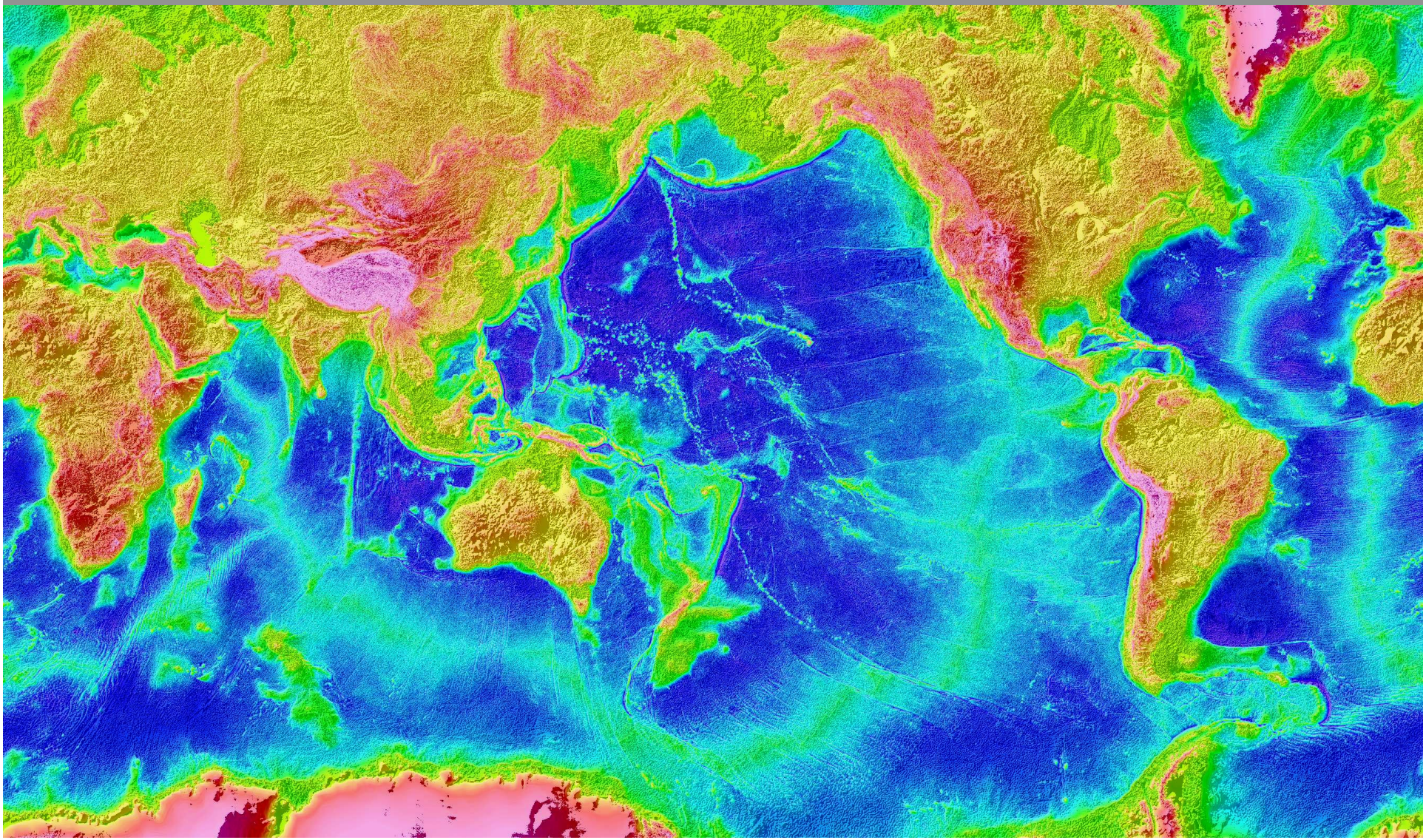
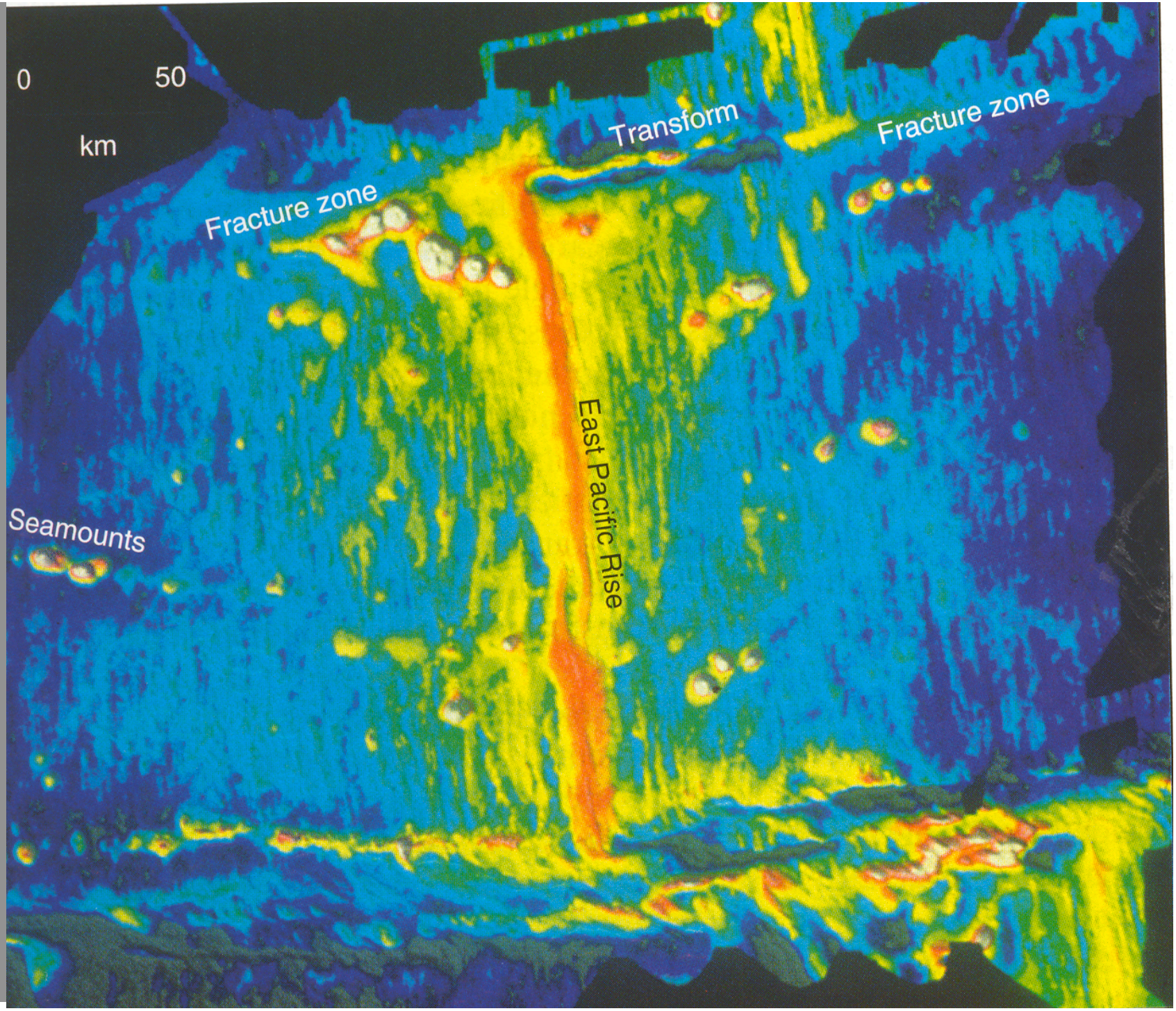
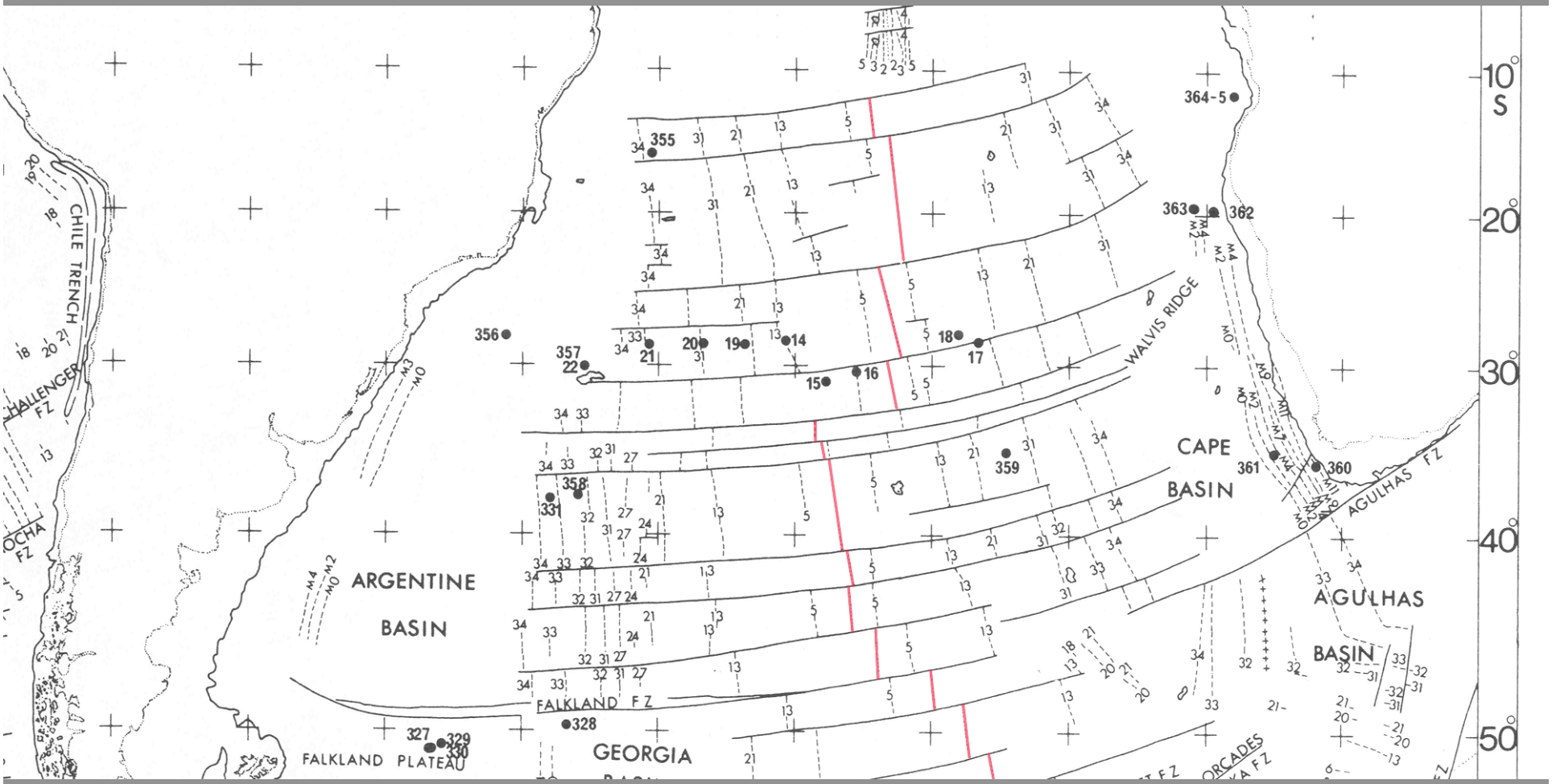
Global topography & bathymetry



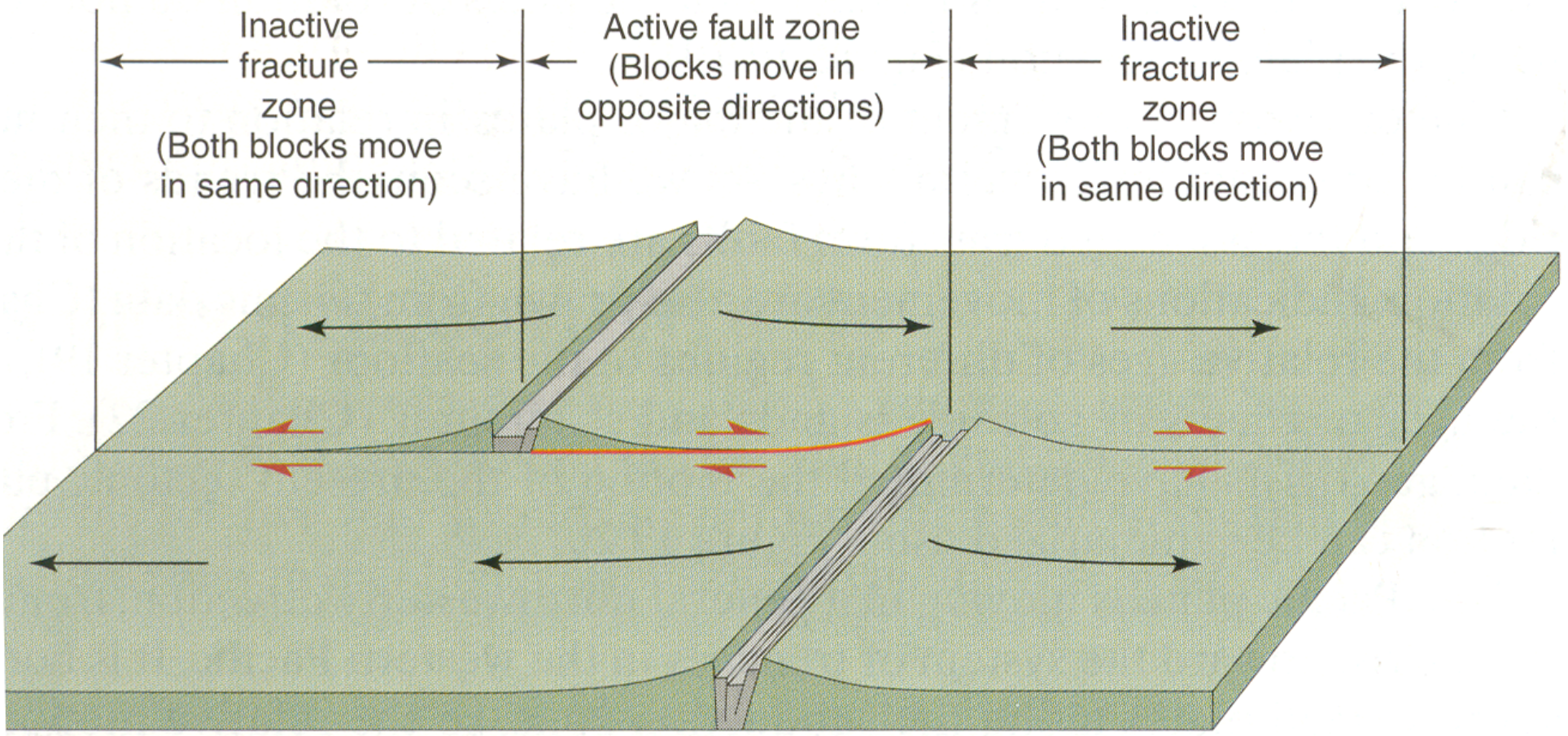

0
50
km
Transform
Fracture zone
Fracture zone
East Pacific Rise
Seamounts

both ridges and magnetic anomalies are offset by transforms



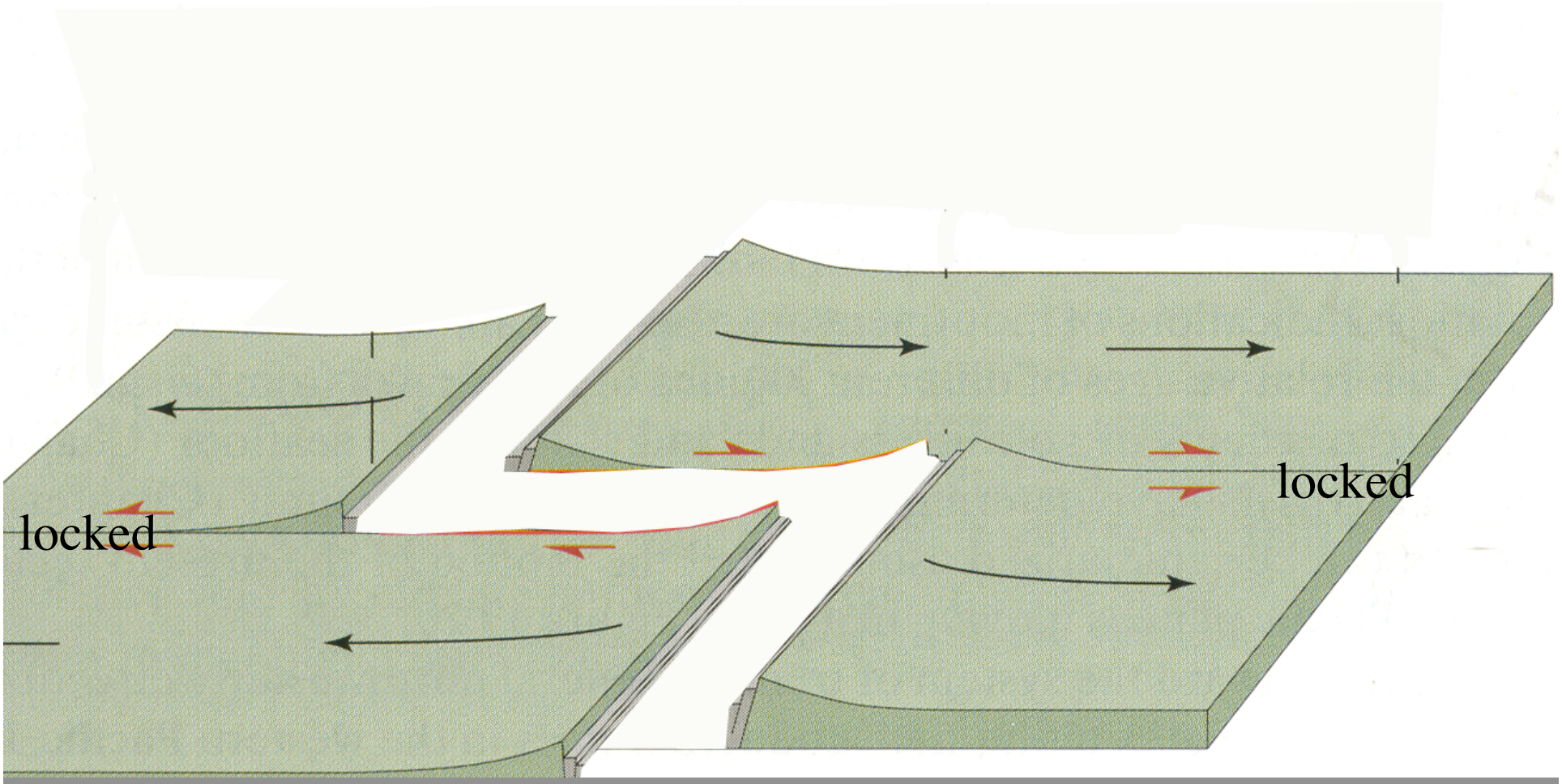
offset remains constant for long periods of time

ridge-ridge transforms
are only active between ridge offsets

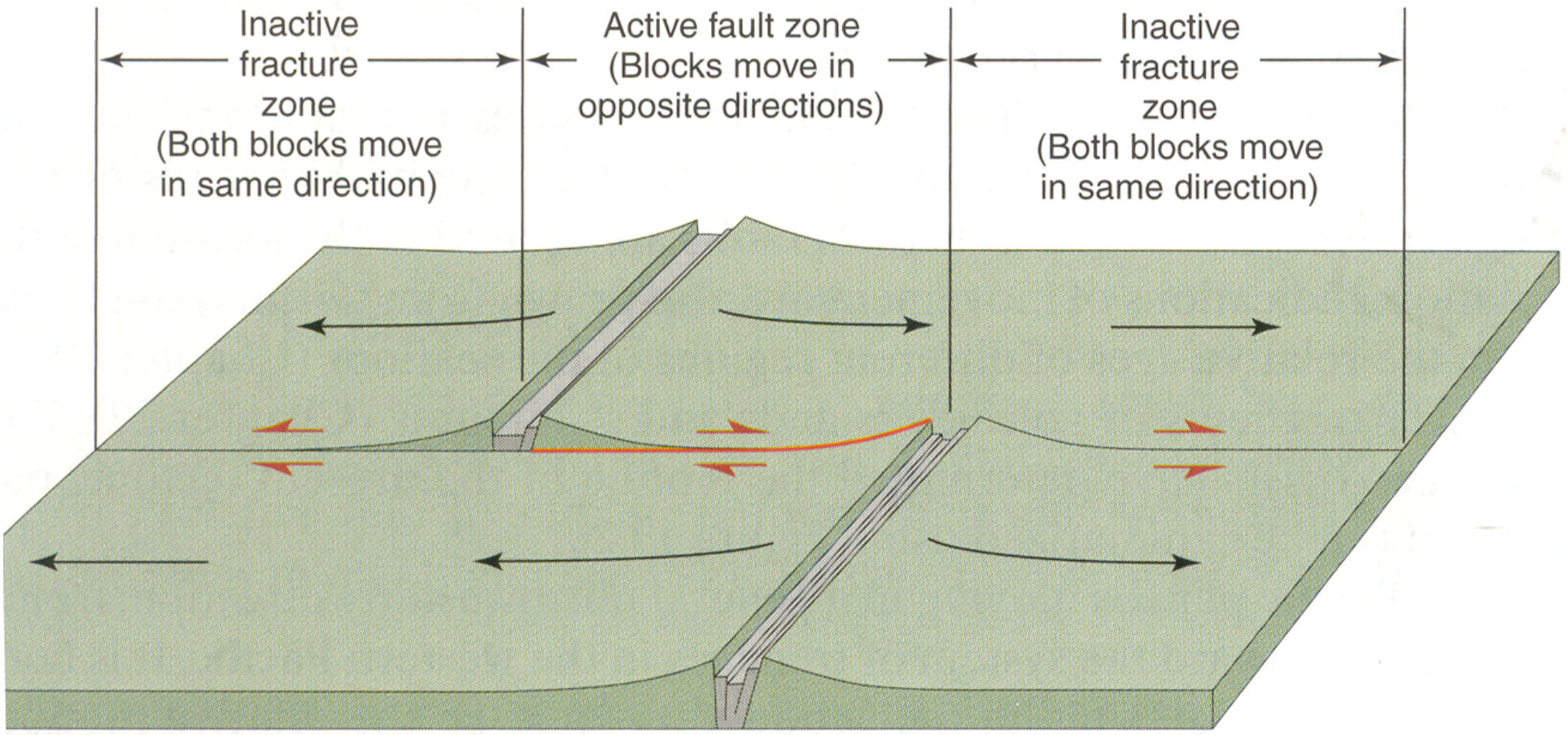


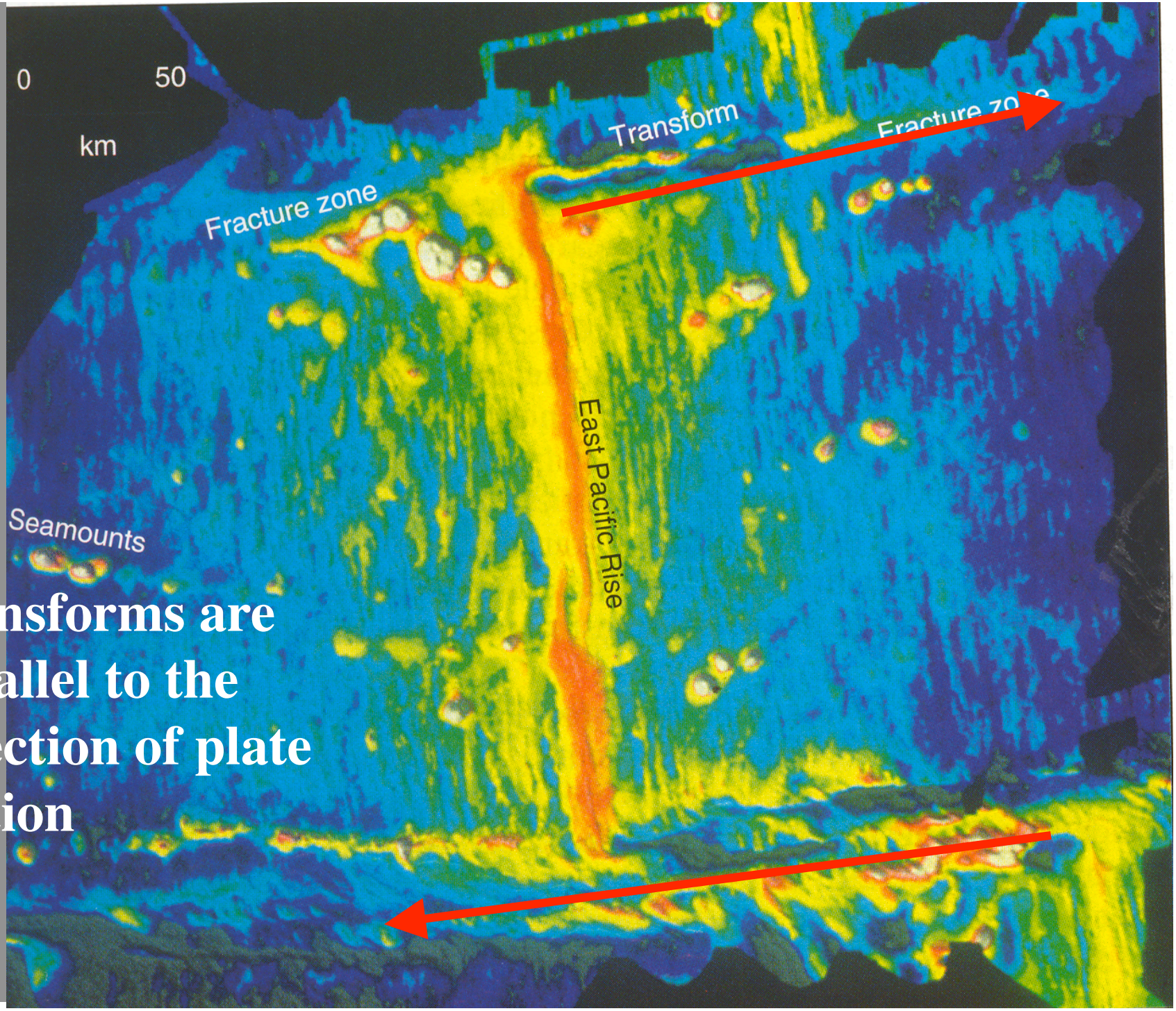
fracture zones are extinct transforms

ridge offset across a ridge-ridge transform remains constant over time



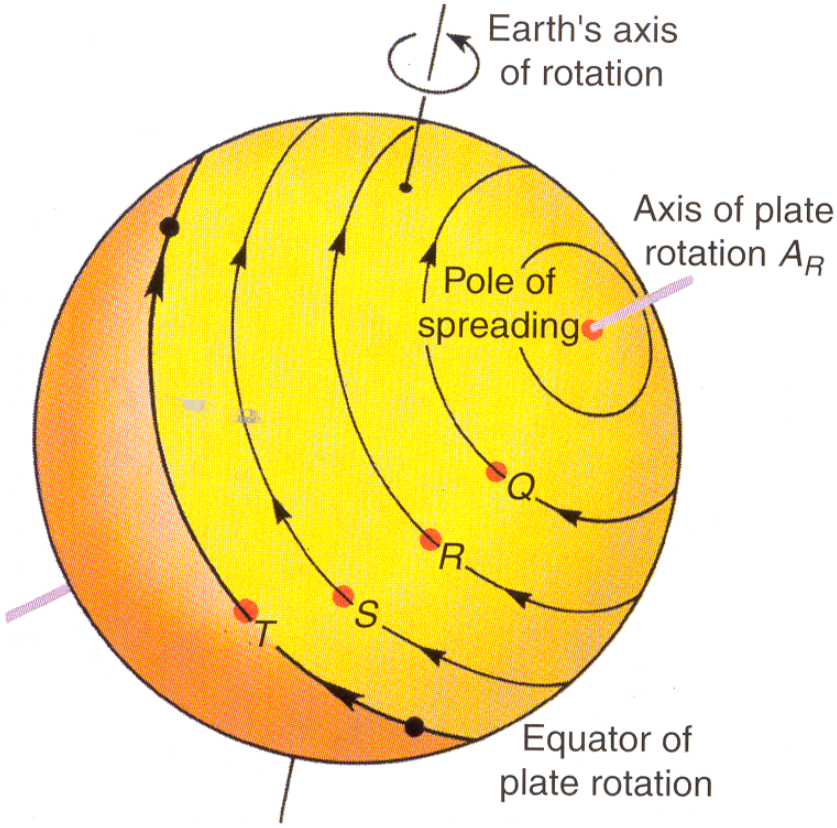
Different age lithosphere is juxtaposed across a fracture zone

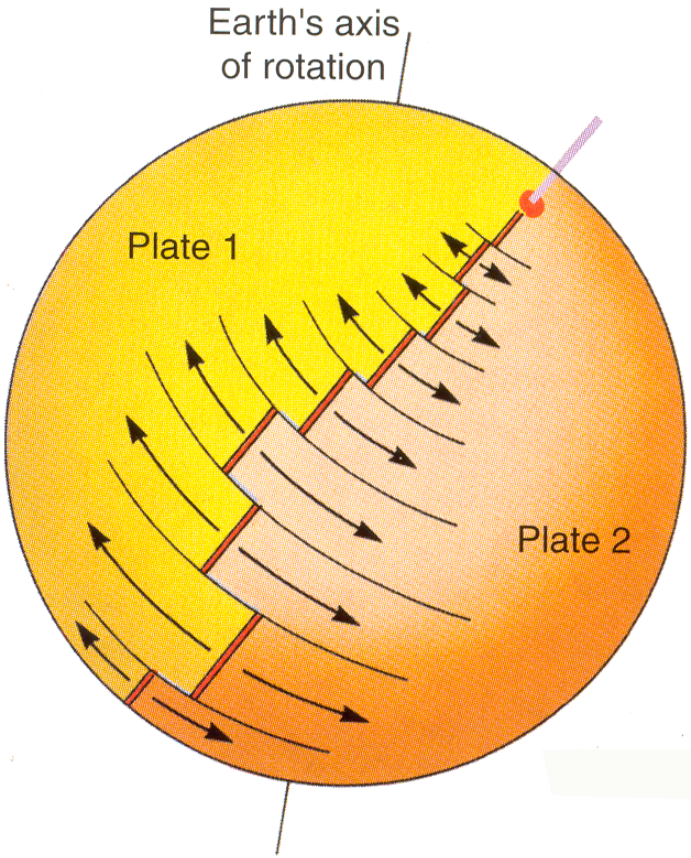




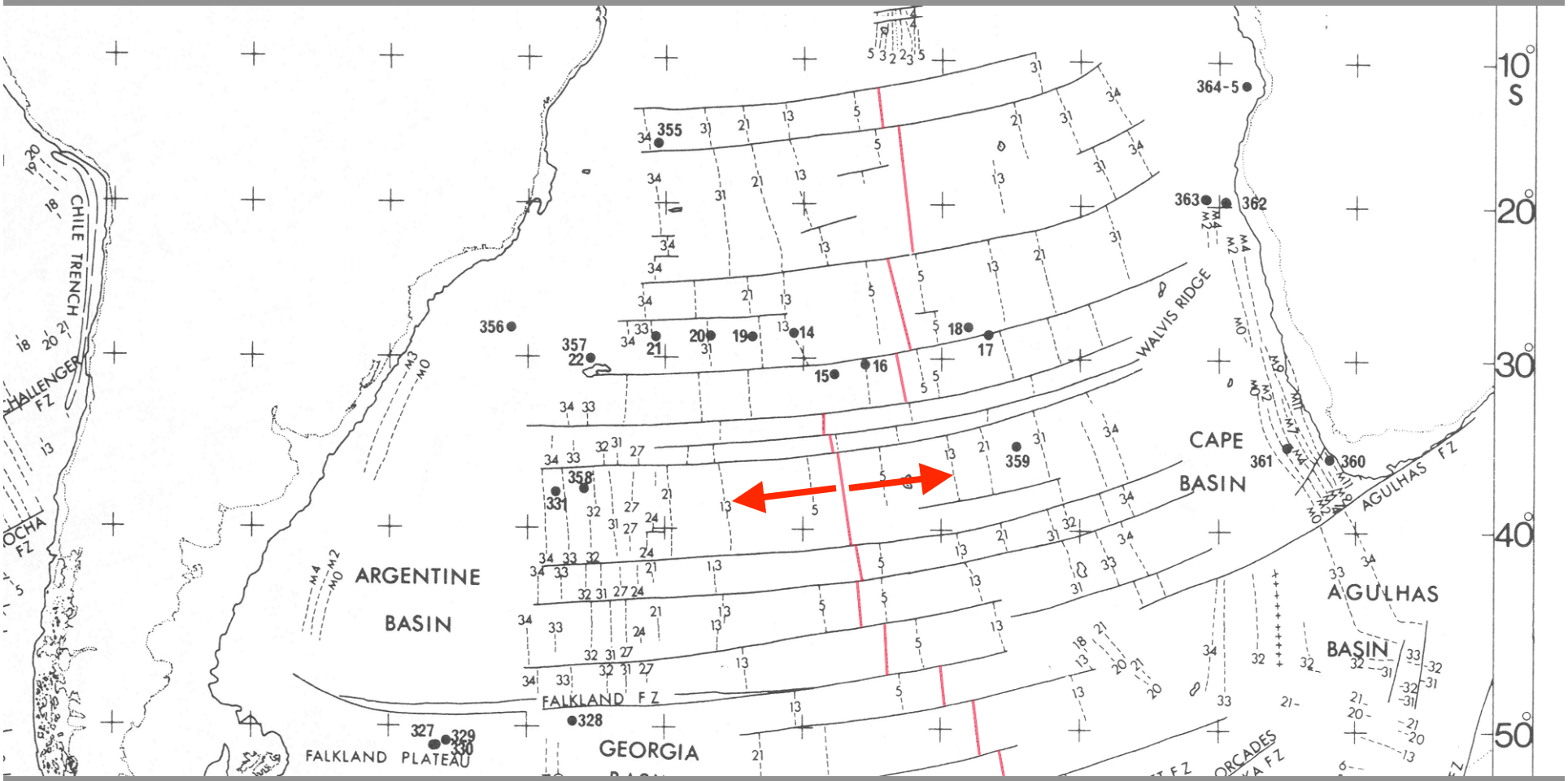
Transforms are parallel to the direction of plate motion

On a spherical earth, transforms are curved. They are "small" circles- similar to latitude lines



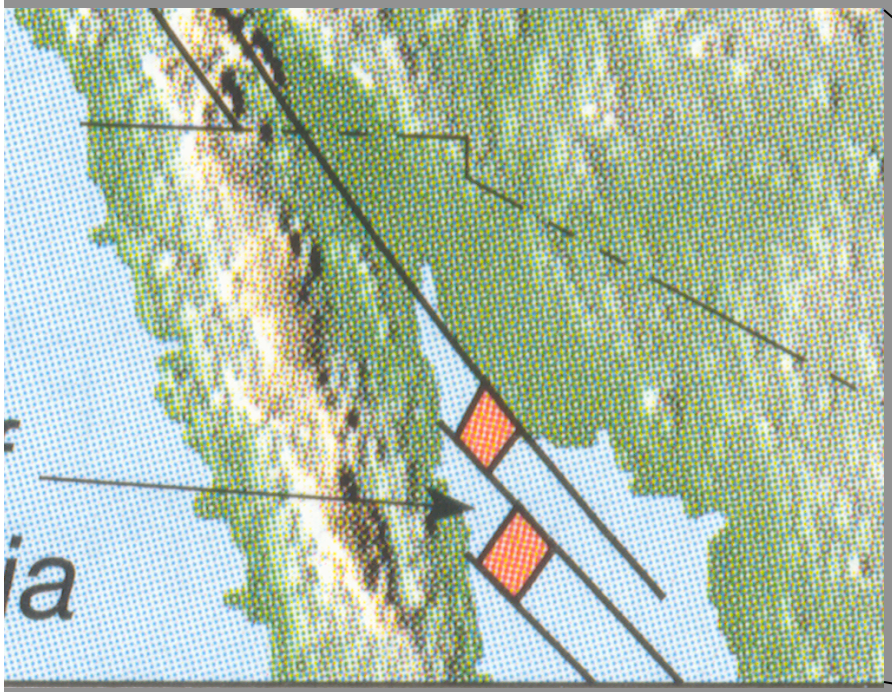


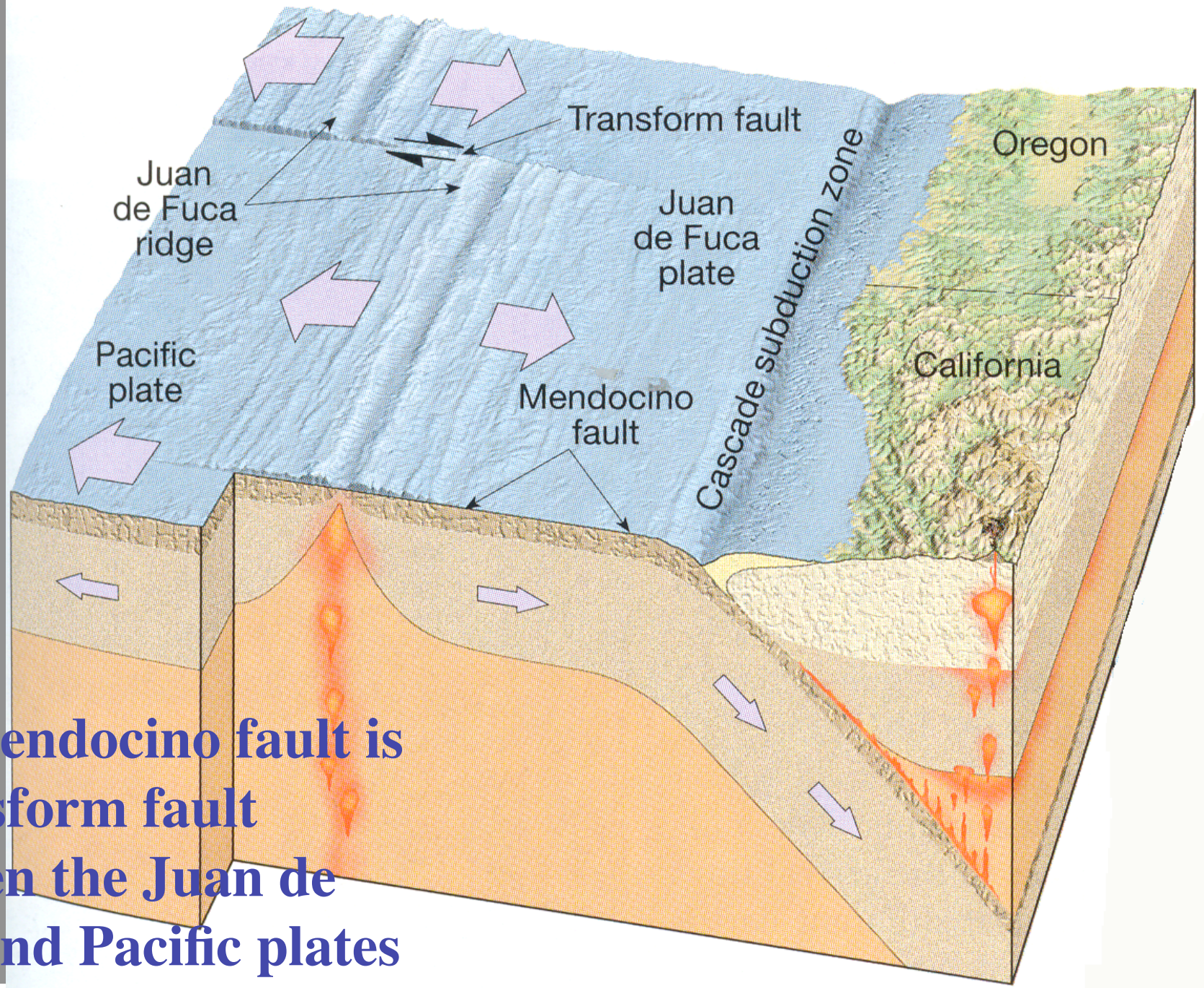
transforms ARE curved



pole of rotation (location) determined from transform curvature

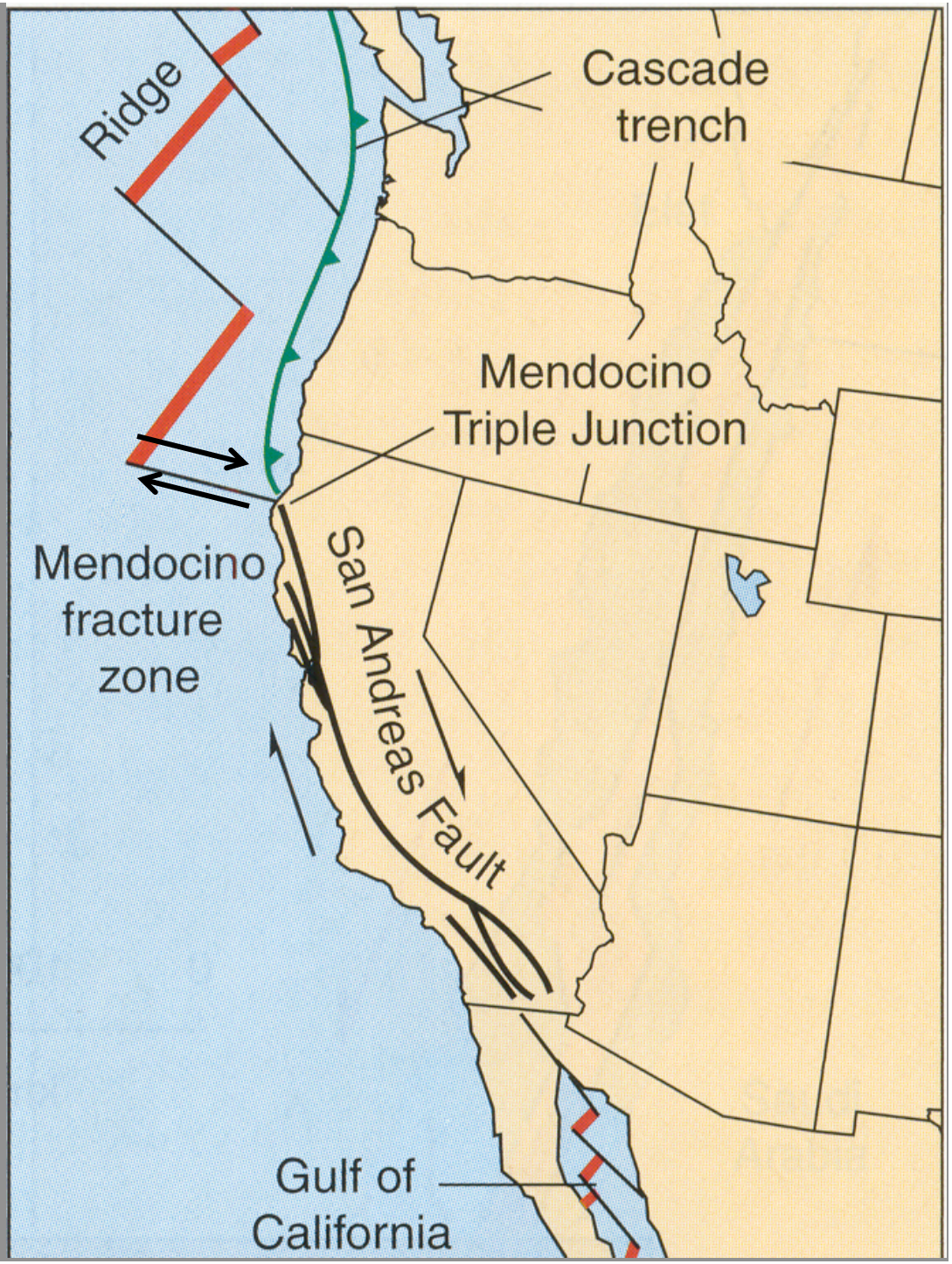
The San Andreas fault is a transform fault between the North American and Pacific plates





The Mendocino fault is a transform fault between the Juan de Fuca and Pacific plates

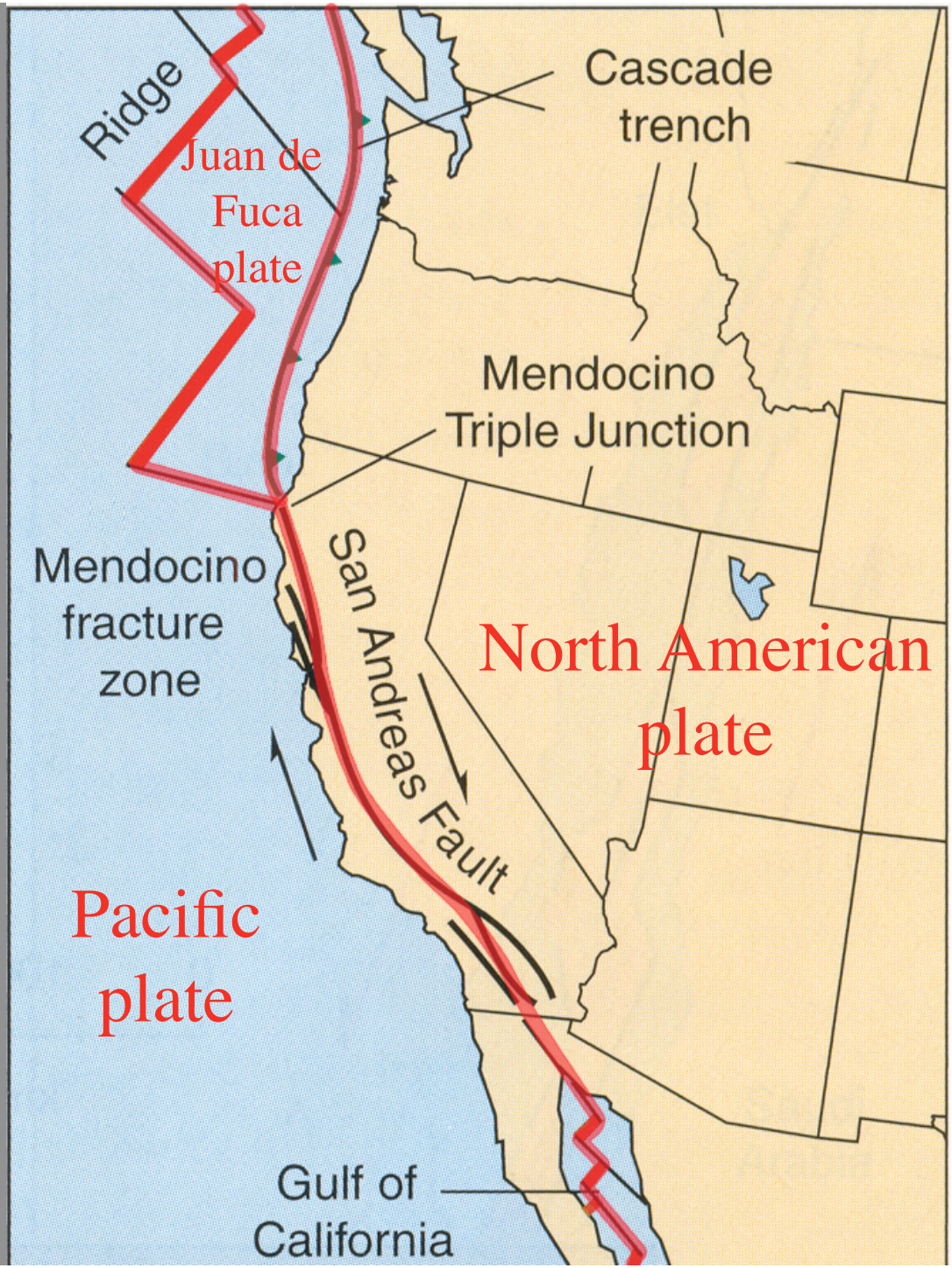
How does the Pacific plate "turn the corner" at the Mendocino triple junction?

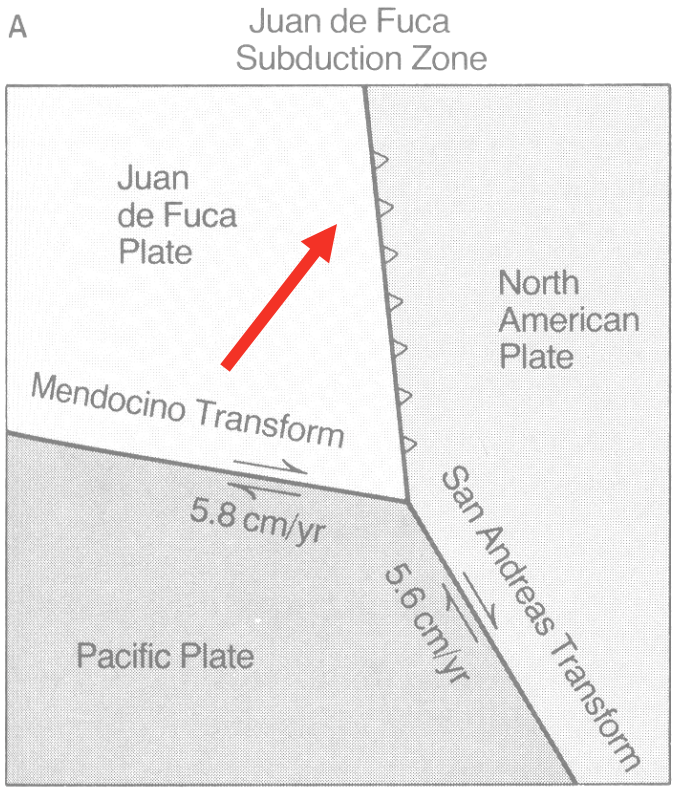


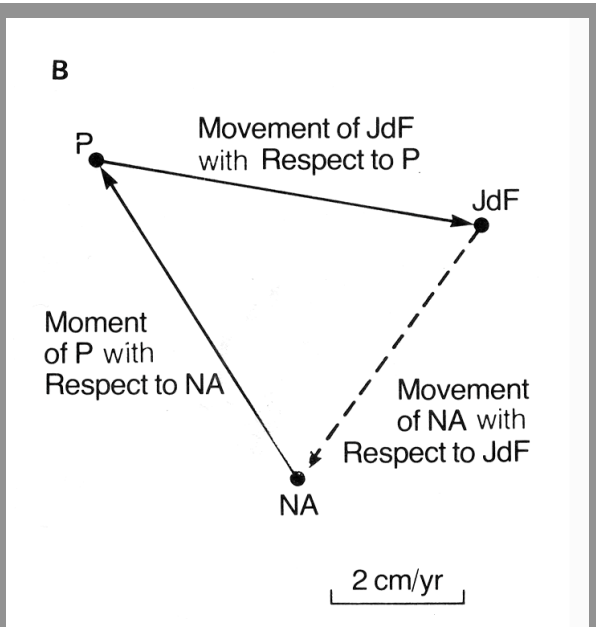
Three plates:

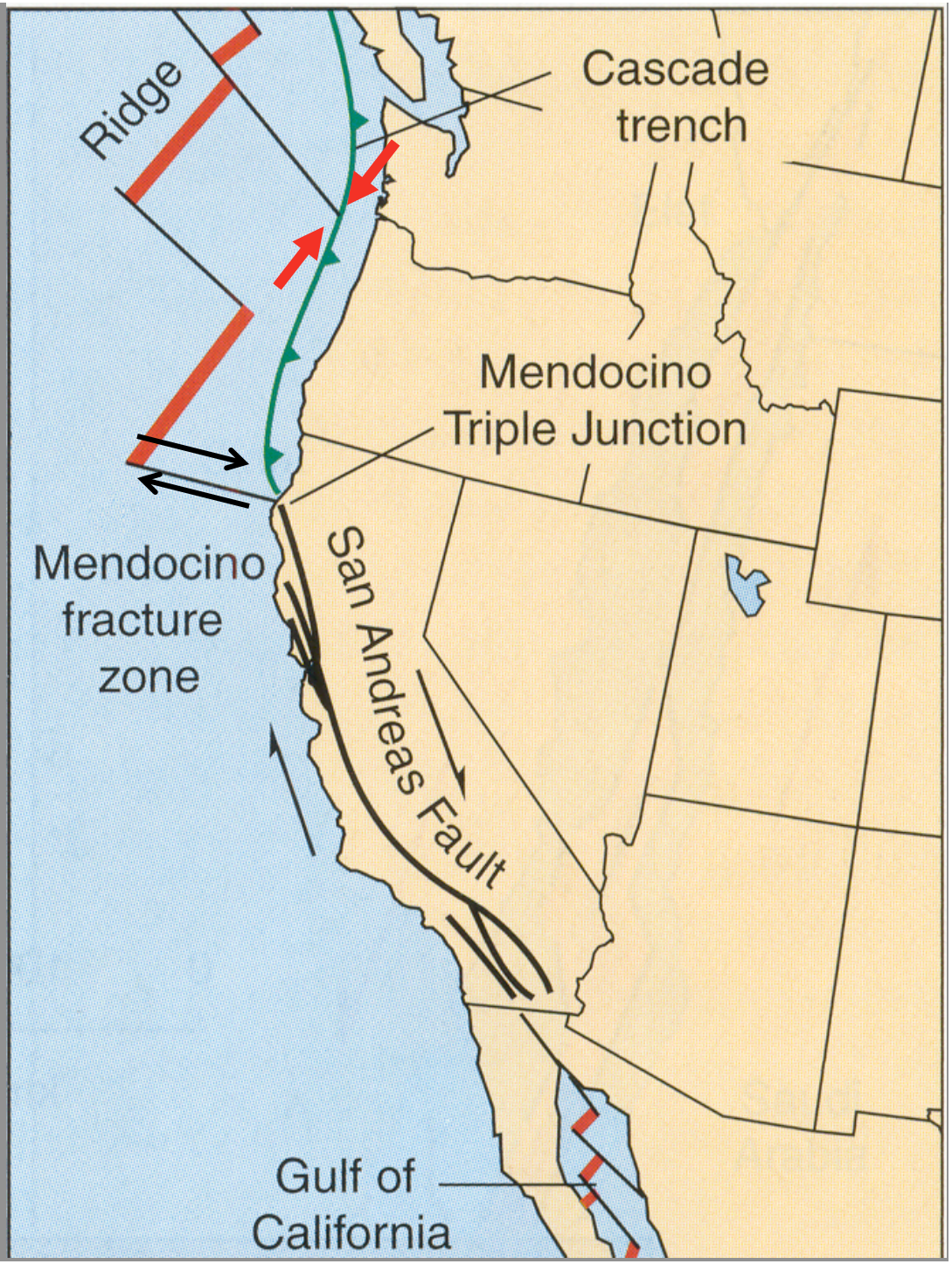
- **Pacific**
- **North American**
- **Juan de Fuca**

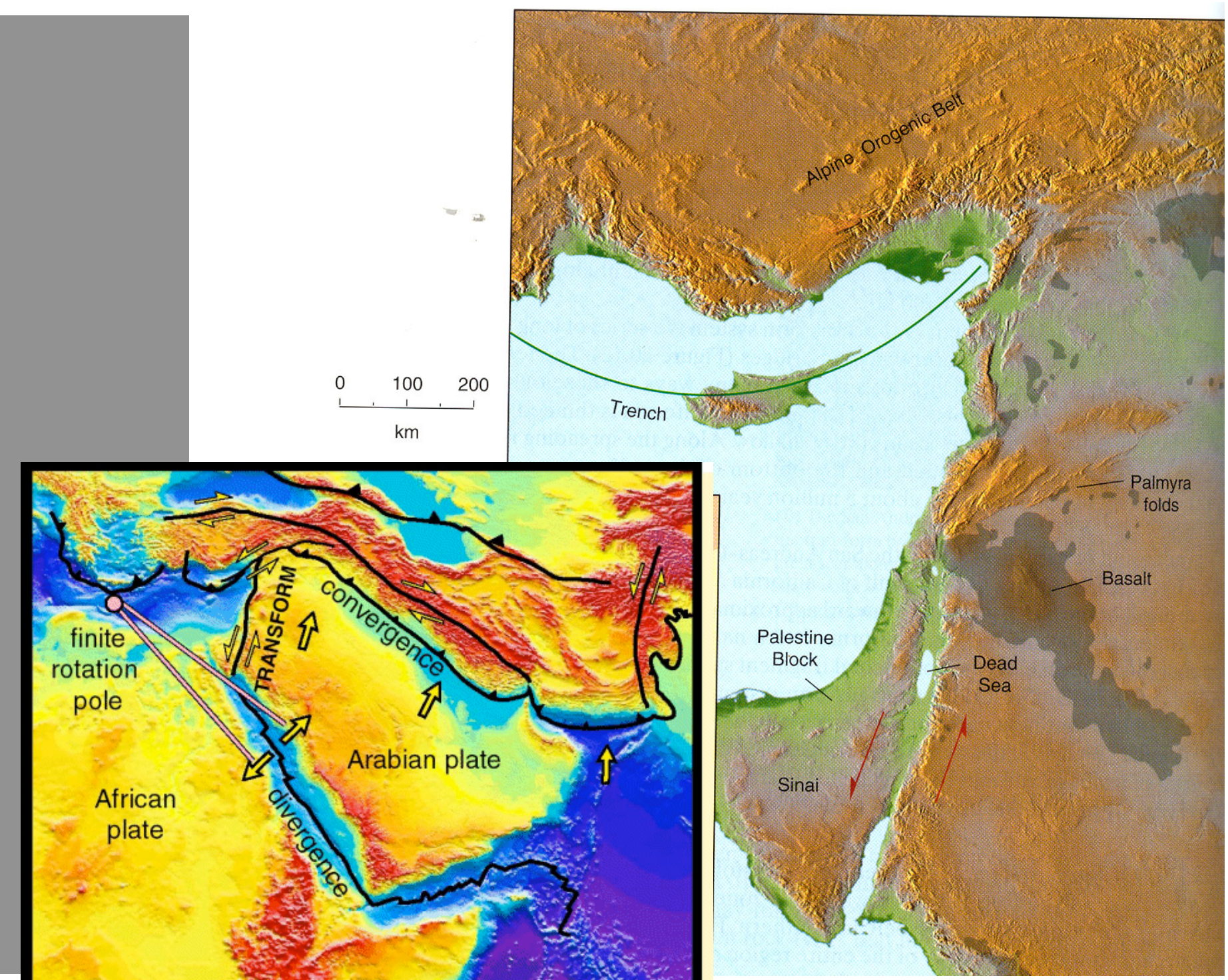
come together at the Mendocino triple junction

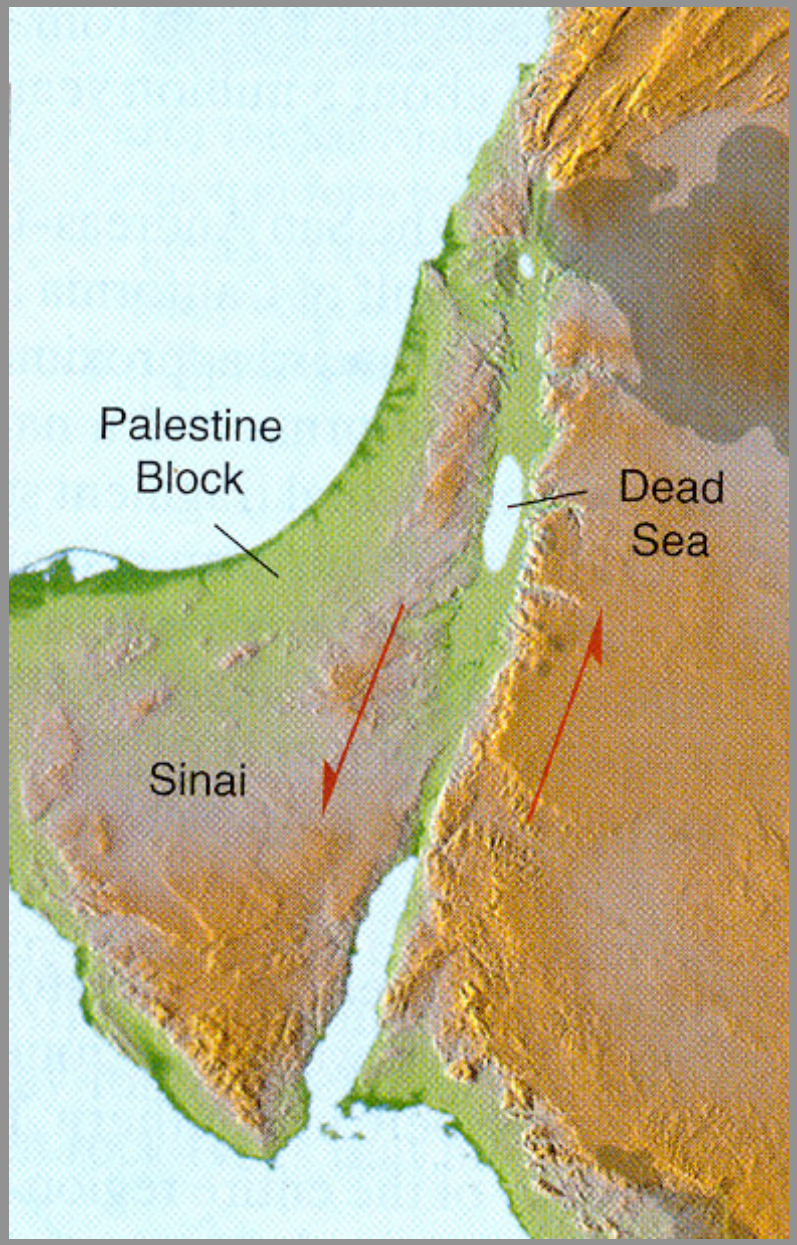


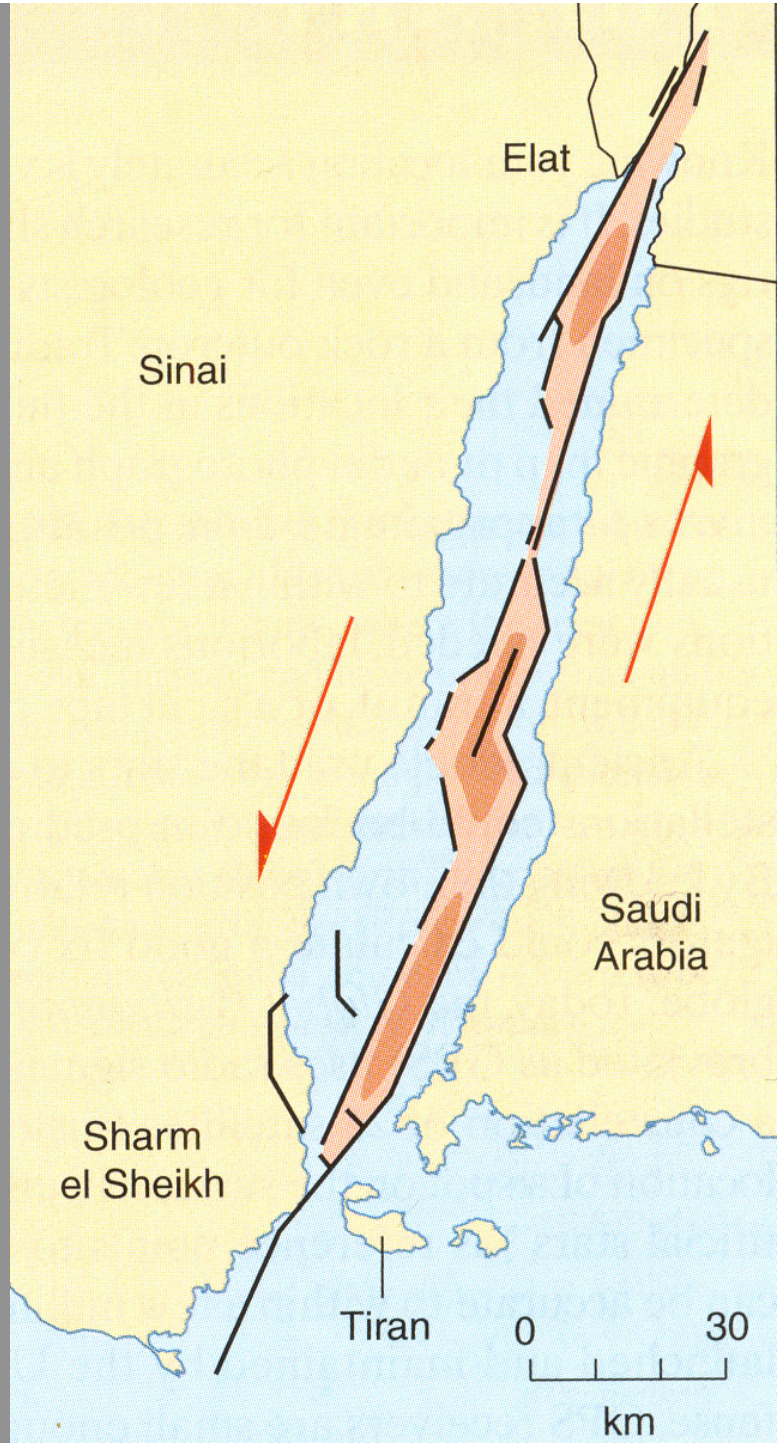

A
Juan de Fuca
Subduction Zone
Juan
de Fuca
Plate
North
American
Plate
Mendocino Transform
5.8 cm/yr
San Andreas Transform
5.6 cm/yr
Pacific Plate

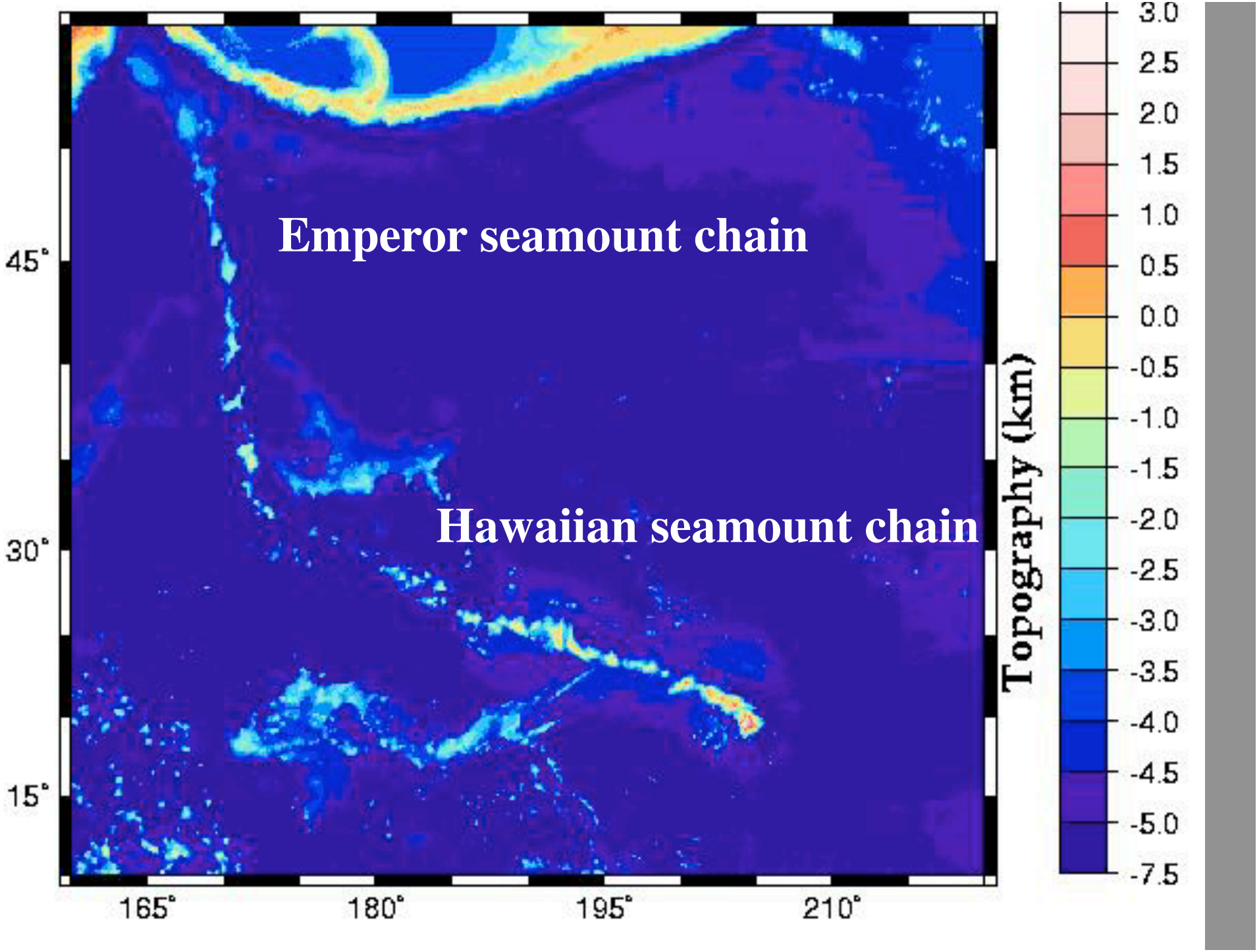

B
P
Movement of JdF
with Respect to P
JdF
Moment
of P with
Respect to NA
Movement
of NA with
Respect to JdF
NA
2 cm/yr

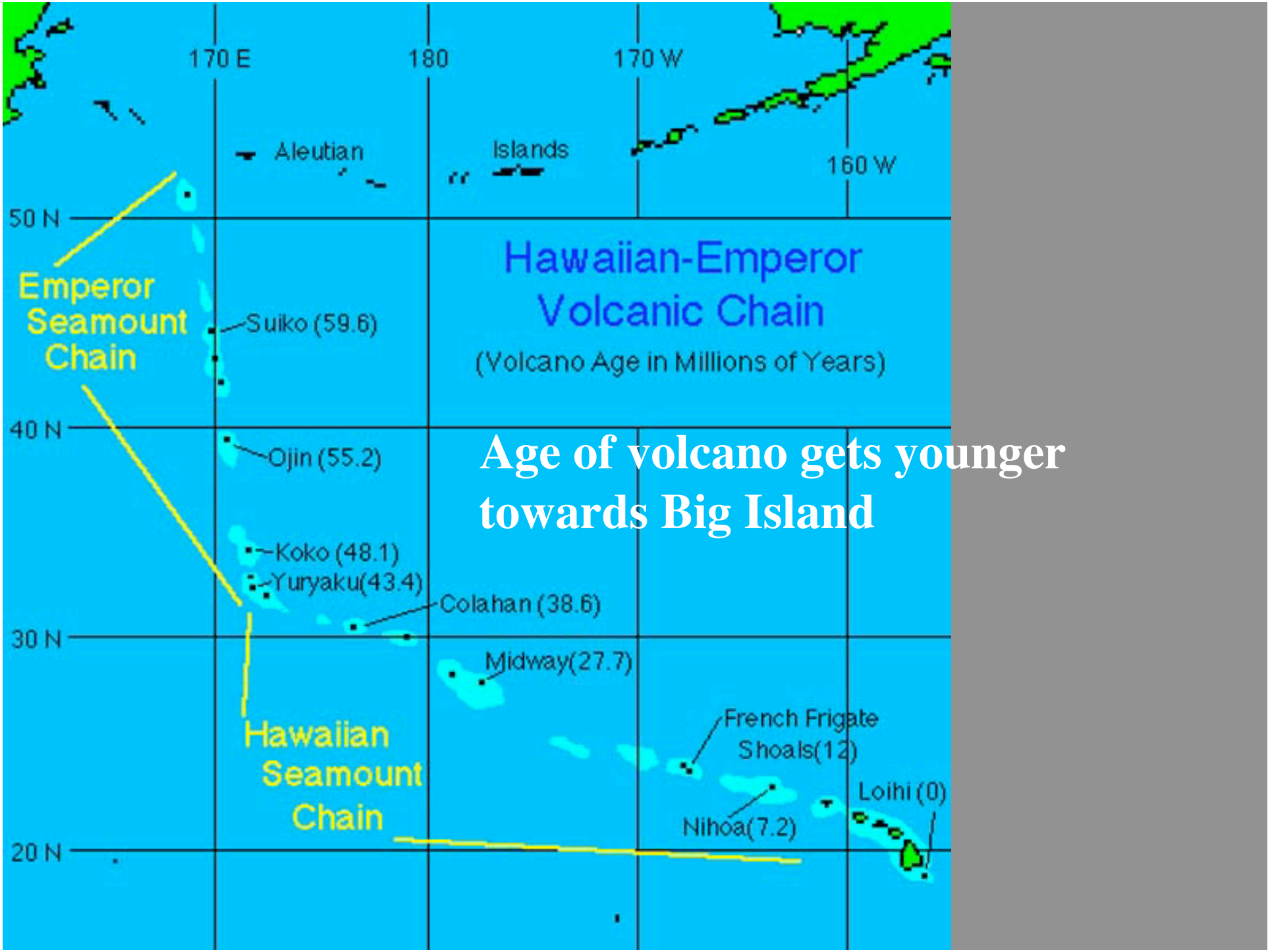

Ridge
Cascade
trench
Mendocino
Triple Junction
Mendocino
fracture
zone
San Andreas Fault
Gulf of
California

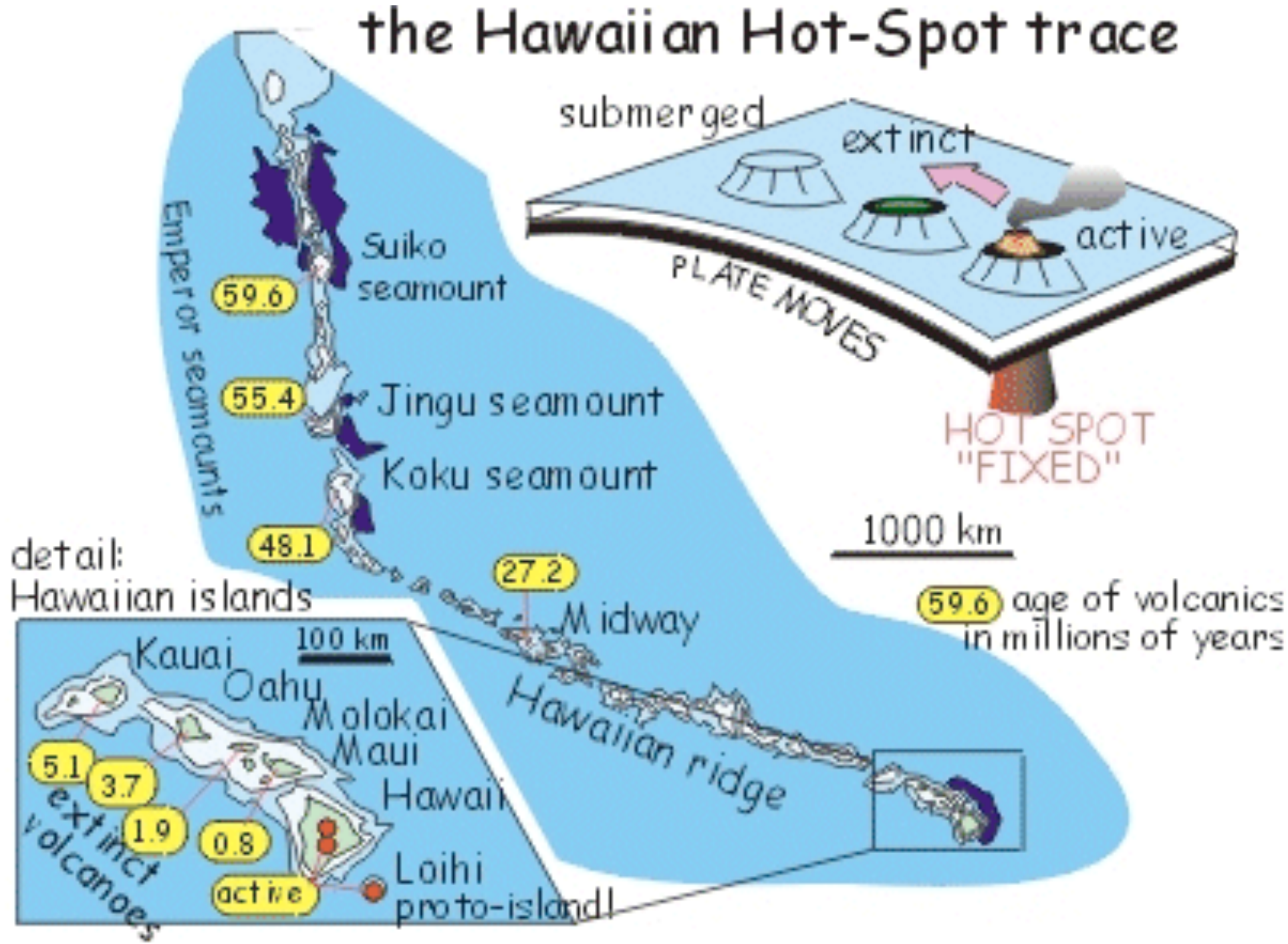

Alpine Orogenic Belt
0
100
200
km
Trench
Palmyra folds
Basalt
Palestine Block
Dead Sea
Sinai
finite rotation pole
TRANSFORM
convergence
Arabian plate
African plate
divergence

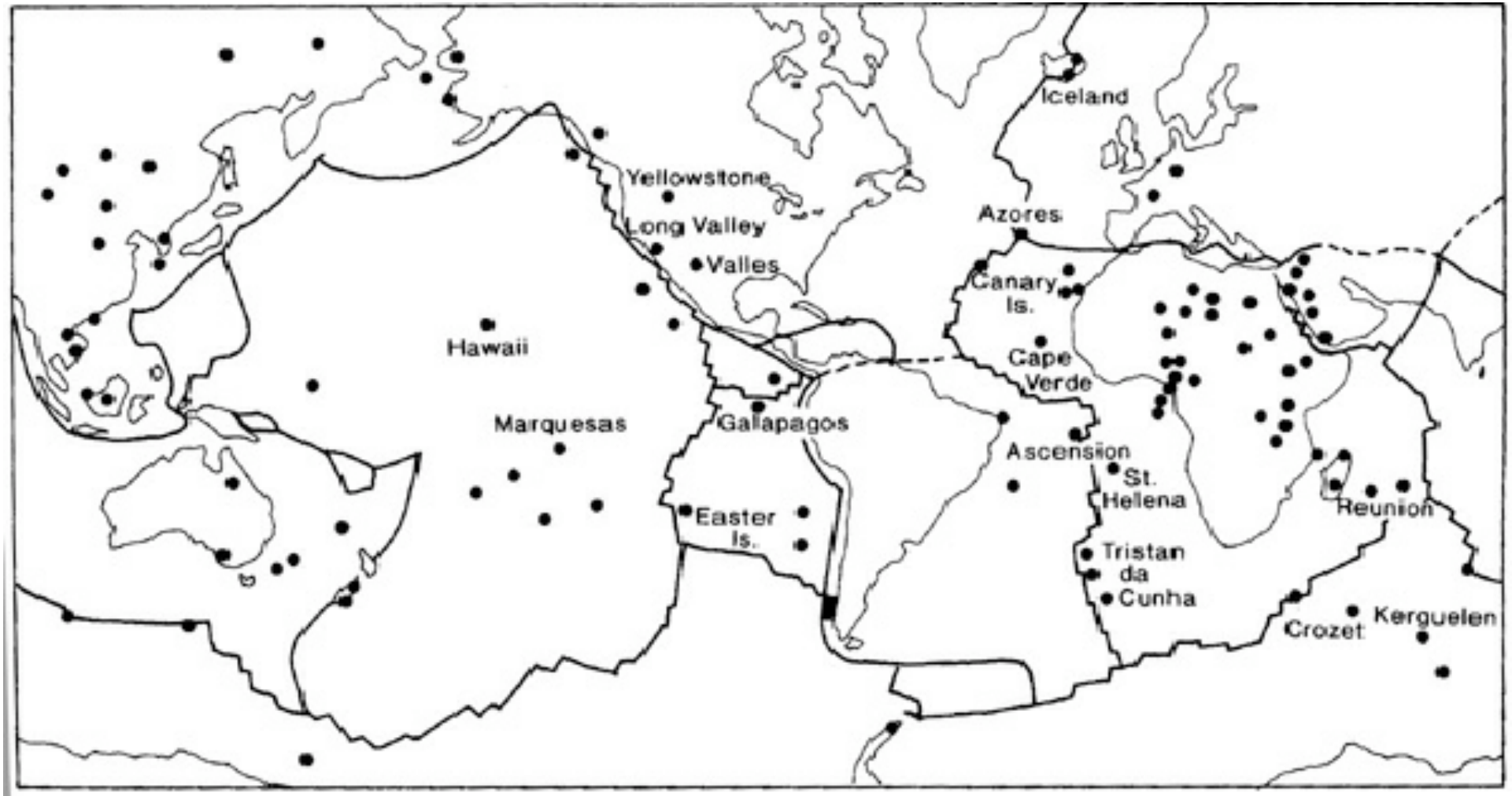

Palestine
Block
Dead
Sea
Sinai


Elat
Sinai
Saudi
Arabia
Sharm
el Sheikh
Tiran
0
30
km

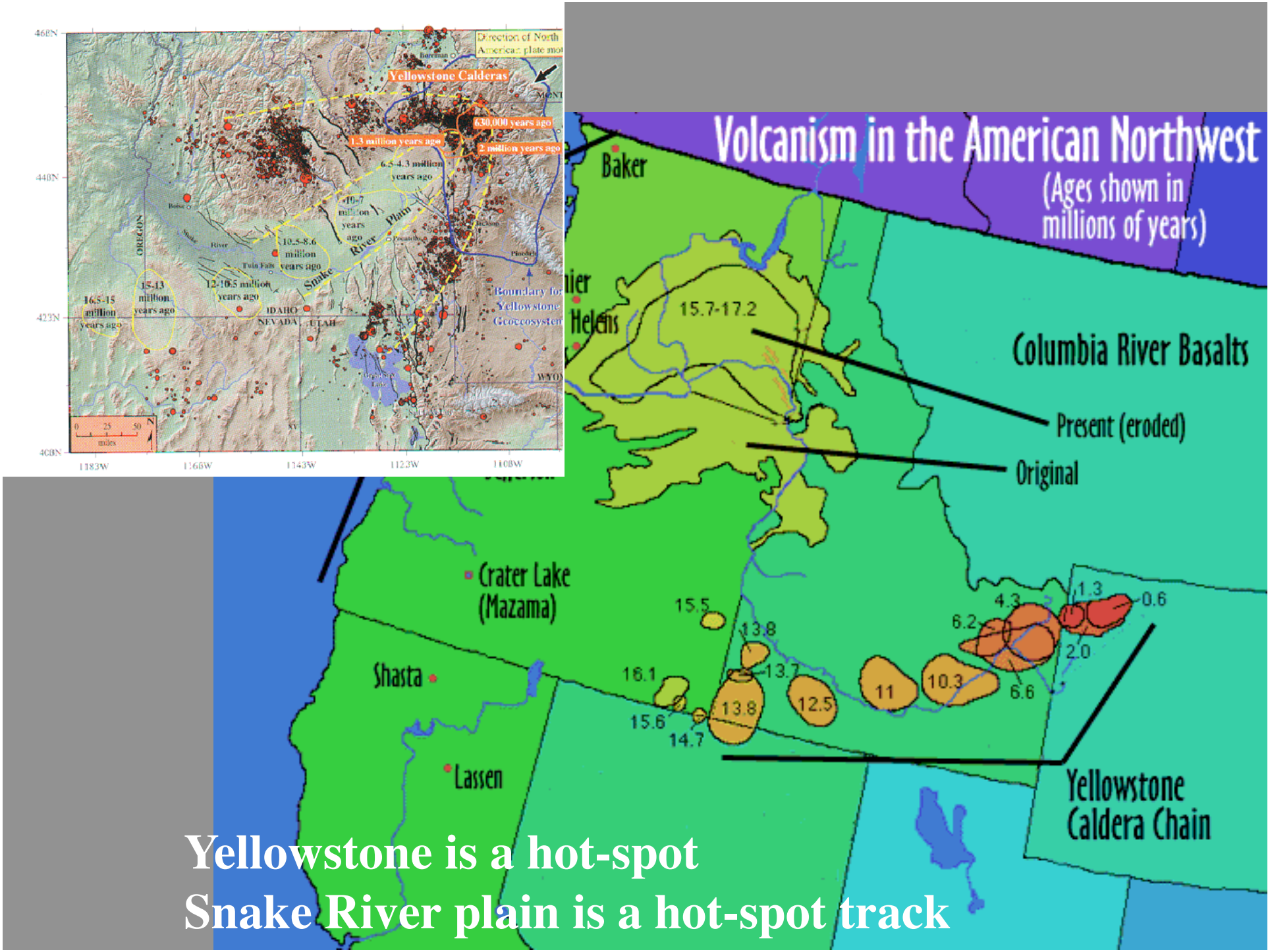

Emperor seamount chain
Hawaiian seamount chain
45°
30°
15°
165°
180°
195°
210°
Topography (km)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
-5.0
-7.5


170 E
180
170 W
160 W
Aleutian
Islands
50 N
40 N
30 N
20 N
Hawaiian-Emperor
Volcanic Chain
(Volcano Age in Millions of Years)
Emperor
Seamount
Chain
Suiko (59.6)
Ojin (55.2)
Koko (48.1)
Yuryaku(43.4)
Colahan (38.6)
Midway(27.7)
French Frigate
Shoals(12)
Nihoa(7.2)
Loihi (0)
Hawaiian
Seamount
Chain
Age of volcano gets younger
towards Big Island

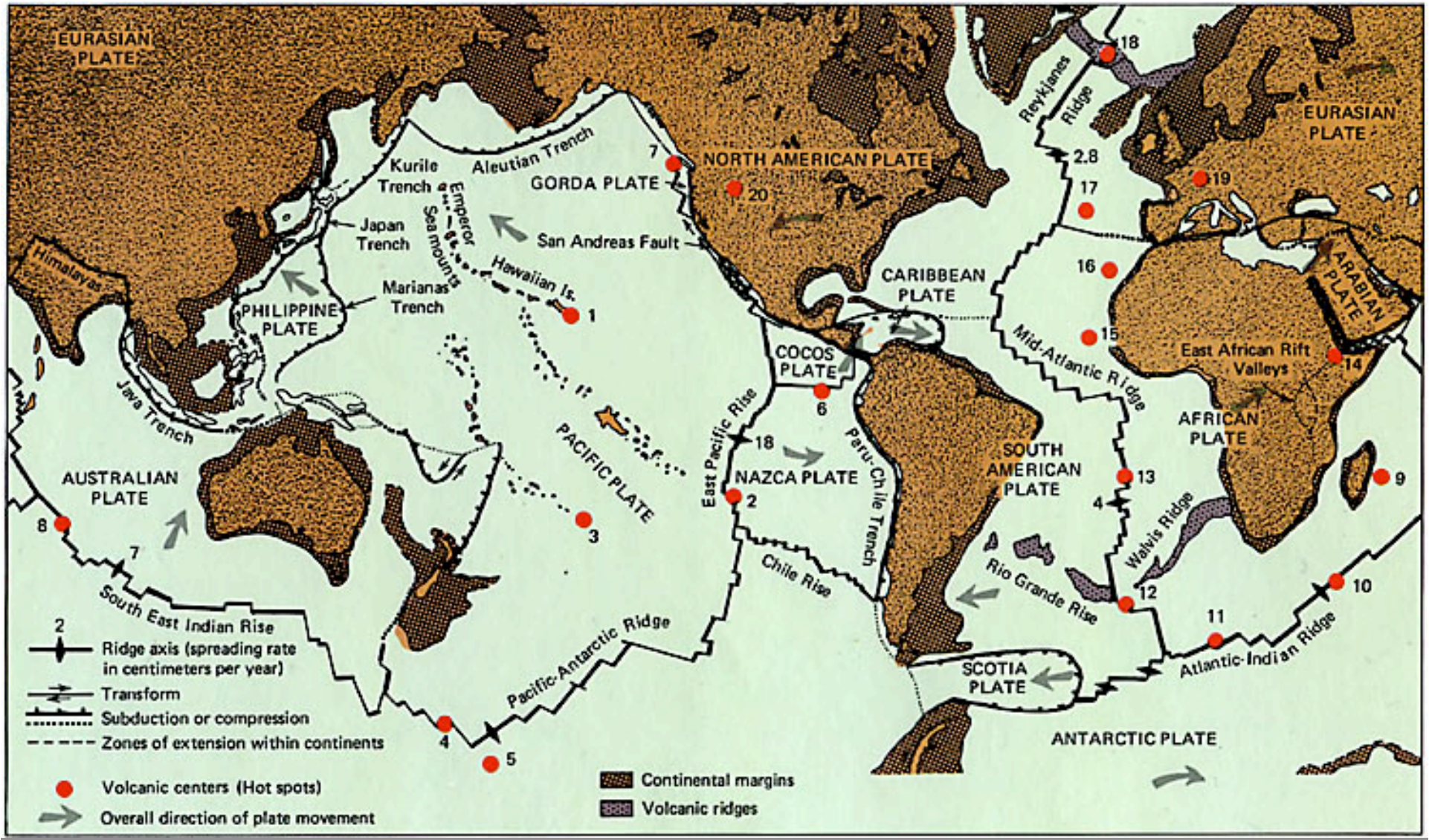

the Hawaiian Hot-Spot trace
submerged
extinct
active
PLATE MOVES
HOT SPOT
"FIXED"
Emperor seamounts
Suiko seamount
59.6
Jingu seamount
55.4
Koku seamount
48.1
27.2
Midway
1000 km
59.6 age of volcanics in millions of years
detail:
Hawaiian islands
100 km
Kauai
Oahu
Molokai
Maui
Hawaii
Hawaiian ridge
5.1
3.7
1.9
0.8
extinct volcanoes
active
Loihi proto-island



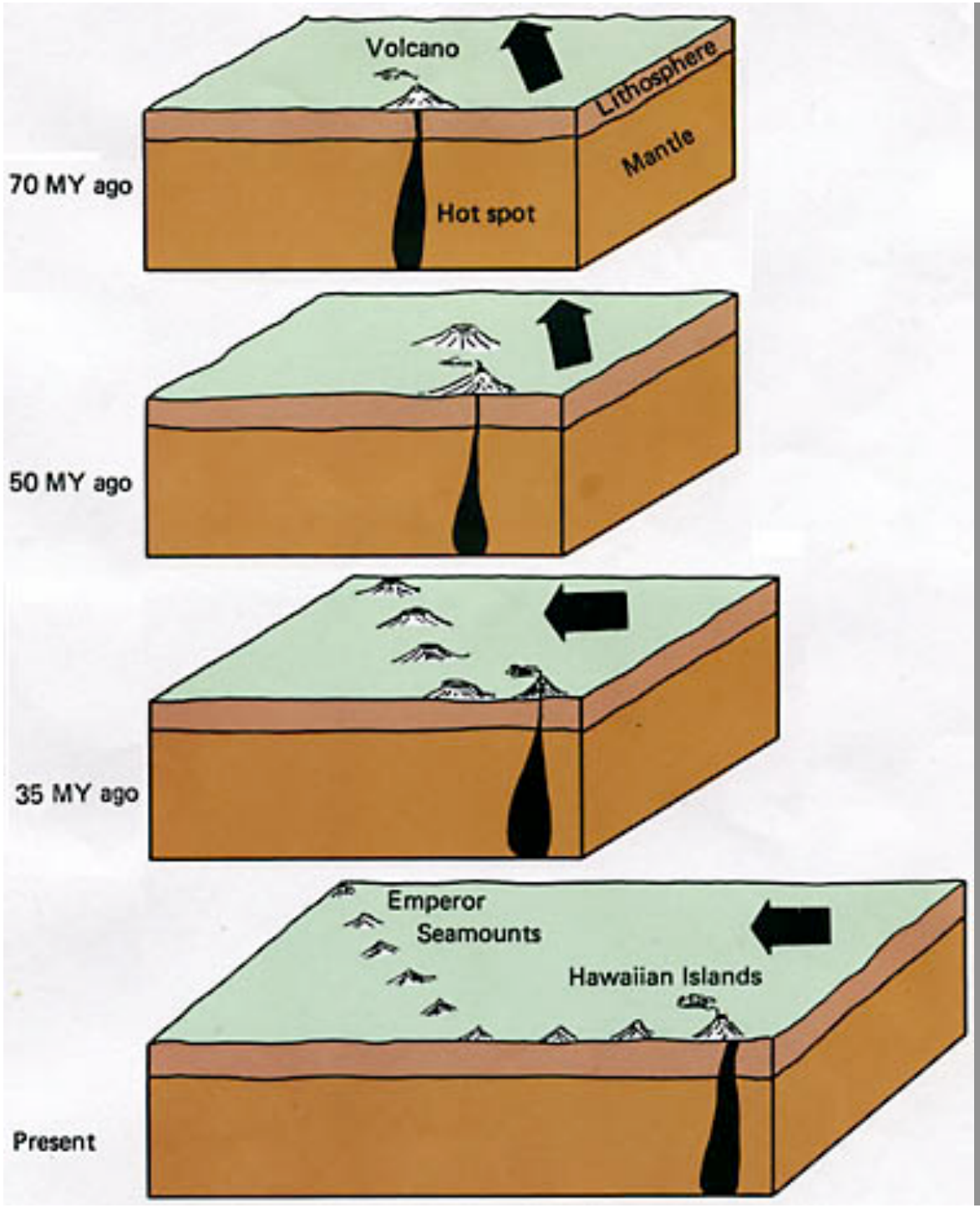
Active hot-spots


Volcanism in the American Northwest
(Ages shown in millions of years)
Yellowstone Calderas
630,000 years ago
1.3 million years ago
2 million years ago
6.5-4.3 million years ago
10-7 million years ago
10.5-8.6 million years ago
12-10.5 million years ago
15-13 million years ago
16.5-15 million years ago
Snake River Plain
Direction of North American plate motion
Boundary for Yellowstone Geoecosystem
OREGON
IDAHO
NEVADA
UTAH
WYO
Baker
Helens
15.7-17.2
Columbia River Basalts
Present (eroded)
Original
Crater Lake (Mazama)
Shasta
Lassen
15.5
13.8
16.1
13.7
15.6
14.7
13.8
12.5
11
10.3
6.2
4.3
6.6
2.0
1.3
0.6
Yellowstone Caldera Chain
Yellowstone is a hot-spot
Snake River plain is a hot-spot track

Snake River plain volcanism



Fixed hot spot-
Absolute plate motions

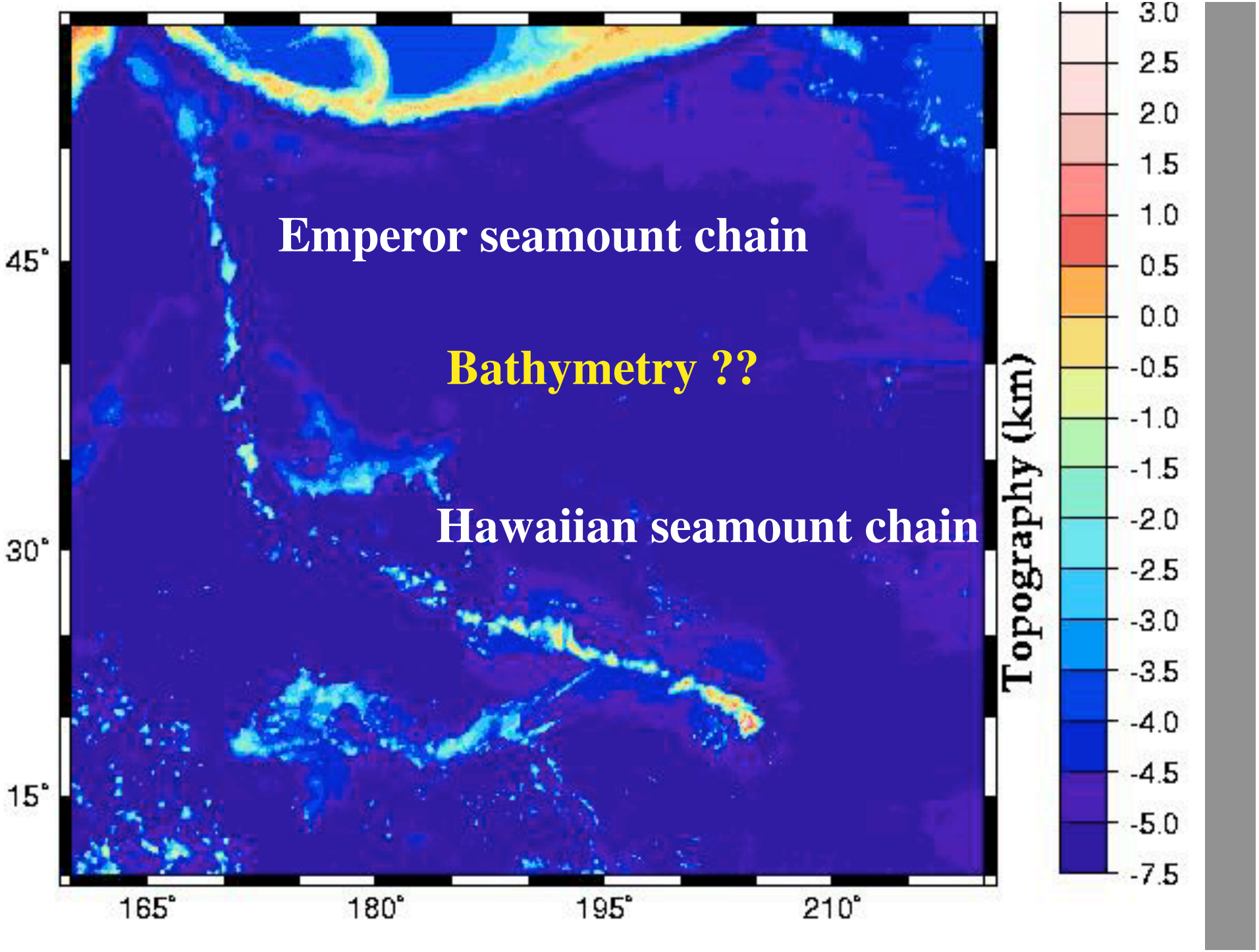


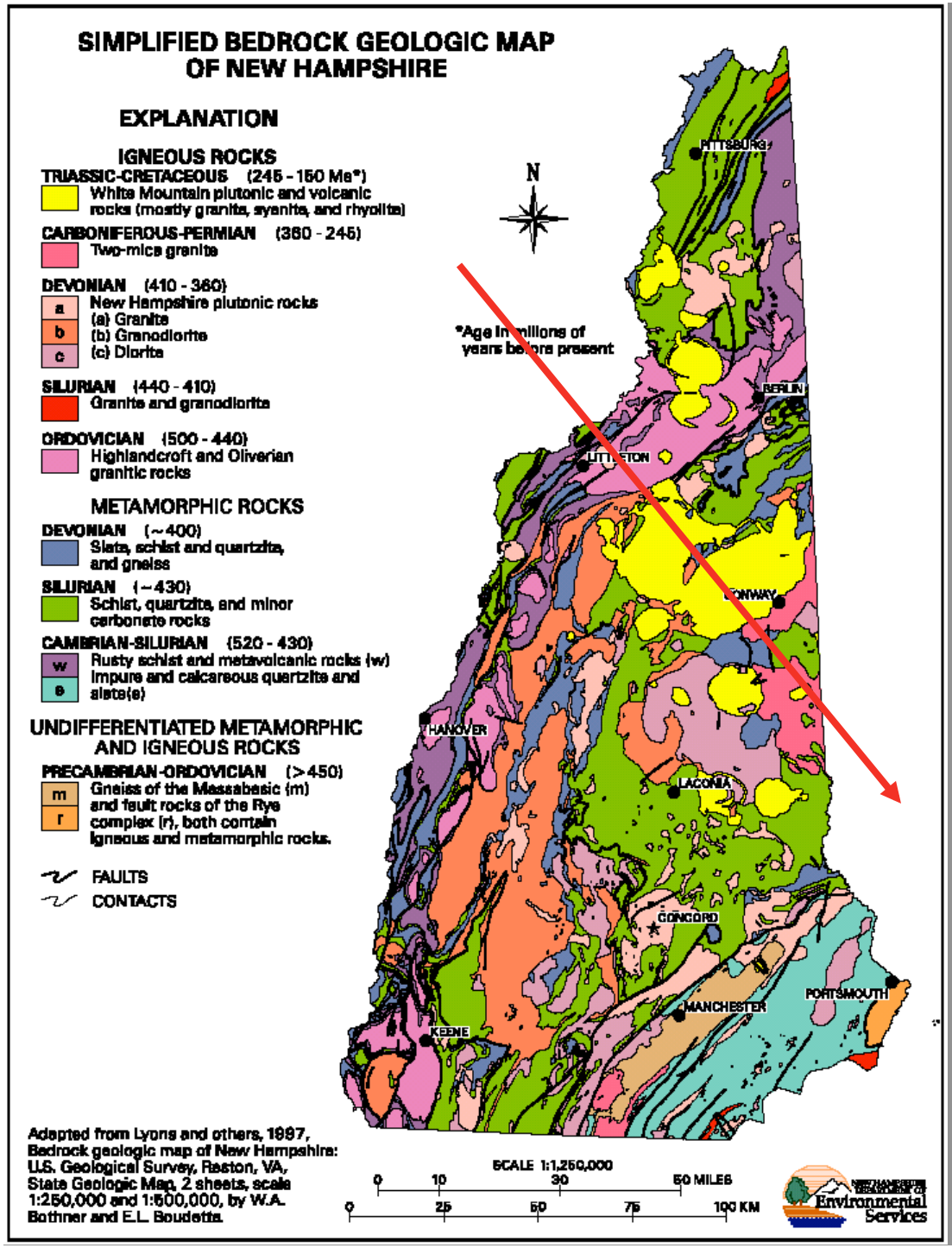
Source of hot spot magmas?

Lithosphere?
No!!!

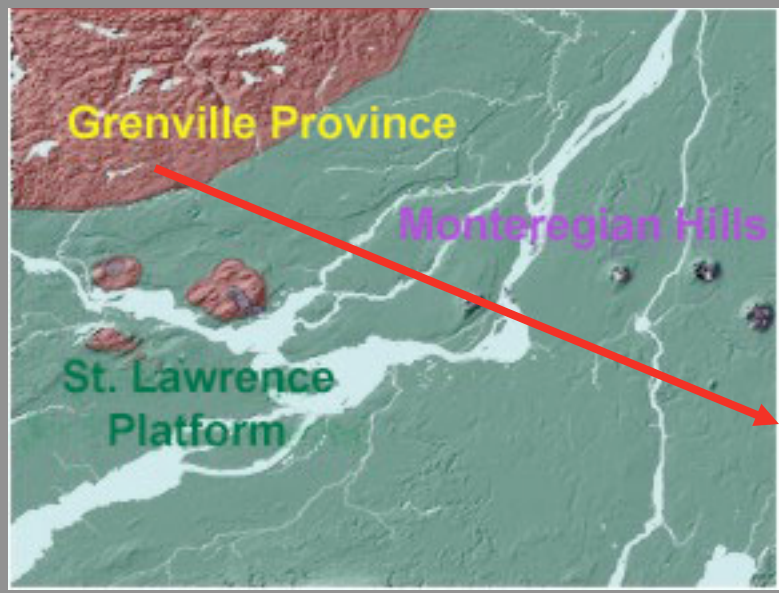
Asthenoshpere
NO!

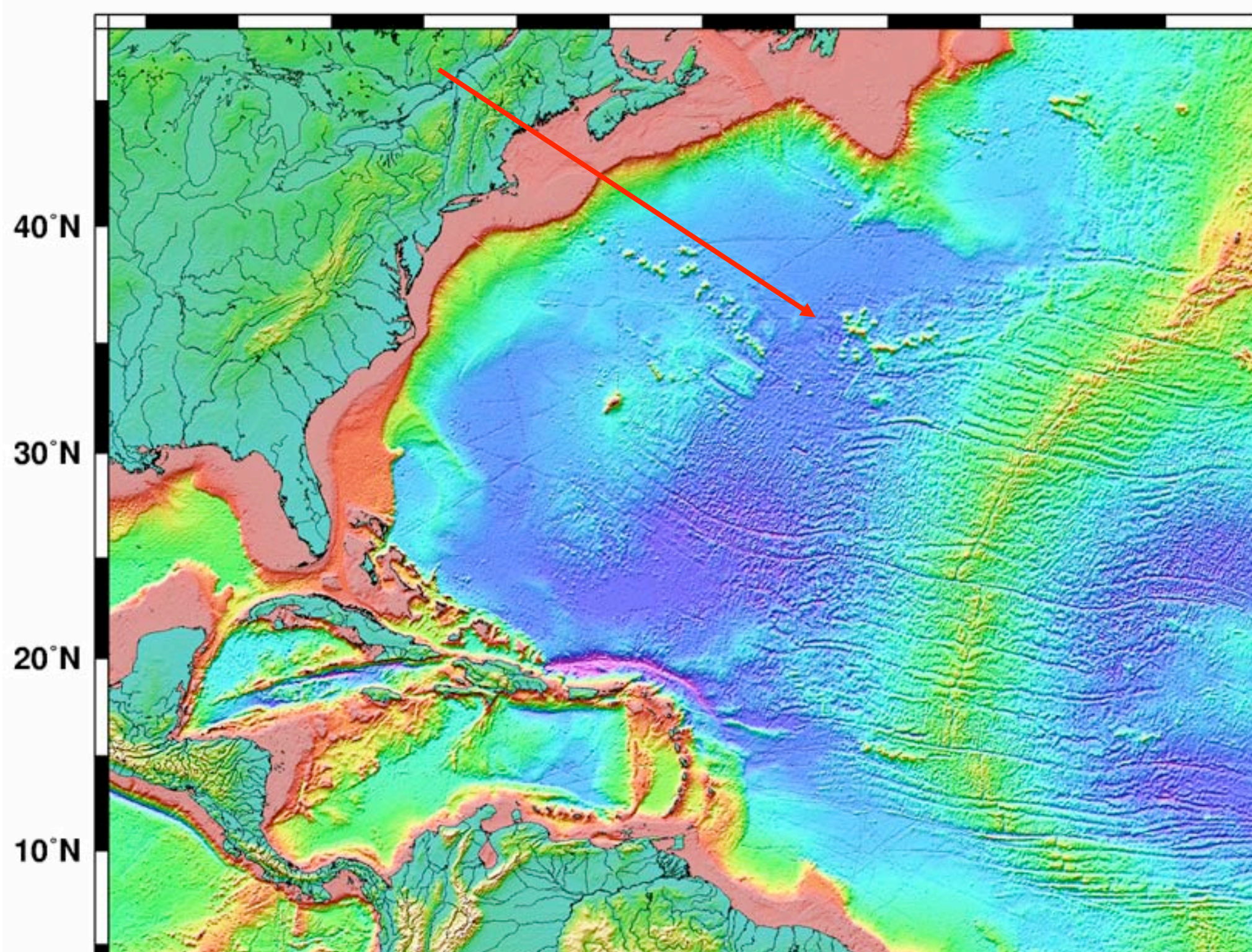
CMB??


Emperor seamount chain
Bathymetry ??
Hawaiian seamount chain
45°
30°
15°
165°
180°
195°
210°
Topography (km)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
-5.0
-7.5



Hot spot track in New Hampshire




40˚N
30˚N
20˚N
10˚N