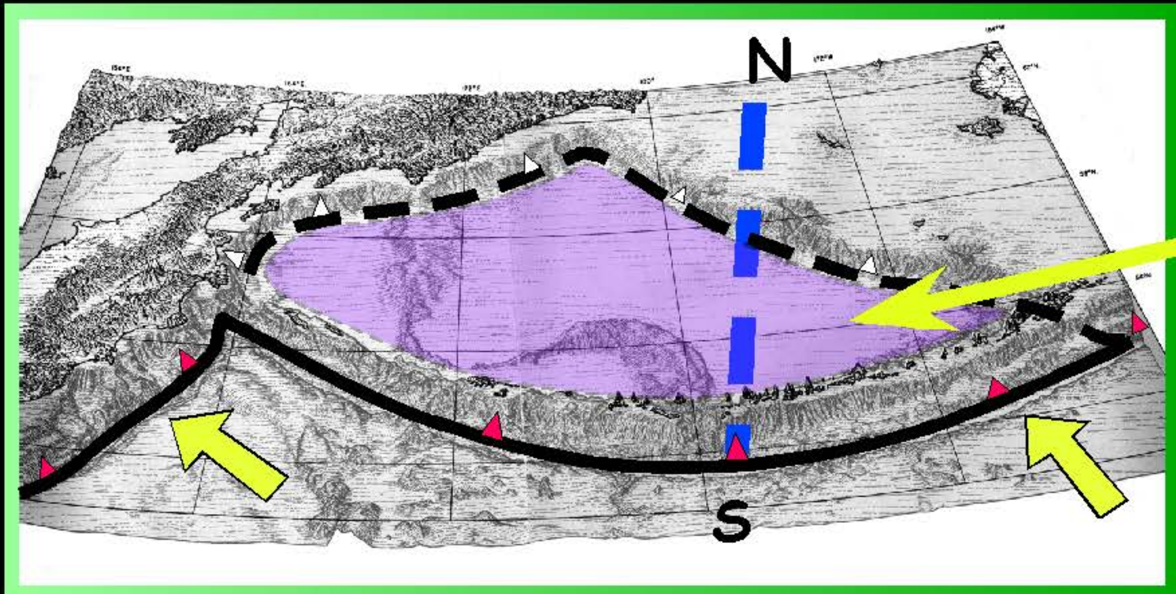
Copper et al., 1991 (Tectonics)



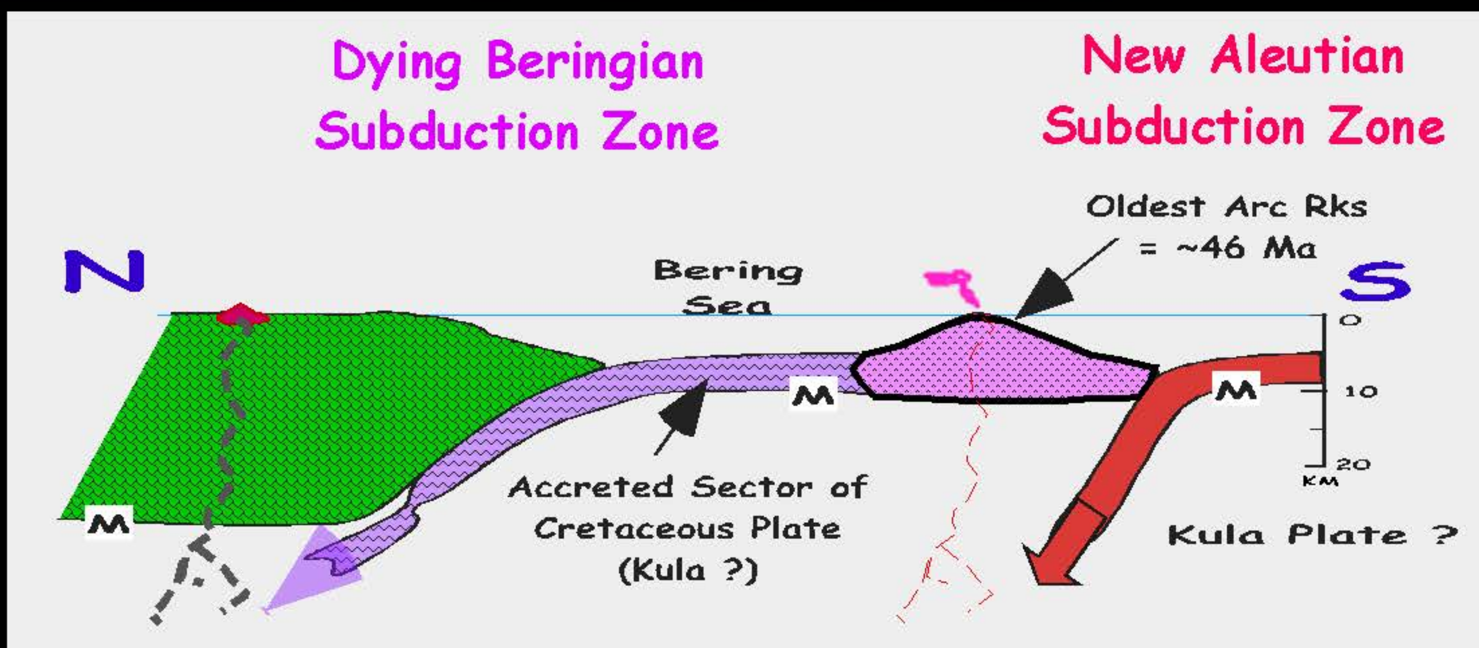
The Oldest Known Arc Volcanic Rocks are Mid-Eocene,~46 Ma, Arc Massif Formed In-Place (Paleomag) off Western Tip of the Alaska Peninsula

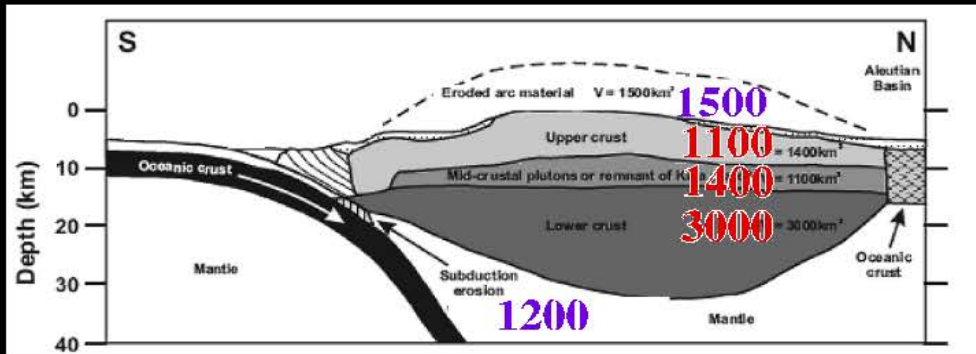
The Late Cretaceous-Earliest Tertiary, a Reasonable Pre-Aleutian Arc Reconstruction of the North Pacific and North Pacific Rim





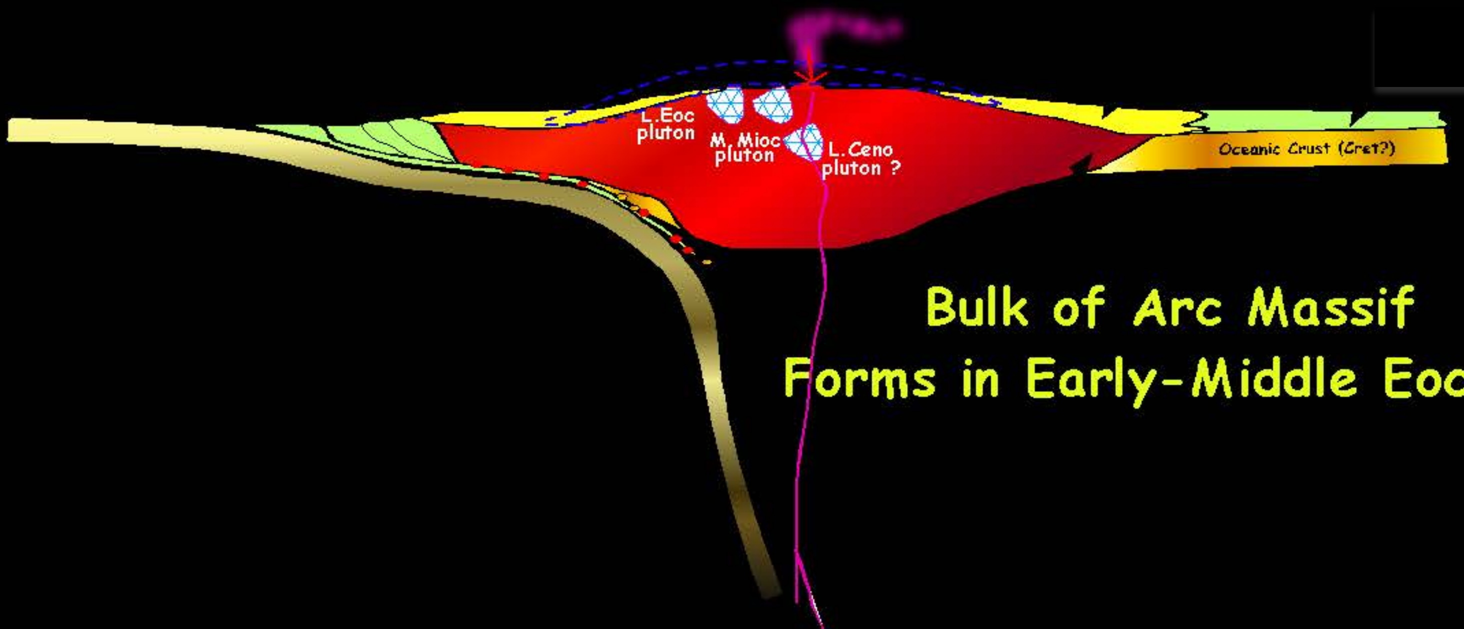
Deep Water Bering Sea Basin was the NW Corner of the Pacific Until Sometime in the Early Eocene





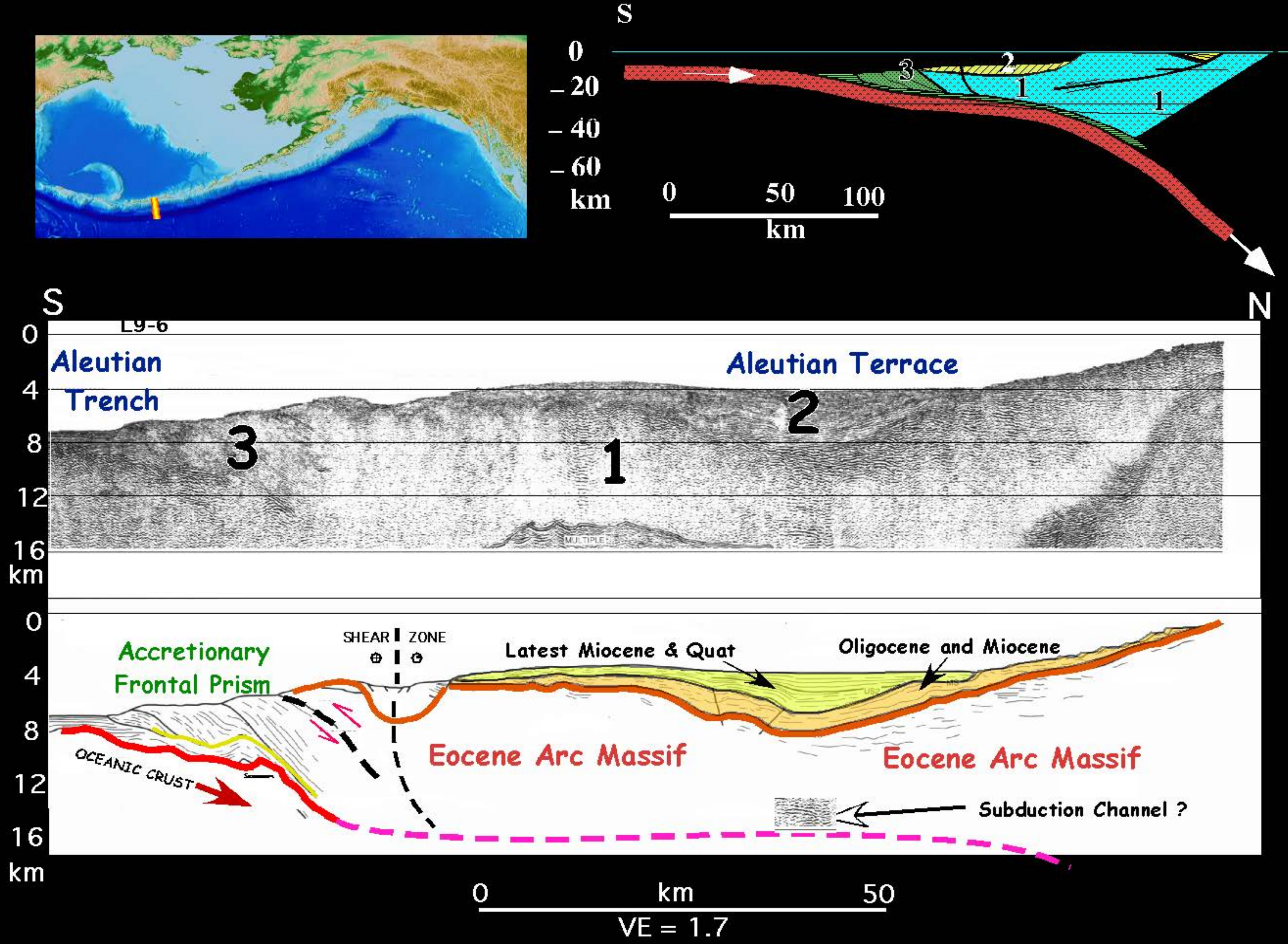
Jicha et al., 2006 (Geology)

Long-term (~50 Myr) Growth Rate Has Been 150-200 km^3/Myr/km

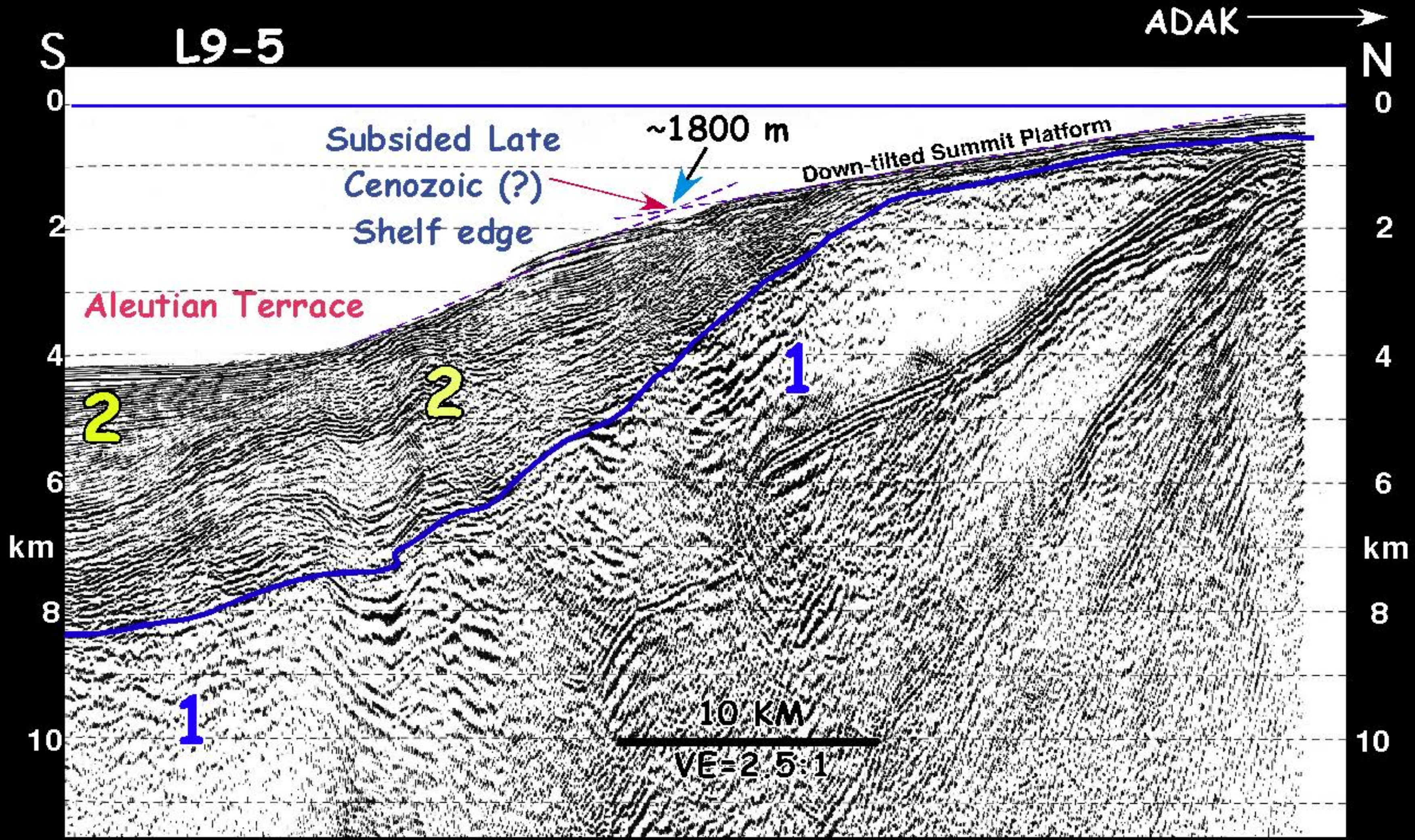


Bulk of Arc Massif Forms in Early-Middle Eocene

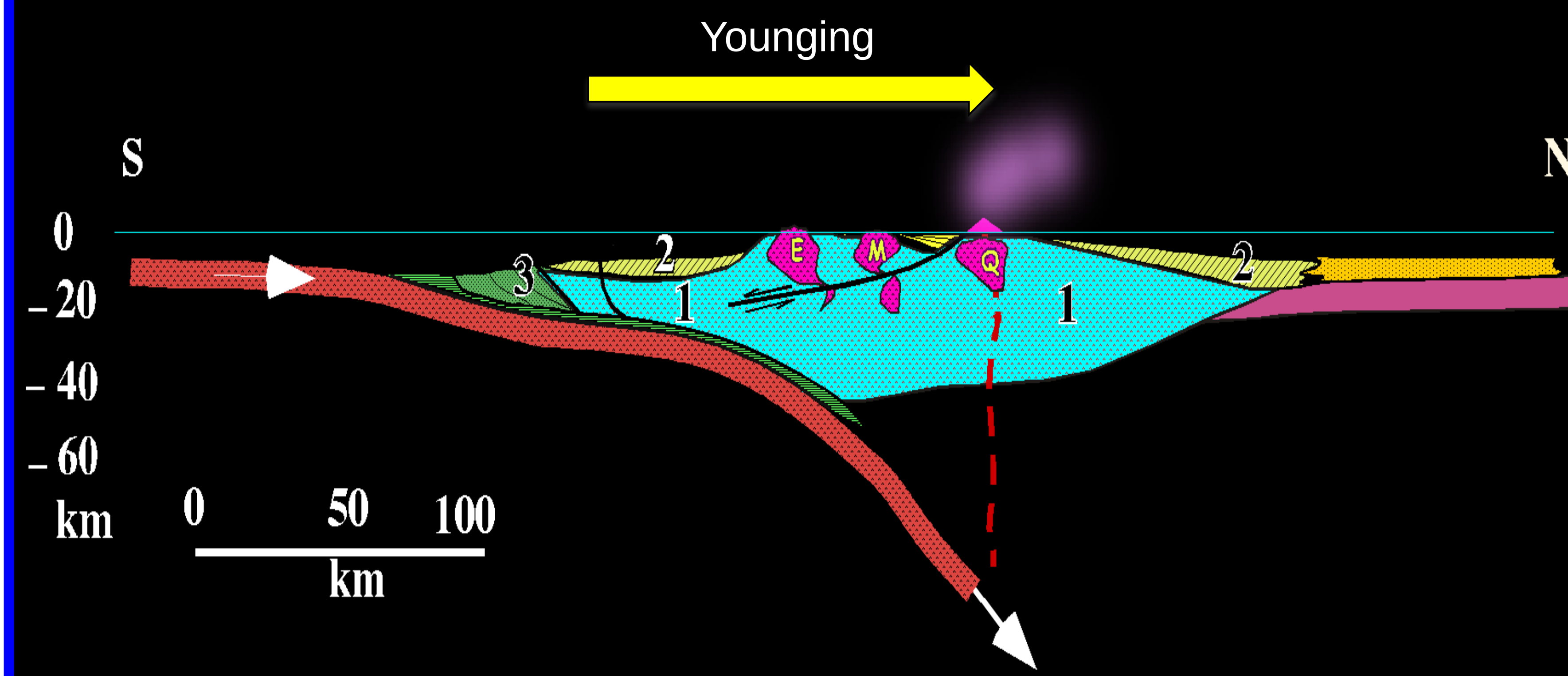
1st 10 Myr of Eocene Growth Occurred at ~500 km^3/Myr/km



S
0
– 20
– 40
– 60
km
3
2
1
1
0
50
100
km
N
S
N
L9-6
0
4
8
12
16
km
Aleutian
Trench
Aleutian Terrace
3
1
2
MULTIPLE
0
4
8
12
16
km
Accretionary
Frontal Prism
SHEAR ZONE
Latest Miocene & Quat
Oligocene and Miocene
OCEANIC CRUST
Eocene Arc Massif
Eocene Arc Massif
Subduction Channel ?
0
km
50
VE = 1.7

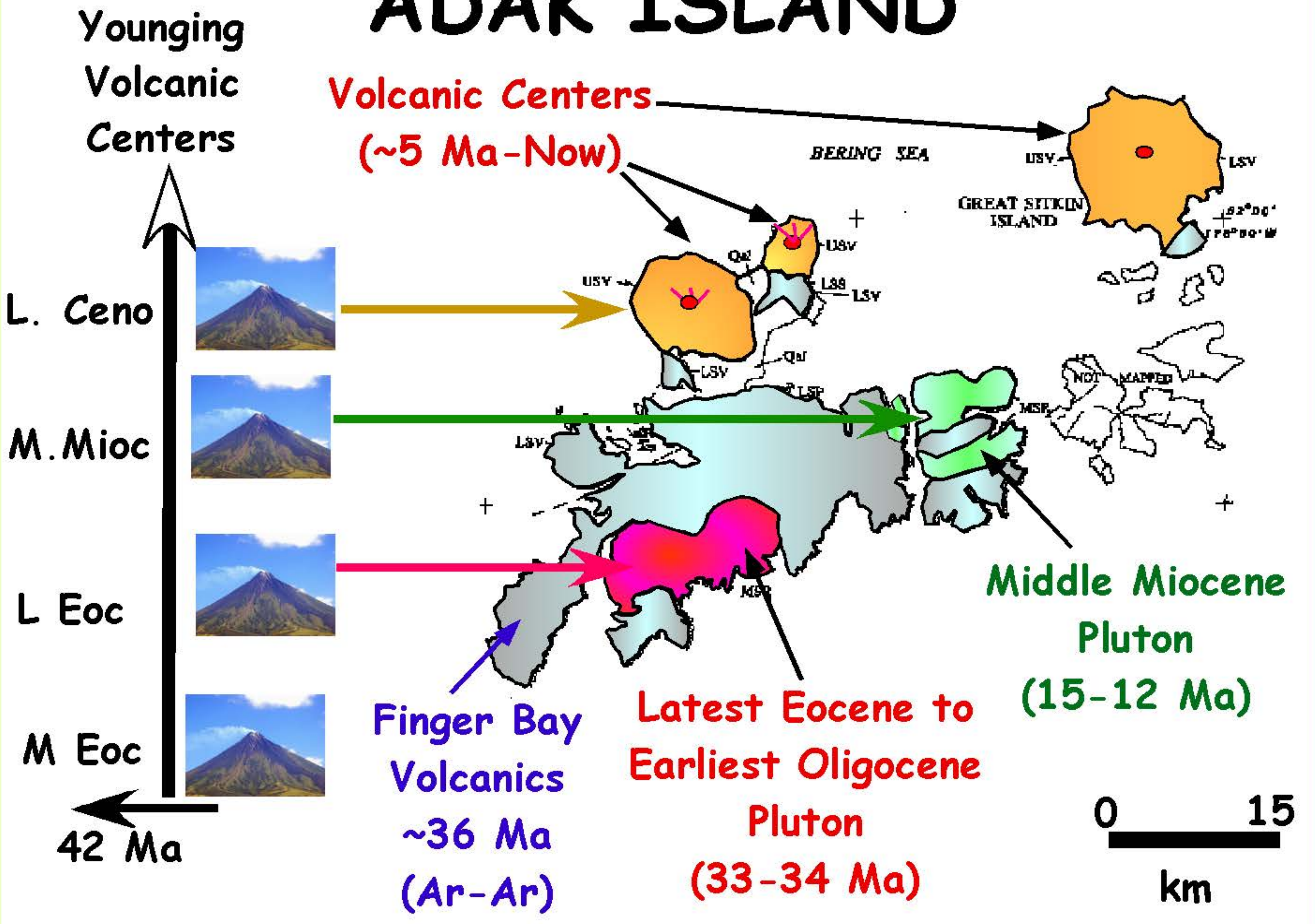


Similar to Alaska, the Aleutian Forearc Exhibits Evidence of Subsidence

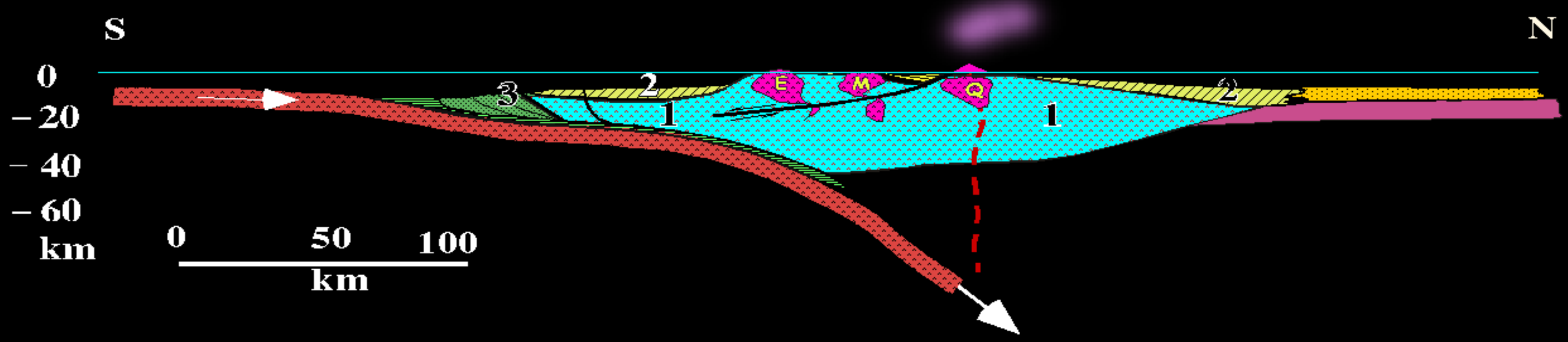


Younging
S
N
0
– 20
– 40
– 60
km
0
50
100
km
3
2
1
E
M
Q
1
2

ADAK ISLAND



Younging Volcanic Centers
L. Ceno
M.Mioc
L Eoc
M Eoc
42 Ma
Volcanic Centers (~5 Ma-Now)
BERING SEA
GREAT SITKIN ISLAND
USV
LSV
NOT MAPPED
Finger Bay Volcanics ~36 Ma (Ar-Ar)
Latest Eocene to Earliest Oligocene Pluton (33-34 Ma)
Middle Miocene Pluton (15-12 Ma)
0
15
km



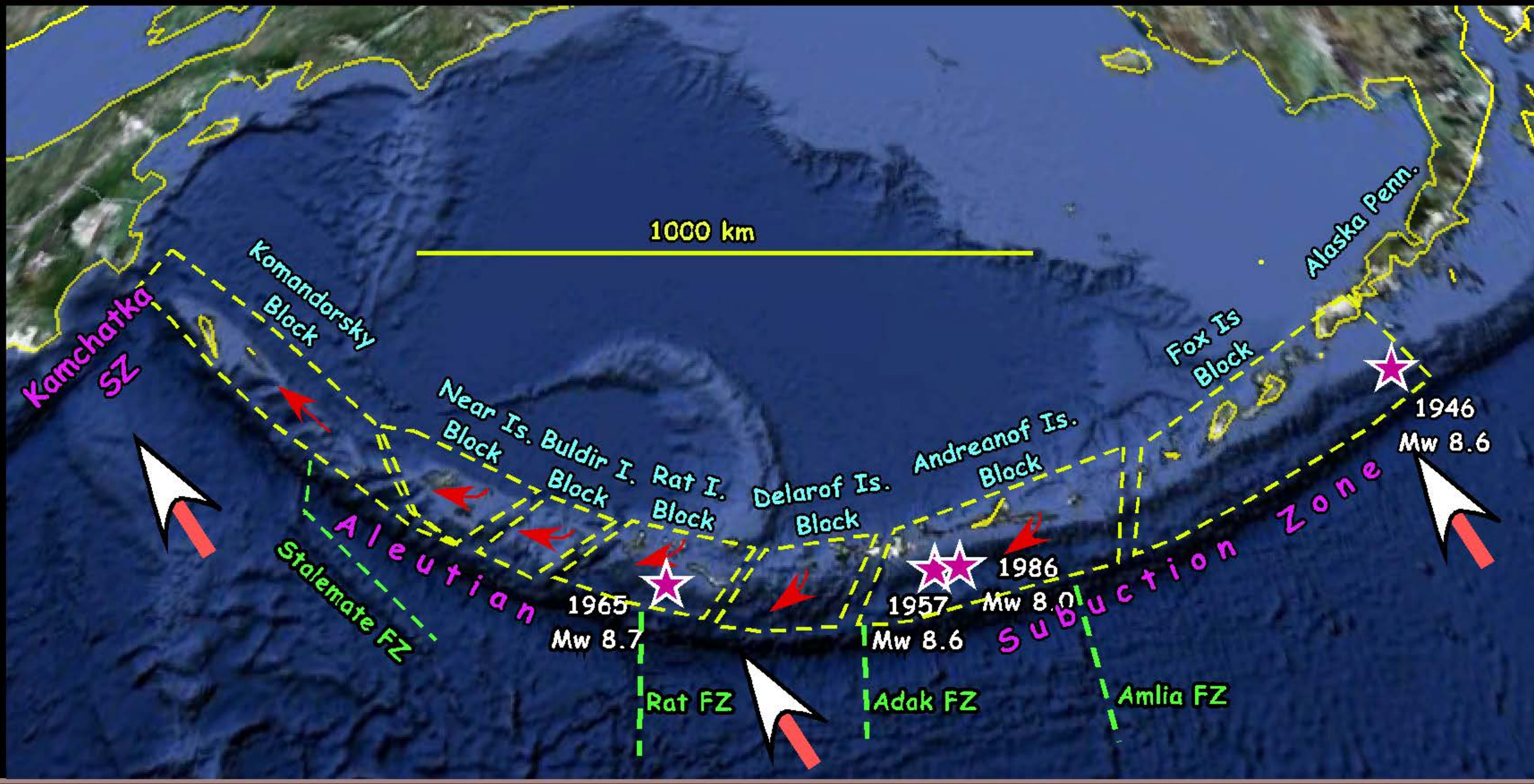
OBSERVATIONS

The Aleutian Arc Massif and Subduction Zone Formed in the Early Tertiary

It's Magmatic Growth Rates Has Been Prodigious (~200 km3/Myr/km)
With Respect to Continental Arc Productivity (~30 km3/Myr/km)

WONDERMENTS

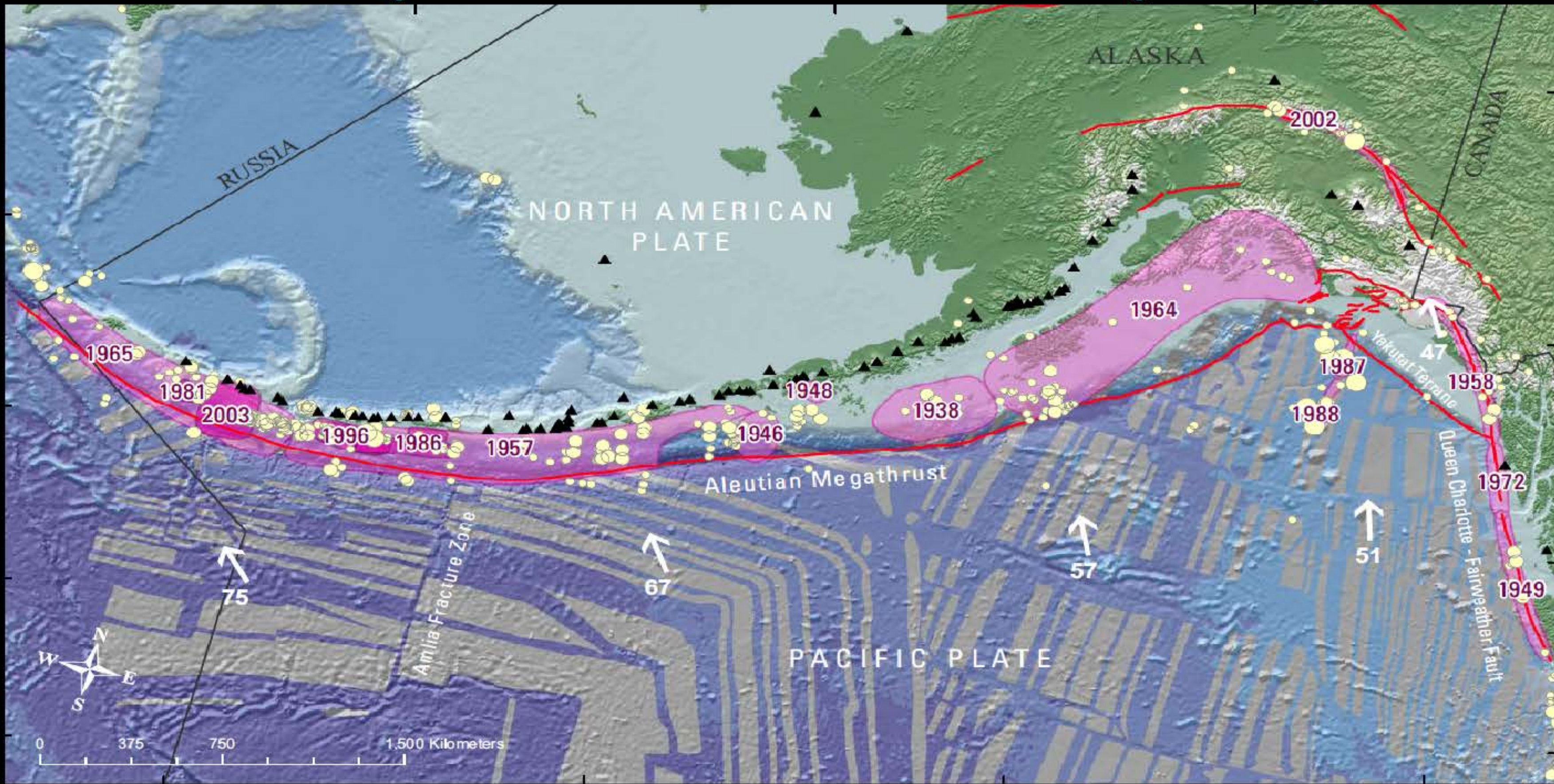
- What Circumstances Caused the Aleutian Subduction Zone and Arc to in Form:
  In-place,
  in an Offshore Position,
  and Aligned with the Alaska Peninsula?
- When, exactly, did the Aleutian Subduction Zone Form?
- Is Formation Temporally Linked to Other Tectonic Happenings,
  i.e., Hawaii-Emperor Bend, birthing of IBM System?
- Why Was Initial magmatic Productivity So Voluminous?



Present Plate Boundary Setting is Fragmenting the Arc Massif into CW Rotating Blocks Moving Westward Toward and Into the Kamchatka Subduction Zone

Fragmentation Appears to Have Accelerated in Late Miocene—RIGHT & WHY?

Forecasting the Future Occurrence of Great and Giant Megathrust Ruptures

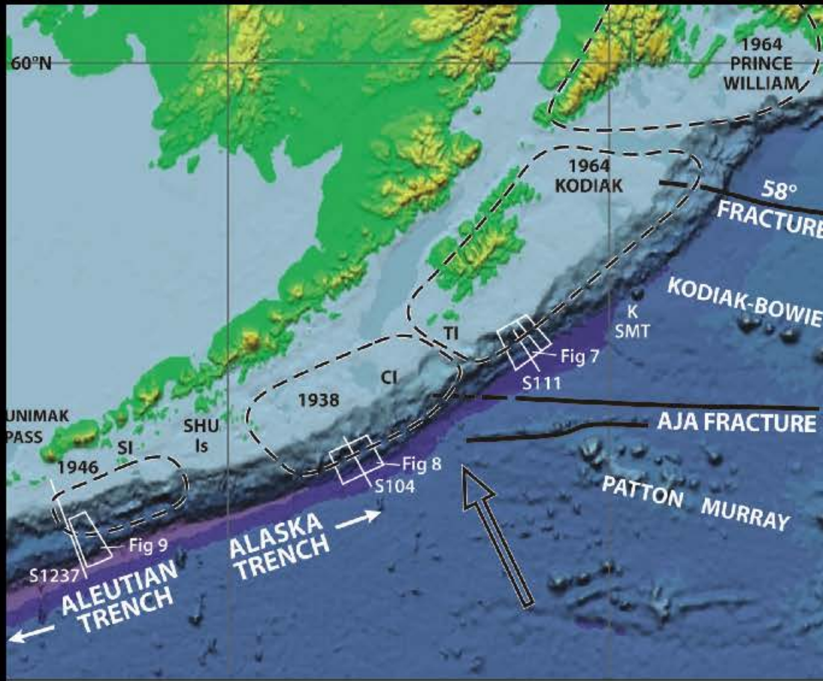


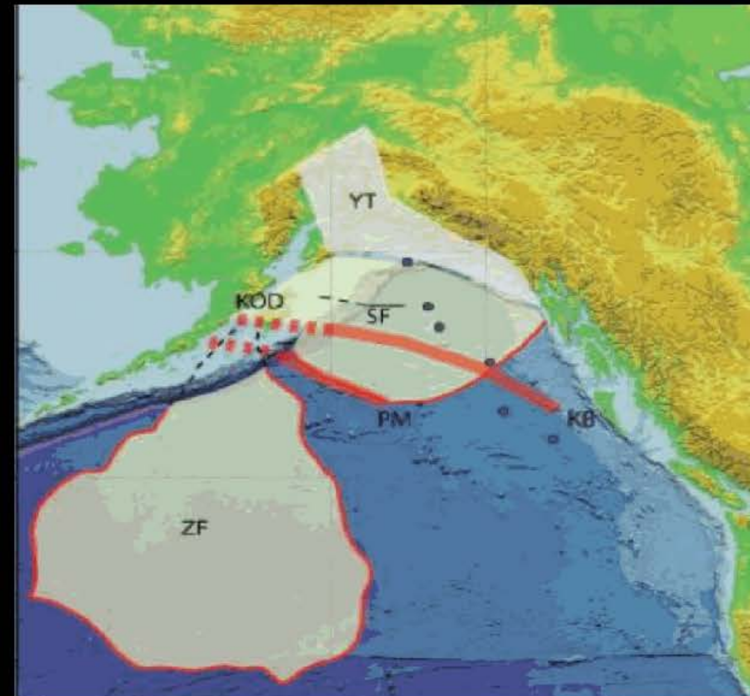
The Aleutian-Alaska Megathrust is Prone to Break in Great (≥Mw8.0) and Giant (≥Mw8.5) Megathrust Earthquakes Characterized by Lengthy (>300 km) Ruptures:

WHY?

WHERE?

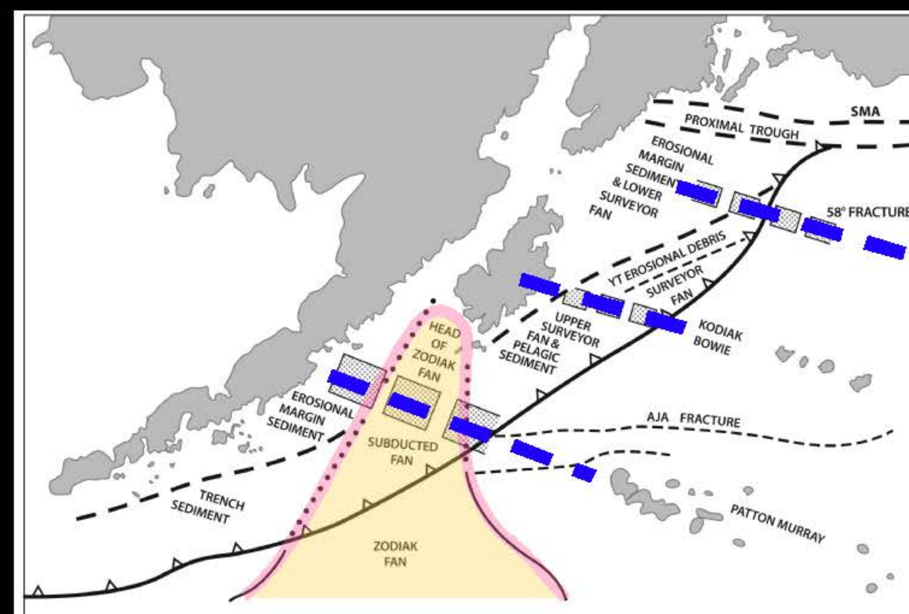
HOW OFTEN?



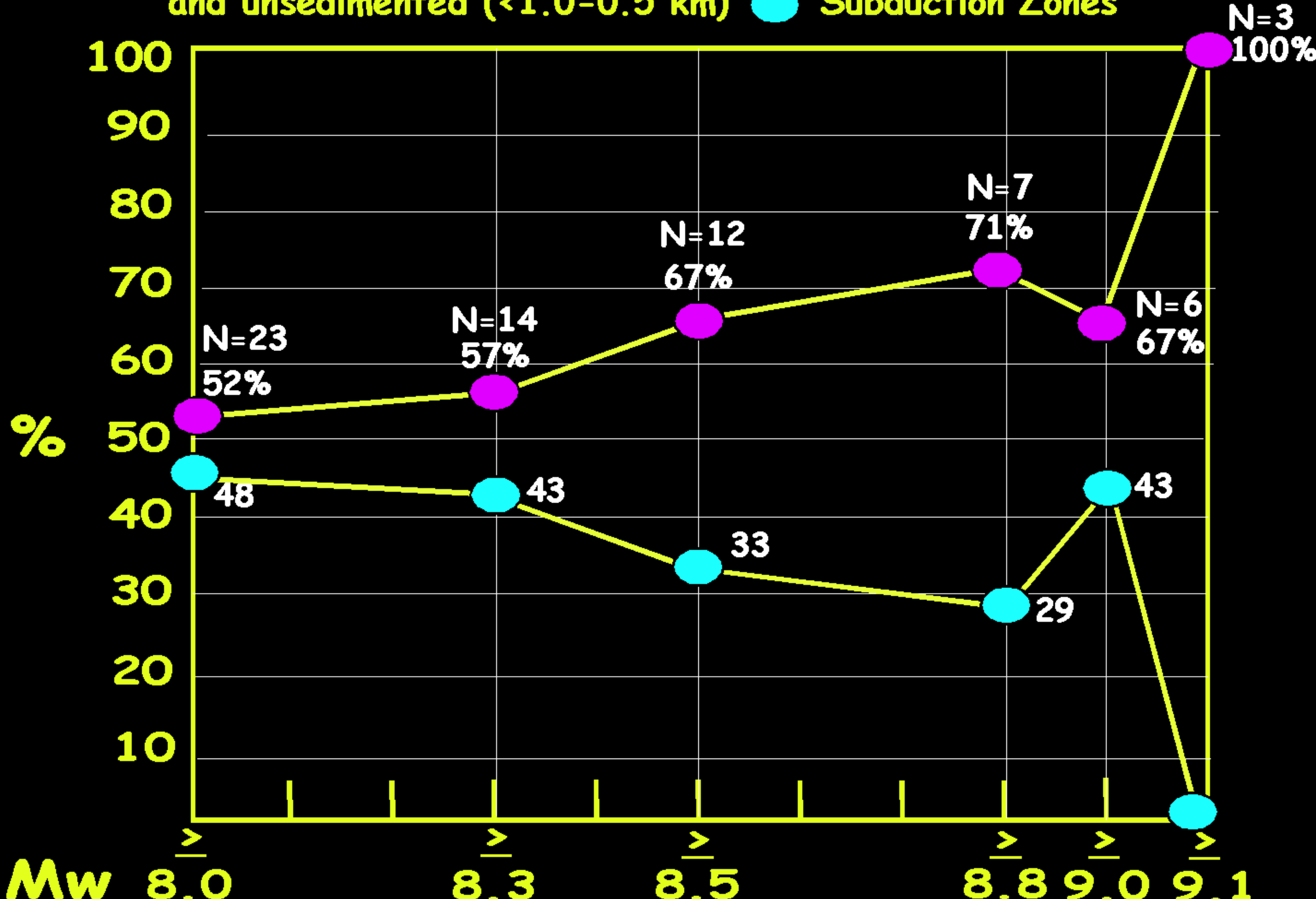


Alaskan Rupture Segments Can Be Linked to Underthrusting Sea Floor Relief and Sediment Patches

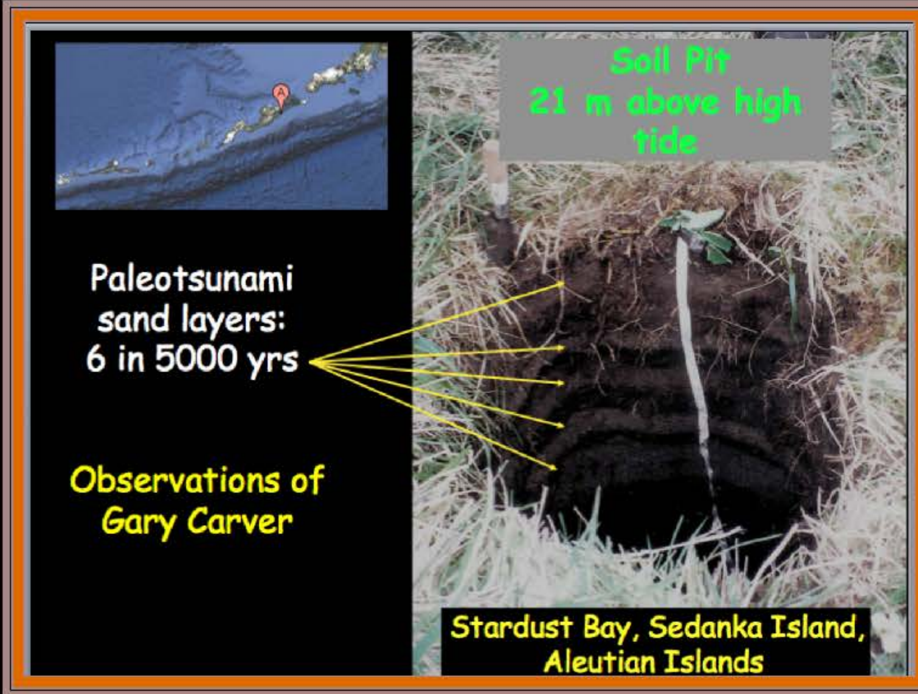
Von Huene et al., in press (Geosphere, Normark Spec Vol)

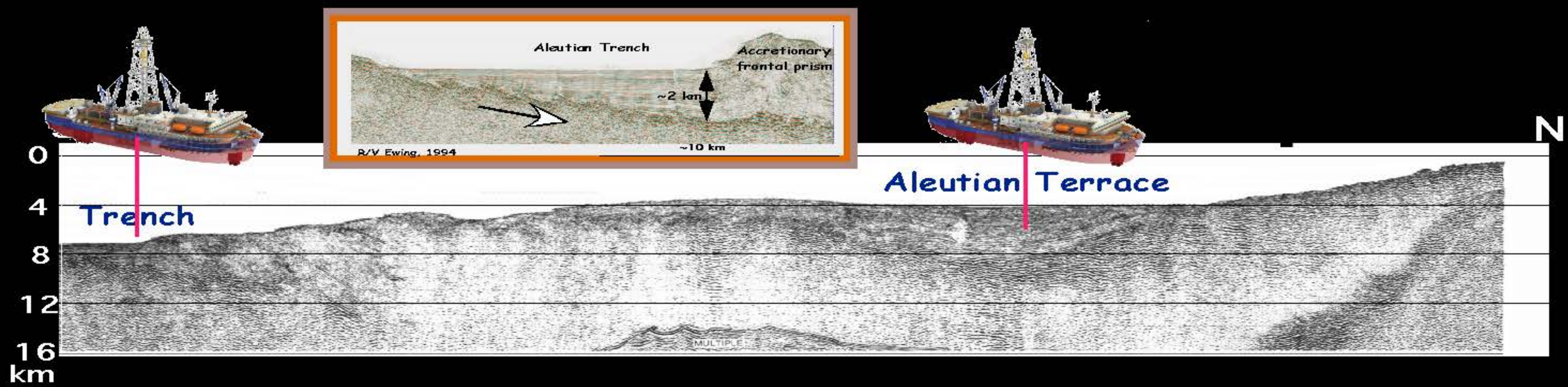


Percent of Instrumentally Recorded, Plus Cascadia (1700), Great and Giant Mw Eqs (N=23) that Ruptured Along Sedimented (>1.0-1.5 km) and unsedimented (<1.0-0.5 km) Subduction Zones

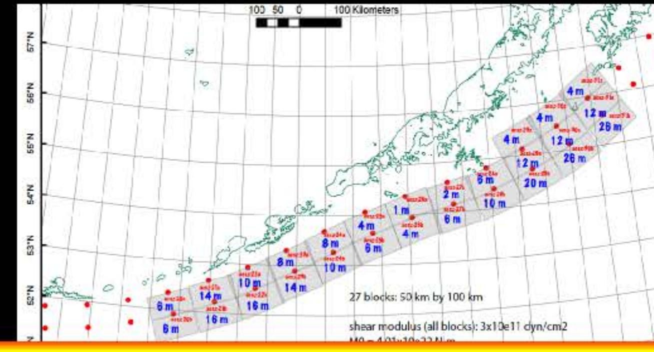


Coastal Area Trenching and Offshore Coring and Drilling is Needed to Recover the Holocene and Older Record of Large Strain-Releasing Events and Tsunami Generation





Probablistic Forecasting of the Likelihood of a Future Great or Giant Megathrust Requires Segment-Specific Knowledge of Paleoseismicity.



Visit Holly Ryan's Poster That Explores the likely Tsunami Consequence of a Fox-Island Mw9.0. Virtually No Knowledge Exists About the Seismic History of This Sector of the Aleutian-Alaska Megathrust