Tema 4.

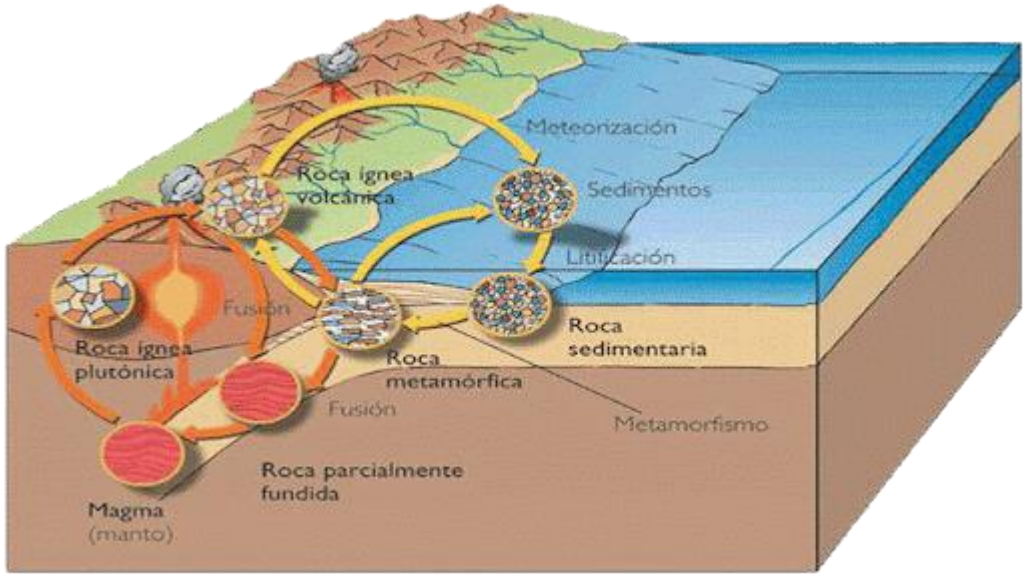
A TECTÓNICA DE PLACAS I

XEOSFERA

TERRA = PLANETA DINÁMICO

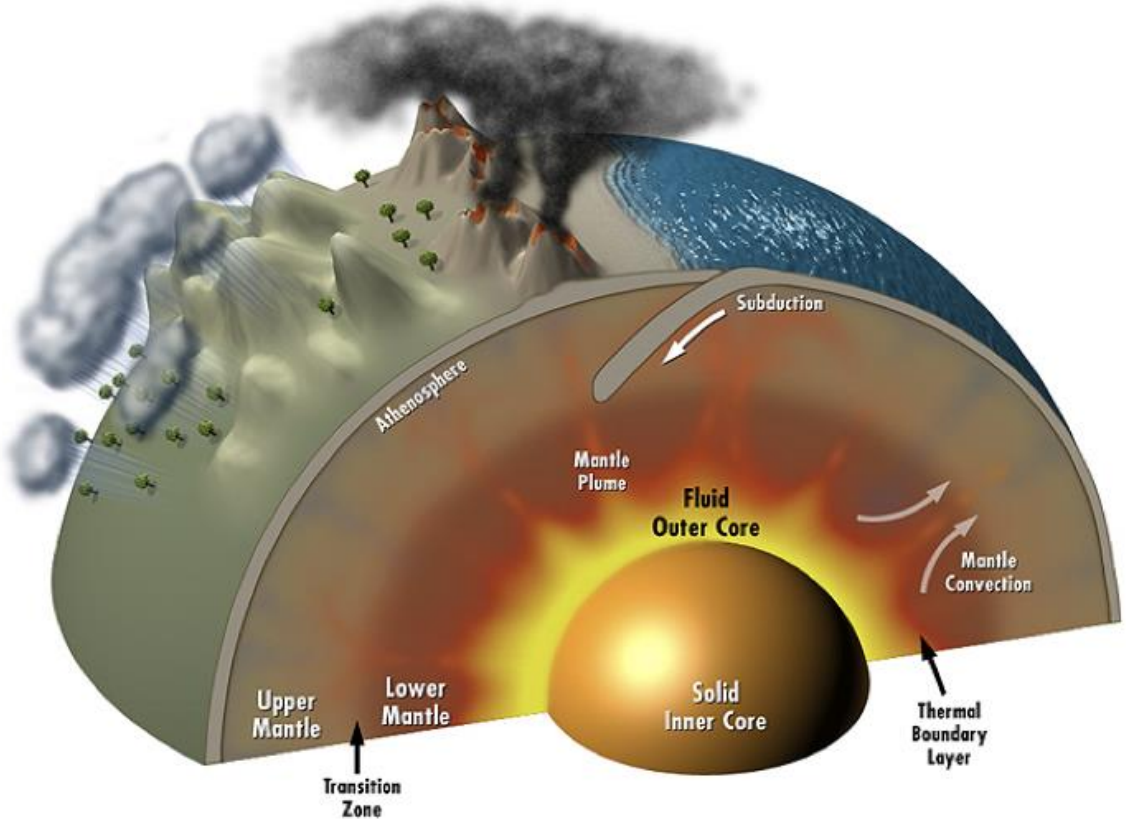
- Algunhas partes se elevan pola formación de montañas e a actividade volcánica (**procesos internos**) grazas a enerxía interna da Terra.

- Outras están rompendo continuamente as súas rochas e desplazando os derrubios a zonas de menor elevación (**procesos externos**) grazas a **enerxía do Sol e a acción da gravidade**.



Procesos internos

Causados pola enerxía interna da Terra



EXEMPLOS

SEISMOS,
VOLCÁNS,
.....

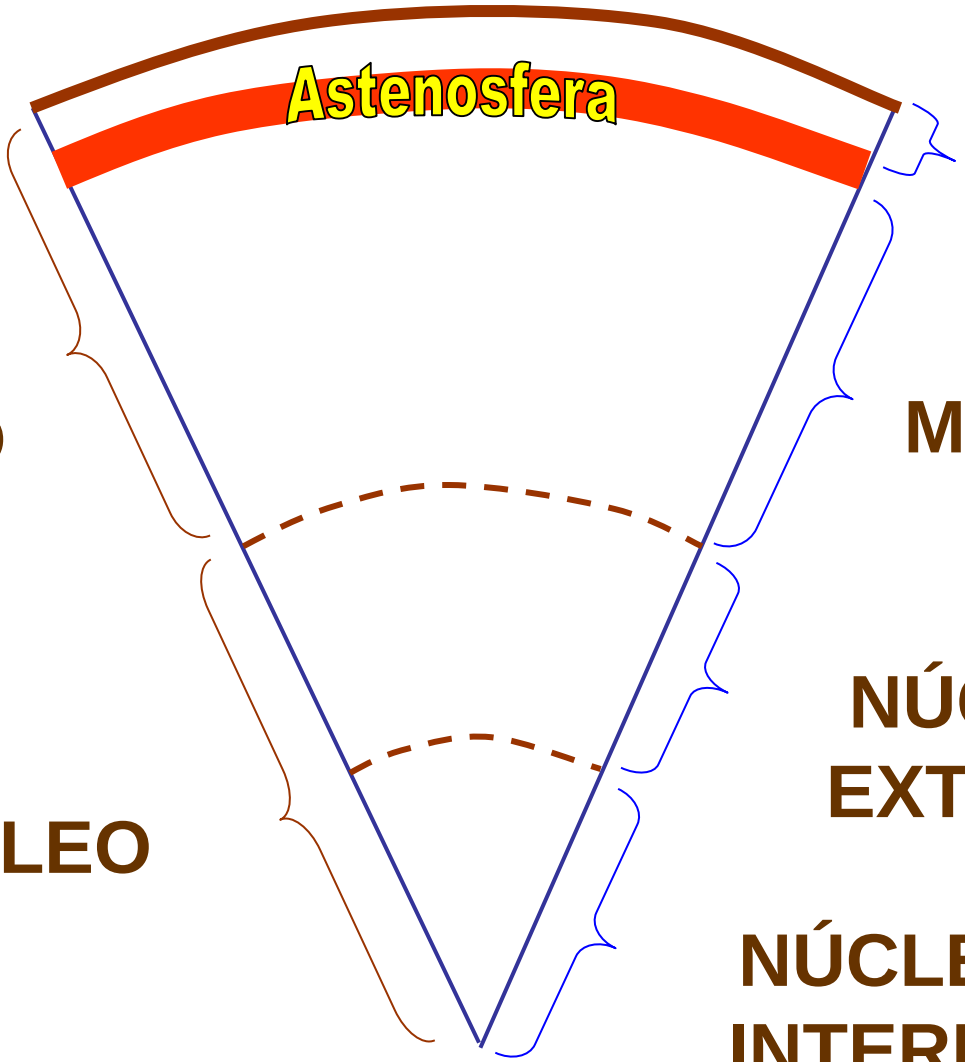
TECTÓNICA DE PLACAS

Modelo dinámico da litosfera terrestre, proposto por **Tuzo Wilson**, en **1965**, que propón que:

- Litosfera fragmentada en placas ríxidas.
- As placas se moven sobre a astenosfera plástica.
- Nos límites ou bordes de placas é onde acontecen a maioría de fenómenos xeolóxicos.

DIVISIÓN XEOQUÍMICA

DIVISIÓN XEODINÁMICA



C O D I A

MANTO

NÚCLEO

LITOSFERA

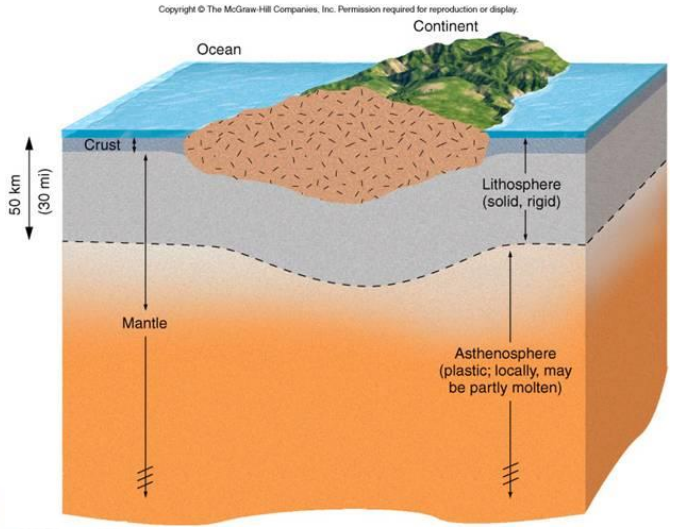
MESOSFERA

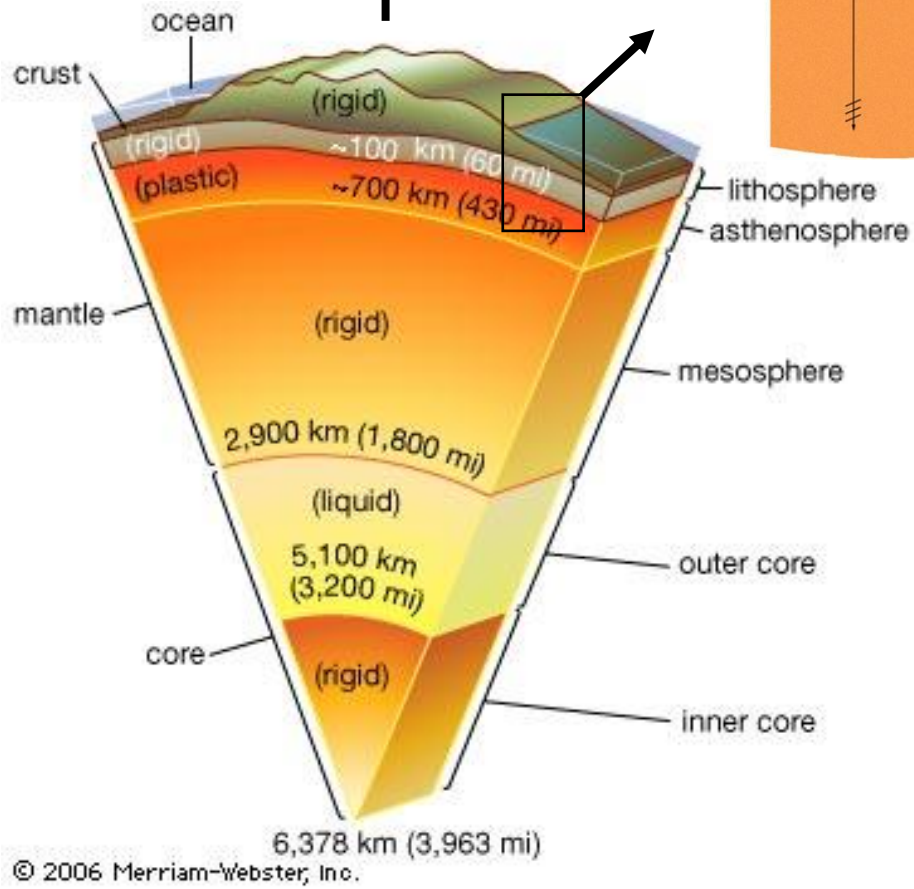
NÚCLEO EXTERNO

NÚCLEO INTERNO

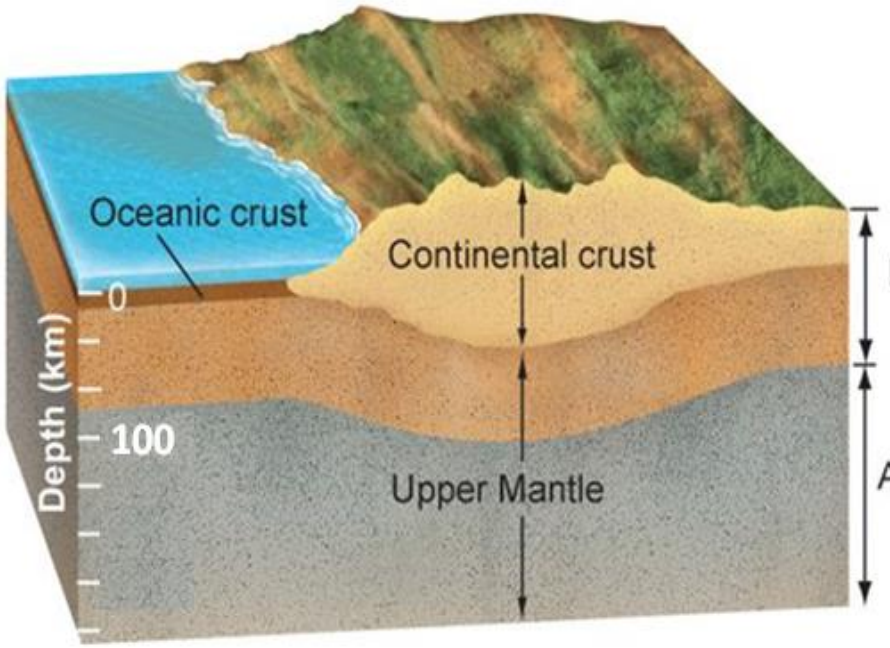
MODELO XEOQUÍMICO

MODELO XEODINÁMICO

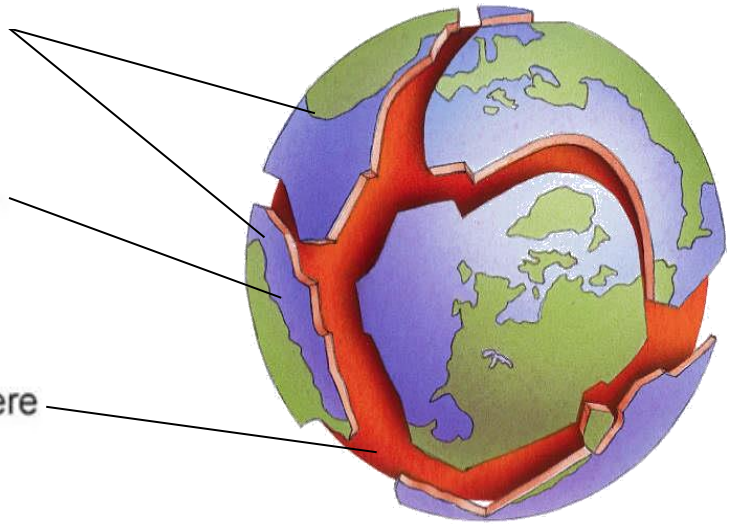




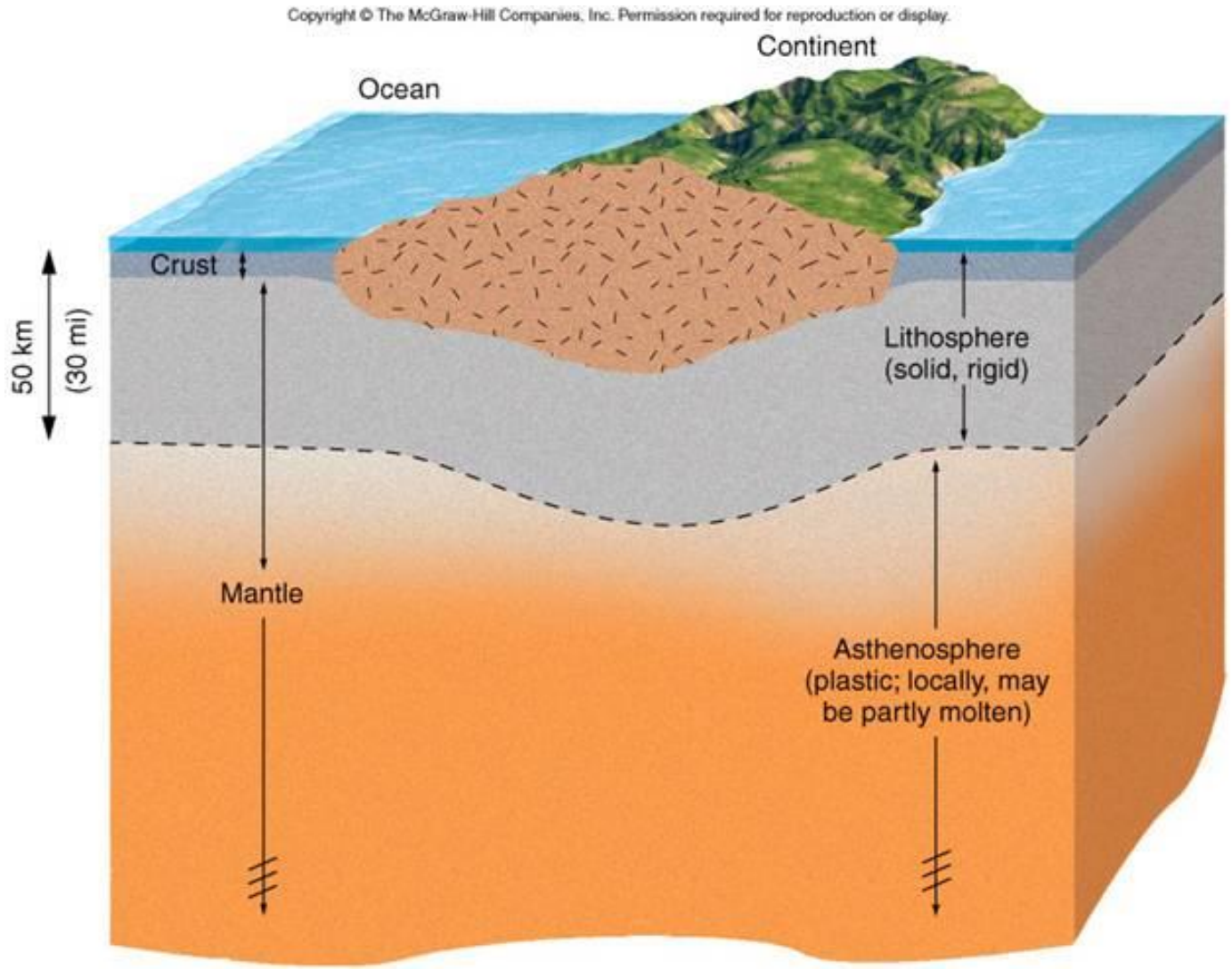
LITOSFERA RÍXIDA



Placas litosféricas

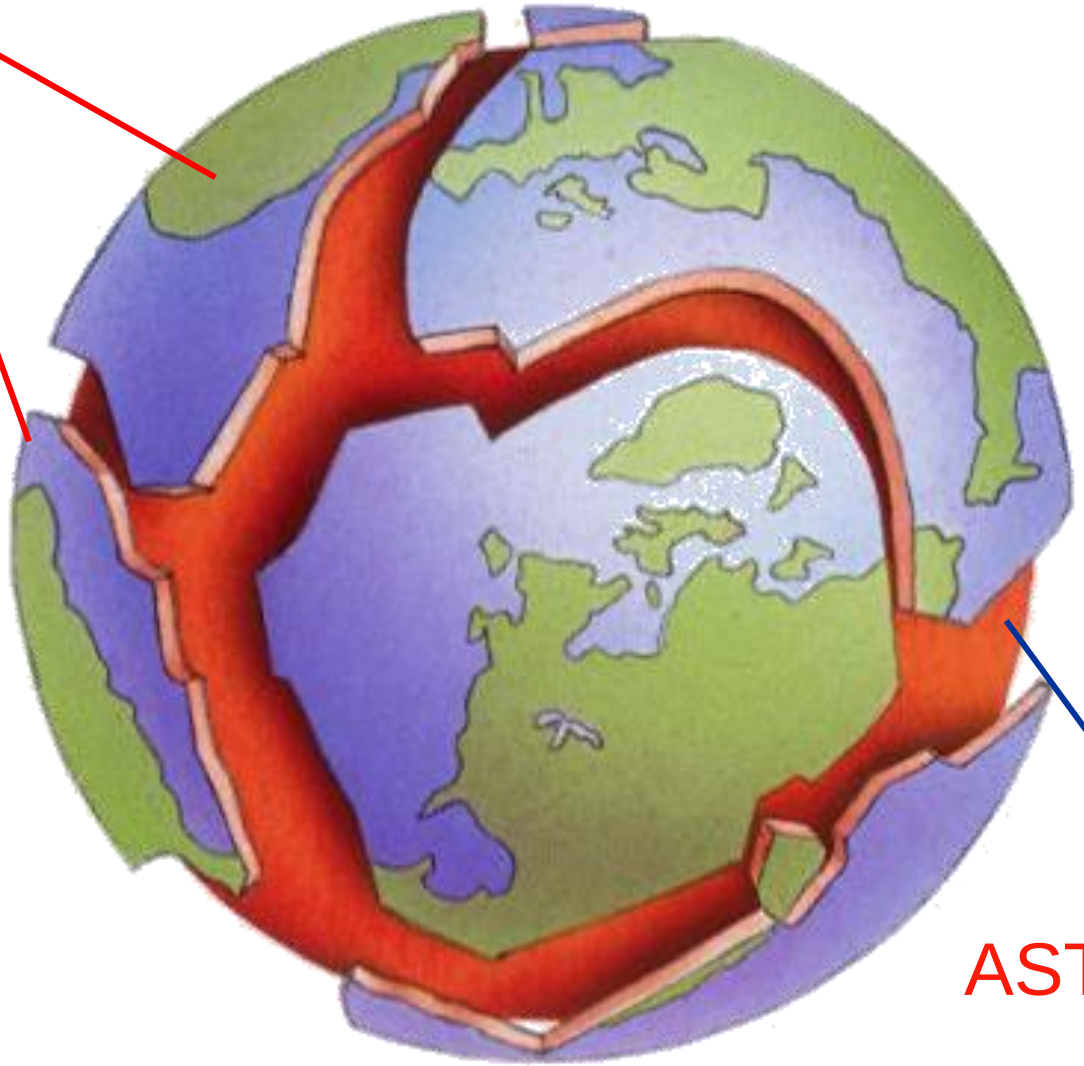


ASTENOSFERA PLÁSTICA



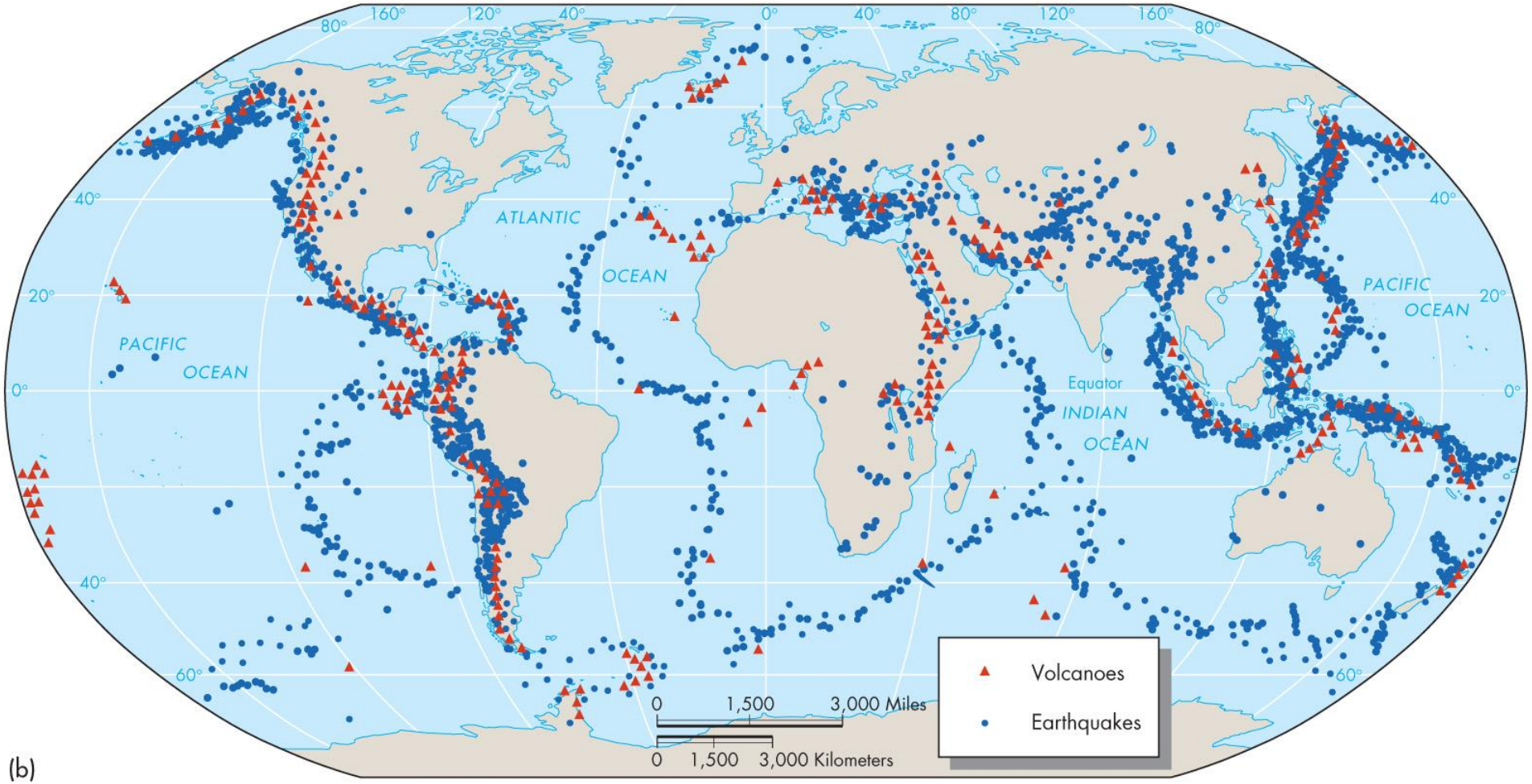
PLACAS LITOSFÉRICAS

LITOSFERA

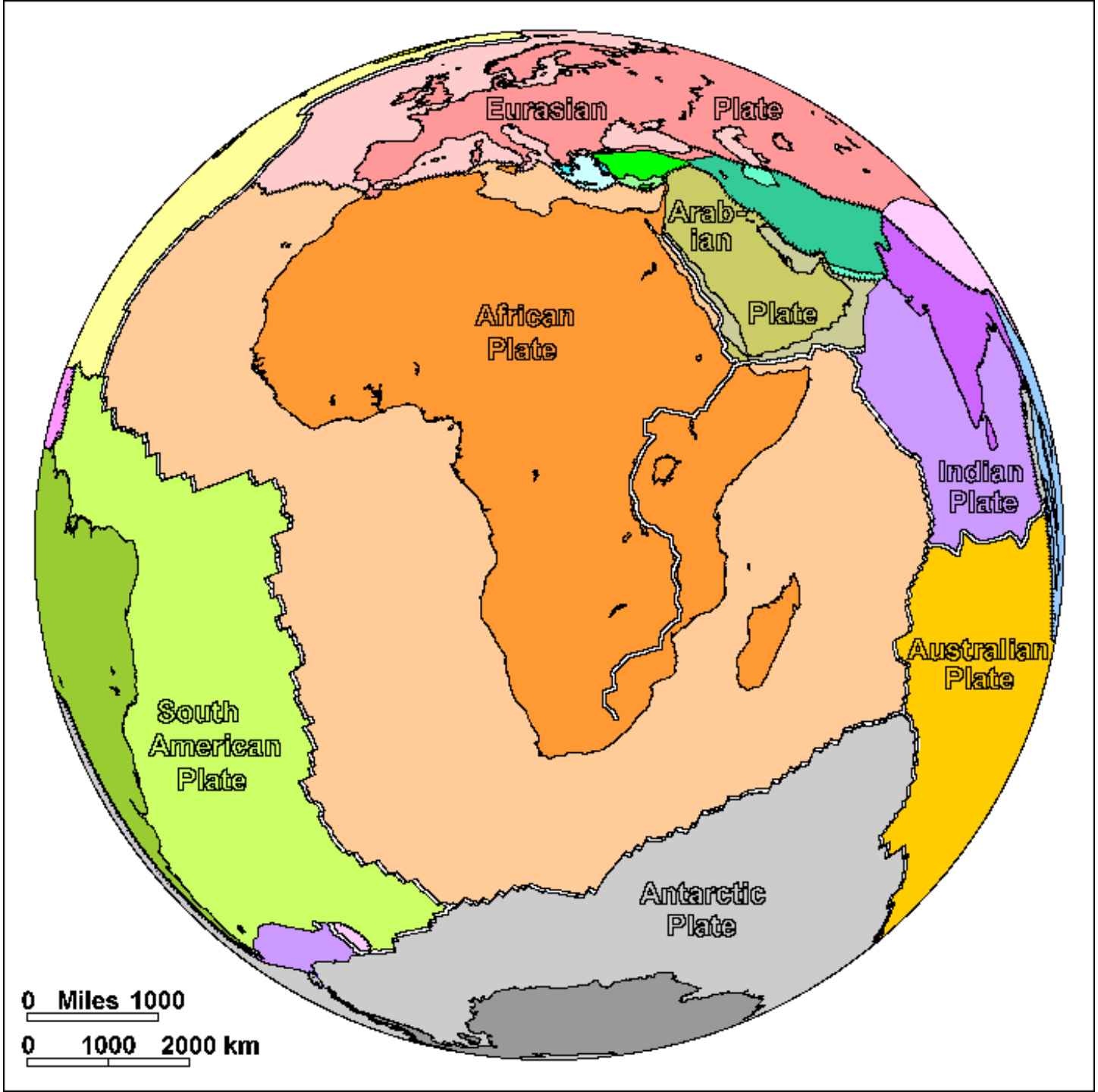


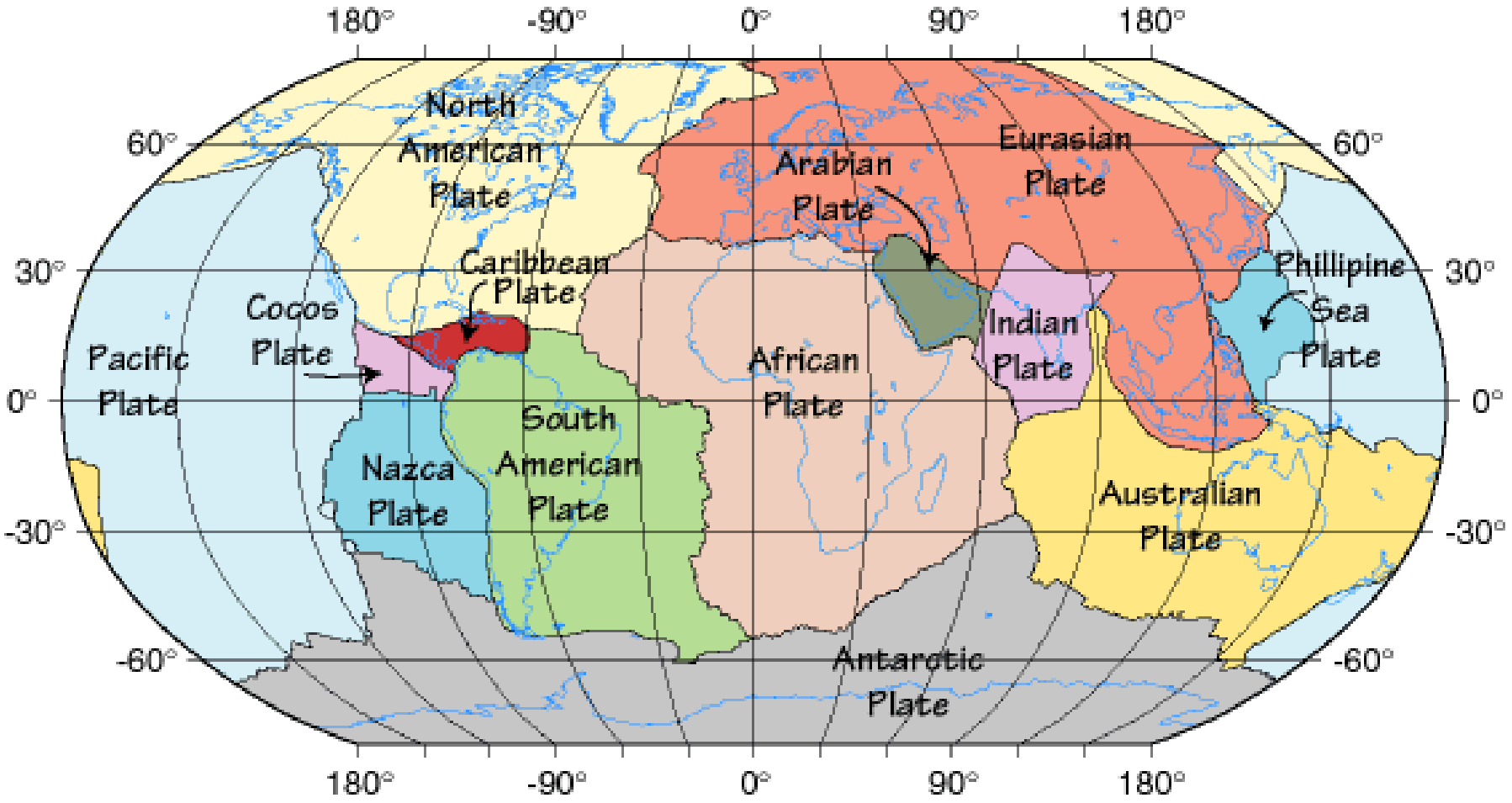
ASTENOSFERA

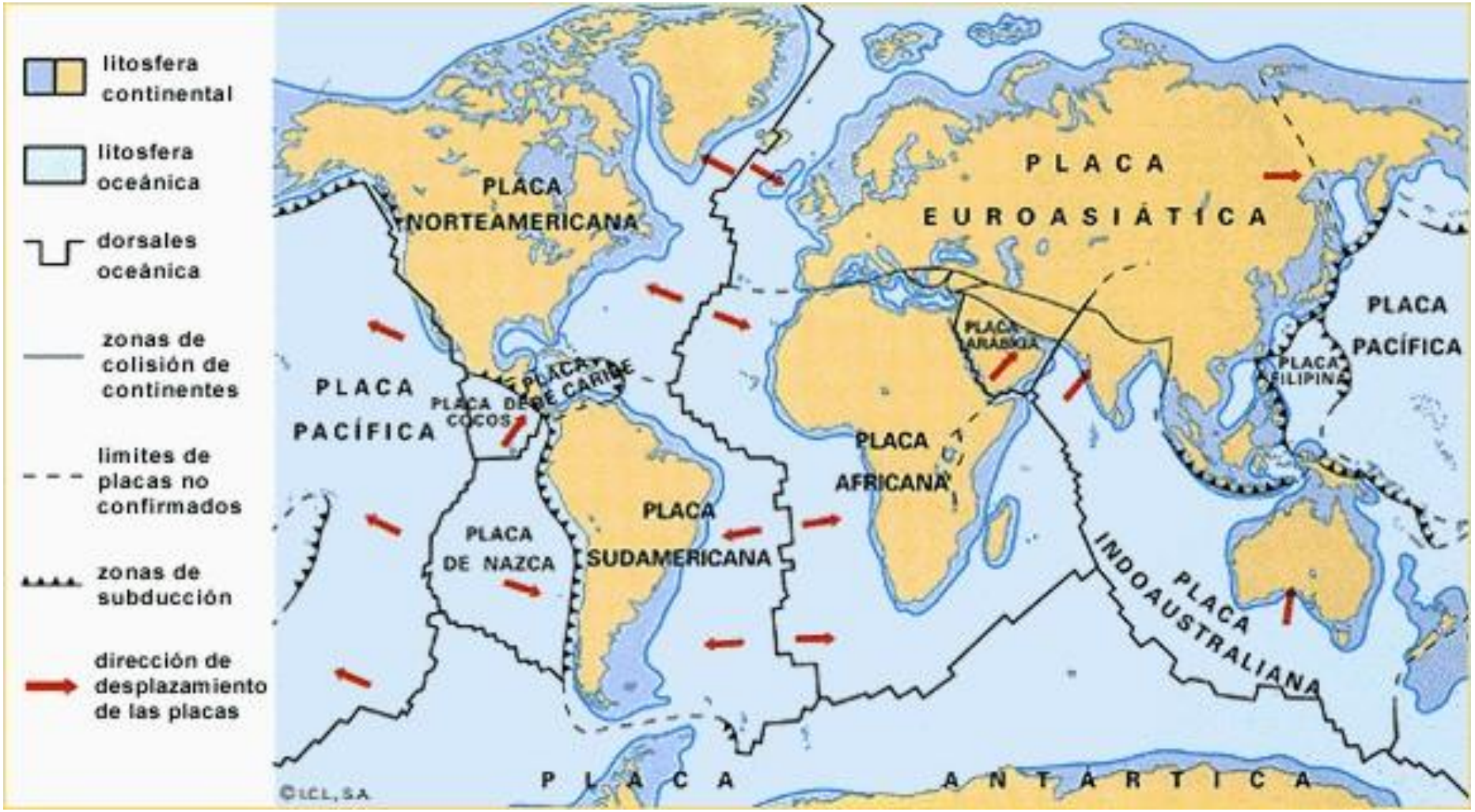
DISTRIBUCIÓN SEISMOS E VOLCÁNS



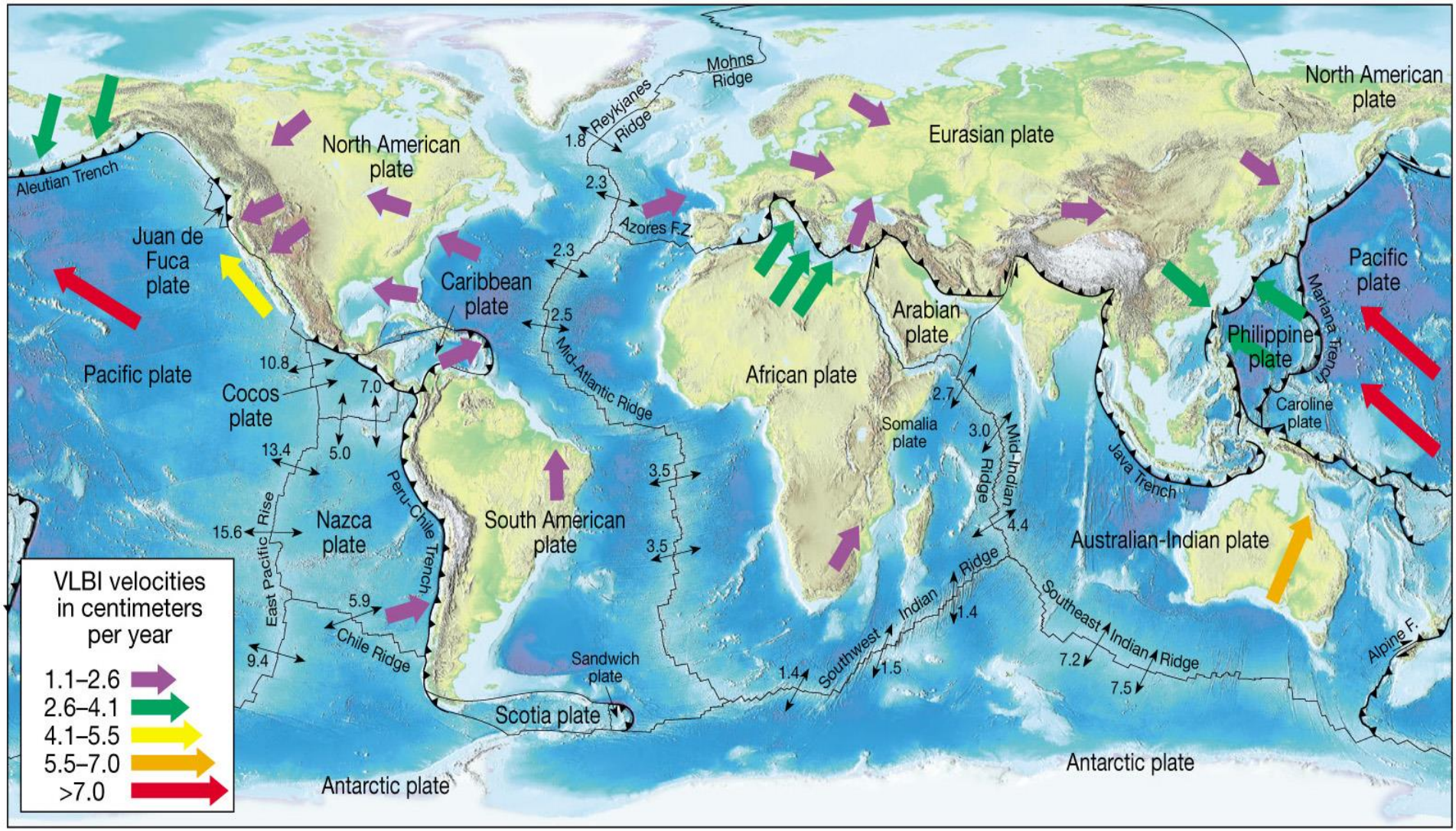
(b)


Eurasian Plate
Arab-ian Plate
African Plate
Indian Plate
Australian Plate
South American Plate
Antarctic Plate
0 Miles 1000
0 1000 2000 km

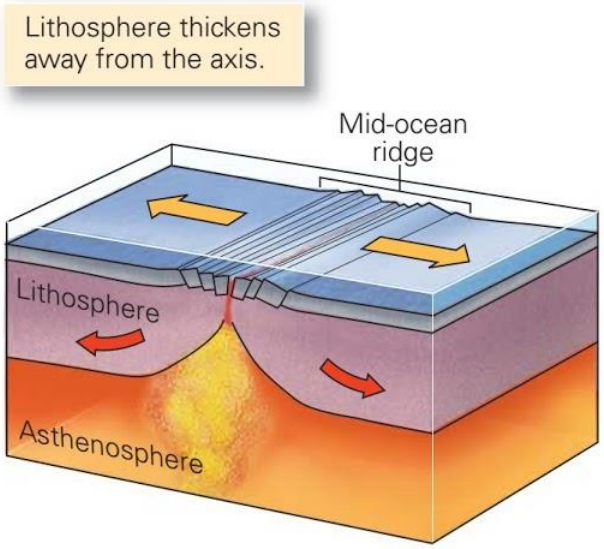

180°
-90°
0°
90°
180°
60°
30°
0°
-30°
-60°
North American Plate
Eurasian Plate
Arabian Plate
Caribbean Plate
Cocos Plate
Pacific Plate
African Plate
Indian Plate
Phillipine Sea Plate
South American Plate
Nazca Plate
Australian Plate
Antarctic Plate


litosfera continental
litosfera oceánica
dorsales oceánica
zonas de colisión de continentes
limites de placas no confirmados
zonas de subducción
dirección de desplazamiento de las placas
PLACA NORTEAMERICANA
PLACA EUROASIÁTICA
PLACA PACÍFICA
PLACA DE COCOS
PLACA DEL CARIBE
PLACA ARÁBIGA
PLACA FILIPINA
PLACA AFRICANA
PLACA DE NAZCA
PLACA SUDAMERICANA
PLACA INDOAUSTRALIANA
PLACA ANTARTICA
©ICCL, S.A.

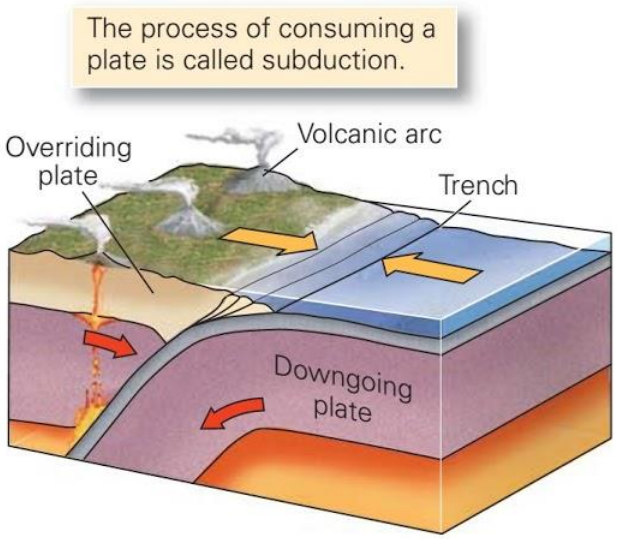
O MOVEMENTO RELATIVO DAS PLACAS



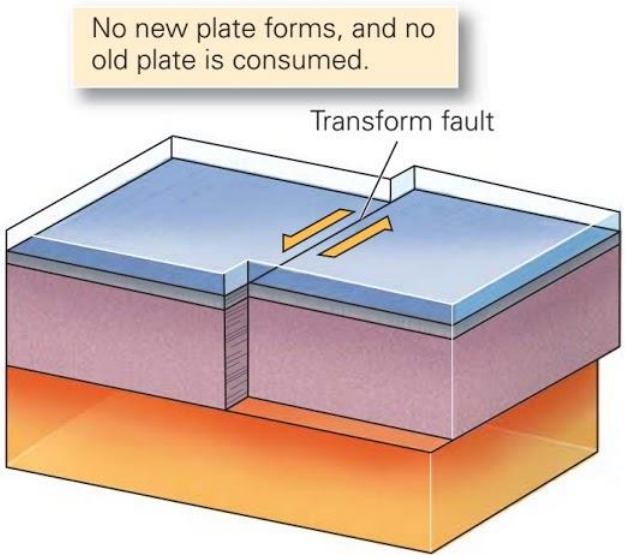
LÍMITES OU BORDES DE PLACA



DIVERXENTES

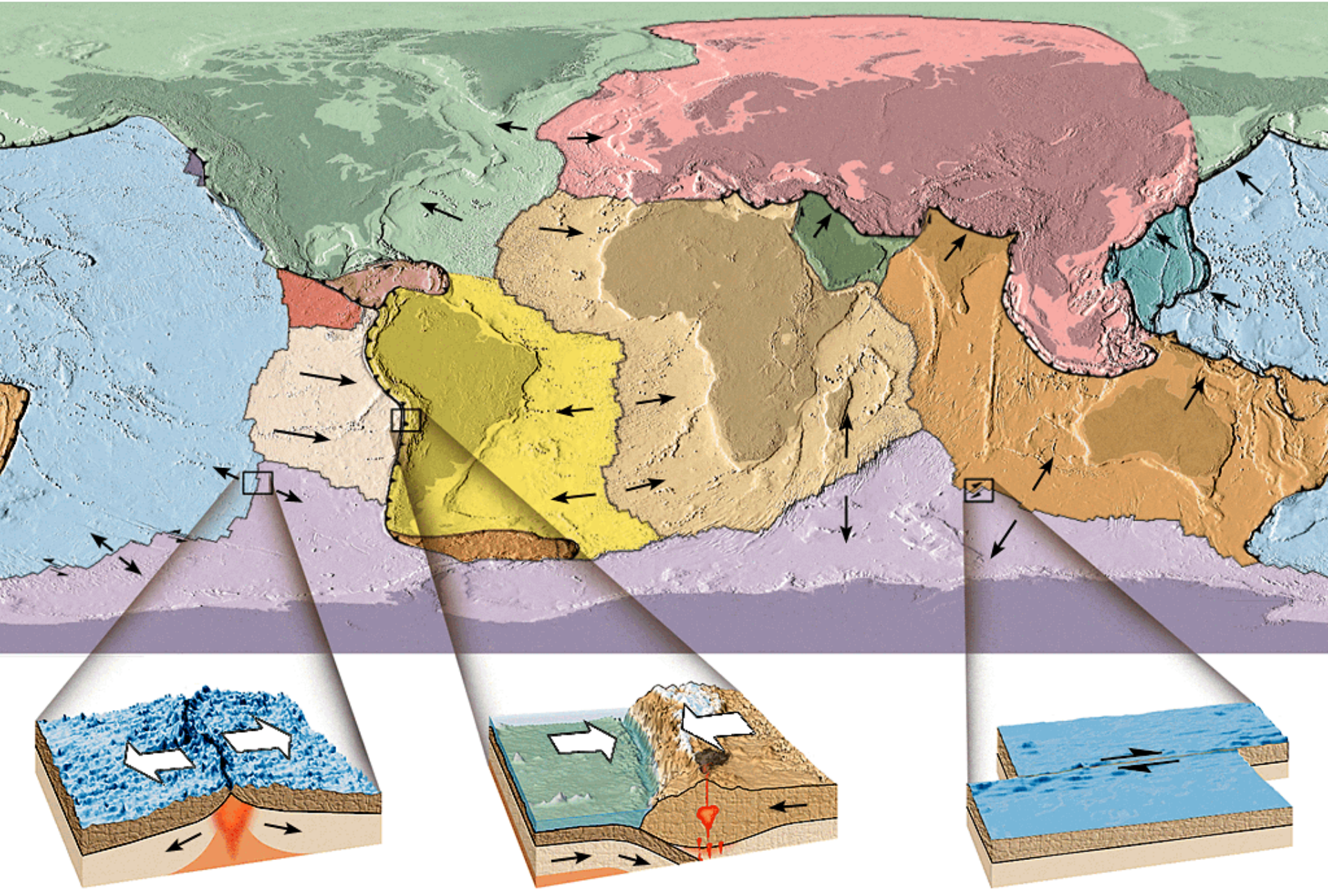


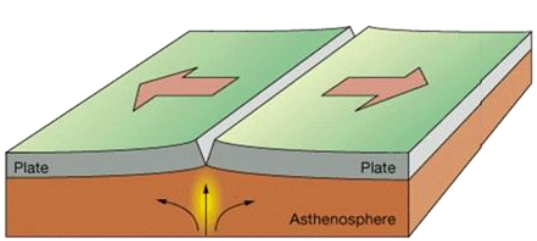
CONVERXENTES

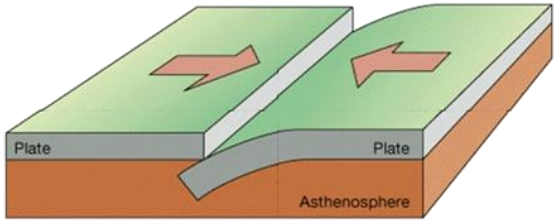


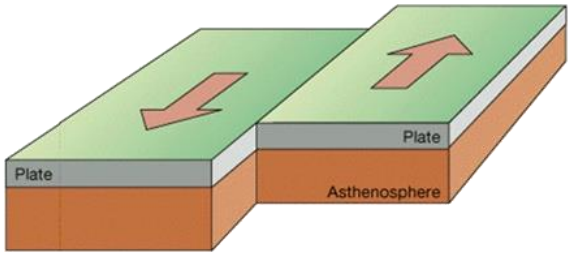
DESLIZANTES

LÍMITES OU BORDES DE PLACA

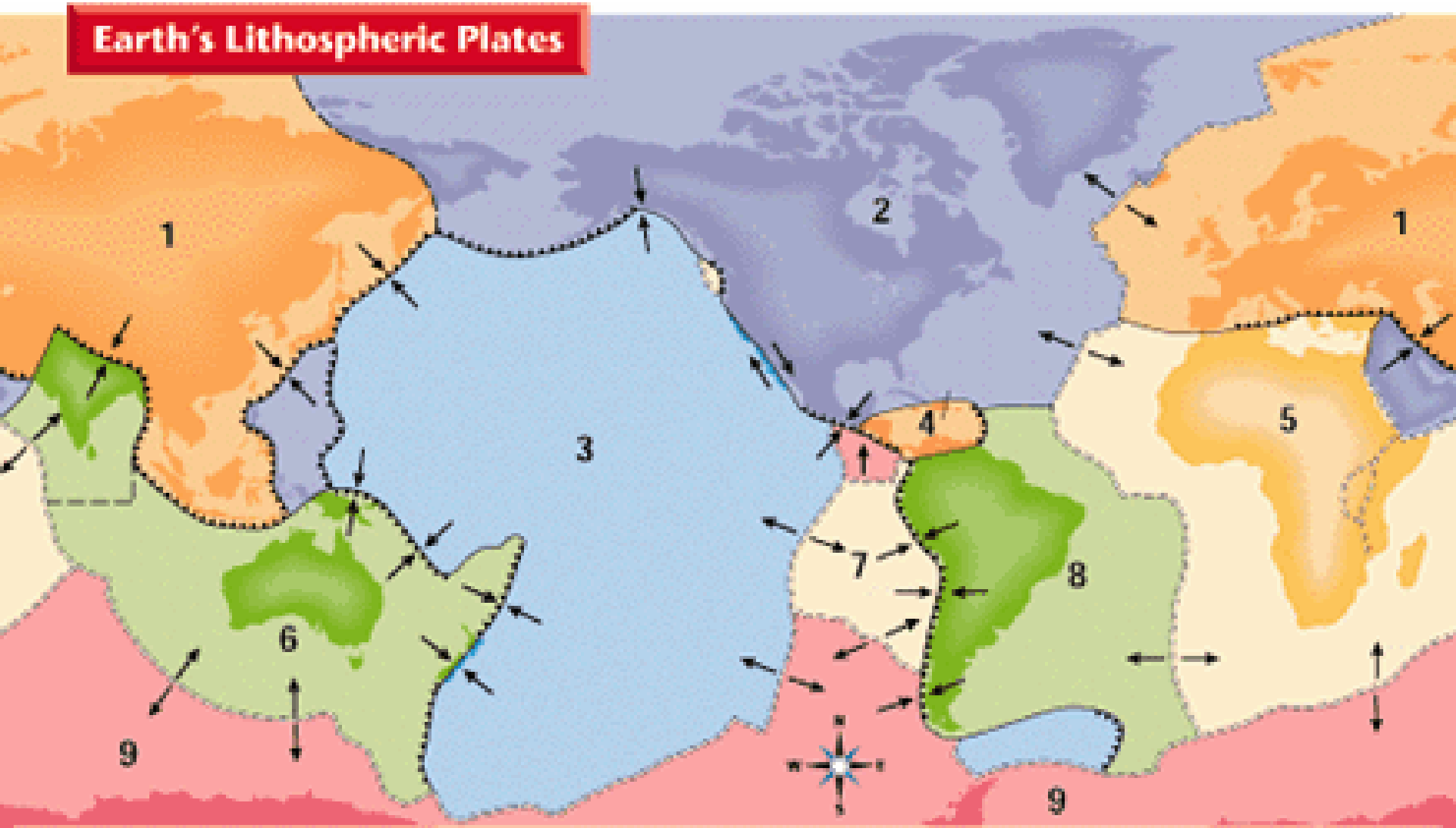




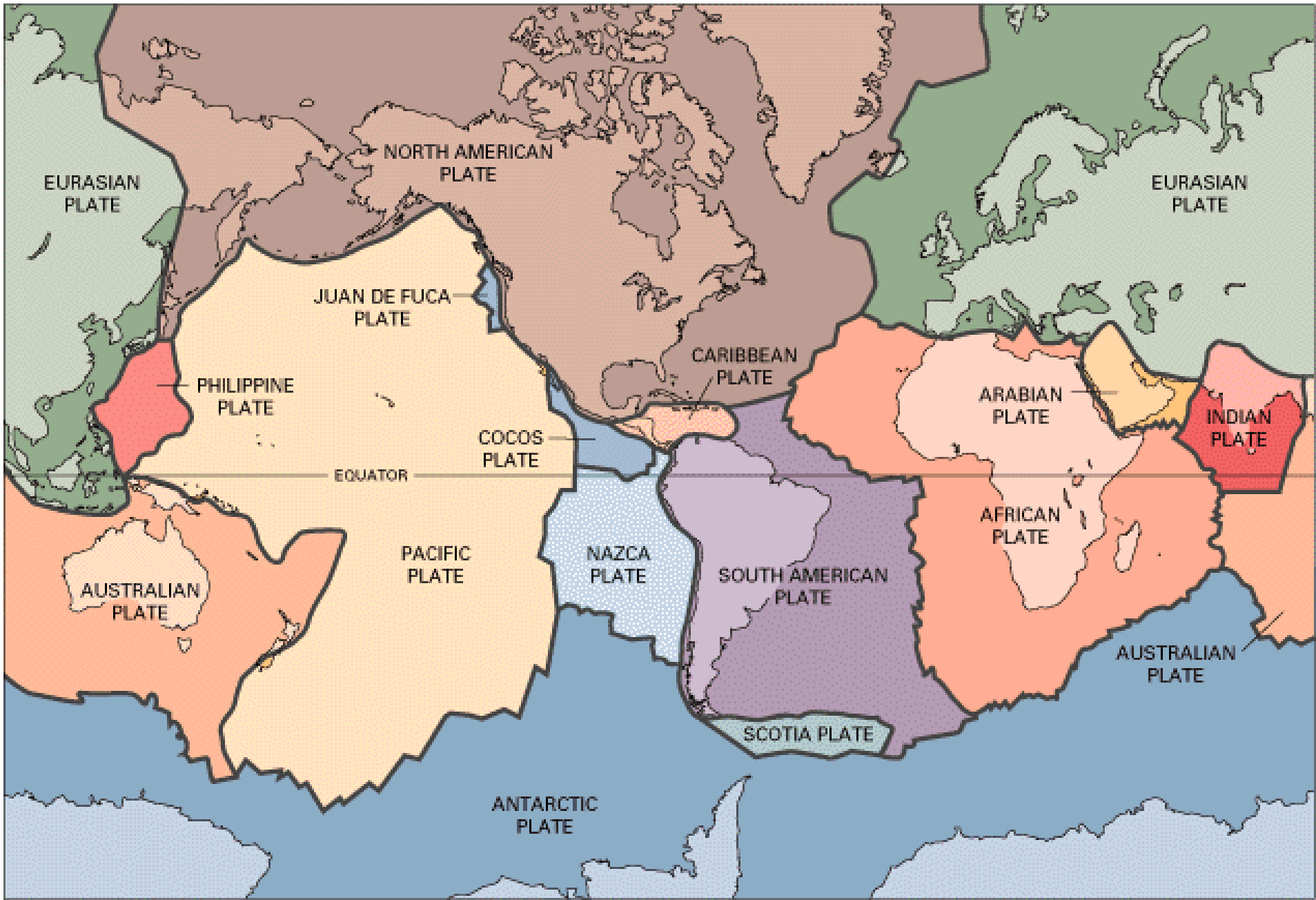




Earth's Lithospheric Plates

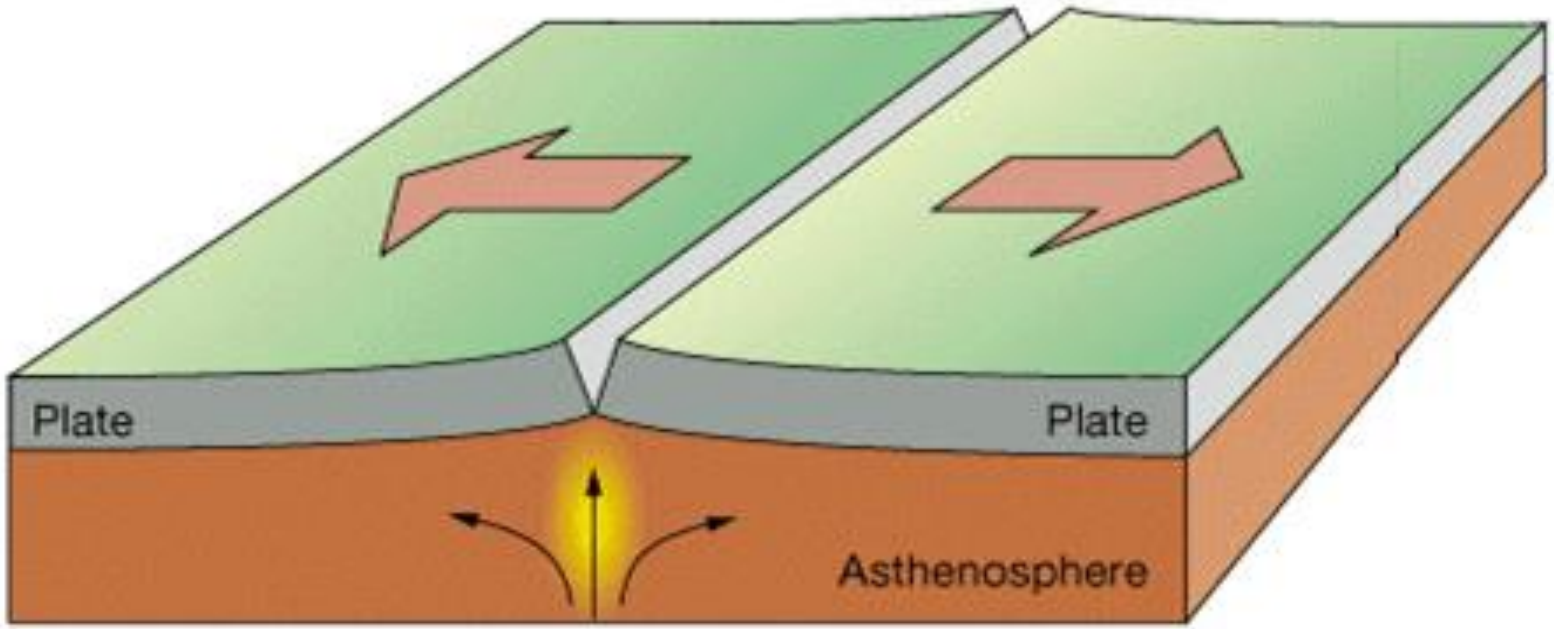


AS PLACAS LITOSFÉRICAS

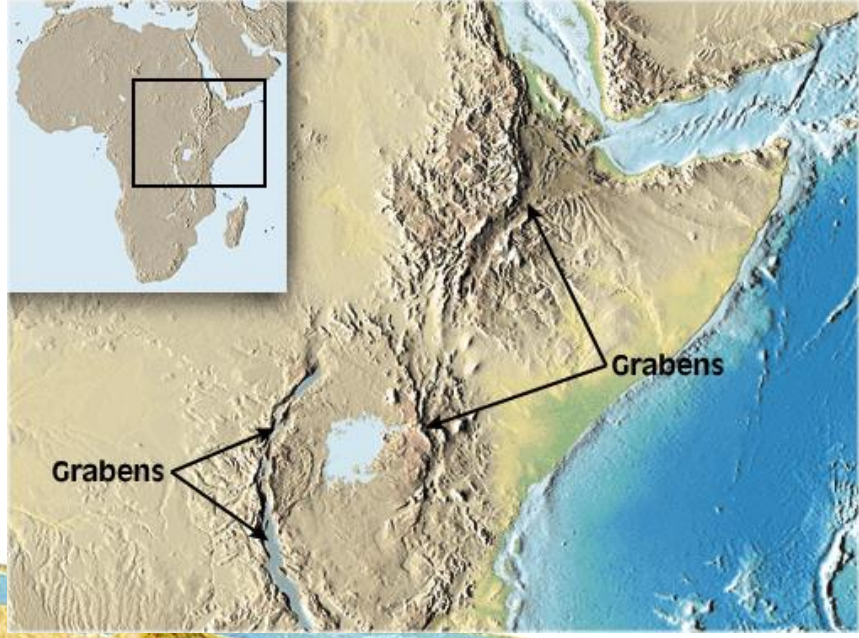


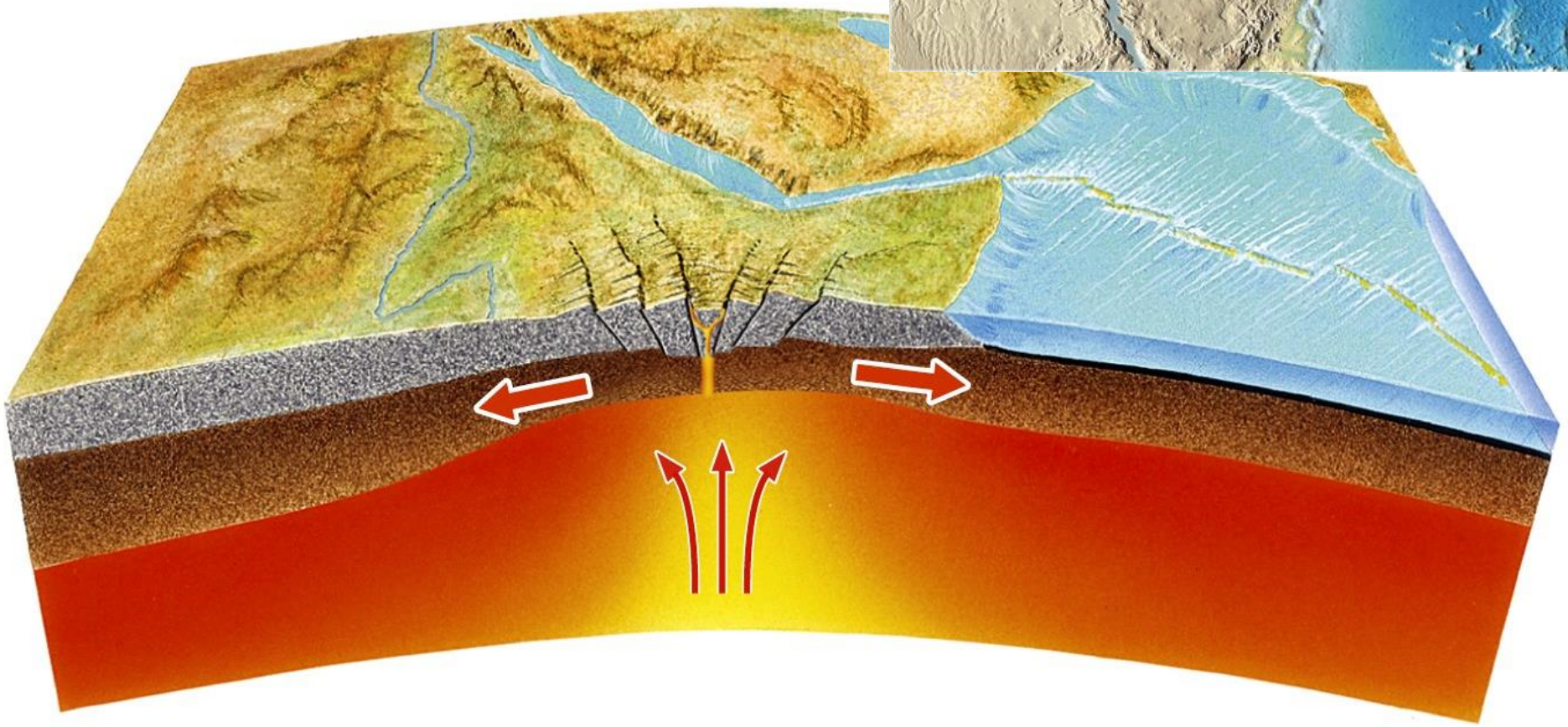
Límites diverxentes

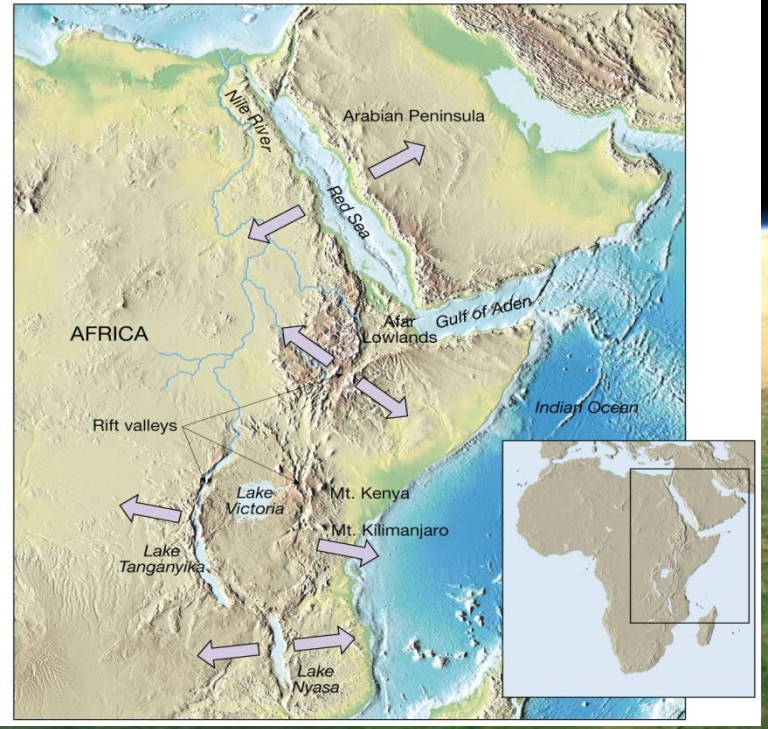
- As placas se separan.
- Son **bordos construtivos** nos que **se crea litosfera oceánica** ao ascender materiais do manto.
- Provocan actividade volcánica.
- Estes bordos coinciden con dúas estruturas xeolóxicas:
  - As **dorsais oceánicas.**
  - Os **Rifts continentais.**



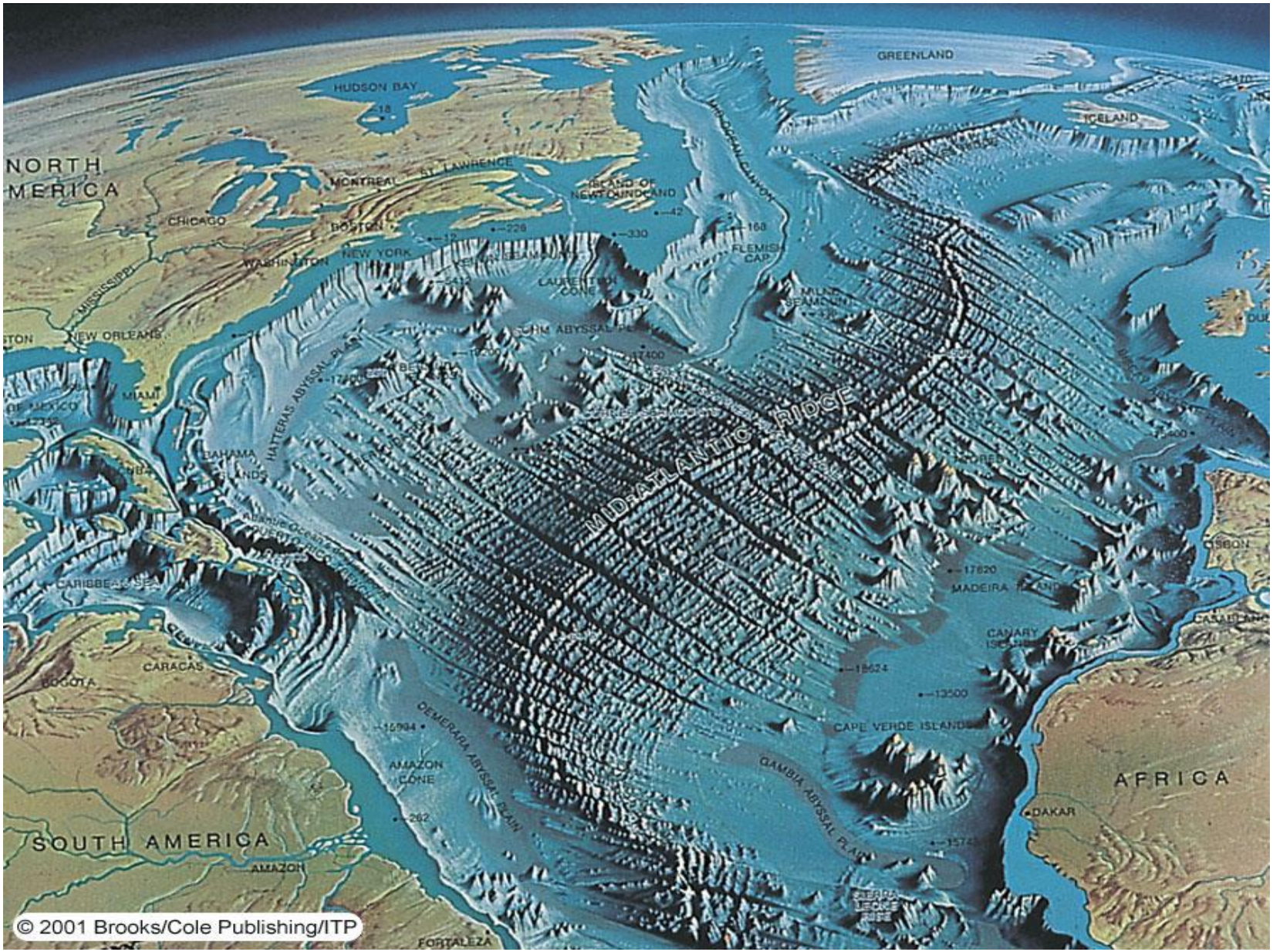
Rift continental



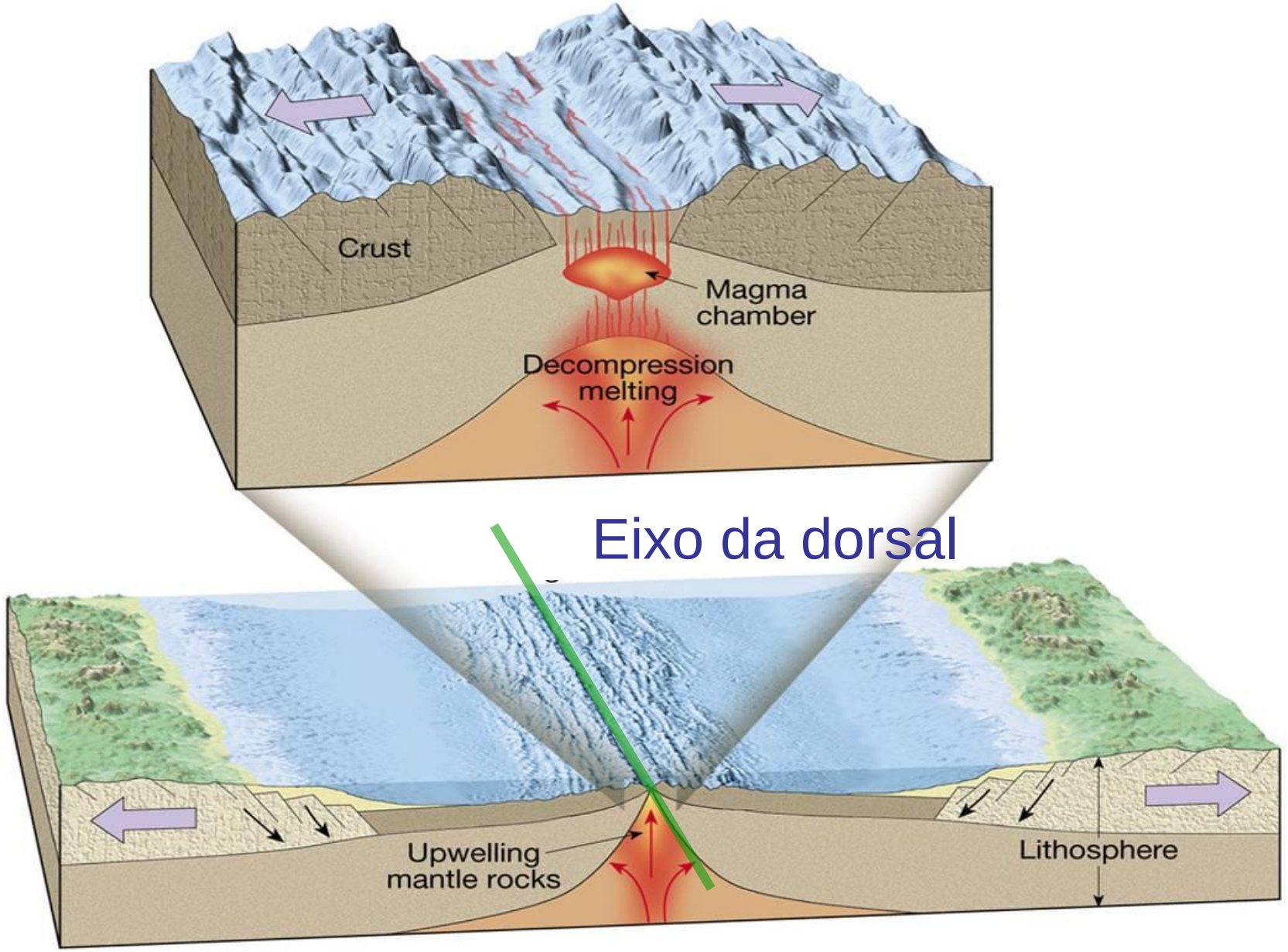


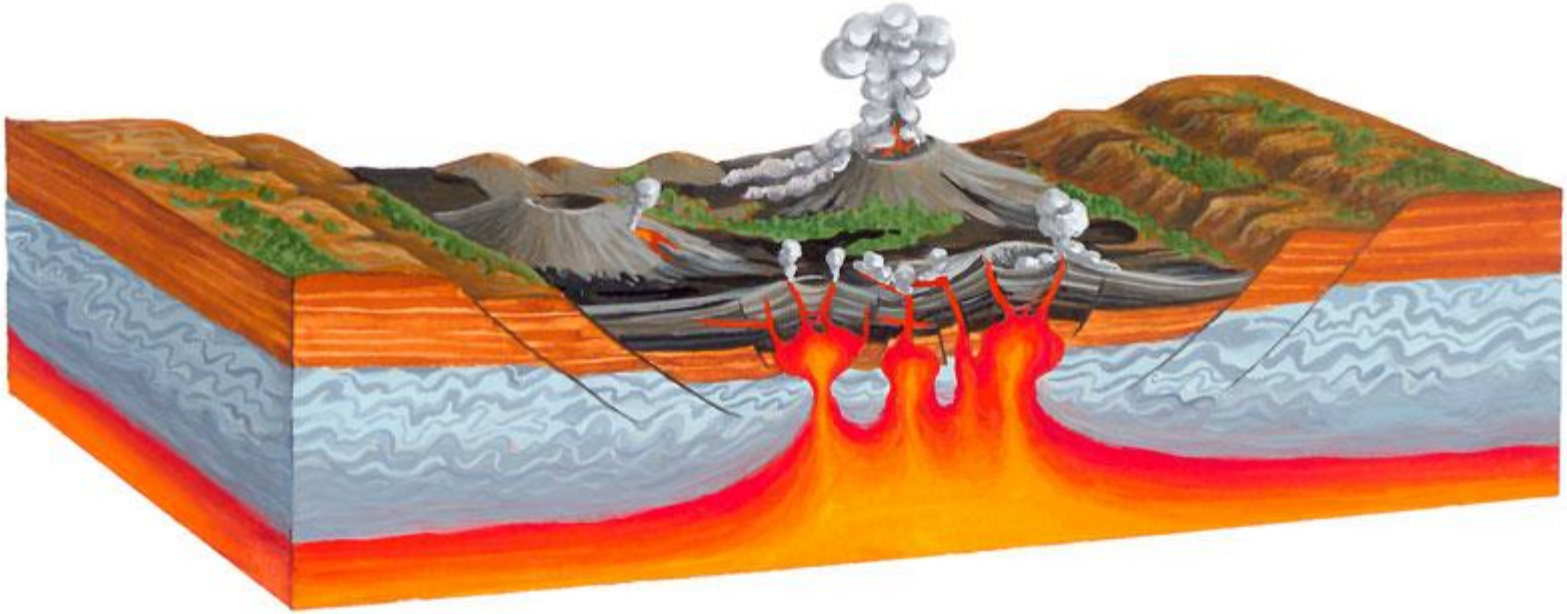


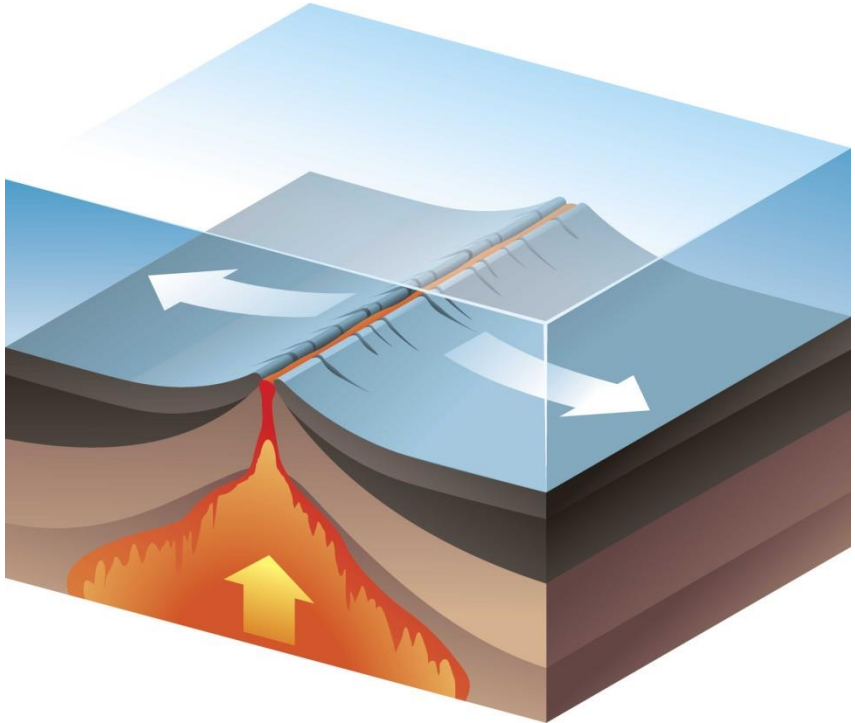
Bordes diverxentes: dorsais oceánicas



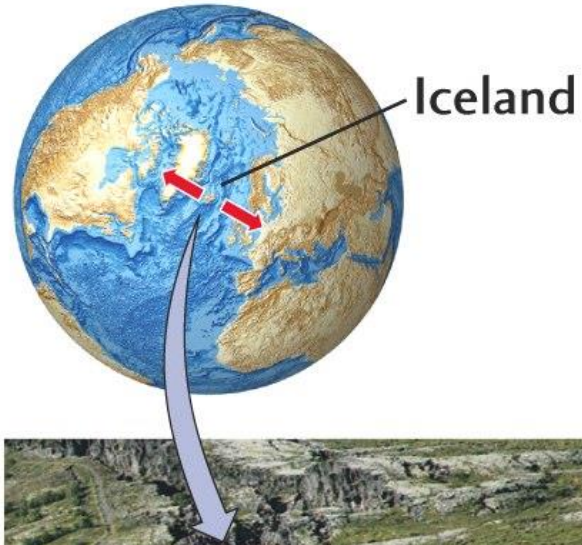
Rift axial

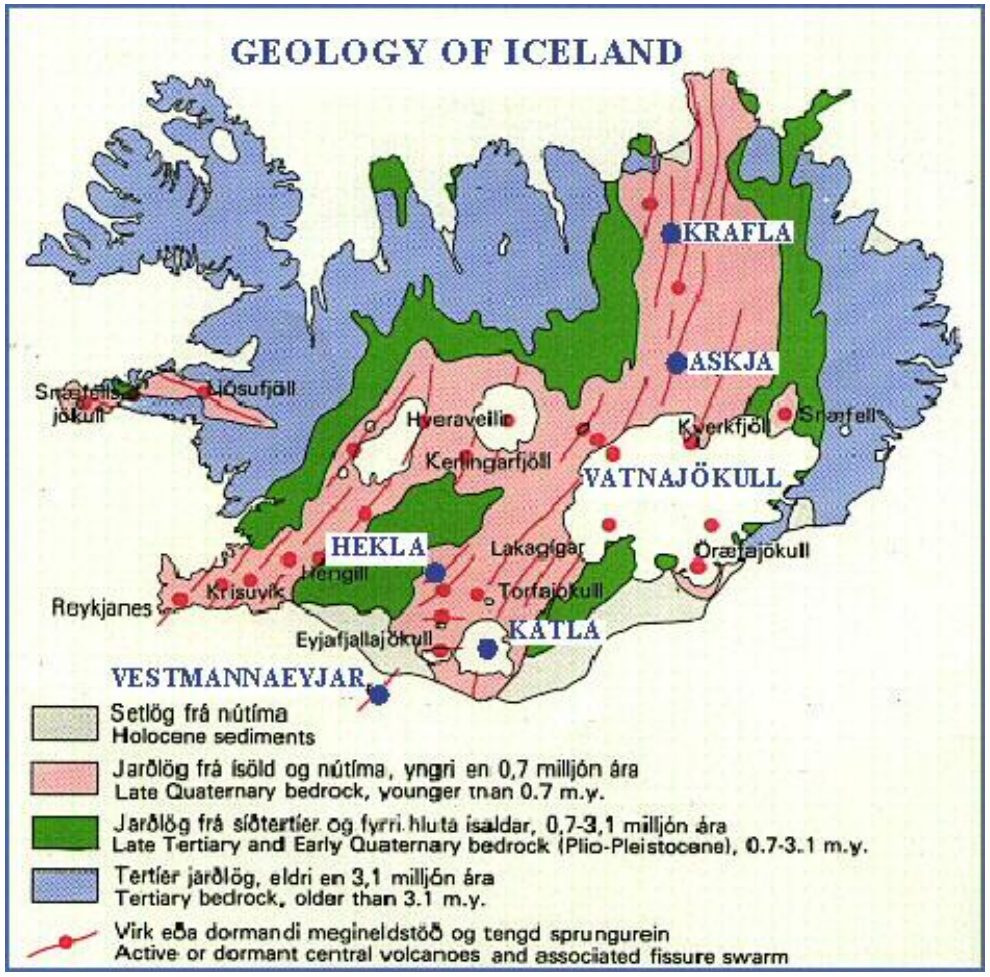

Crust
Magma chamber
Decompression melting
Eixo da dorsal
Upwelling mantle rocks
Lithosphere

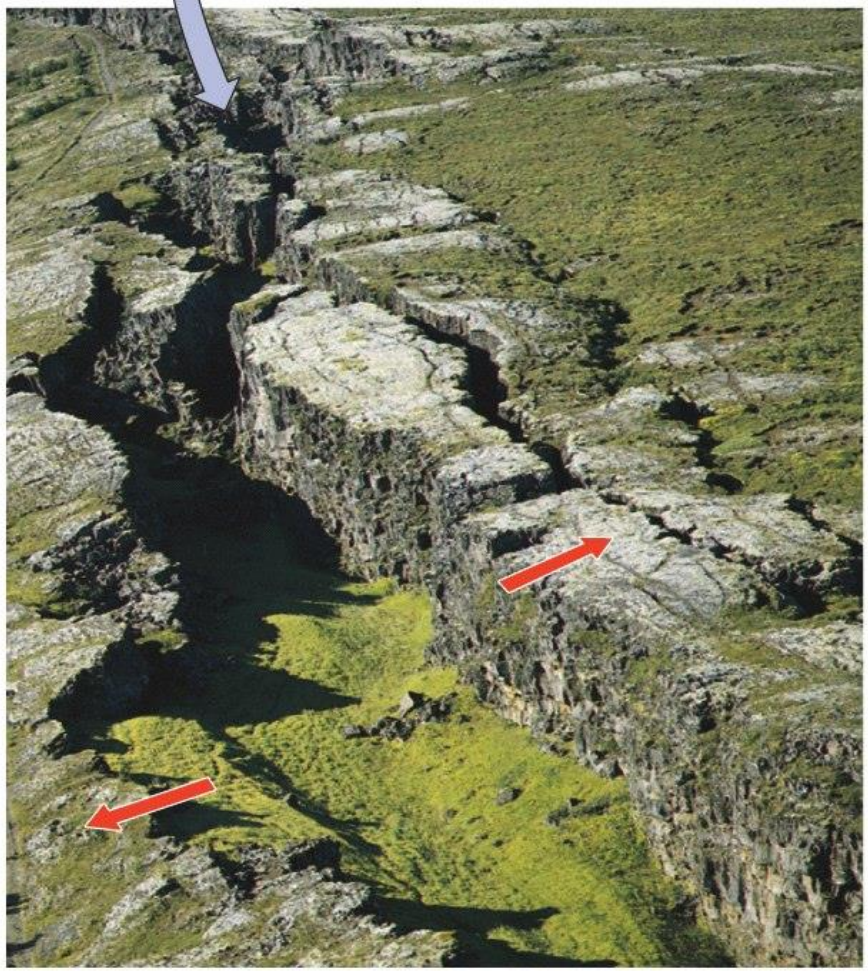


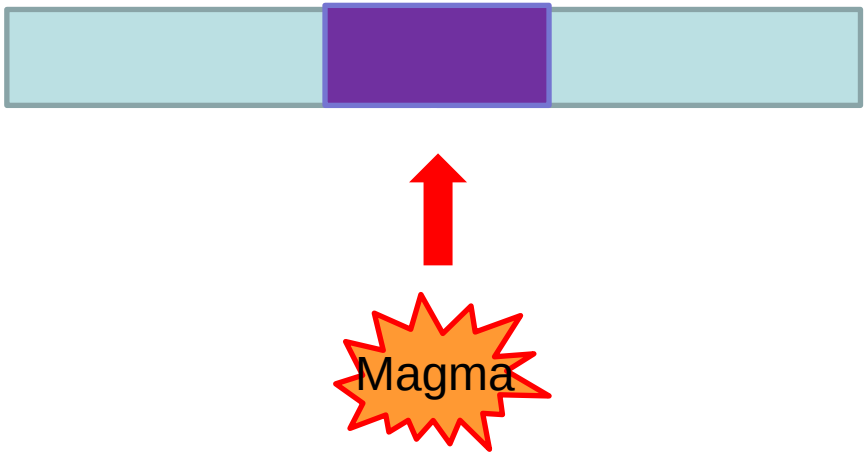


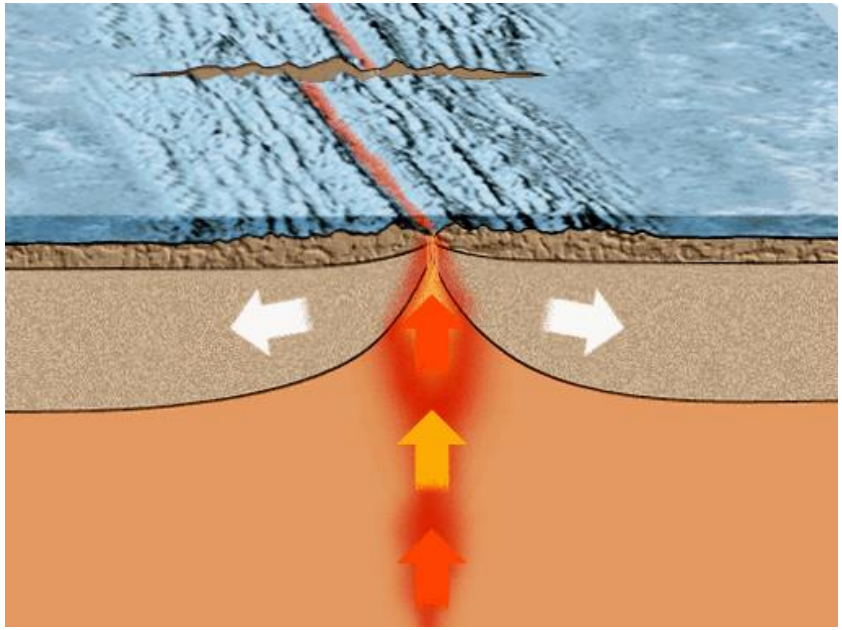
ISLANDIA

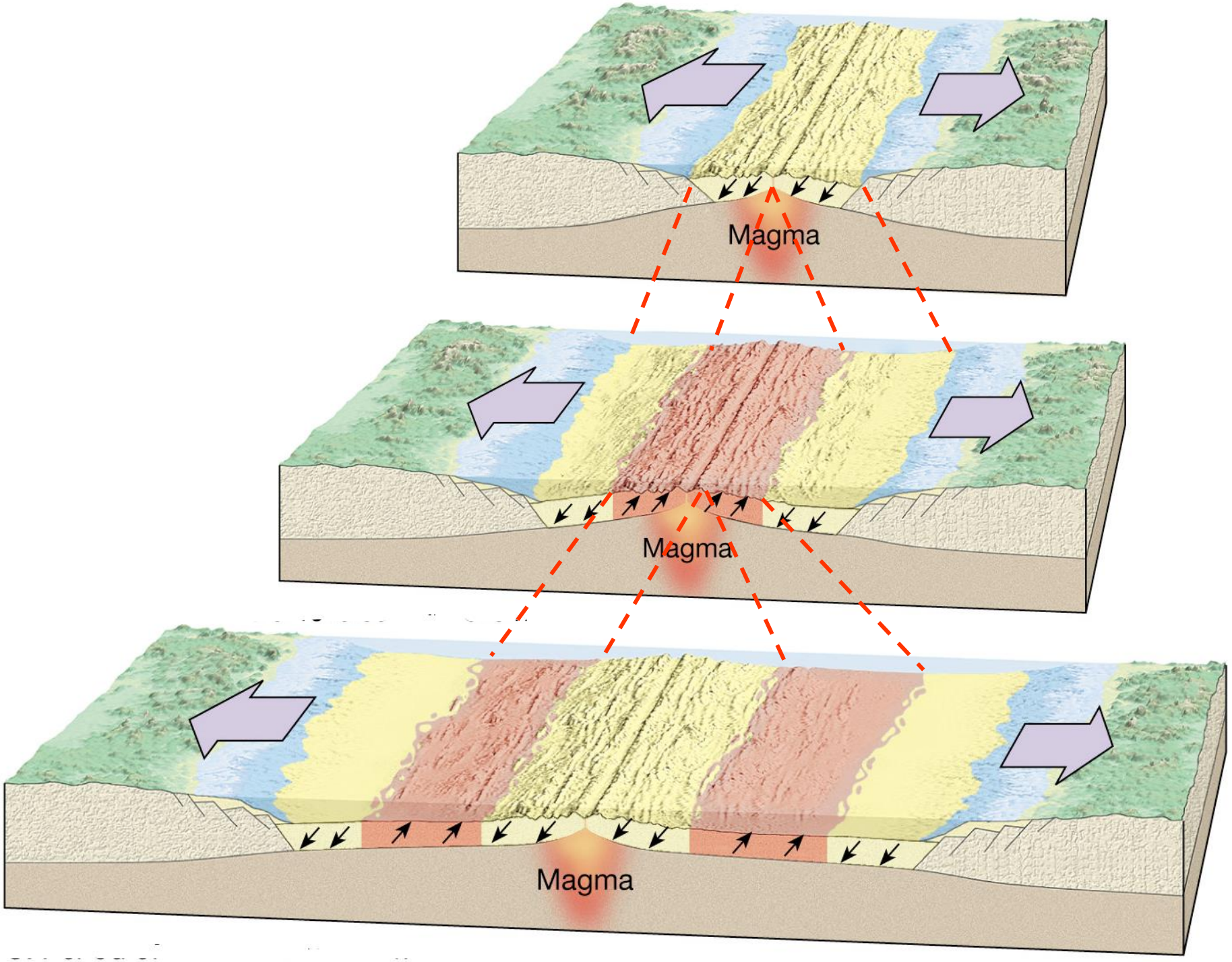

Iceland


GEOLOGY OF ICELAND
KRAFLA
ASKJA
Snæfellsjökull
Ljósufjöll
Hveravellir
Kverkfjöll
Snæfell
Kerlingarfjöll
VATNAJÖKULL
HEKLA
Lakagígar
Öræfajökull
Hengill
Krísuvík
Reykjanes
Torfajökull
KATLA
Eyjafjallajökull
VESTMANNAEYJAR
Setlög frá nútíma
Holocene sediments
Jarðlög frá ísöld og nútíma, yngri en 0,7 milljón ára
Late Quaternary bedrock, younger than 0.7 m.y.
Jarðlög frá síðtertíer og fyrri hluta ísaldar, 0,7-3,1 milljón ára
Late Tertiary and Early Quaternary bedrock (Plio-Pleistocene), 0.7-3.1 m.y.
Tertíer jarðlög, eldri en 3,1 milljón ára
Tertiary bedrock, older than 3.1 m.y.
Virk eða dormandi megineldstöð og tengd sprungurein
Active or dormant central volcanoes and associated fissure swarm

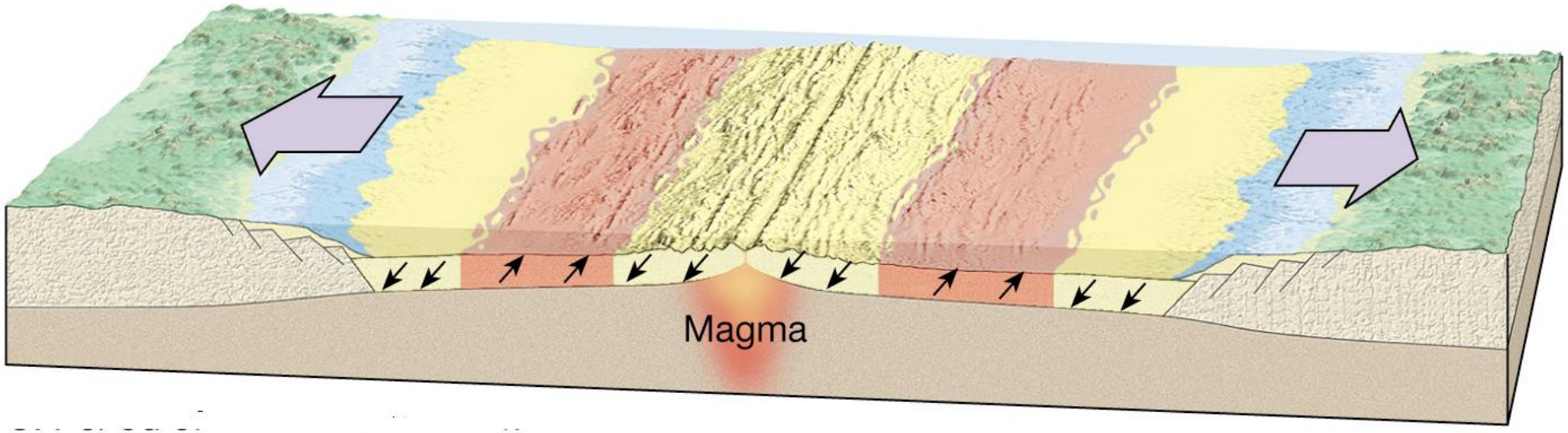



Magma

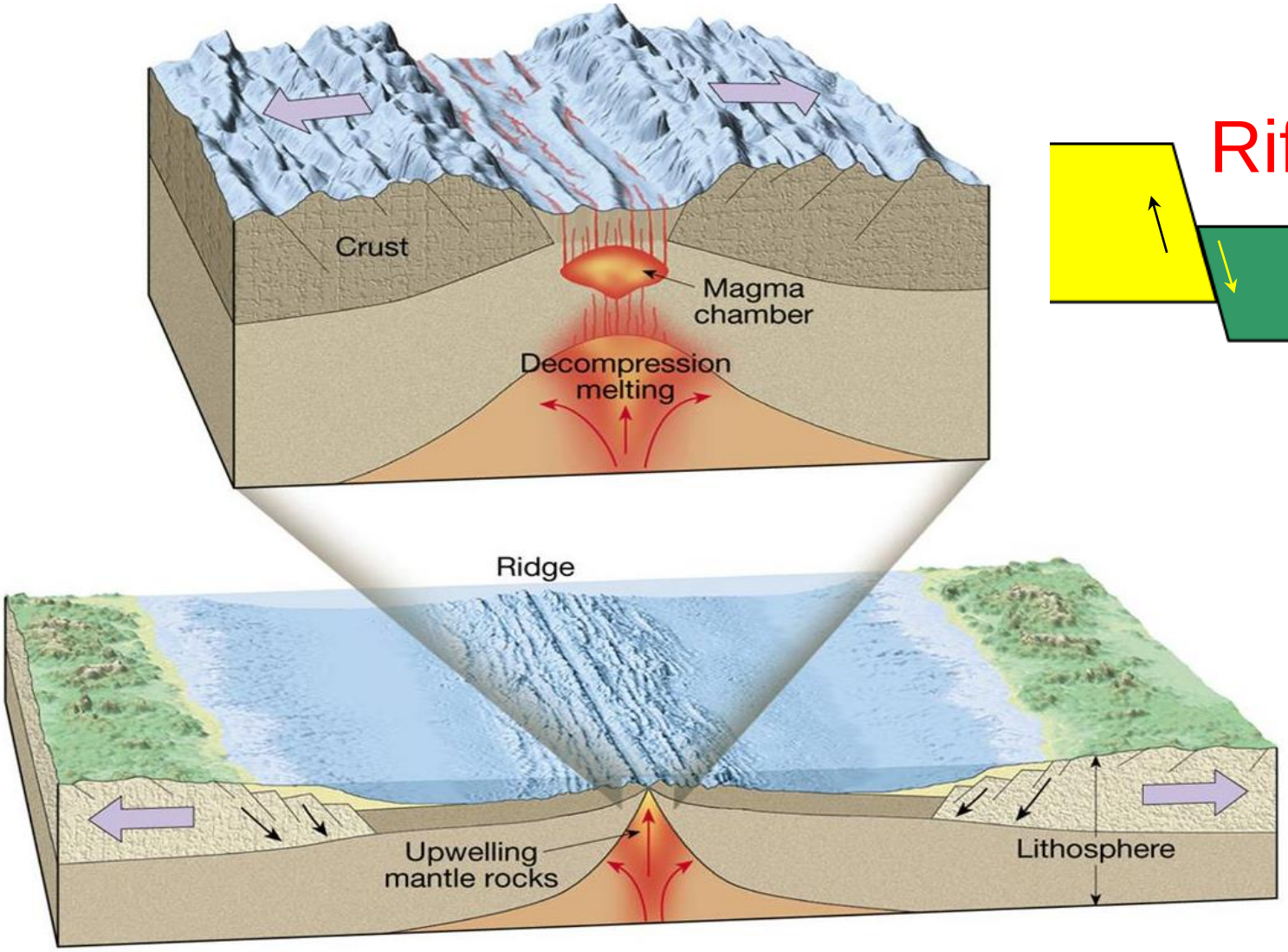


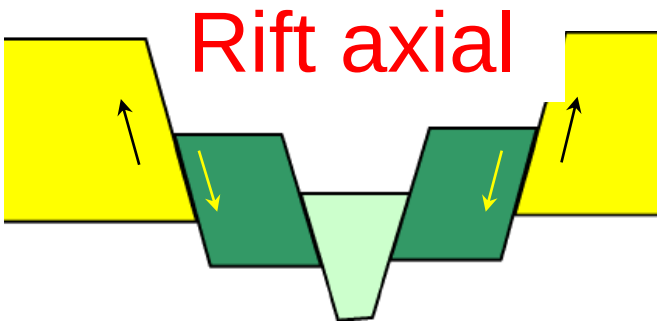

Magma
Magma
Magma

Expansión do fondo oceánico

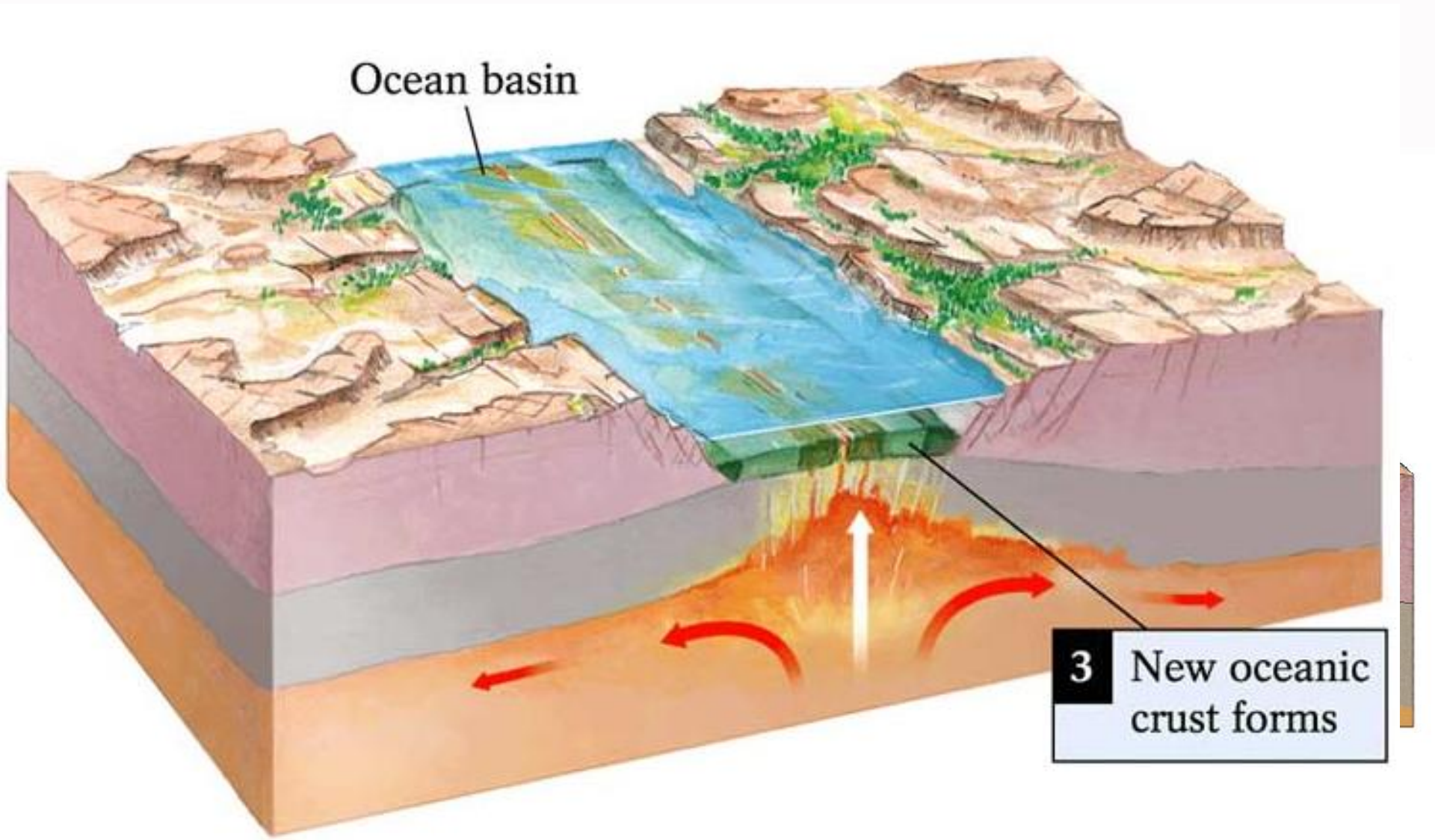


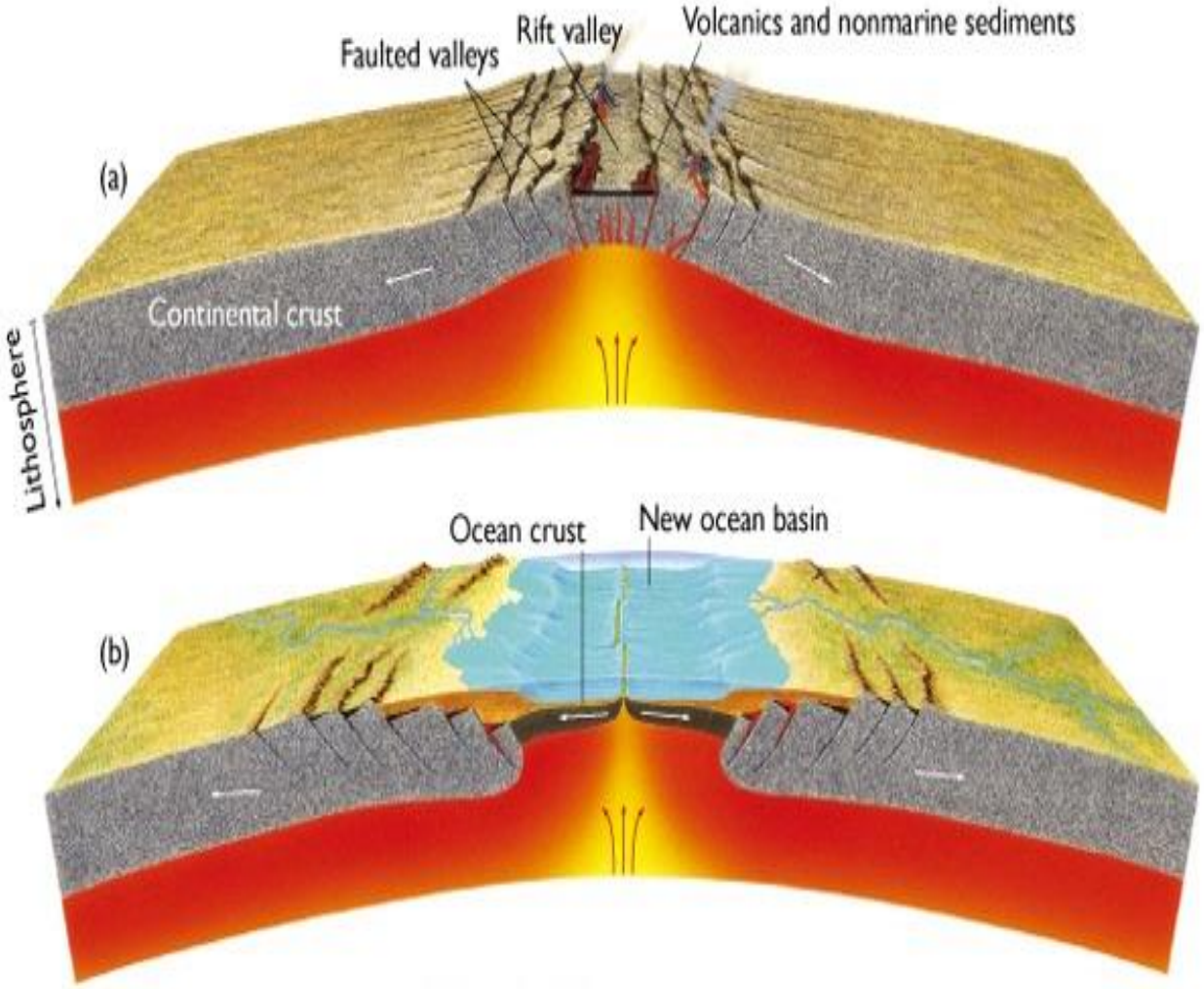
Seismos de foco superficial

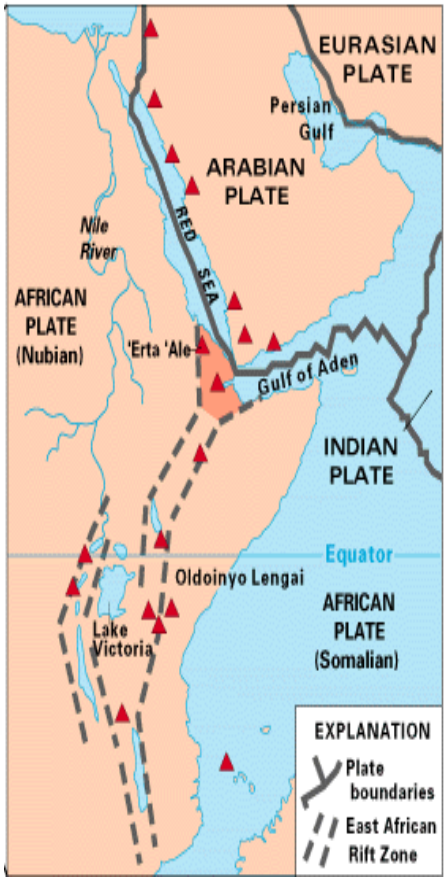


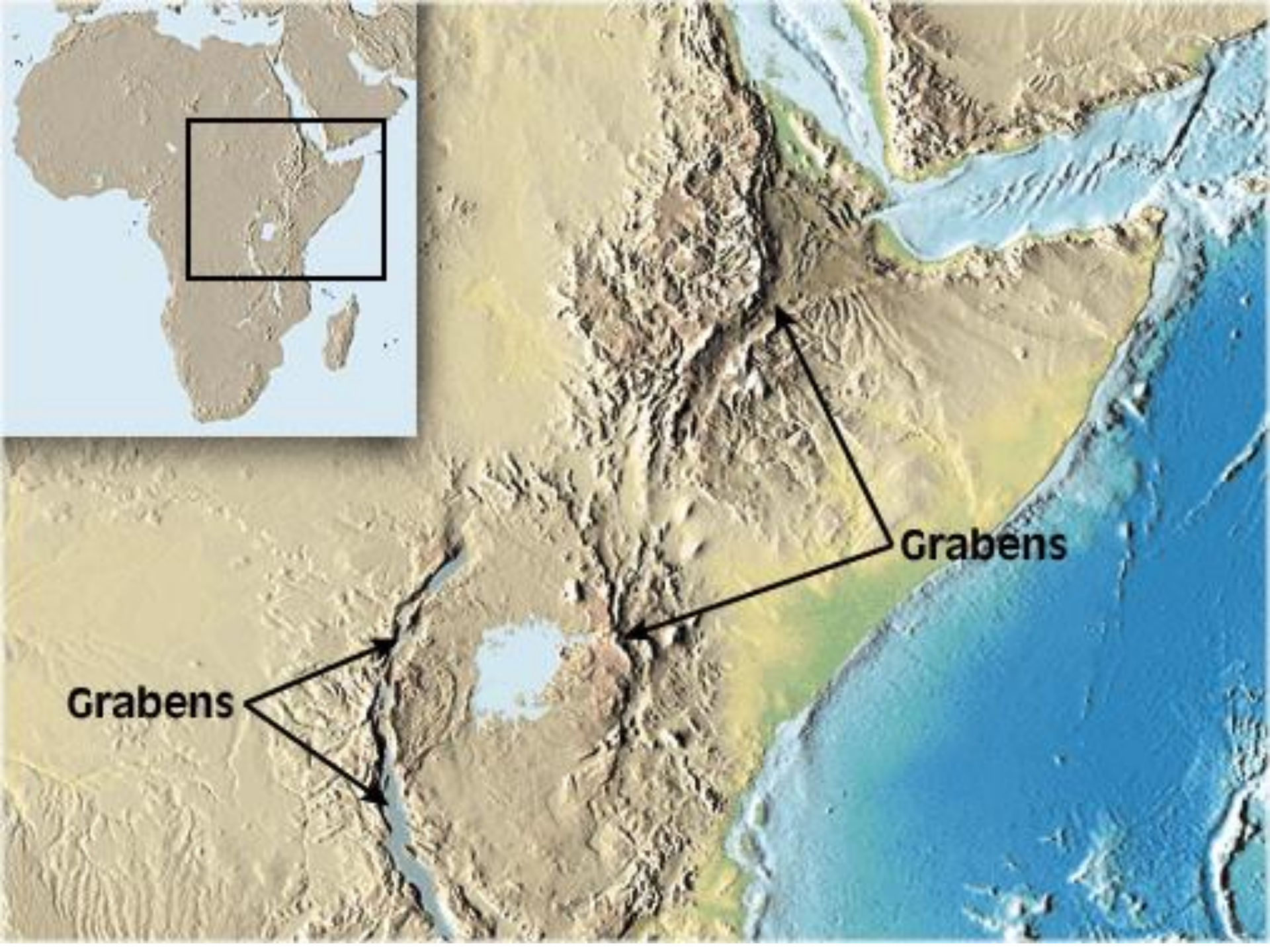


A FRAGMENTACIÓN CONTINENTAL



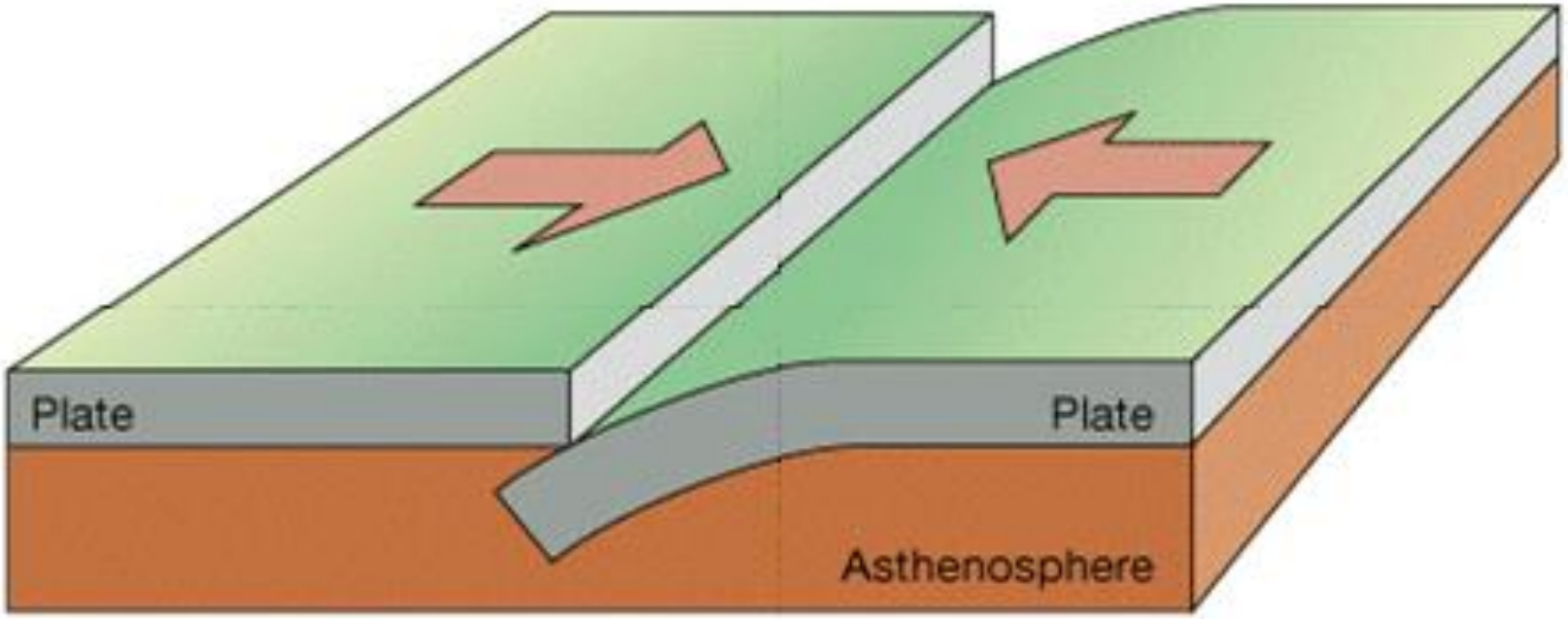

Faulted valleys
Rift valley
Volcanics and nonmarine sediments
(a)
Continental crust
Lithosphere
Ocean crust
New ocean basin
(b)


EURASIAN PLATE
Persian Gulf
ARABIAN PLATE
Nile River
RED SEA
AFRICAN PLATE (Nubian)
'Erta 'Ale
Gulf of Aden
INDIAN PLATE
Equator
Oldoinyo Lengai
AFRICAN PLATE (Somalian)
Lake Victoria
EXPLANATION
Plate boundaries
East African Rift Zone

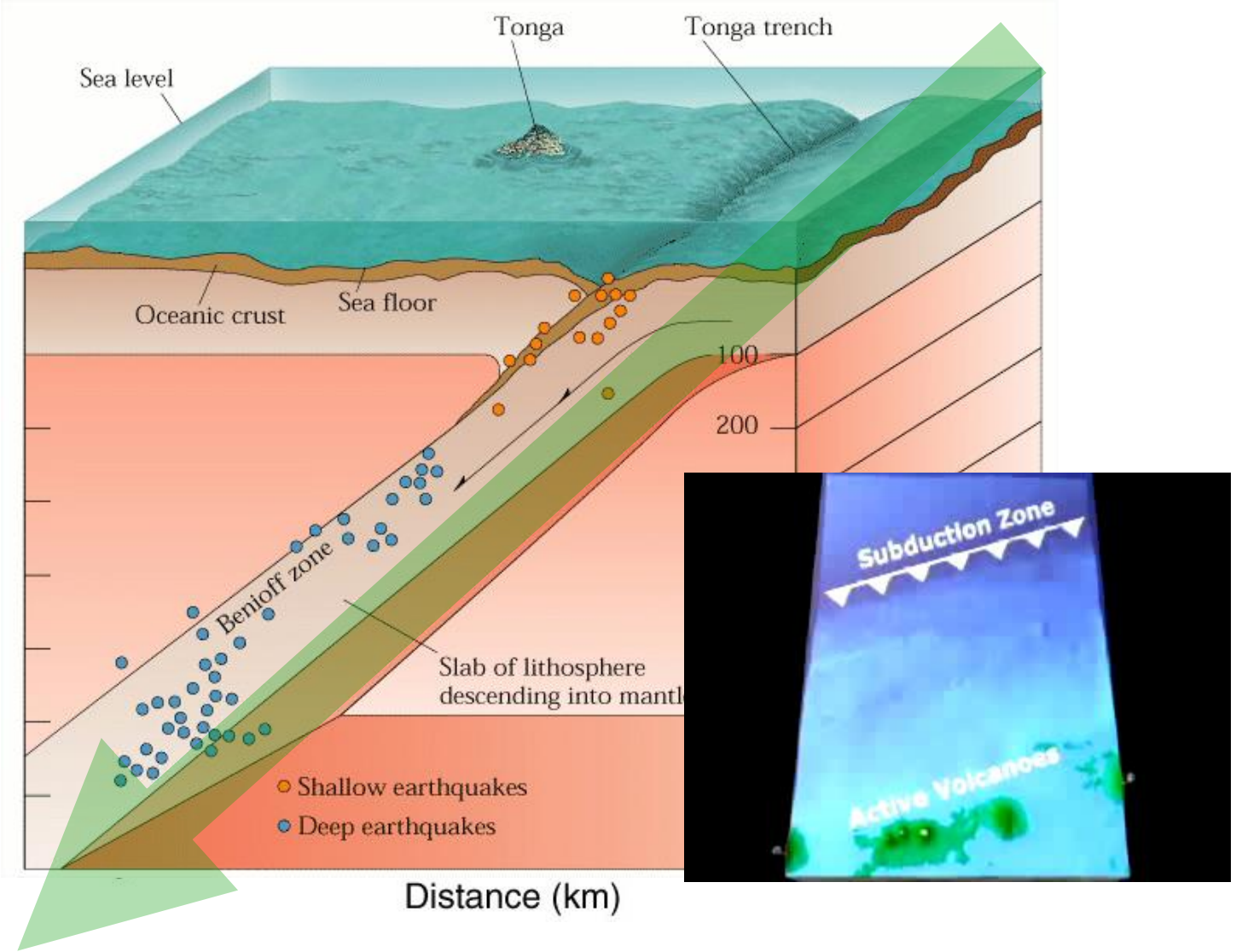

Grabens
Grabens

Límites converxentes

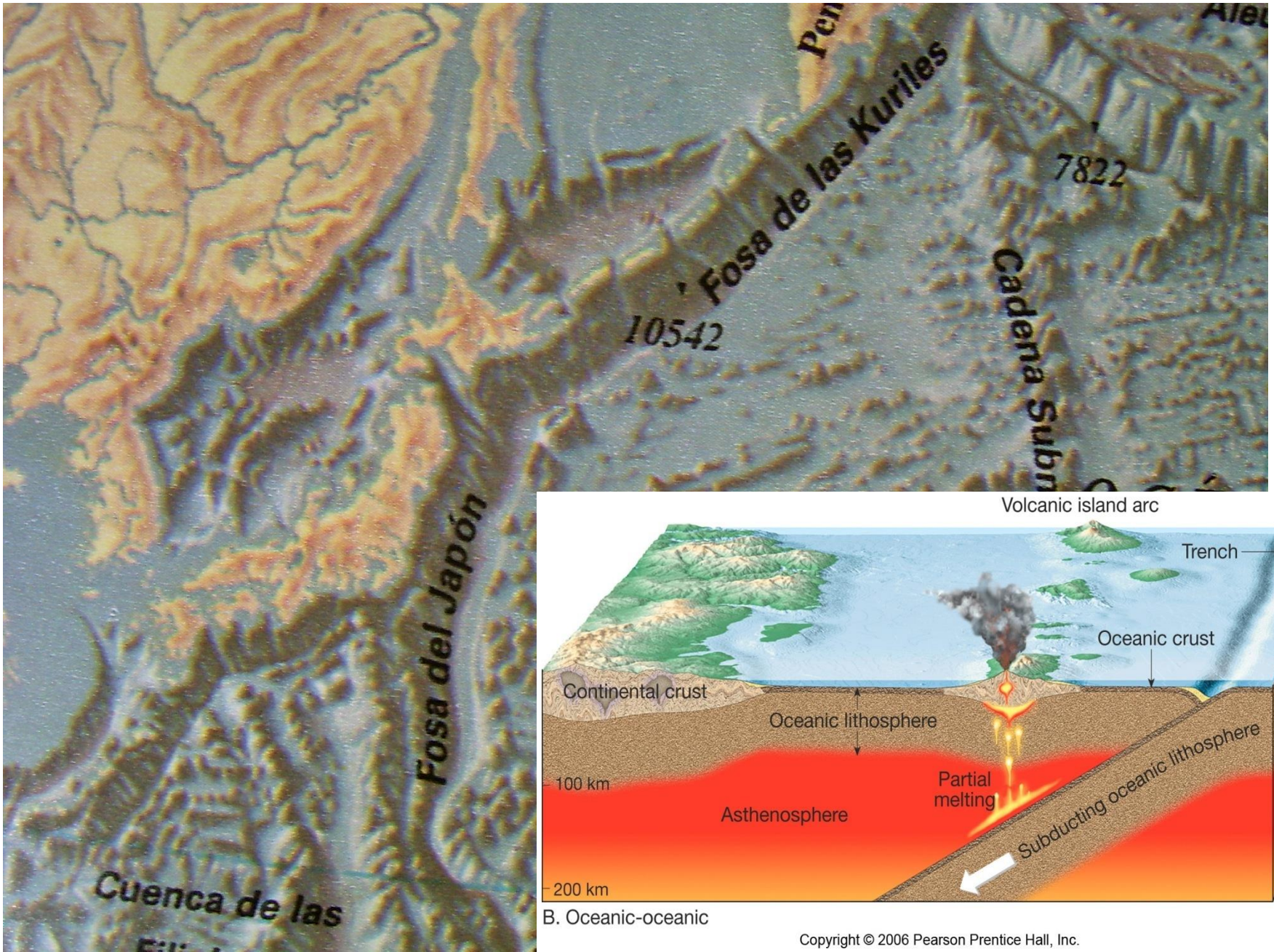
- As placas se xuntan.
- Son **bordos destrutivos** nos que **se destrúe litosfera**.
- Son **zonas de subdución** ou de **colisión continental**.
- Provocan numerosos sismos e actividade volcánica.



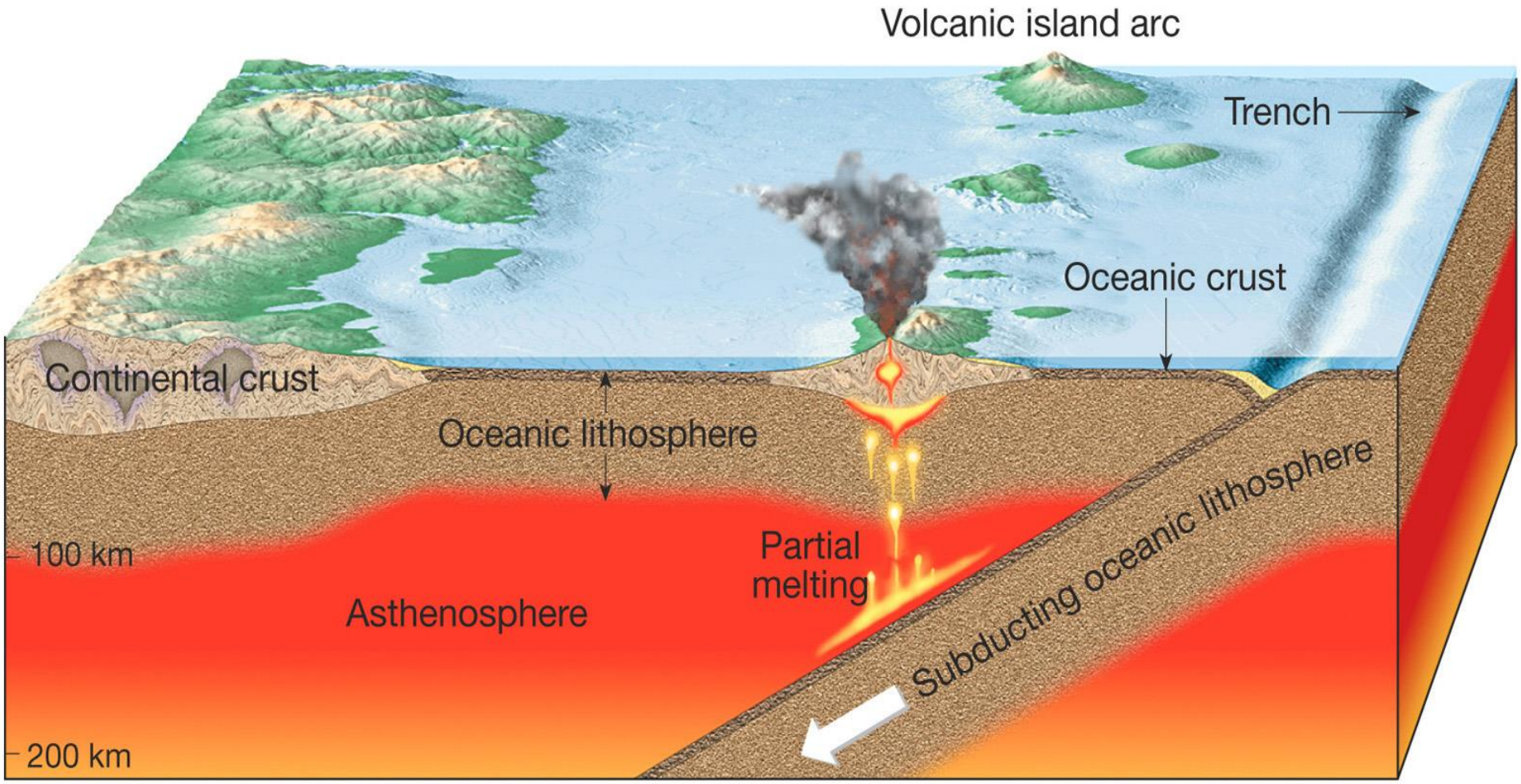
AS ZONAS DE SUBDUCCIÓN



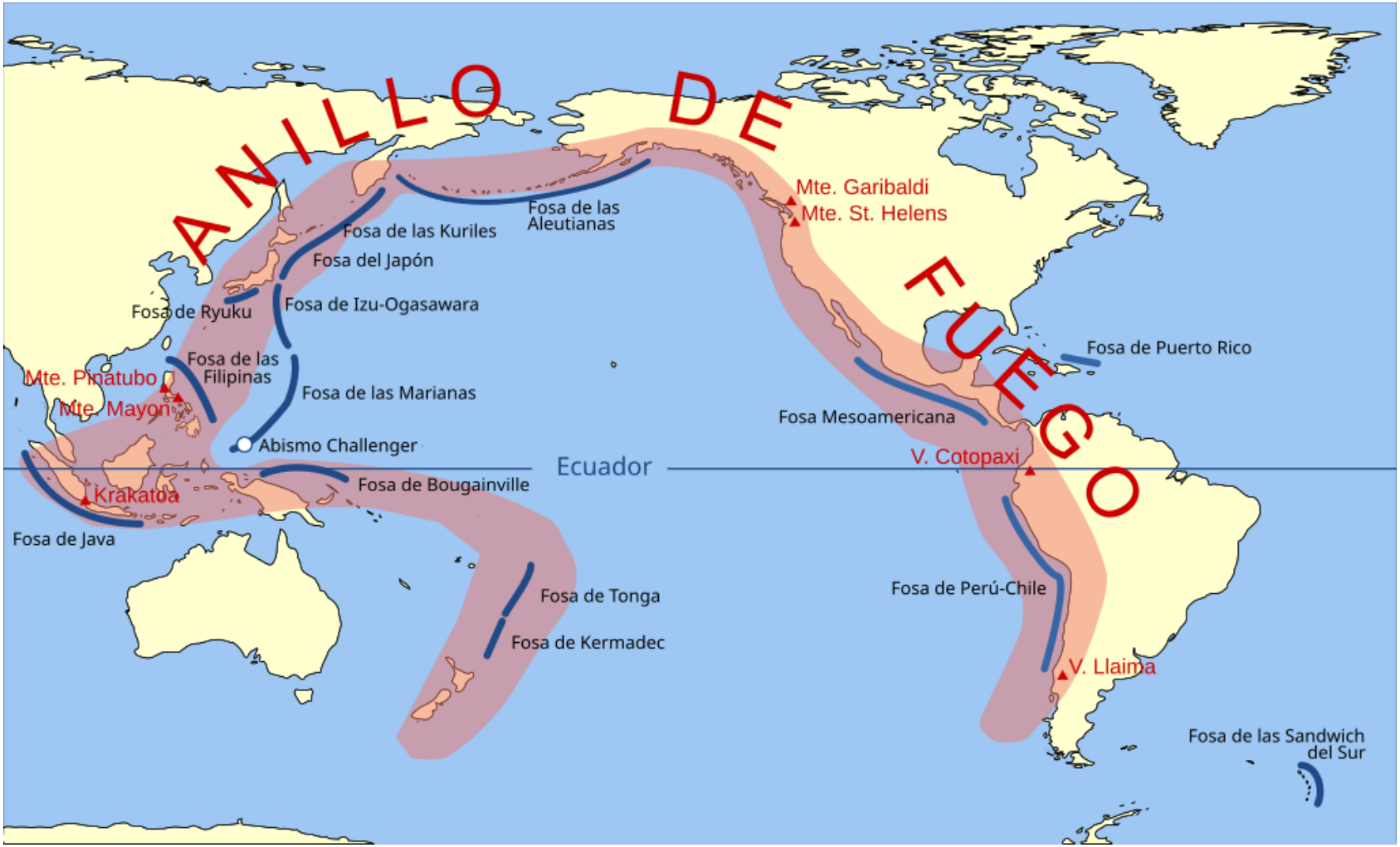
OCEÁNICA-OCEÁNICA: ARCOS-ILLAS

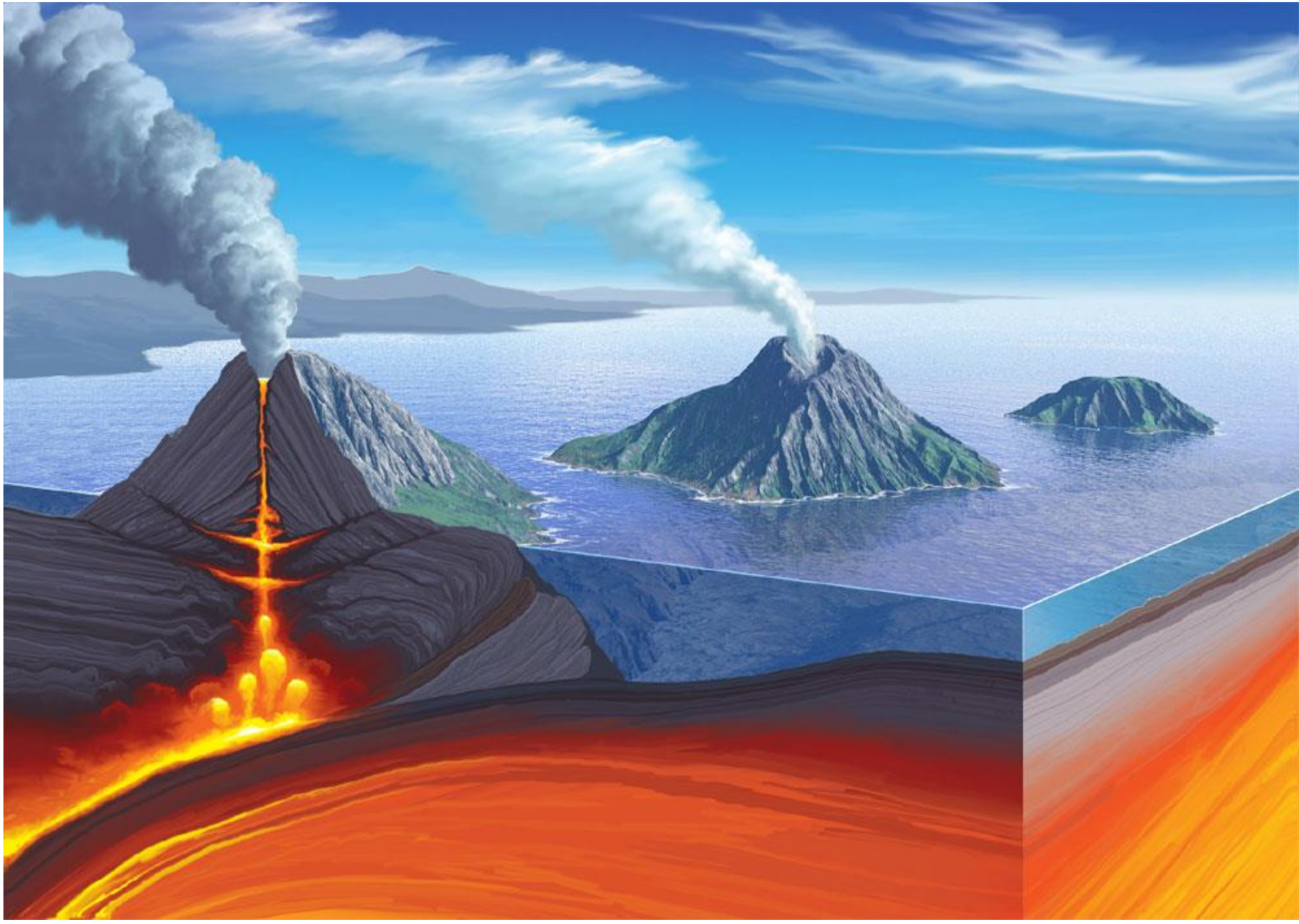


B. Oceanic-oceanic

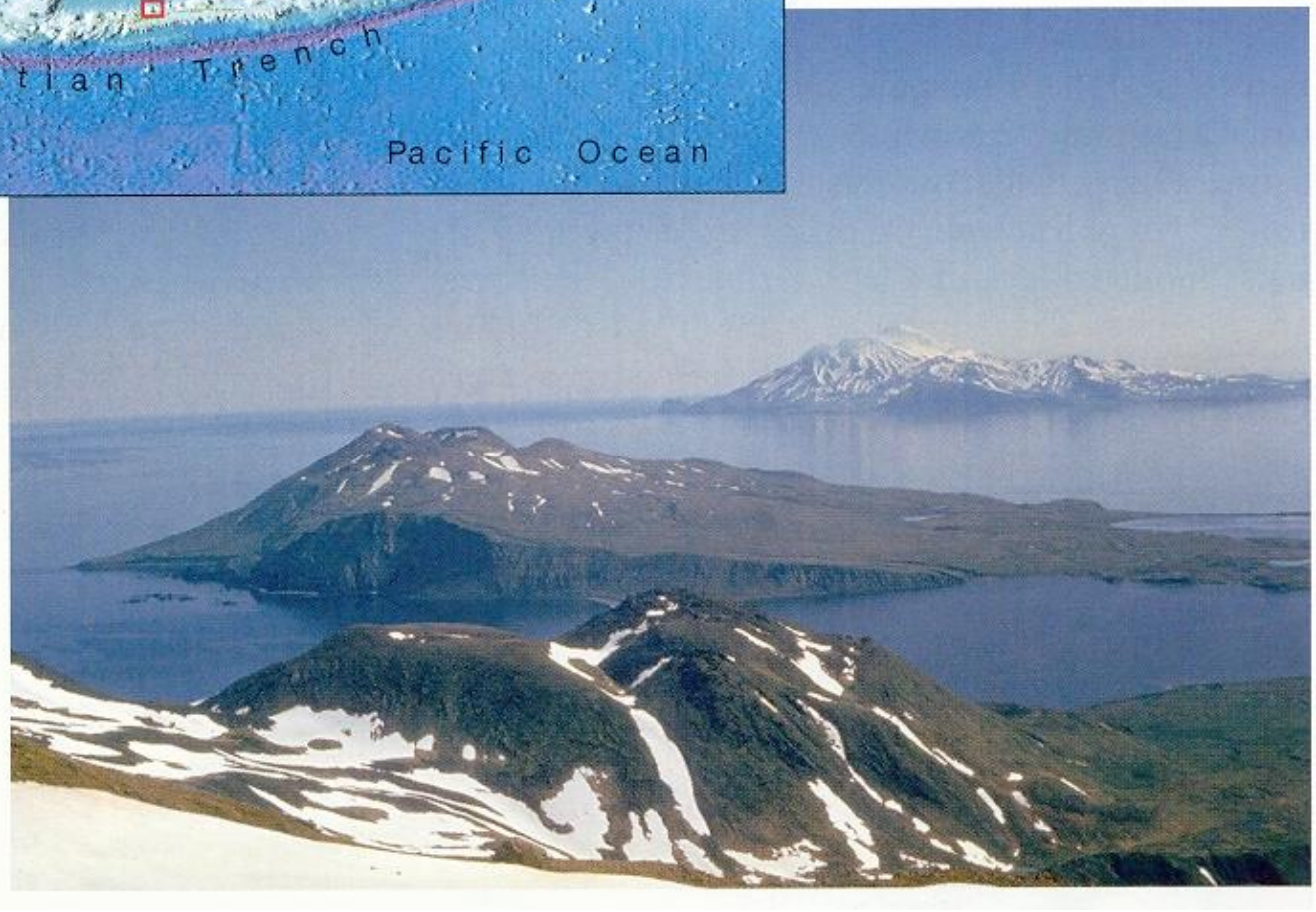


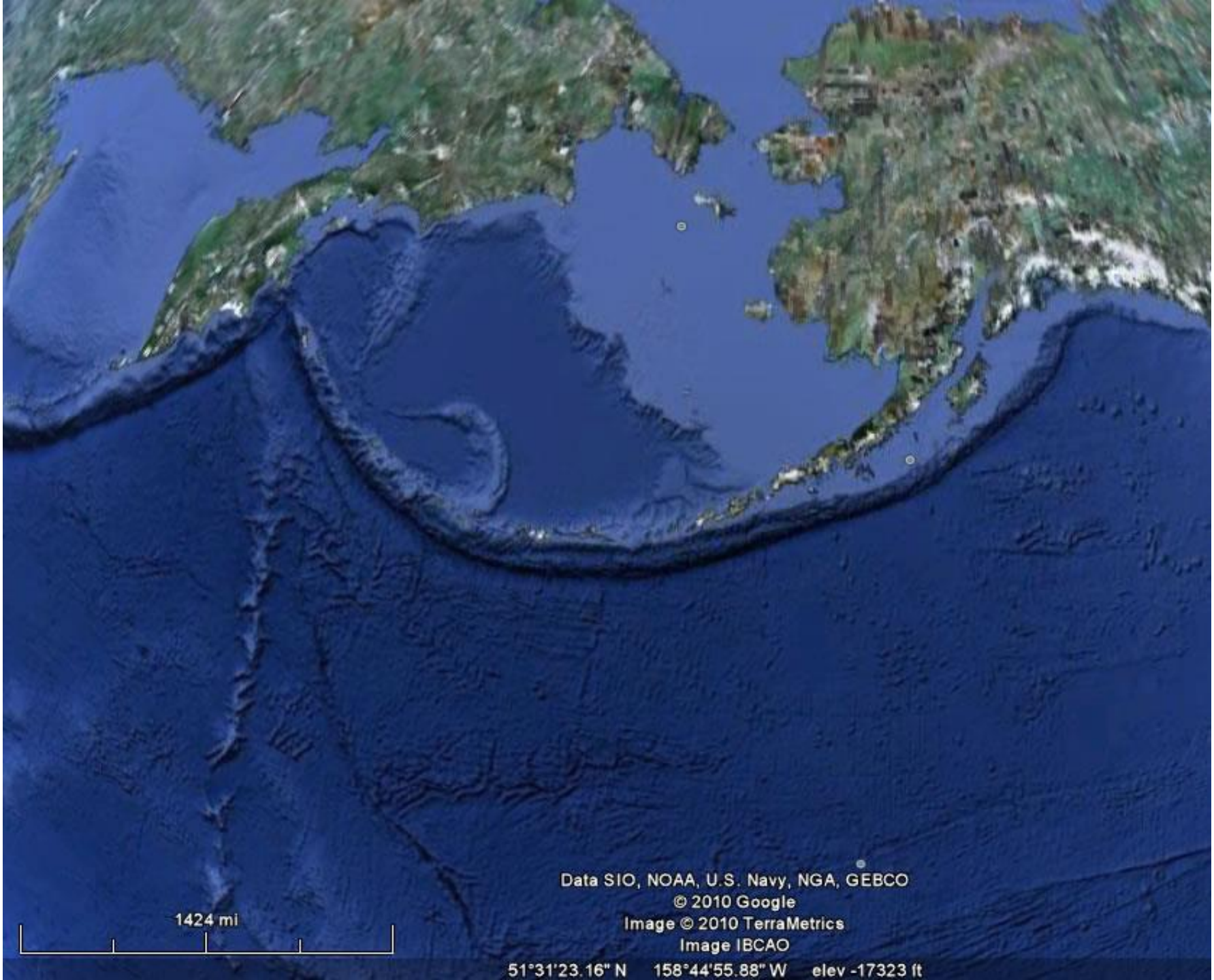
B. Oceanic-oceanic

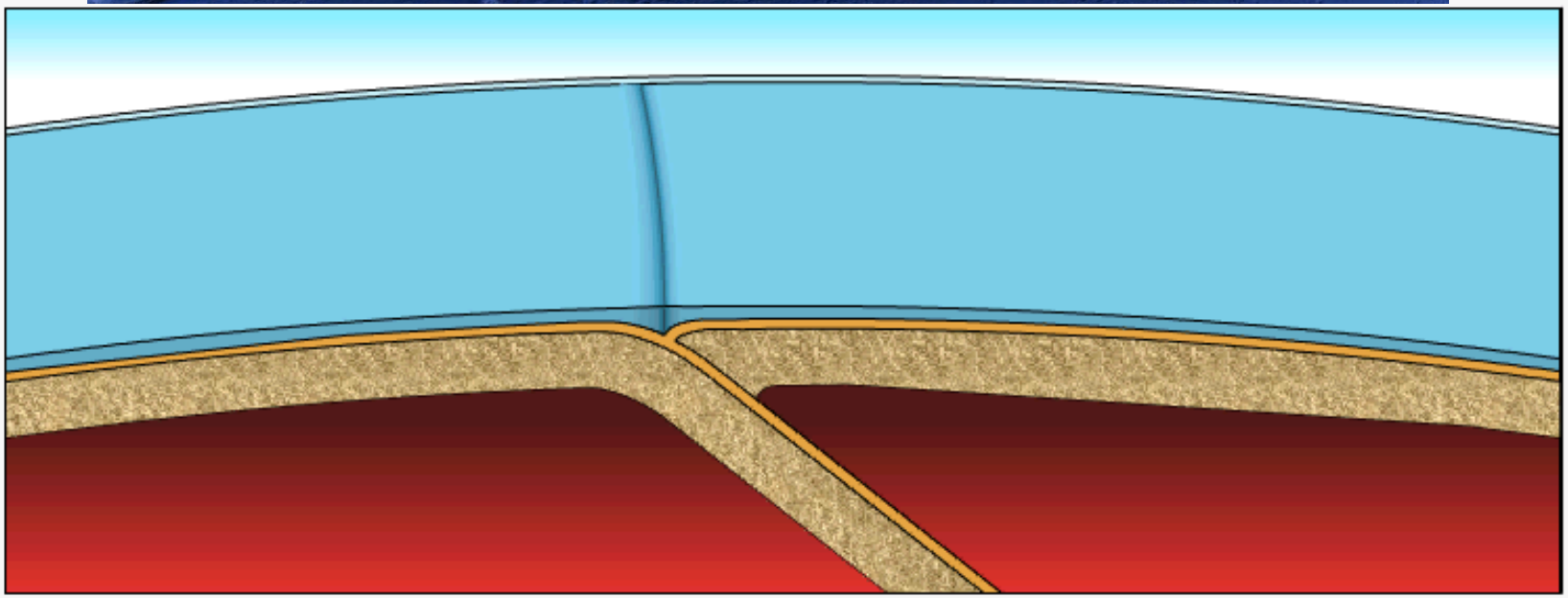

ANILLO DE FUEGO
Mte. Garibaldi
Mte. St. Helens
Fosa de las Aleutianas
Fosa de las Kuriles
Fosa del Japón
Fosa de Izu-Ogasawara
Fosa de Ryuku
Fosa de las Filipinas
Fosa de las Marianas
Mte. Pinatubo
Mte. Mayon
Abismo Challenger
Ecuador
Fosa de Bougainville
Krakatoa
Fosa de Java
Fosa de Tonga
Fosa de Kermadec
Fosa de Puerto Rico
Fosa Mesoamericana
V. Cotopaxi
Fosa de Perú-Chile
V. Llaima
Fosa de las Sandwich del Sur



Aleutian Island Arc, Alaska




1424 mi
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2010 Google
Image © 2010 TerraMetrics
Image IBCAO
51°31'23.16" N 158°44'55.88" W elev -17323 ft



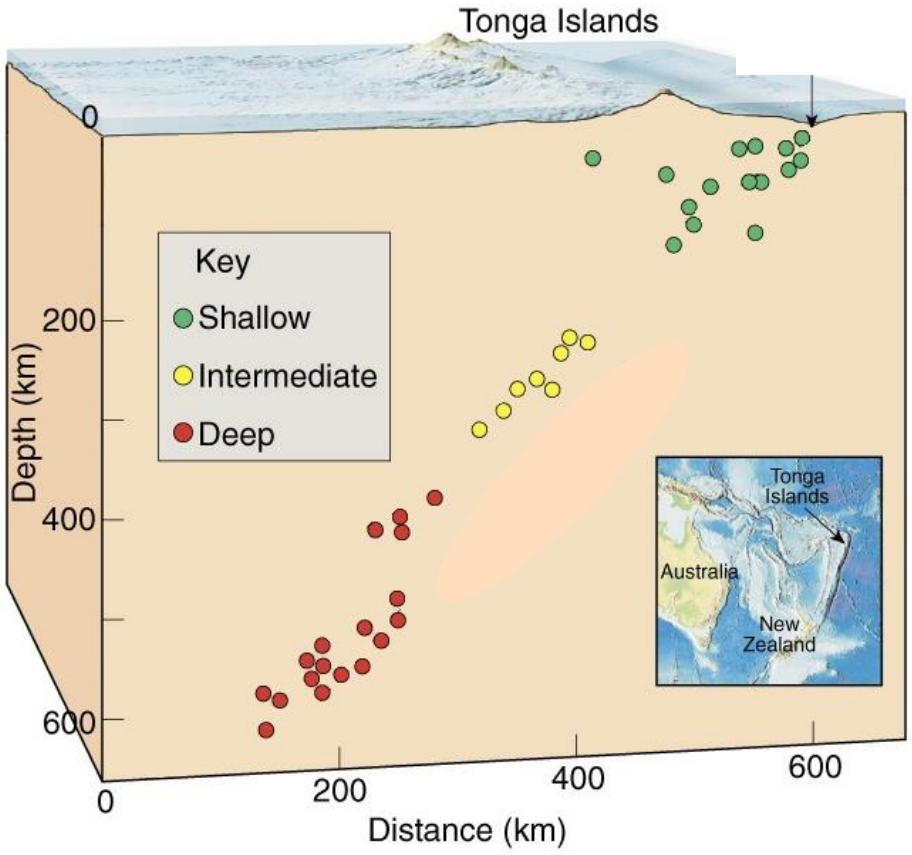
0 5 10 15 20 25 30 35 40 45 50

Millions of years

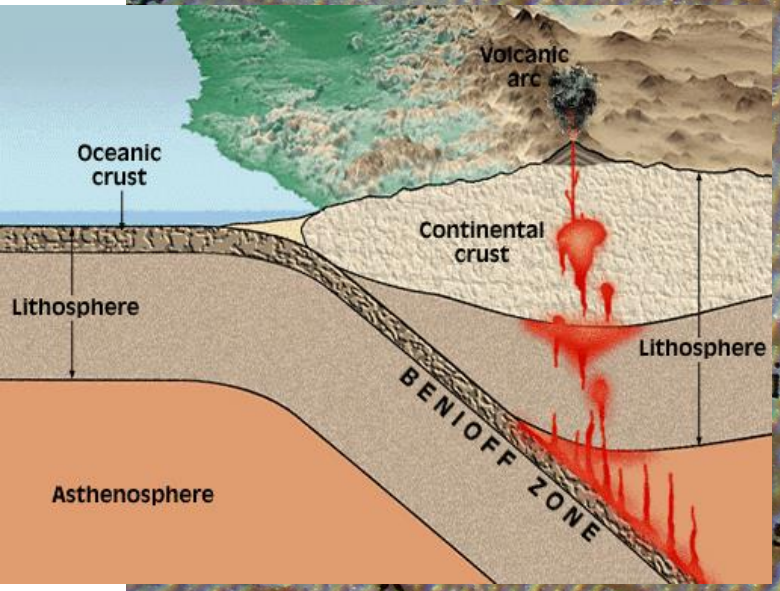
Labels Off

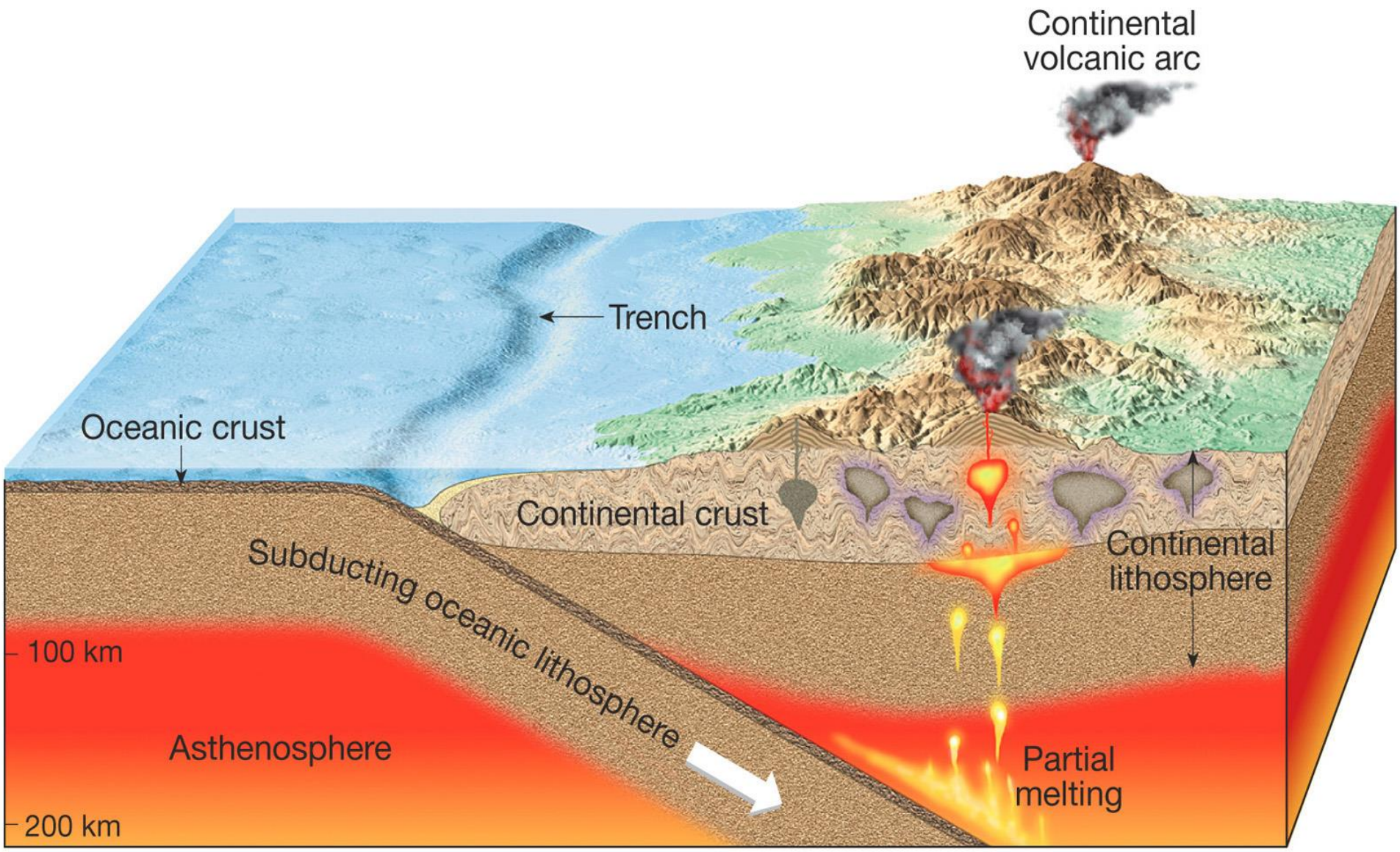
Main page

EXERCICIO 1

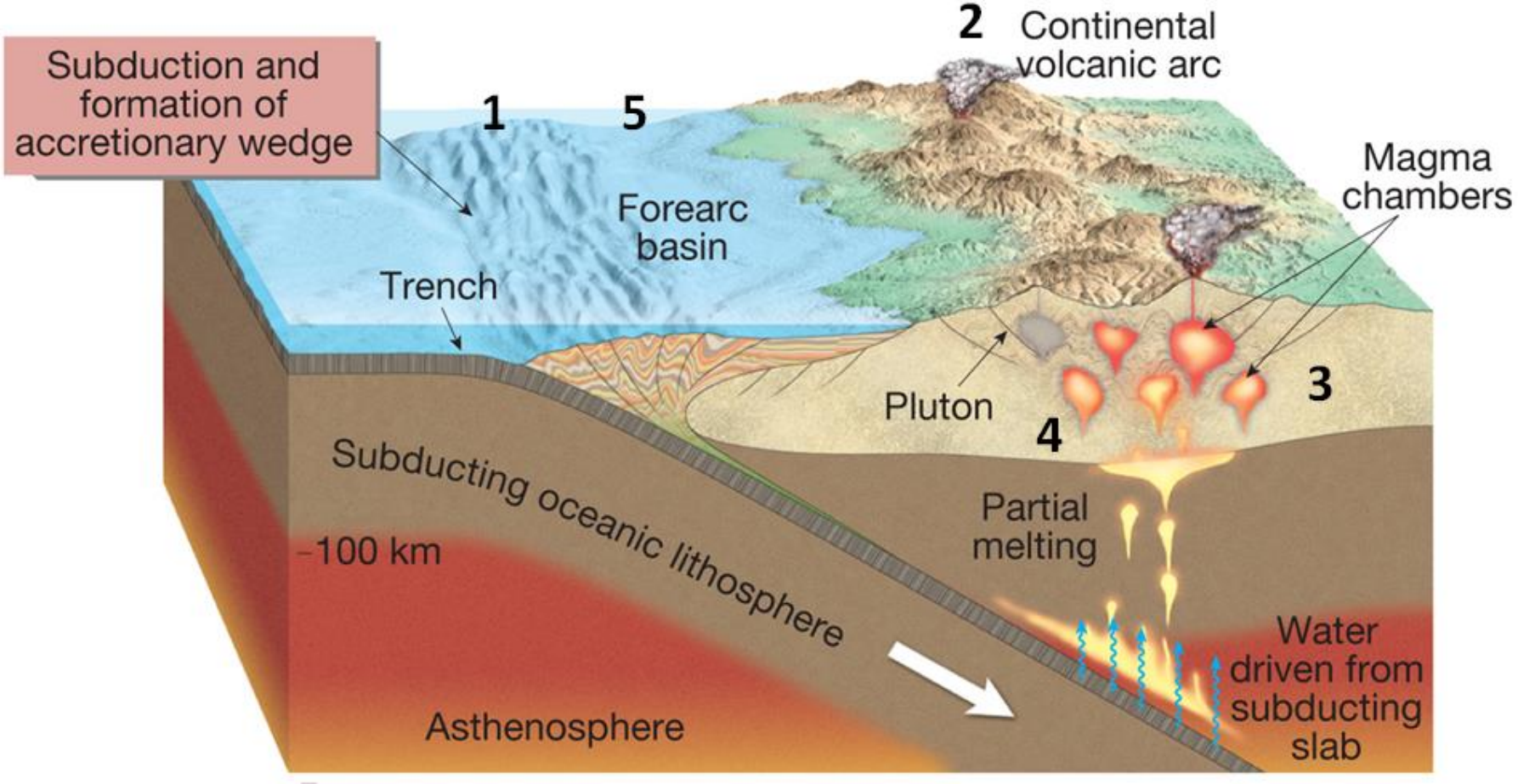

Tonga Islands
0
200
400
600
Depth (km)
Key
Shallow
Intermediate
Deep
Tonga Islands
Australia
New Zealand
0
200
400
600
Distance (km)

CONT-OC: ORÓXENOS PERICONTINENTAIS

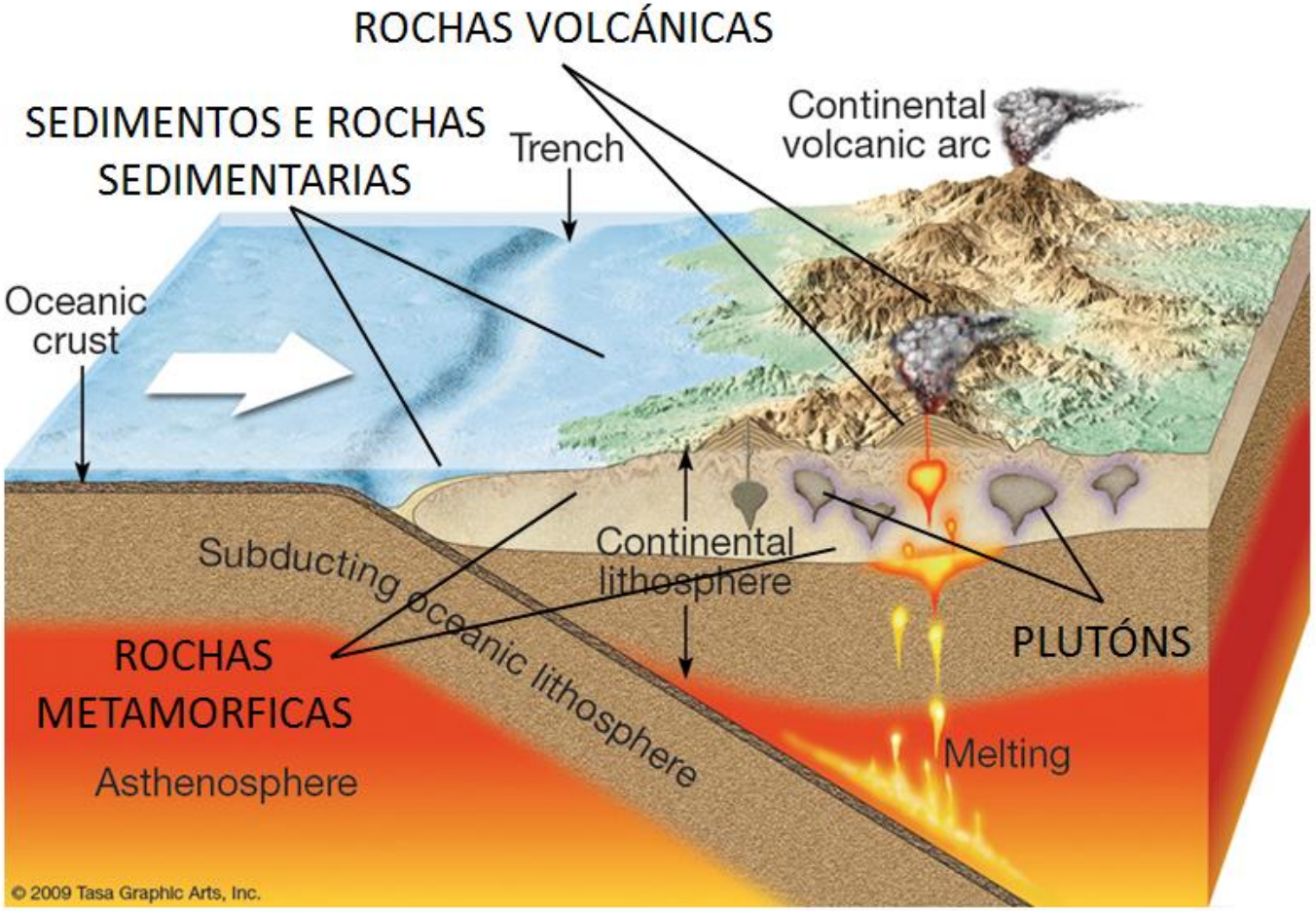




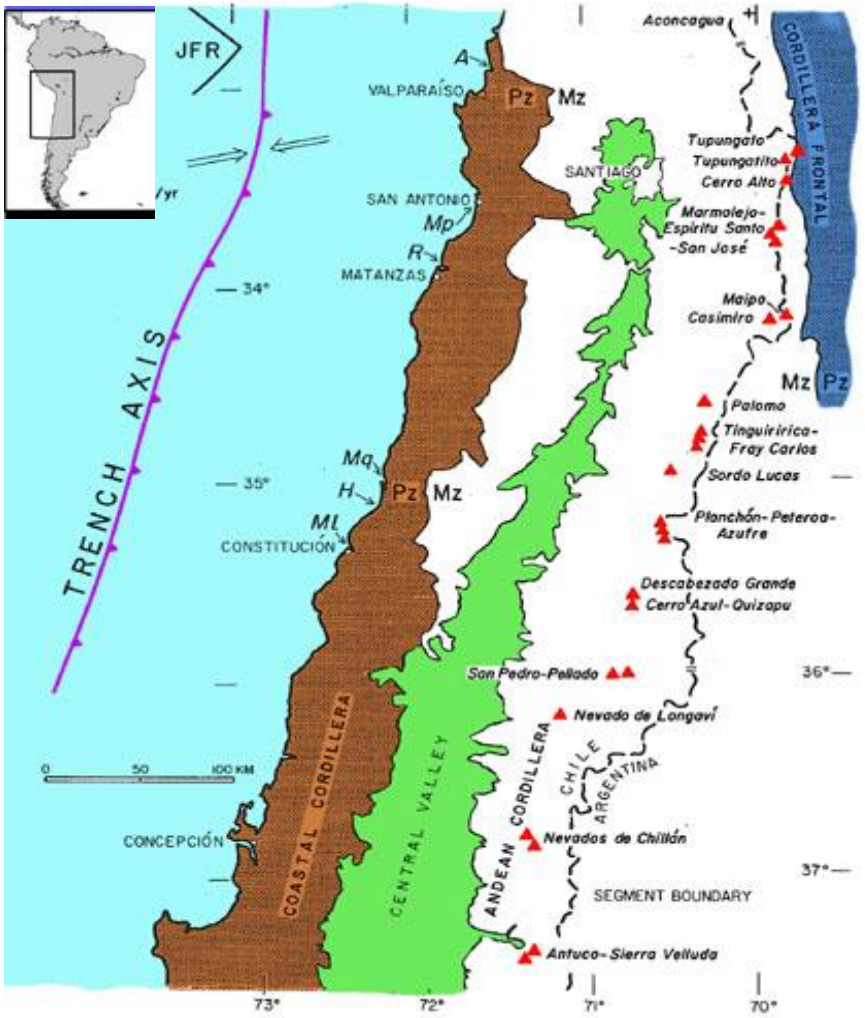
A. Oceanic-continental


Subduction and formation of accretionary wedge
1
2
Continental volcanic arc
5
Forearc basin
Trench
Magma chambers
Pluton
3
4
Subducting oceanic lithosphere
Partial melting
100 km
Water driven from subducting slab
Asthenosphere

DISTRIBUCIÓN DAS ROCHAS

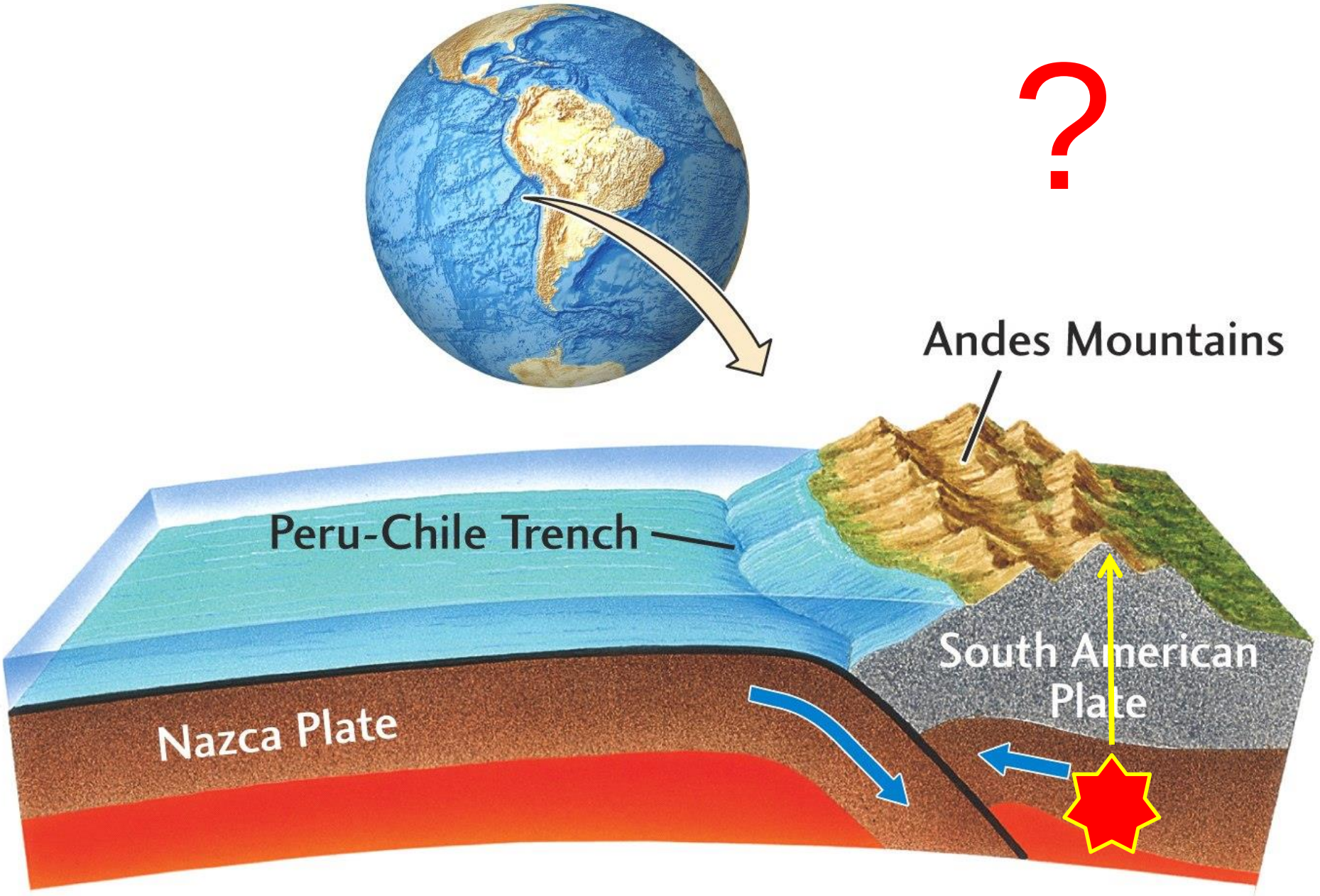


EXERCICIO

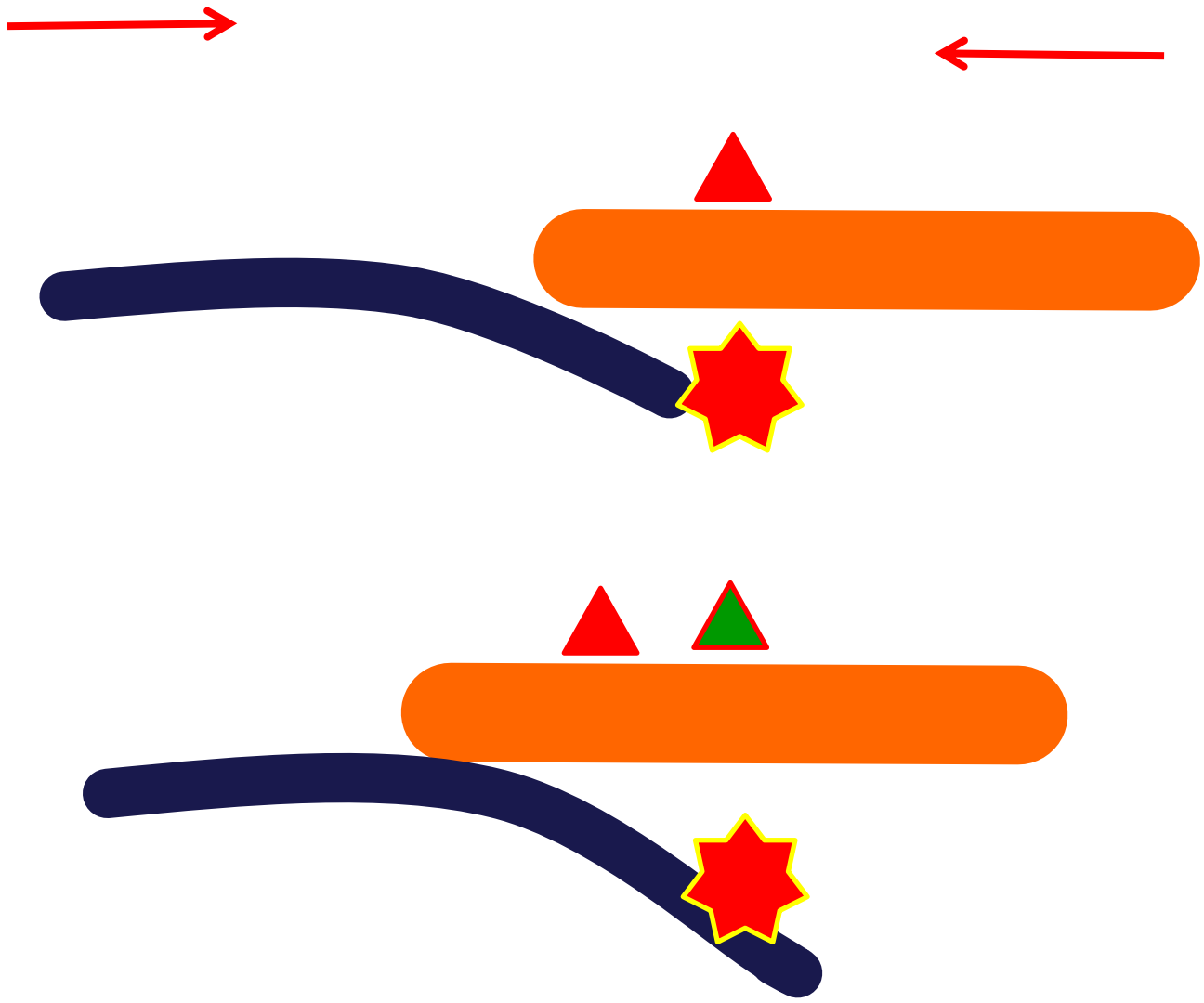


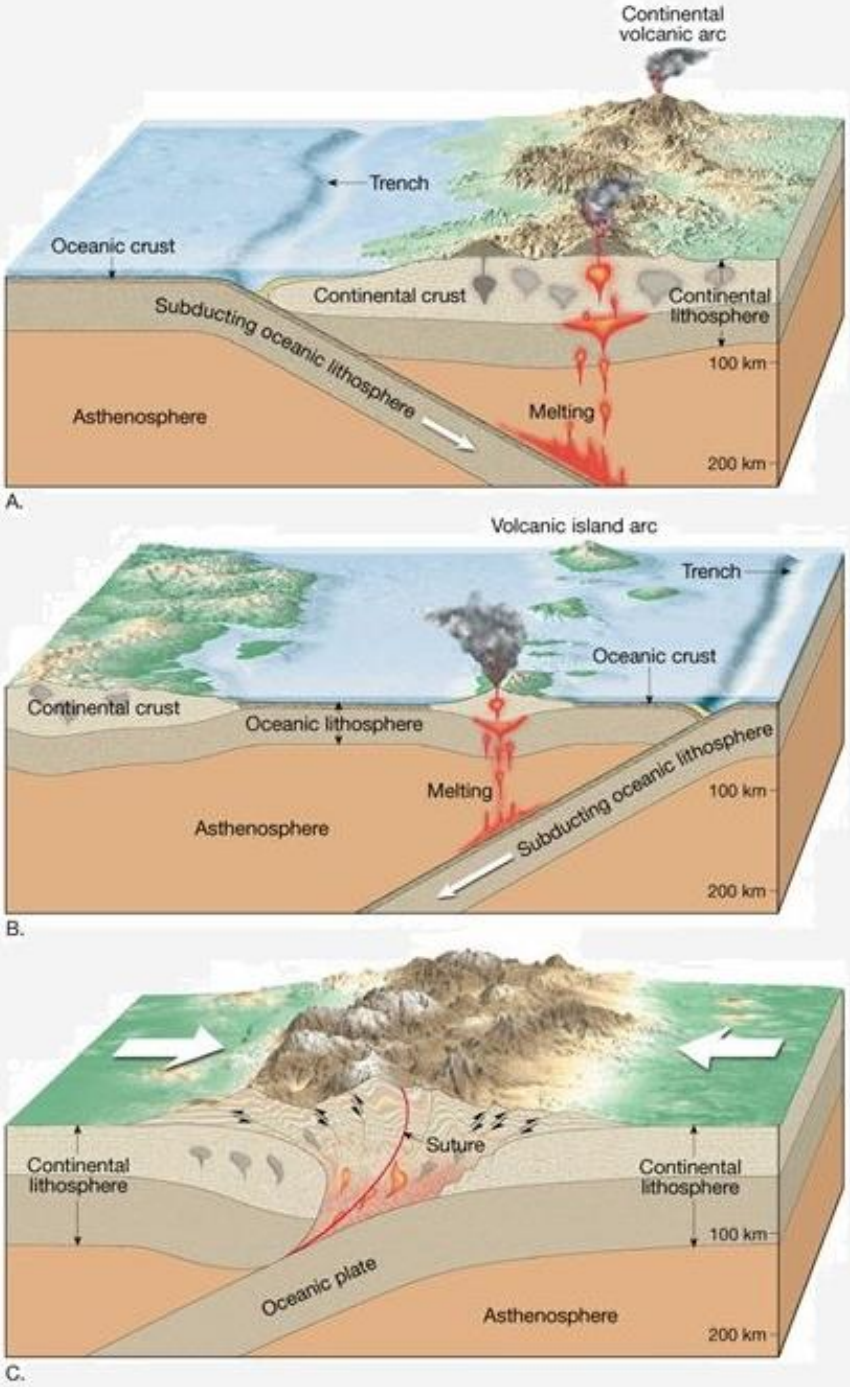
A cordilleira dos Andes é un típico exemplo de oróxeno pericontinental, con todo é máis complexo do que inicialmente podería parecer.

A parte máis alta da cordilleria se corresponde cunha cadea de volcáns activos na actualidade (triángulos no mapa da esquerda). Paralela a esta cadea existen ata dúas antigas cadeas de volcáns inactivos. A idade destas cadeas aumenta a medida que nos achegamós á costa (cara o oeste).

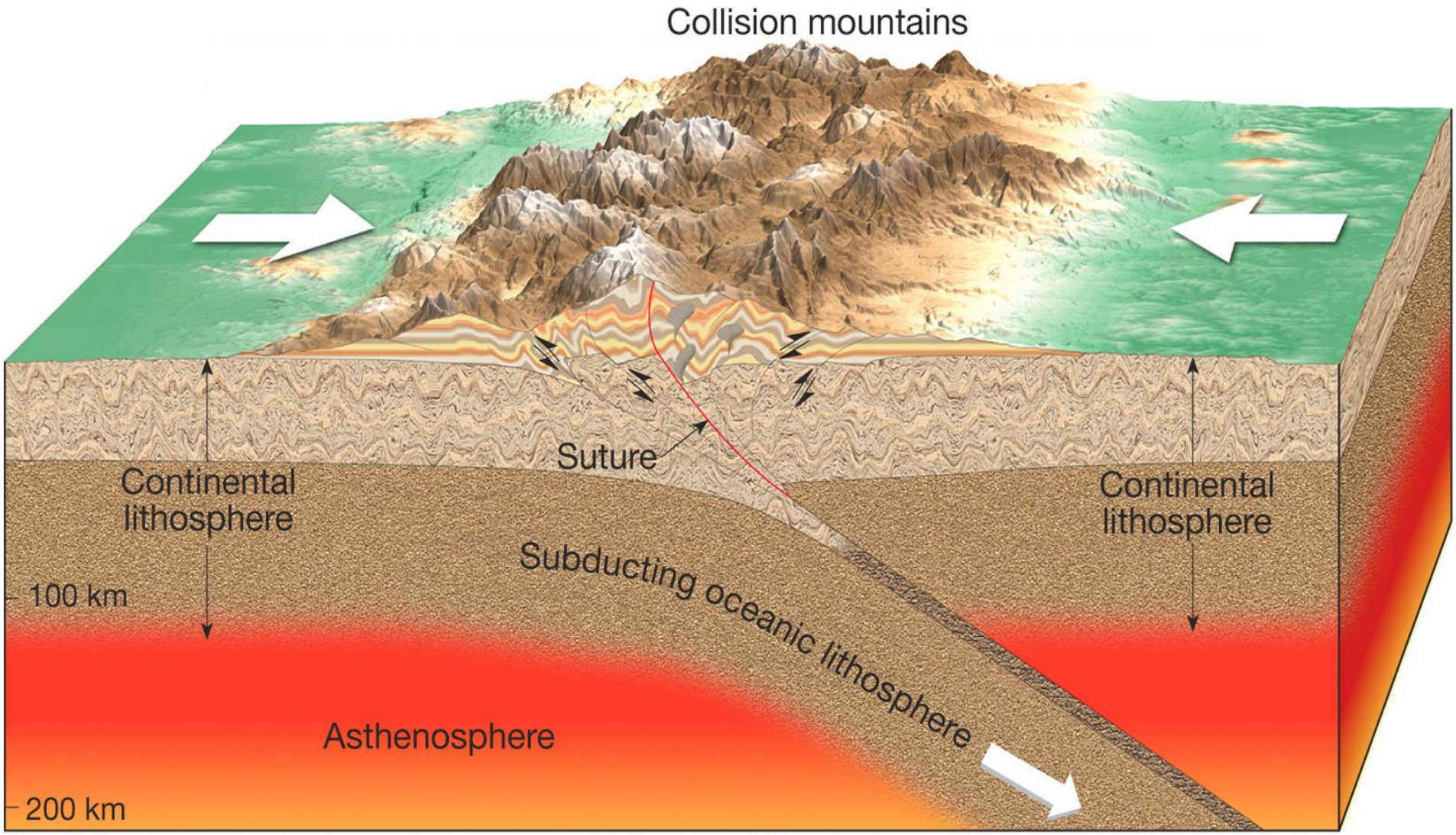

?
Andes Mountains
Peru-Chile Trench
South American Plate
Nazca Plate

MOVEMENTO DAS PLACAS ?

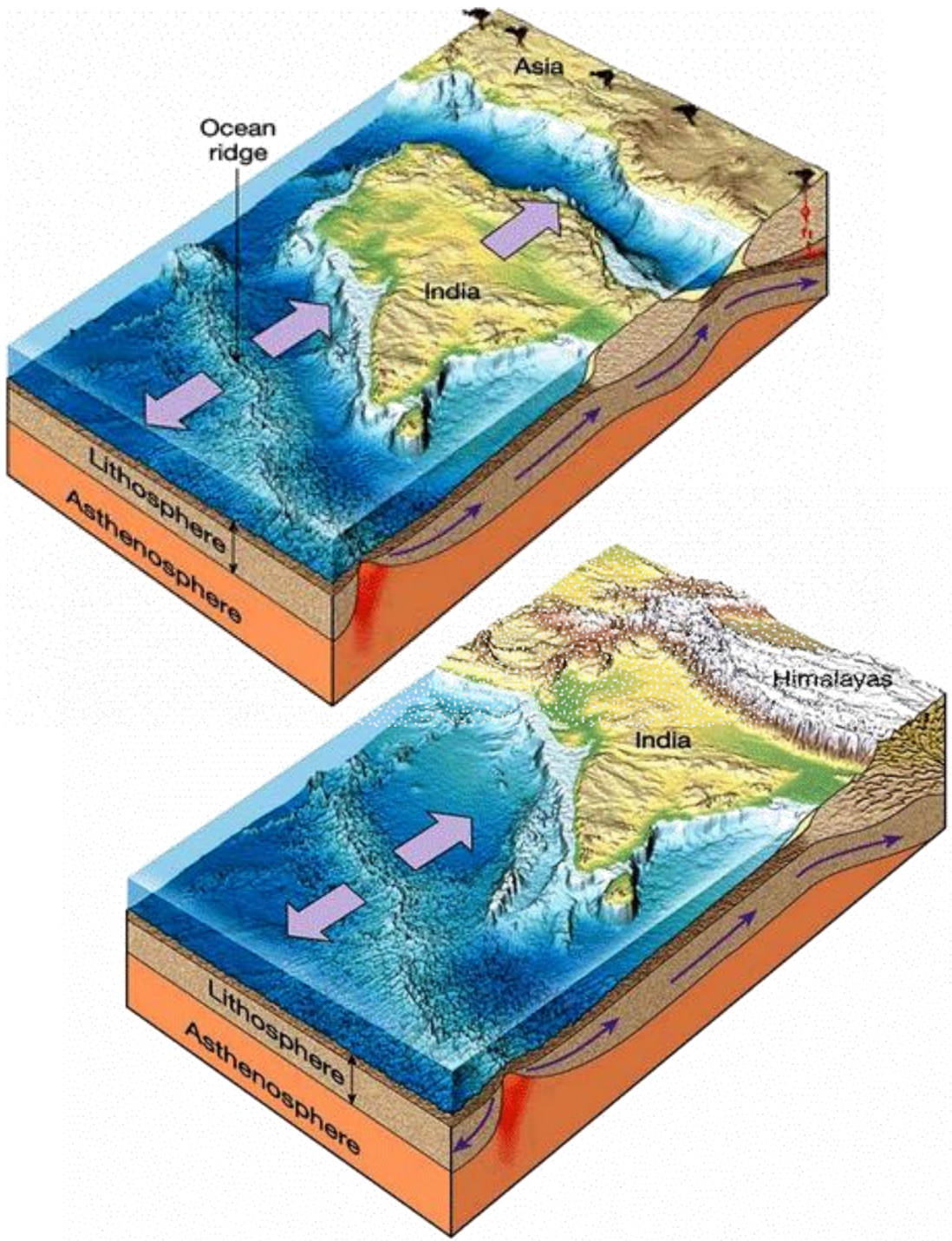


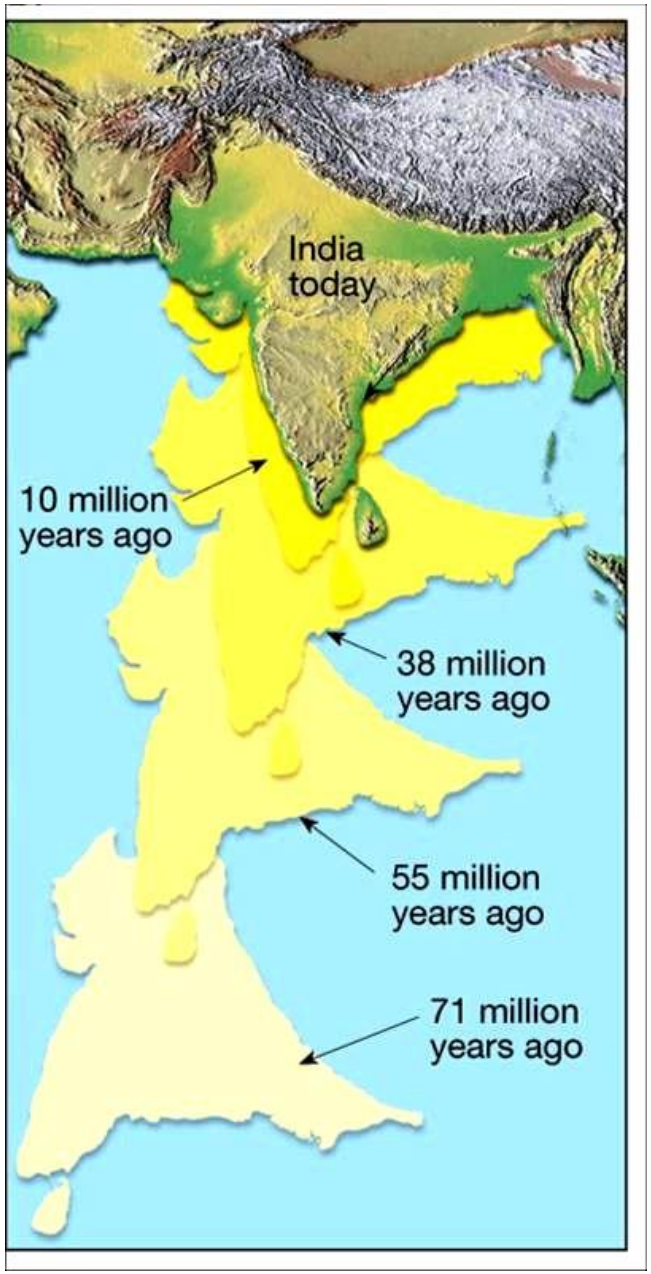

Continental volcanic arc
Trench
Oceanic crust
Continental crust
Continental lithosphere
Subducting oceanic lithosphere
100 km
Asthenosphere
Melting
200 km
A.
Volcanic island arc
Trench
Oceanic crust
Continental crust
Oceanic lithosphere
Melting
Subducting oceanic lithosphere
100 km
Asthenosphere
200 km
B.
Suture
Continental lithosphere
Continental lithosphere
100 km
Oceanic plate
Asthenosphere
200 km
C.

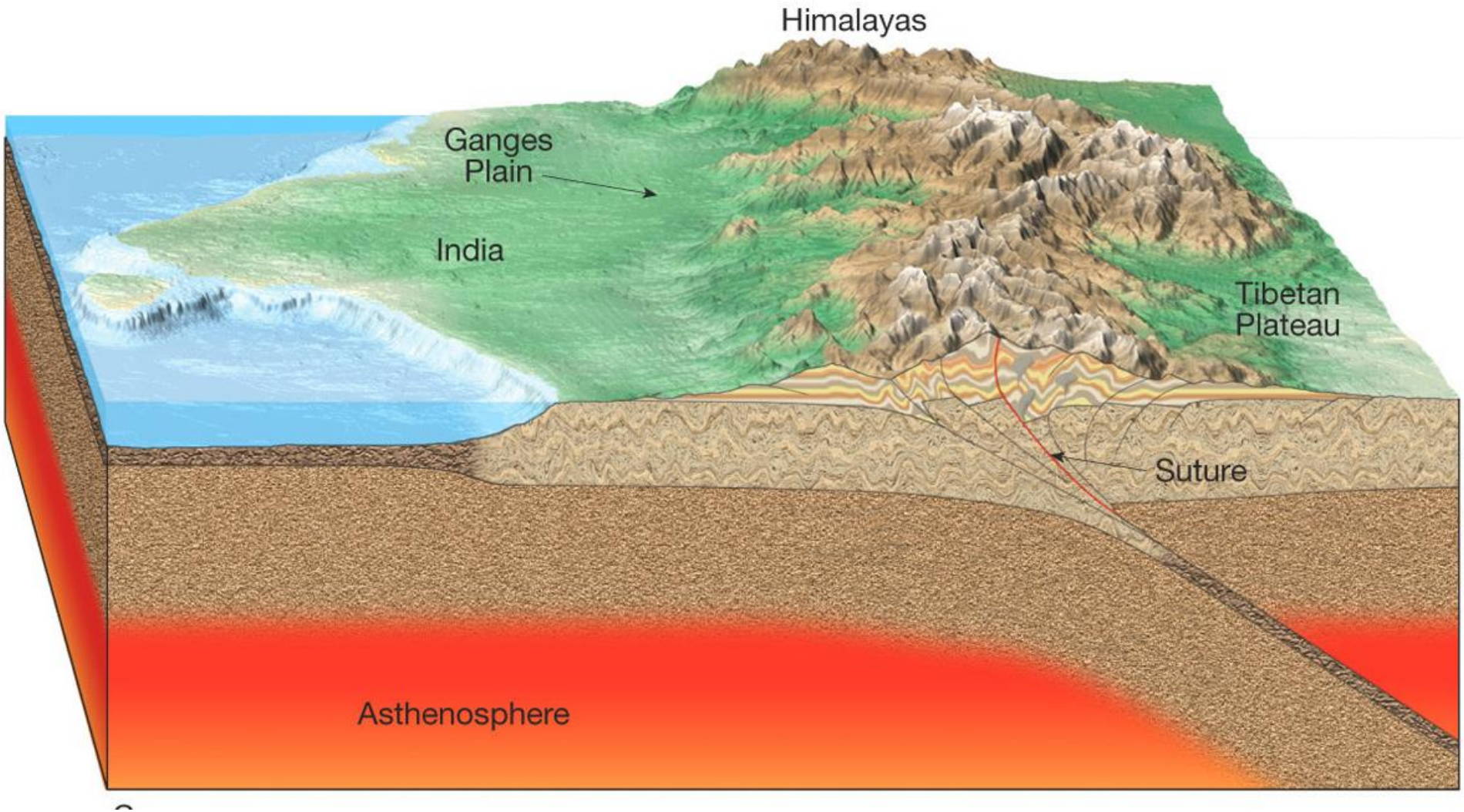
A colisión continental



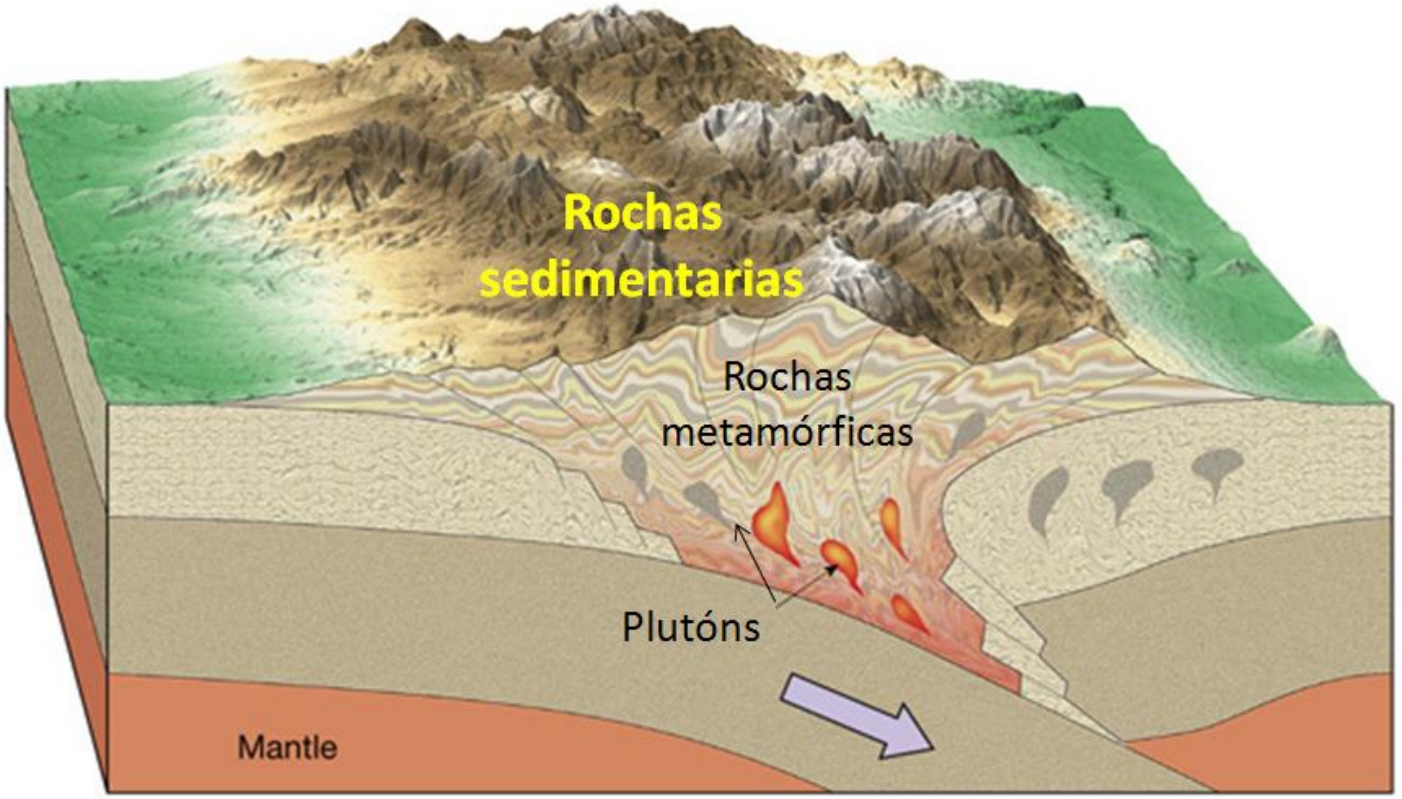
C. Continental-continental


Asia
Ocean ridge
India
Lithosphere
Asthenosphere
Himalayas
India
Lithosphere
Asthenosphere

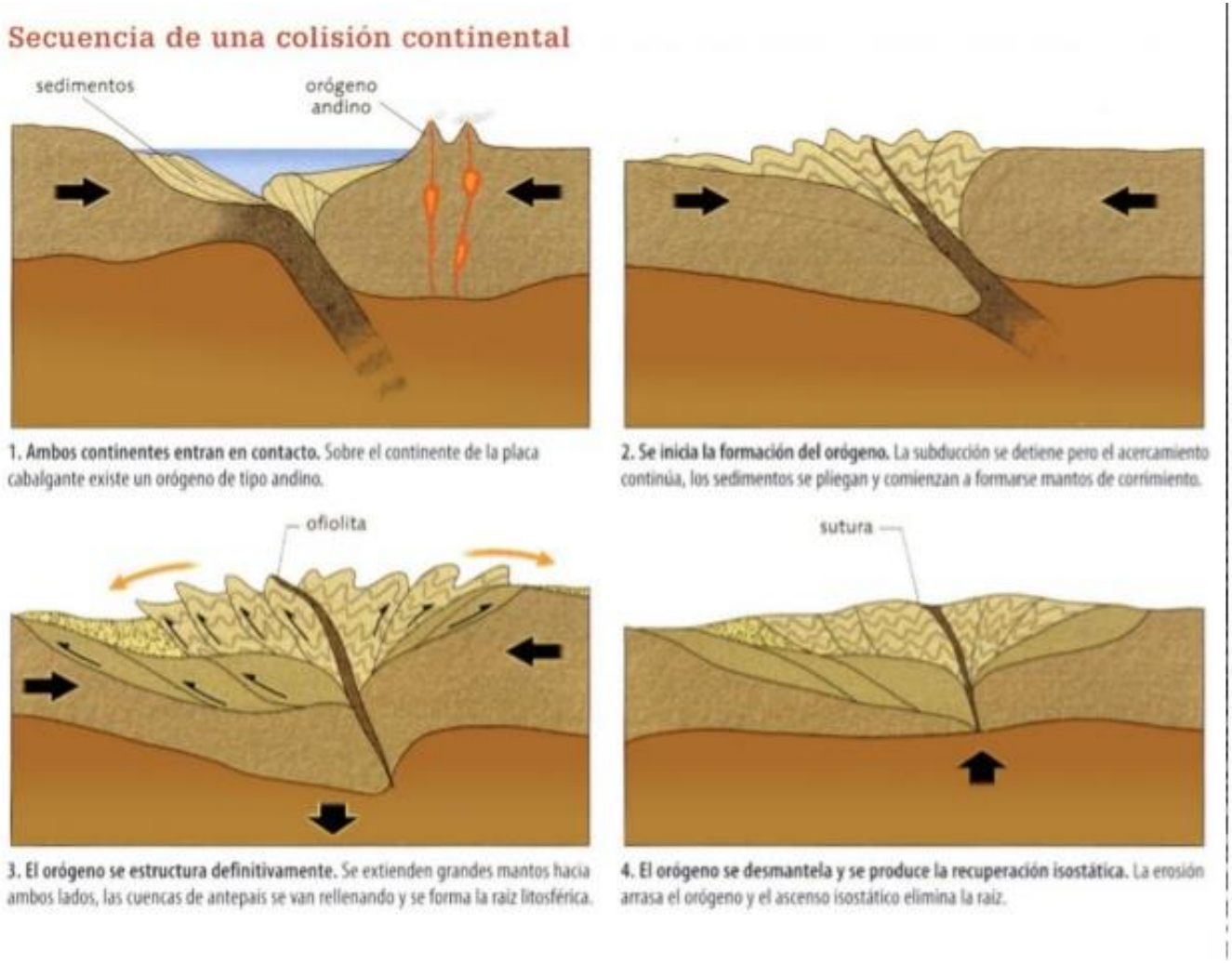

India today
10 million years ago
38 million years ago
55 million years ago
71 million years ago


Himalayas
Ganges
Plain
India
Tibetan
Plateau
Suture
Asthenosphere

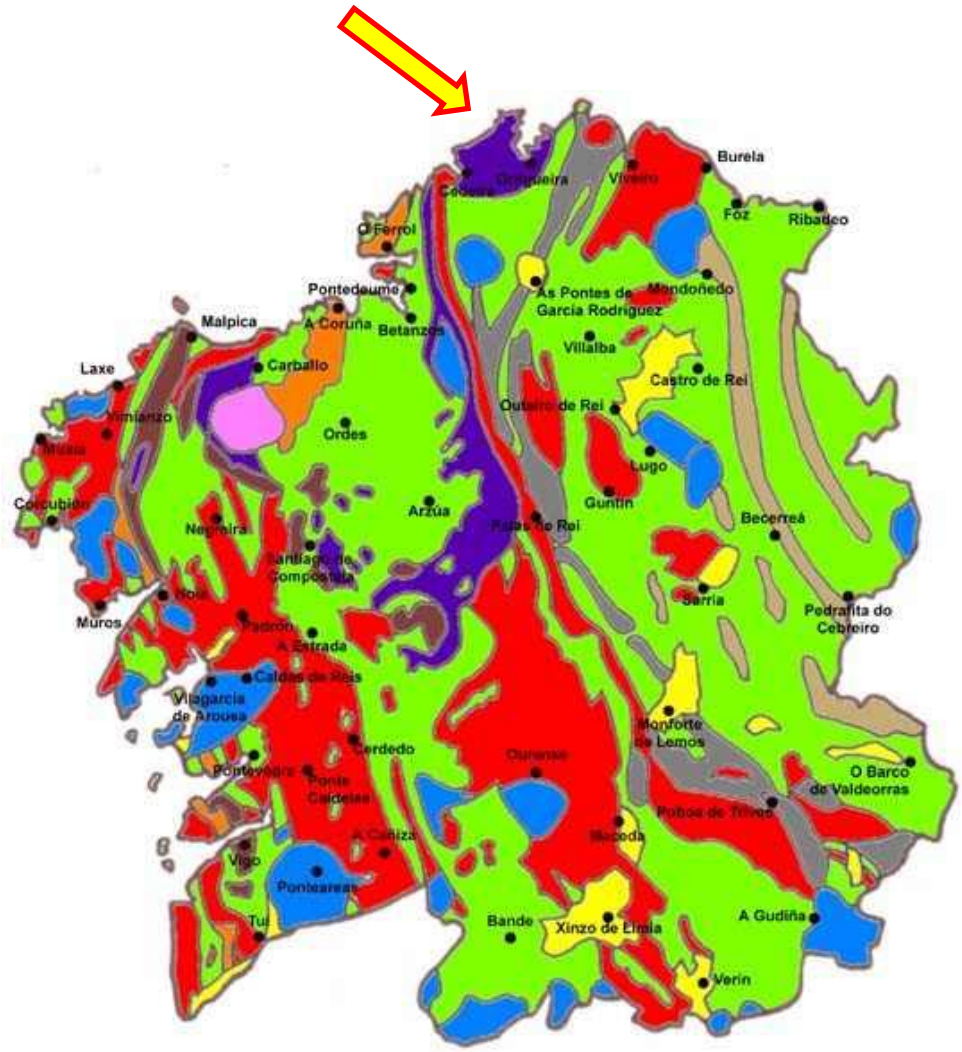
DISTRIBUCIÓN DAS ROCHAS



OBDUCCIÓN E OFIOLITAS

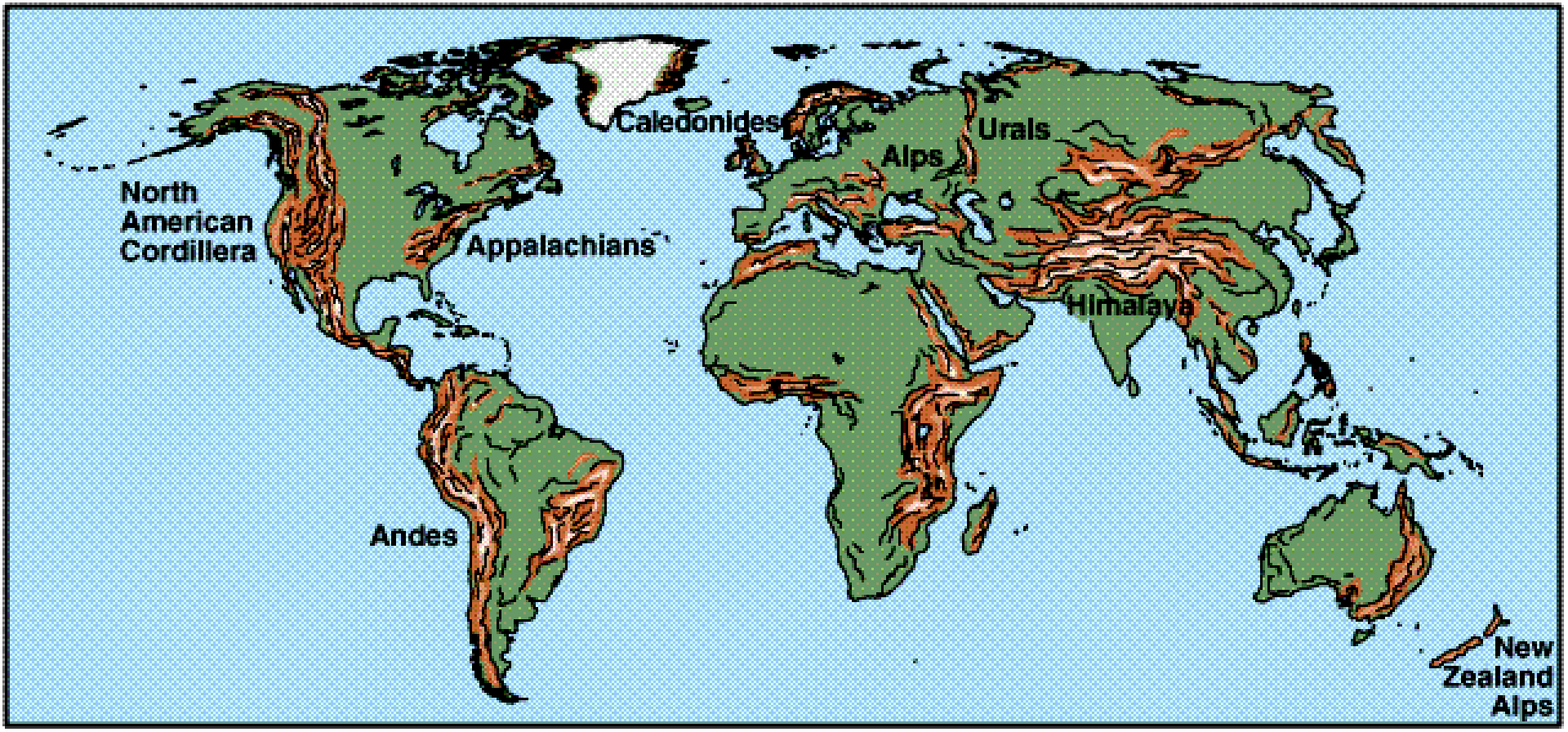


SERRA DA CAPELADA




©masrutasymenosrutinas.com

World's Major Mountain Belts



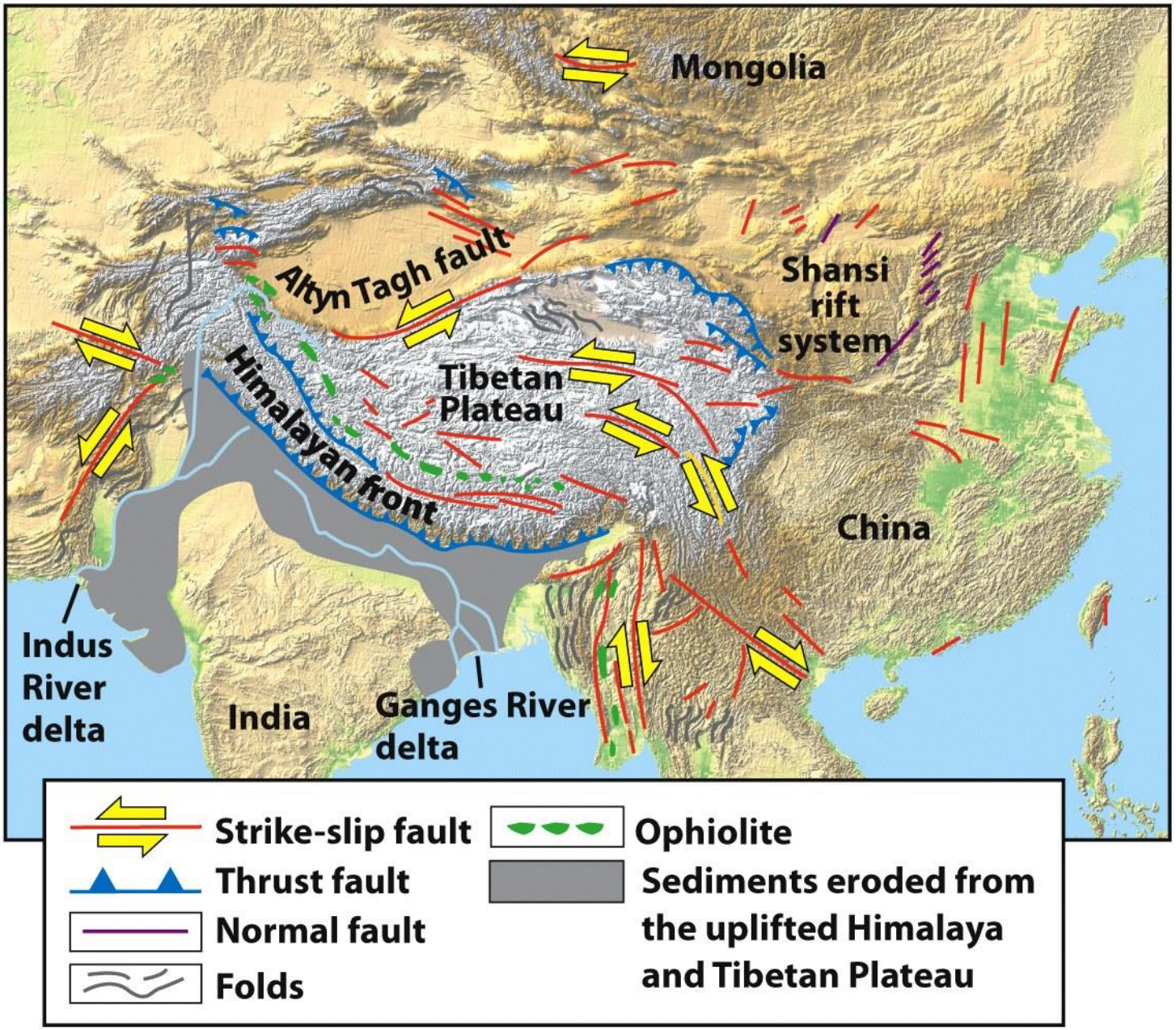
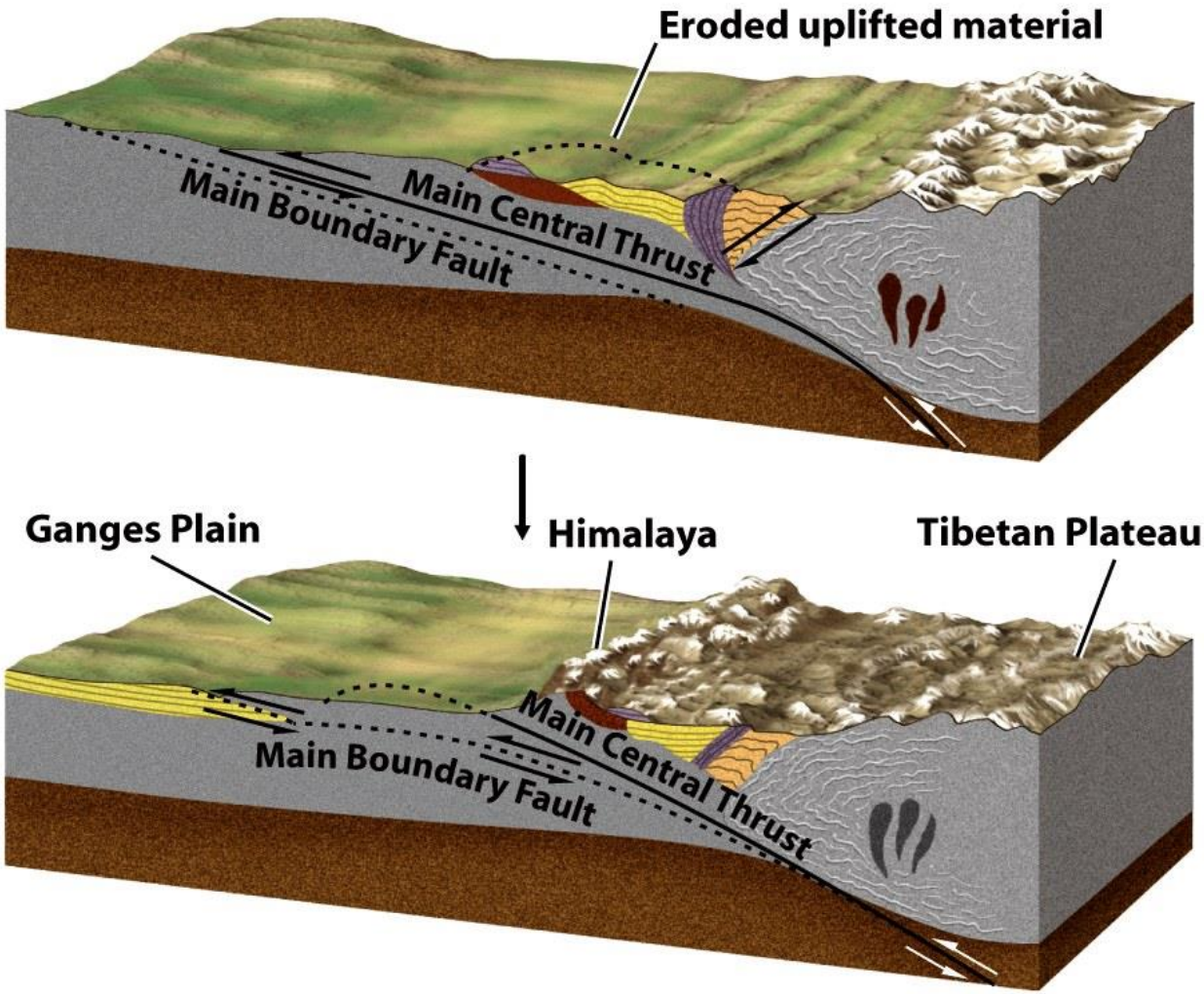


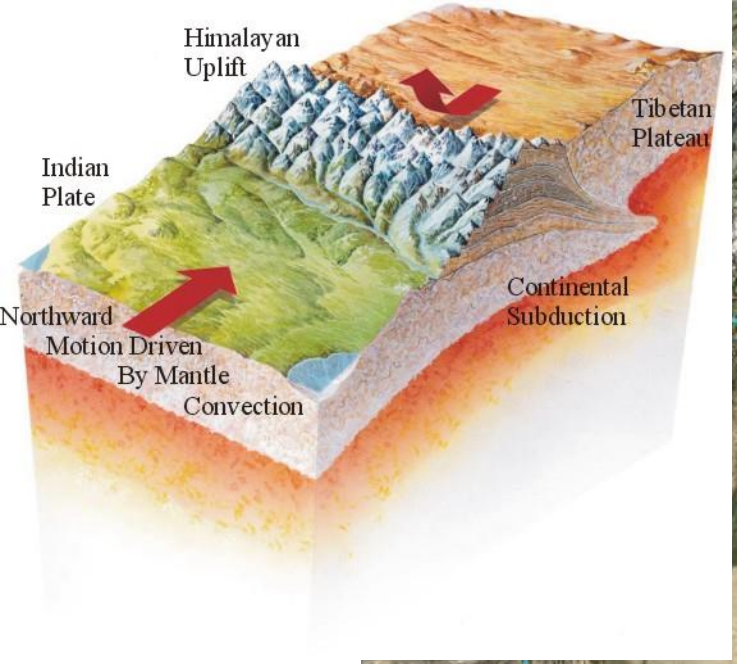
Figure 10.16
***Understanding Earth*, Sixth Edition**

Cabalgamiento basal



10–20 Ma
A second thrust fault—the Main Boundary Fault—developed, stacking a second slice of crust on India and lifting the first slice. Thus, two overthrust sheets make up the bulk of the Himalaya.

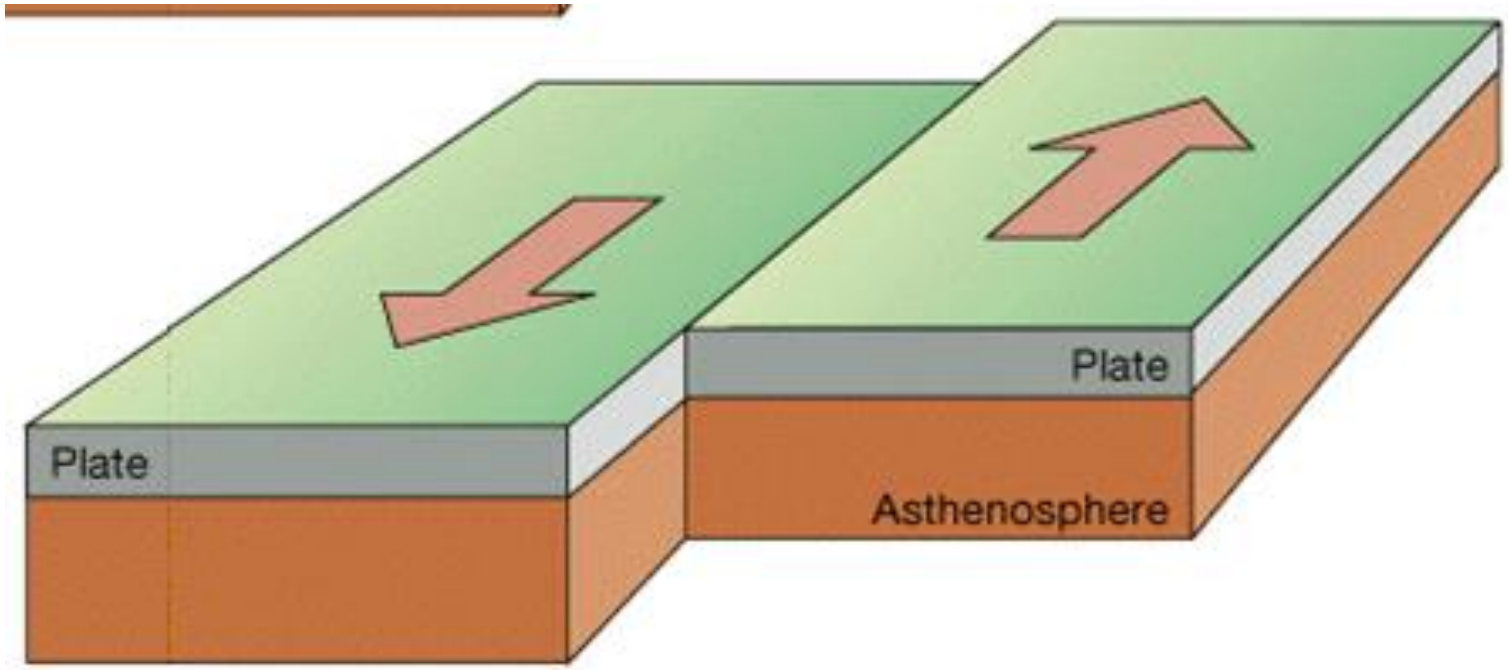
Figure 10.15 part 4
***Understanding Earth*, Sixth Edition**


Himalayan
Uplift
Tibetan
Plateau
Indian
Plate
Continental
Subduction
Northward
Motion Driven
By Mantle
Convection

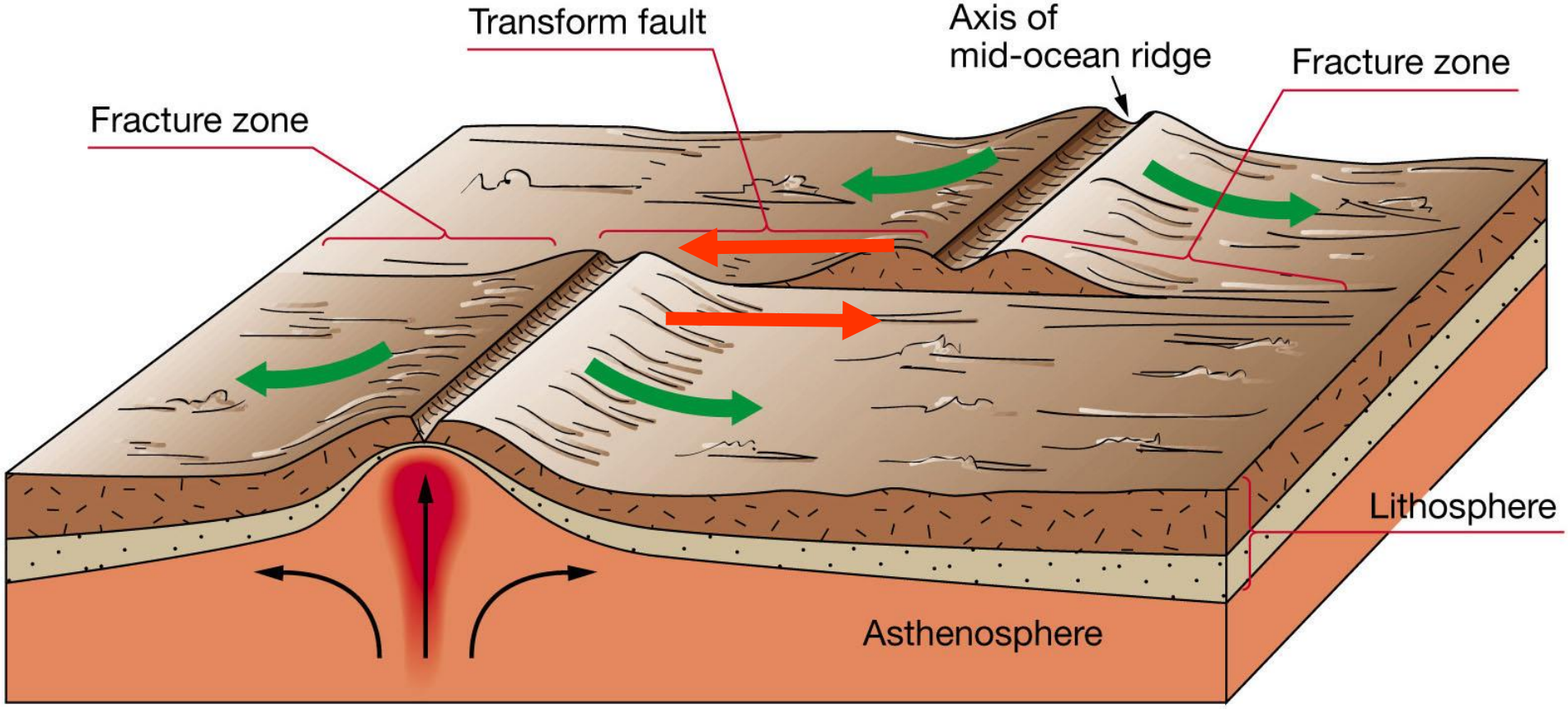

Face of the Earth™
©NAVTEQ 2003

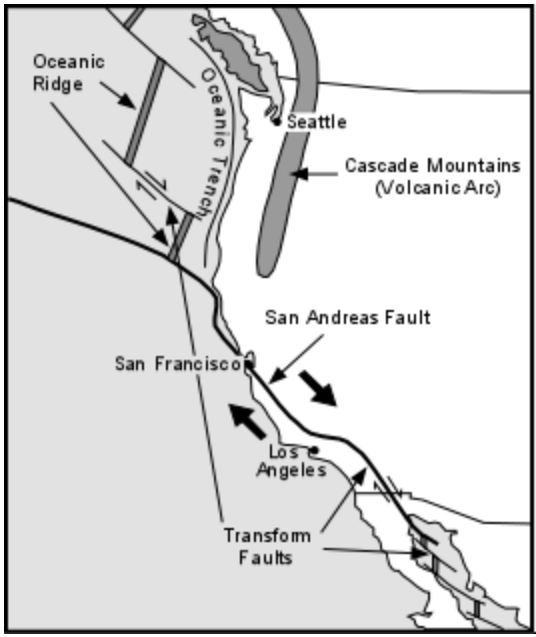
Límites neutros: as fallas transformantes

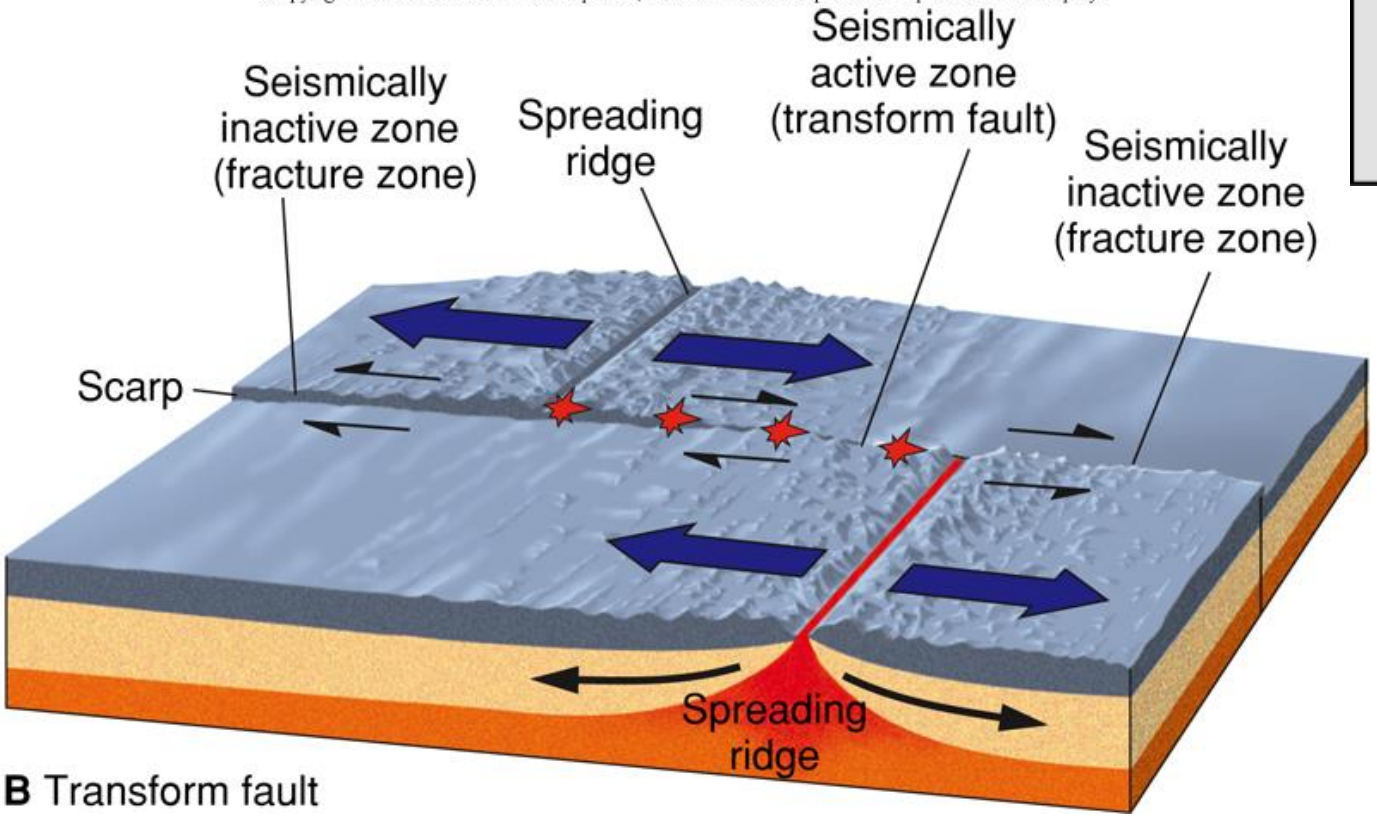
- As placas **se deslizan lateralmente.**
- **Non se forma nin destrúe litosfera** (bordes conservativos).
- Atópanse xeralmente cortando e desprazando as dorsais oceánicas.
- Son zonas de intensa actividade sísmica pero non volcánica.



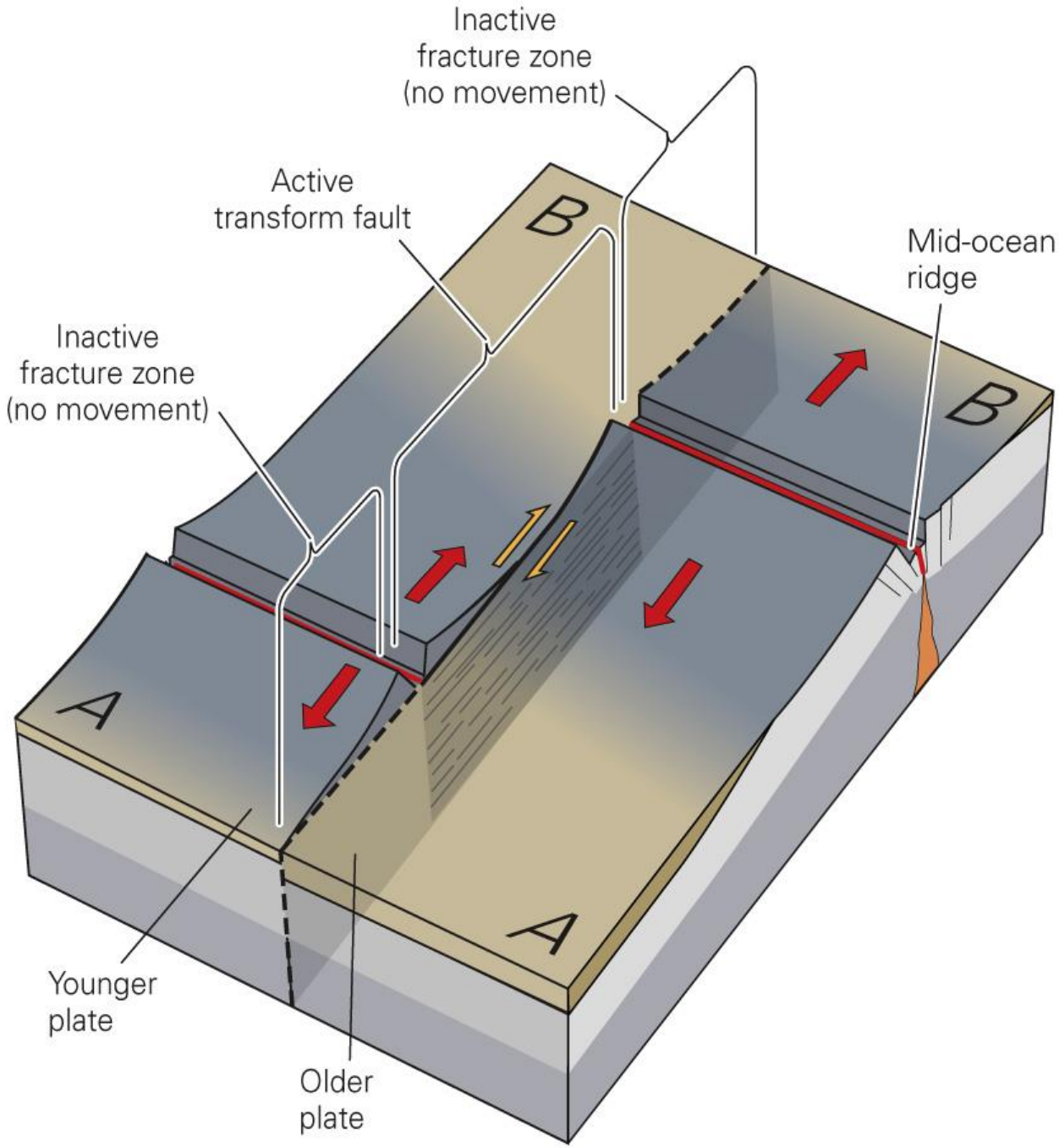
Bordes deslizantes ou fallas transformantes

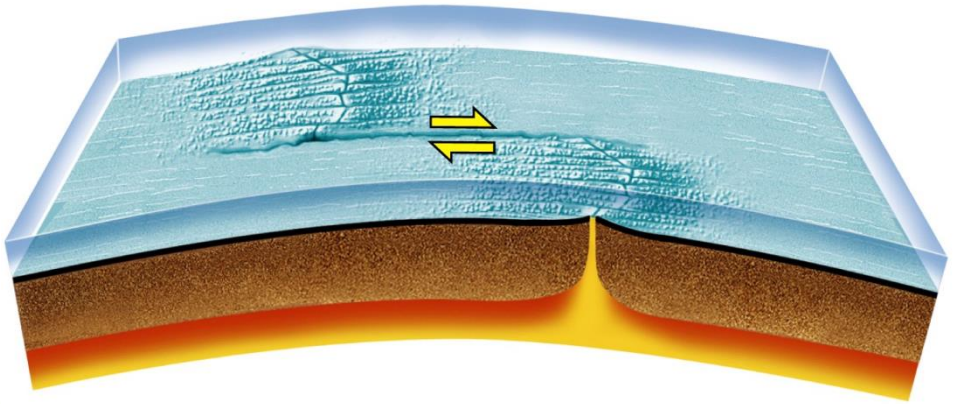


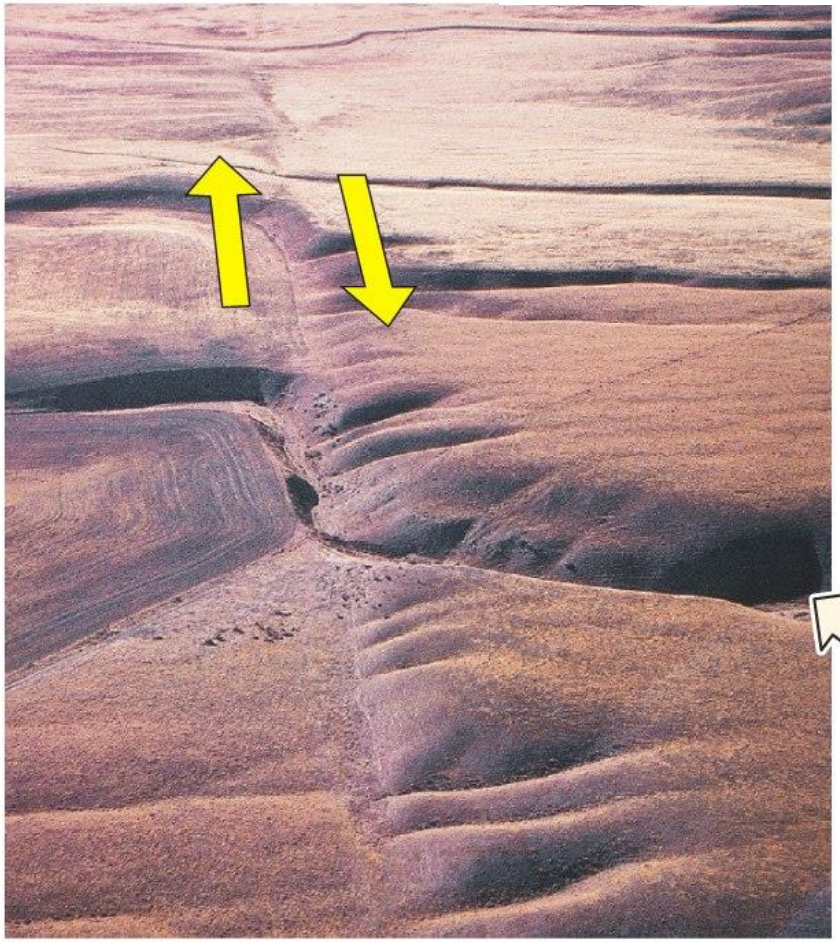




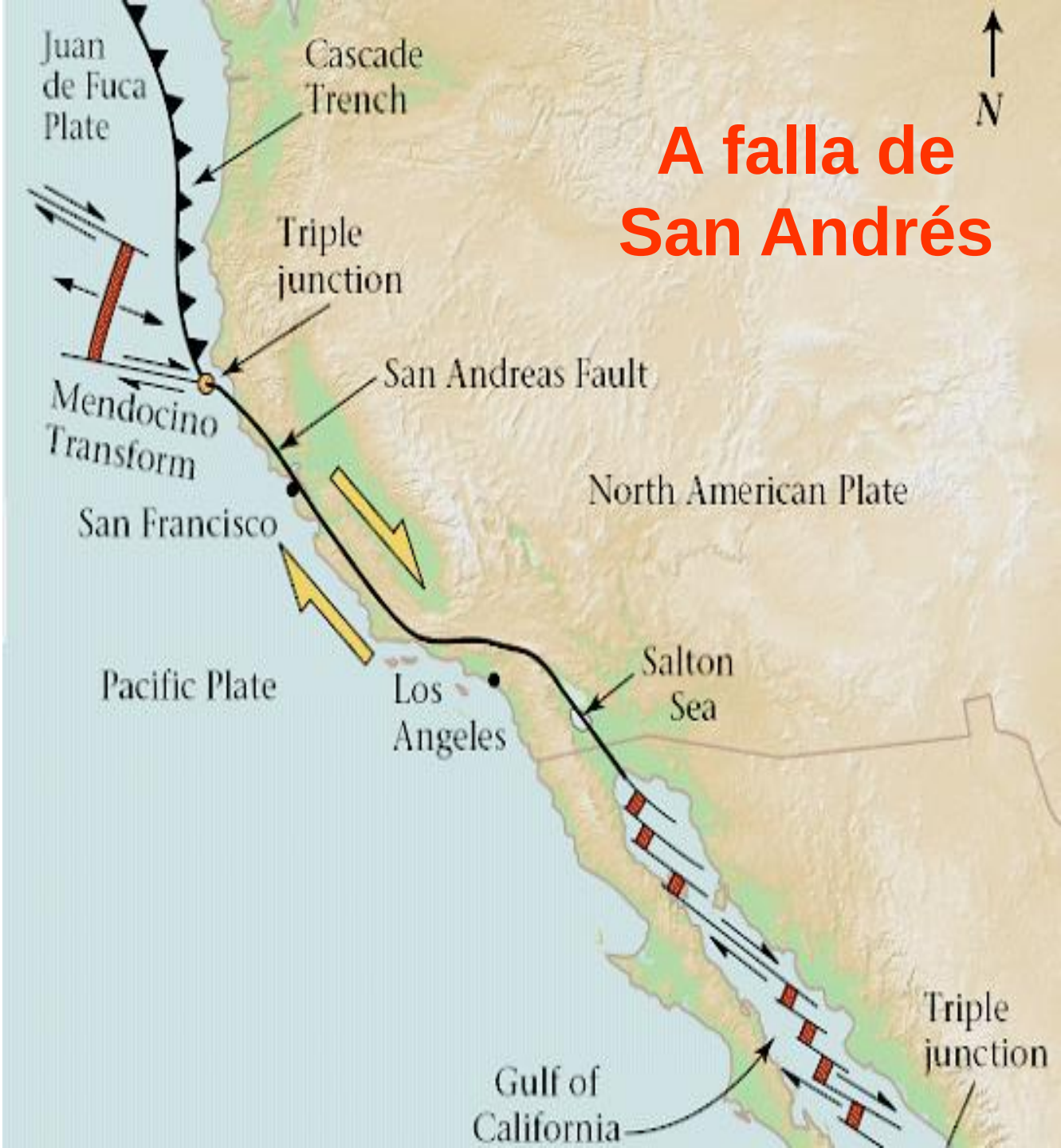
B Transform fault



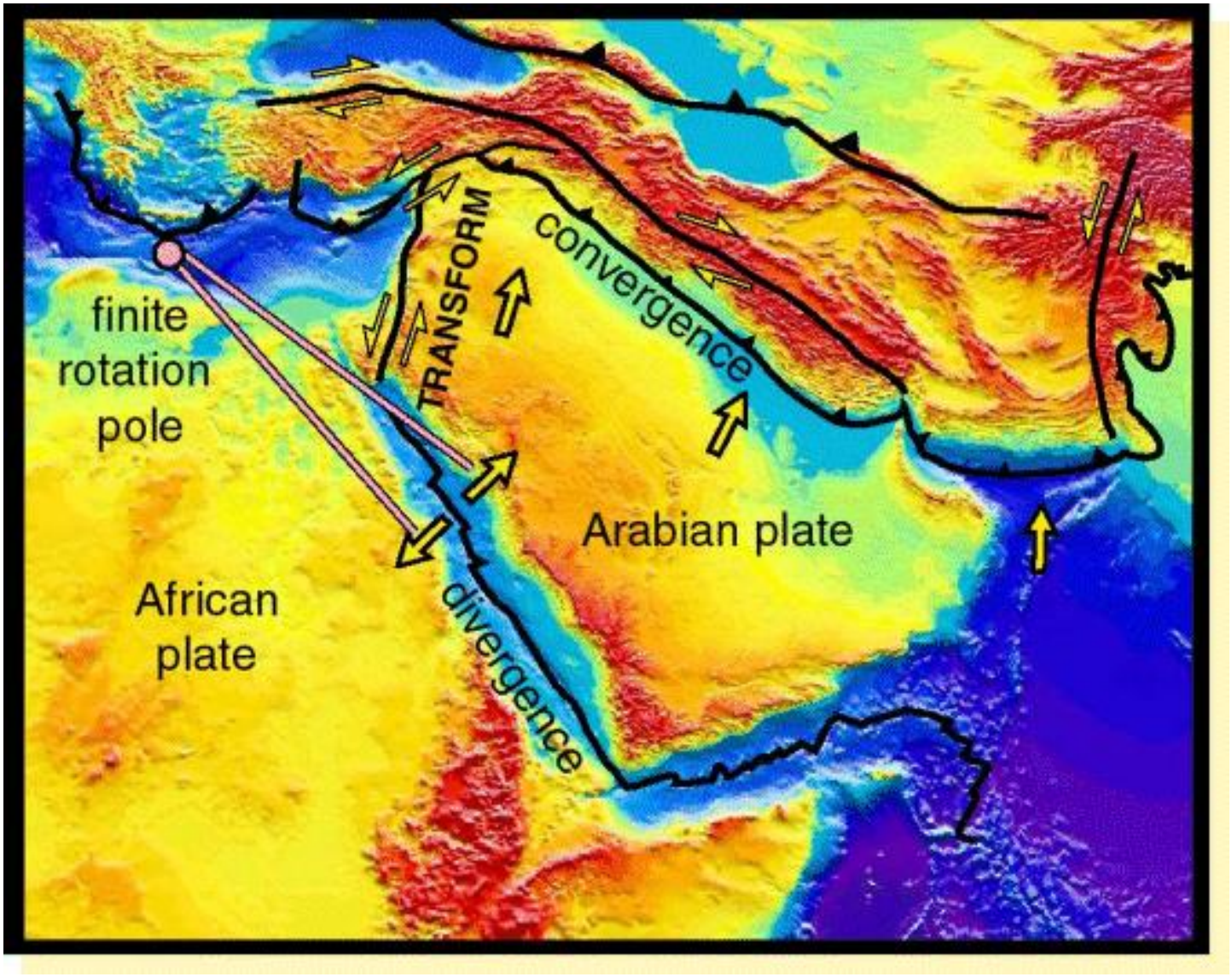




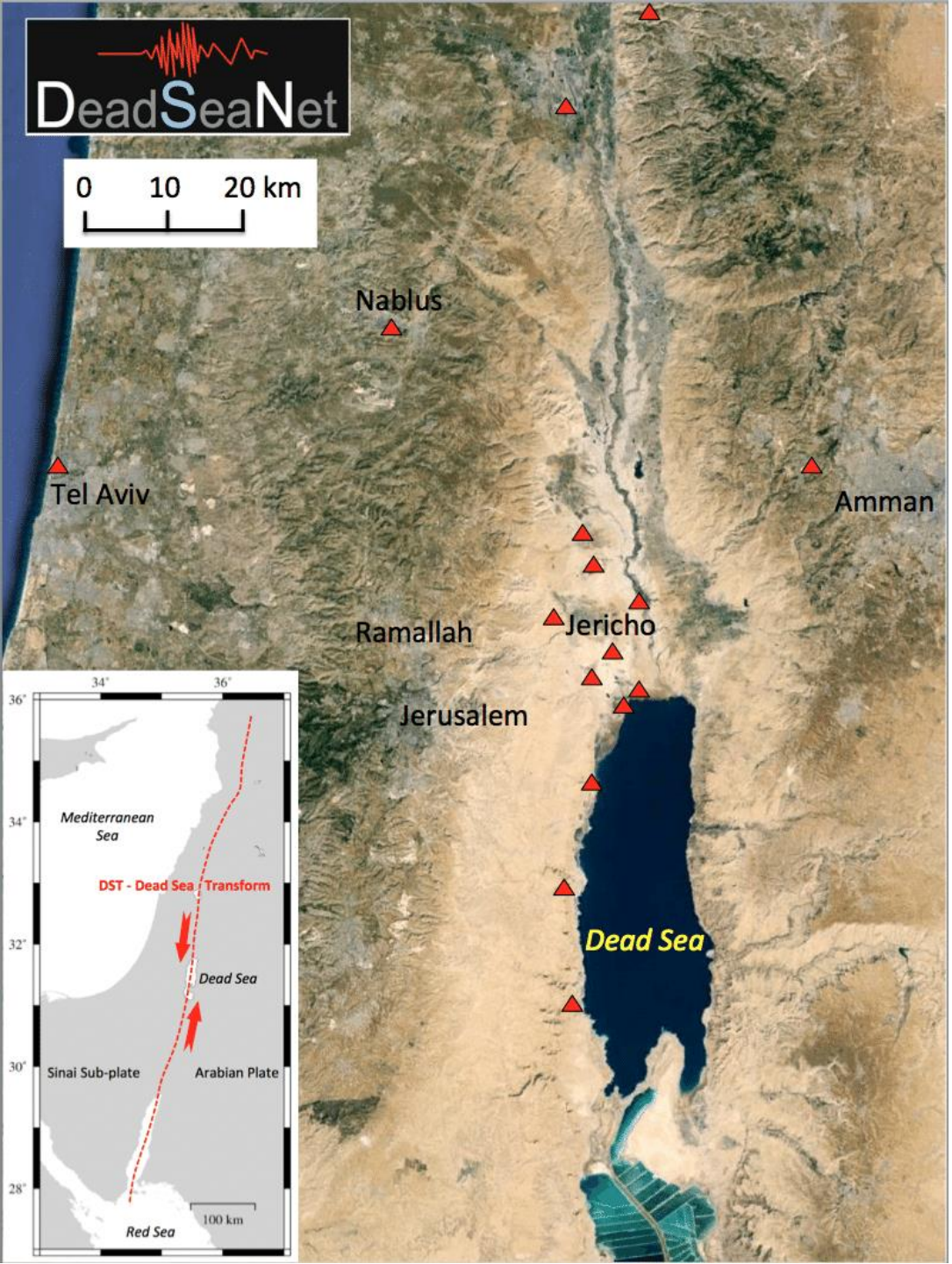

San Francisco
San Andreas fault
Los Angeles

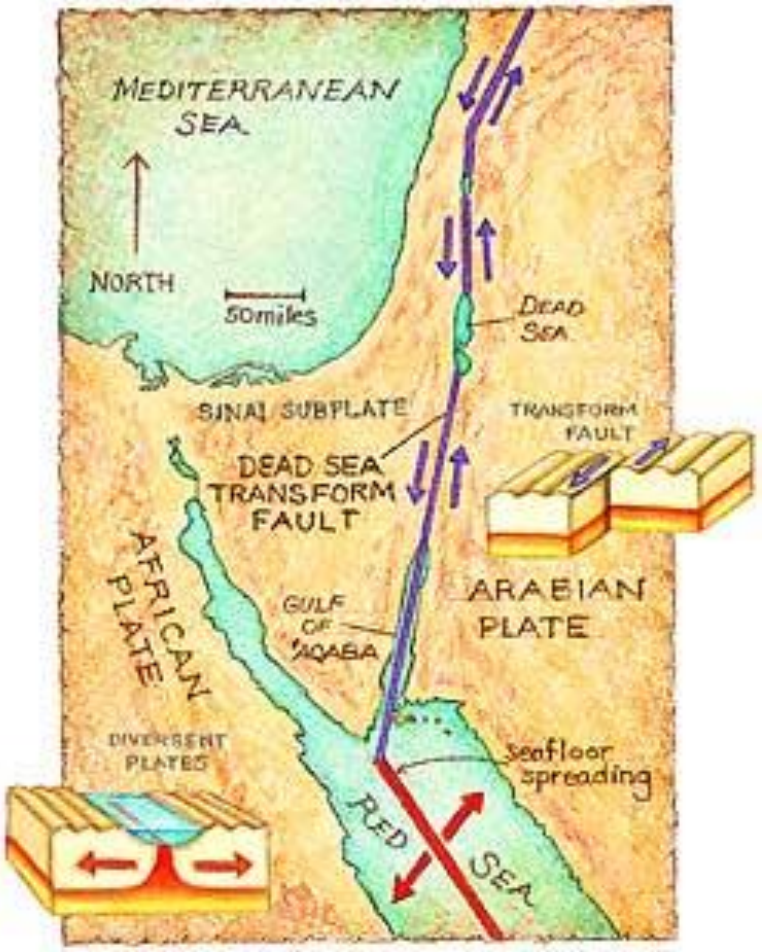

Juan
de Fuca
Plate
Cascade
Trench
N
A falla de
San Andrés
Triple
junction
San Andreas Fault
Mendocino
Transform
North American Plate
San Francisco
Pacific Plate
Los
Angeles
Salton
Sea
Triple
junction
Gulf of
California

Dead Sea Transform (DST)

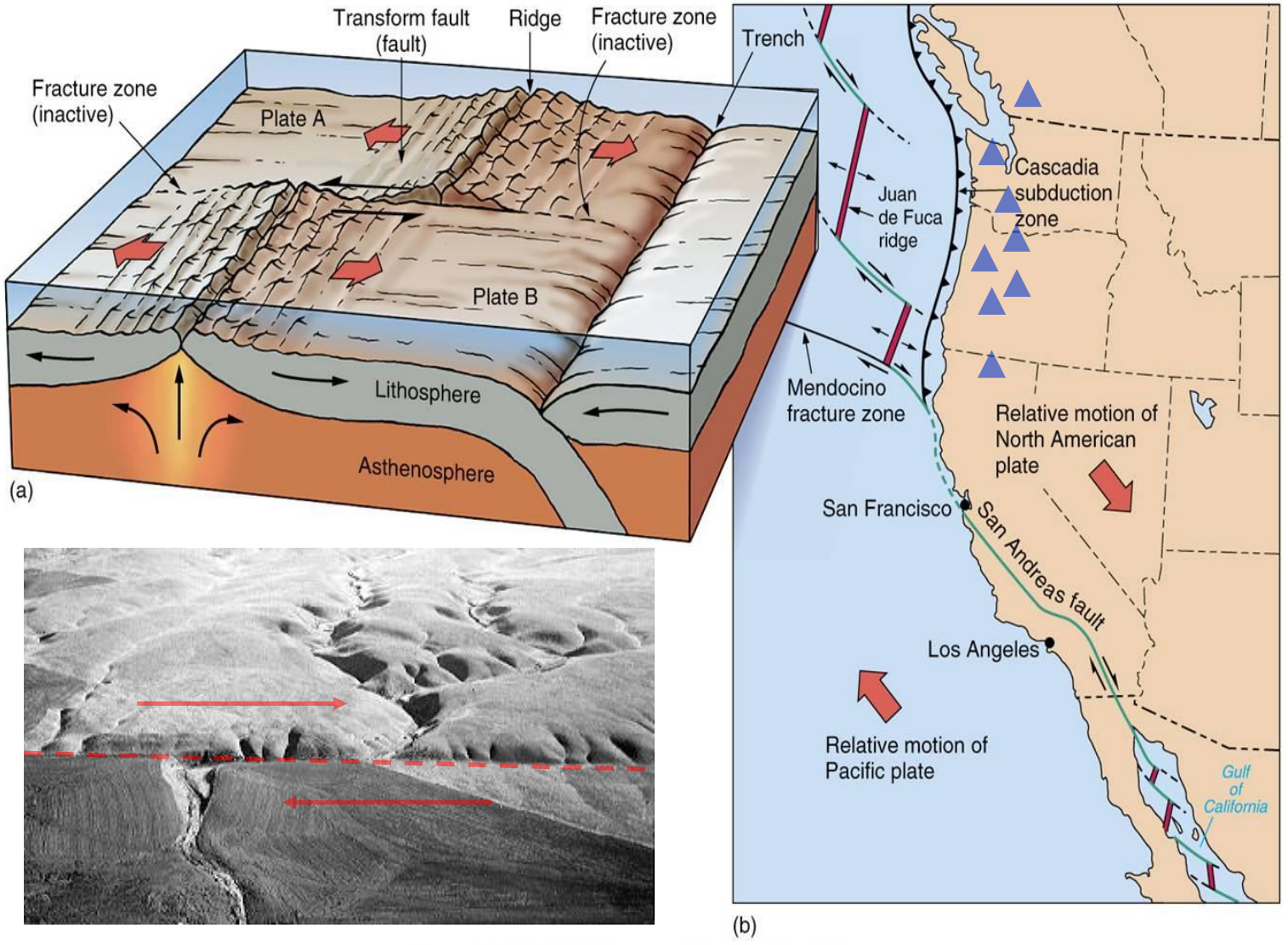


Dead Sea Transform (DST)

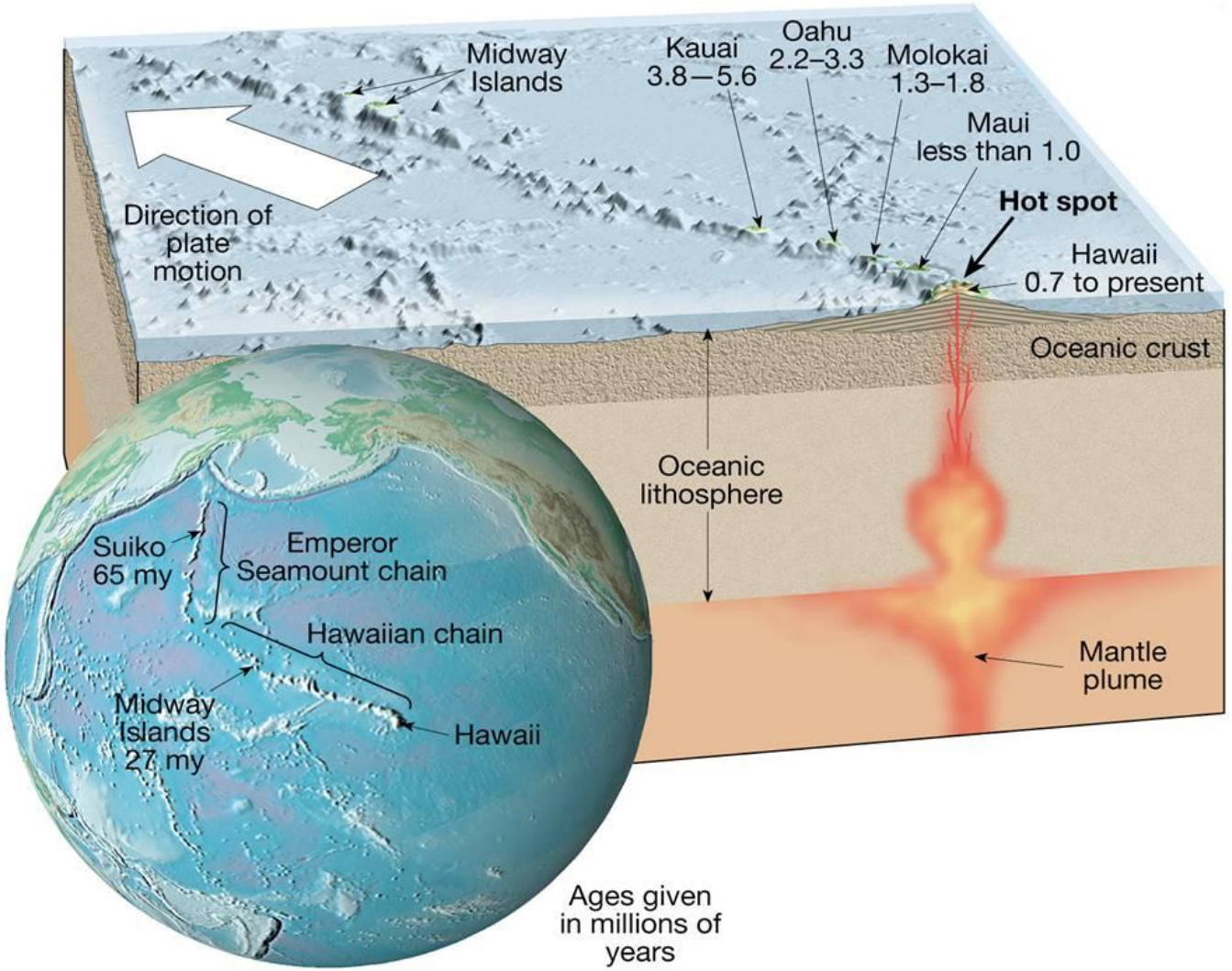




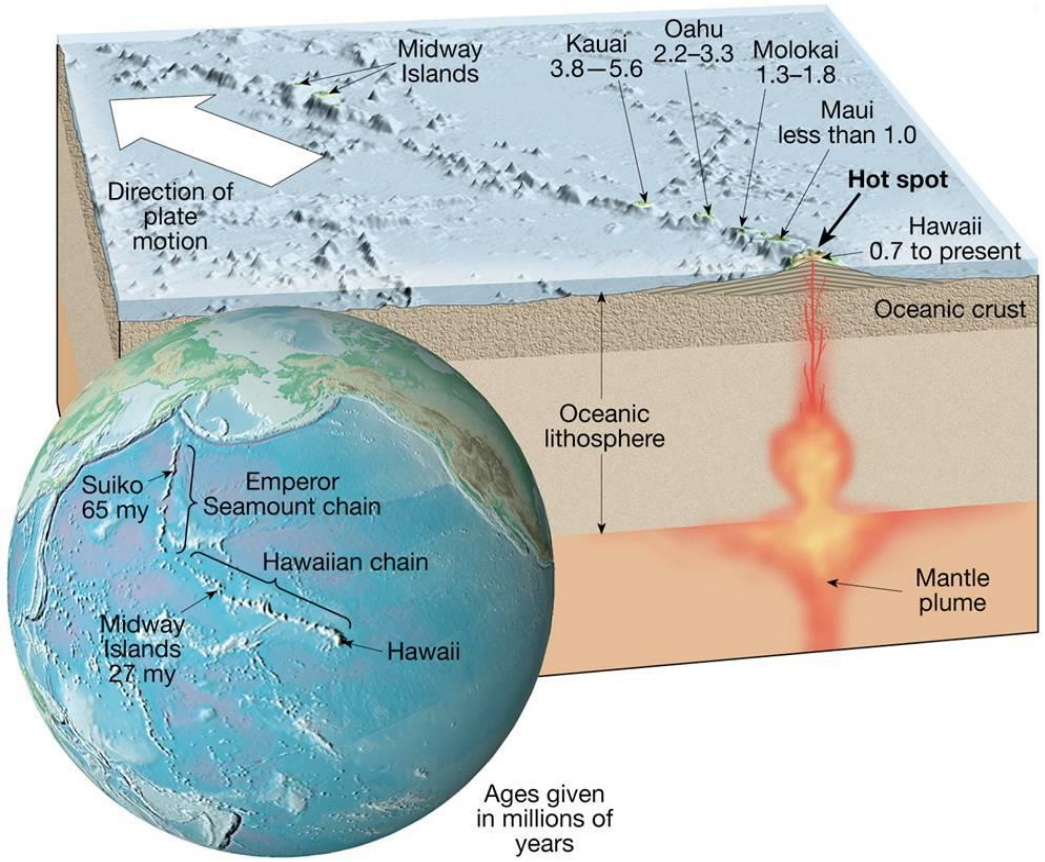
EXERCICIO 2


Transform fault
(fault)
Ridge
Fracture zone
(inactive)
Fracture zone
(inactive)
Plate A
Plate B
Lithosphere
Asthenosphere
(a)
Trench
Juan
de Fuca
ridge
Cascadia
subduction
zone
Mendocino
fracture zone
Relative motion of
North American
plate
San Francisco
San Andreas fault
Los Angeles
Relative motion of
Pacific plate
Gulf
of
California
(b)

FENÓMENOS INTRAPLACA: OS PUNTOS QUENTES

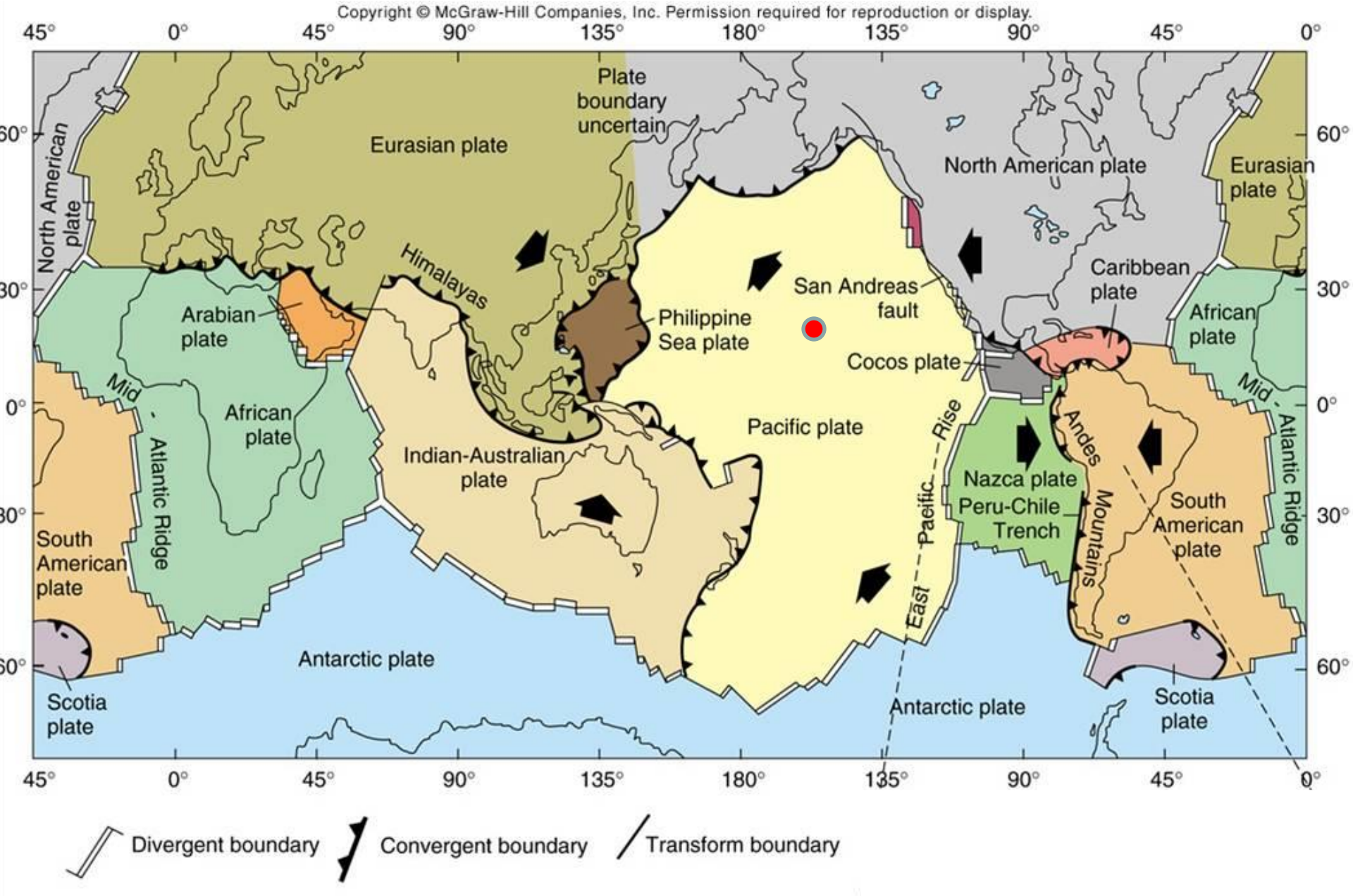


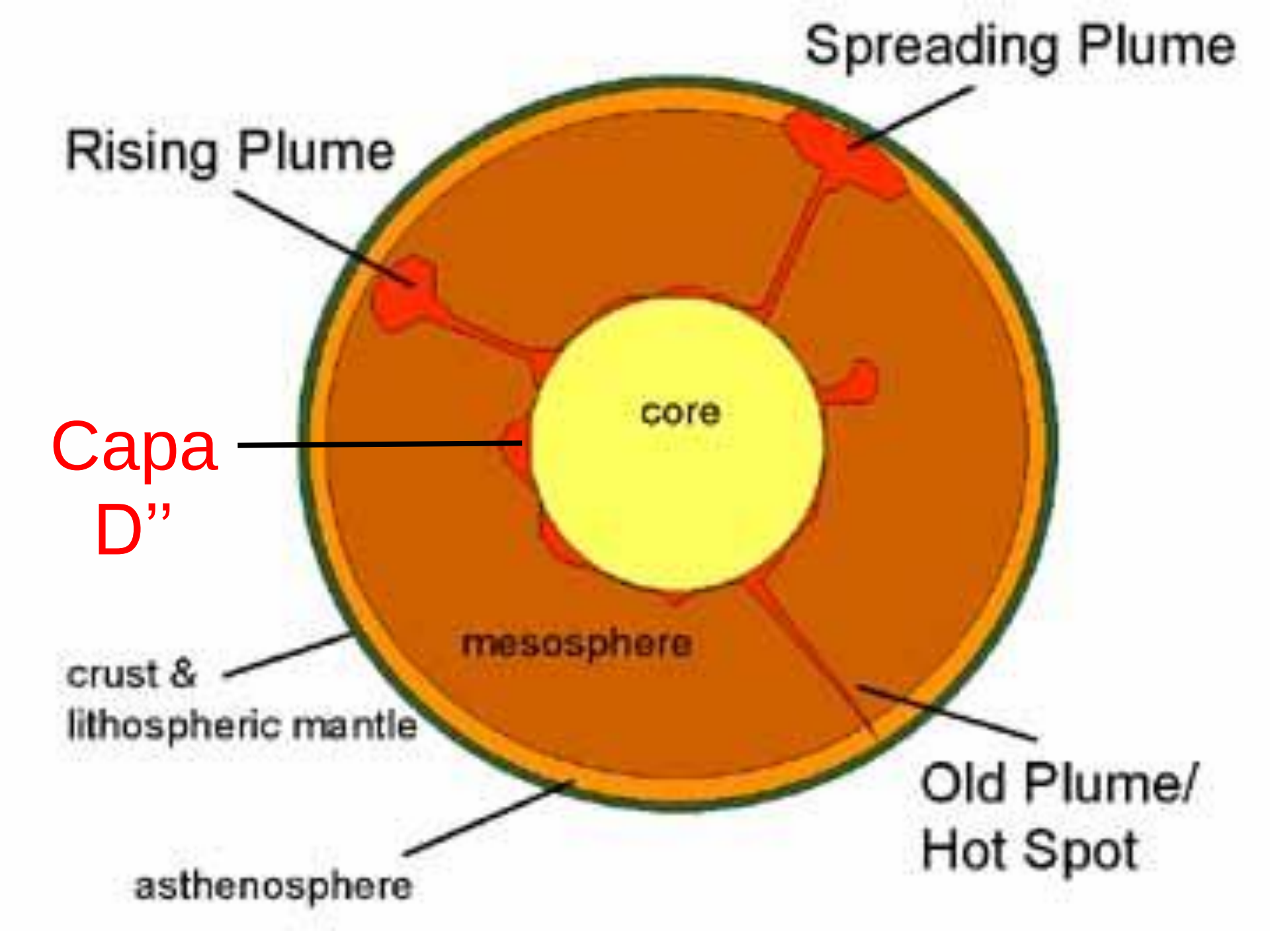
EXERCICIO 3


Midway Islands
Kauai 3.8—5.6
Oahu 2.2–3.3
Molokai 1.3–1.8
Maui less than 1.0
Hot spot
Hawaii 0.7 to present
Direction of plate motion
Oceanic crust
Oceanic lithosphere
Mantle plume
Suiko 65 my
Emperor Seamount chain
Hawaiian chain
Midway Islands 27 my
Hawaii
Ages given in millions of years

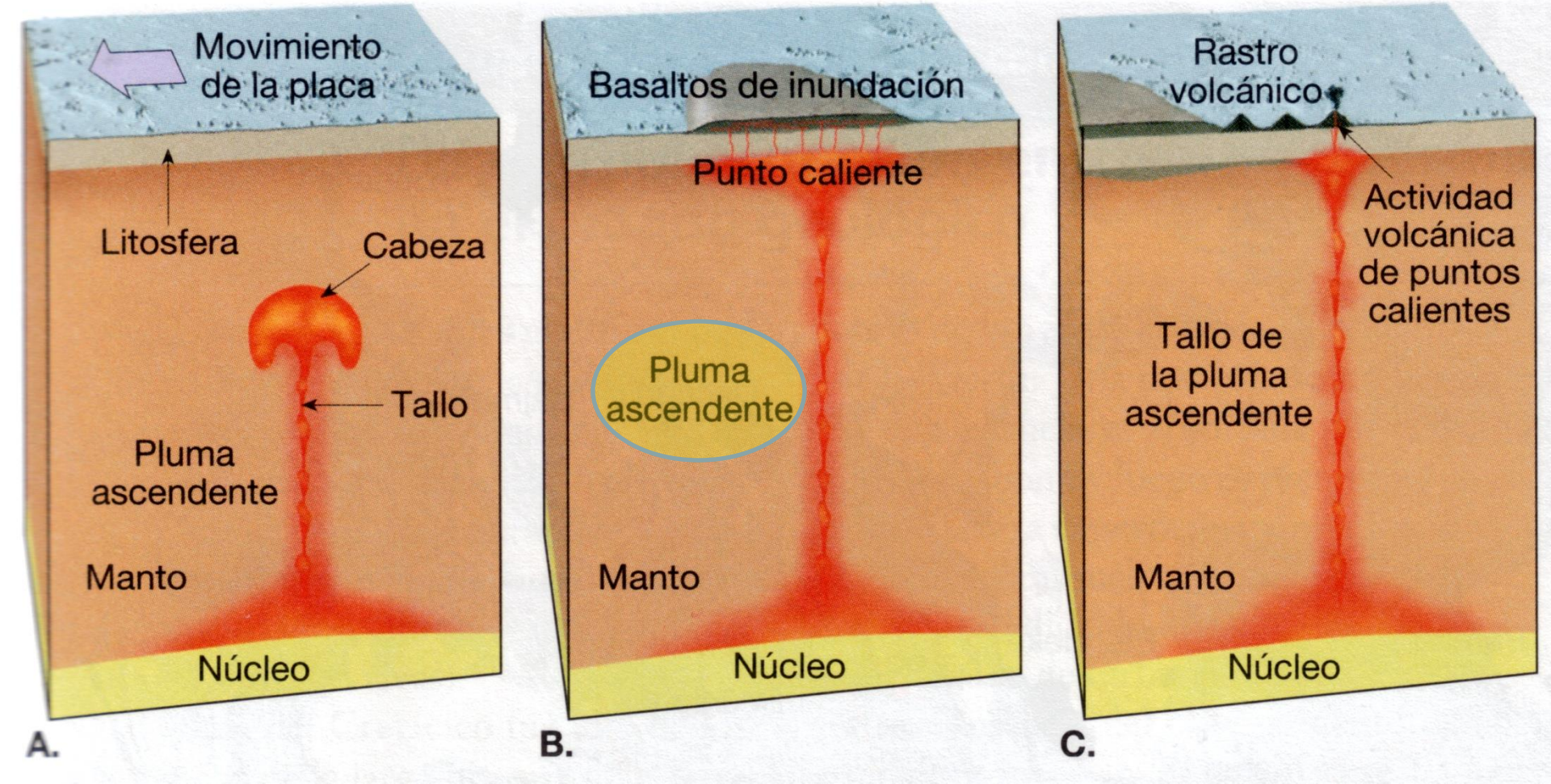

Mar de Bering
Mar de Ojotsk
Península de
Cuenca de las Aleutianas
7822
Fosa de las Aleutianas
Fosa de las Kuriles
10542
Cadena Submarina del Emperador
OCÉANO PACÍFICO
Fosa del Japón
Cuenca del Pacífico del Noroeste
Cuenca del
Zona de fractura de Murra
Pacífico Norte
Montañas Submarinas de los Cartógrafos
Dorsal de las Hawaii
Zona de fractura de
Fosa de las Marianas
Hawaii
Zona de fractura
11034

AS PLACAS LITOSFÉRICAS

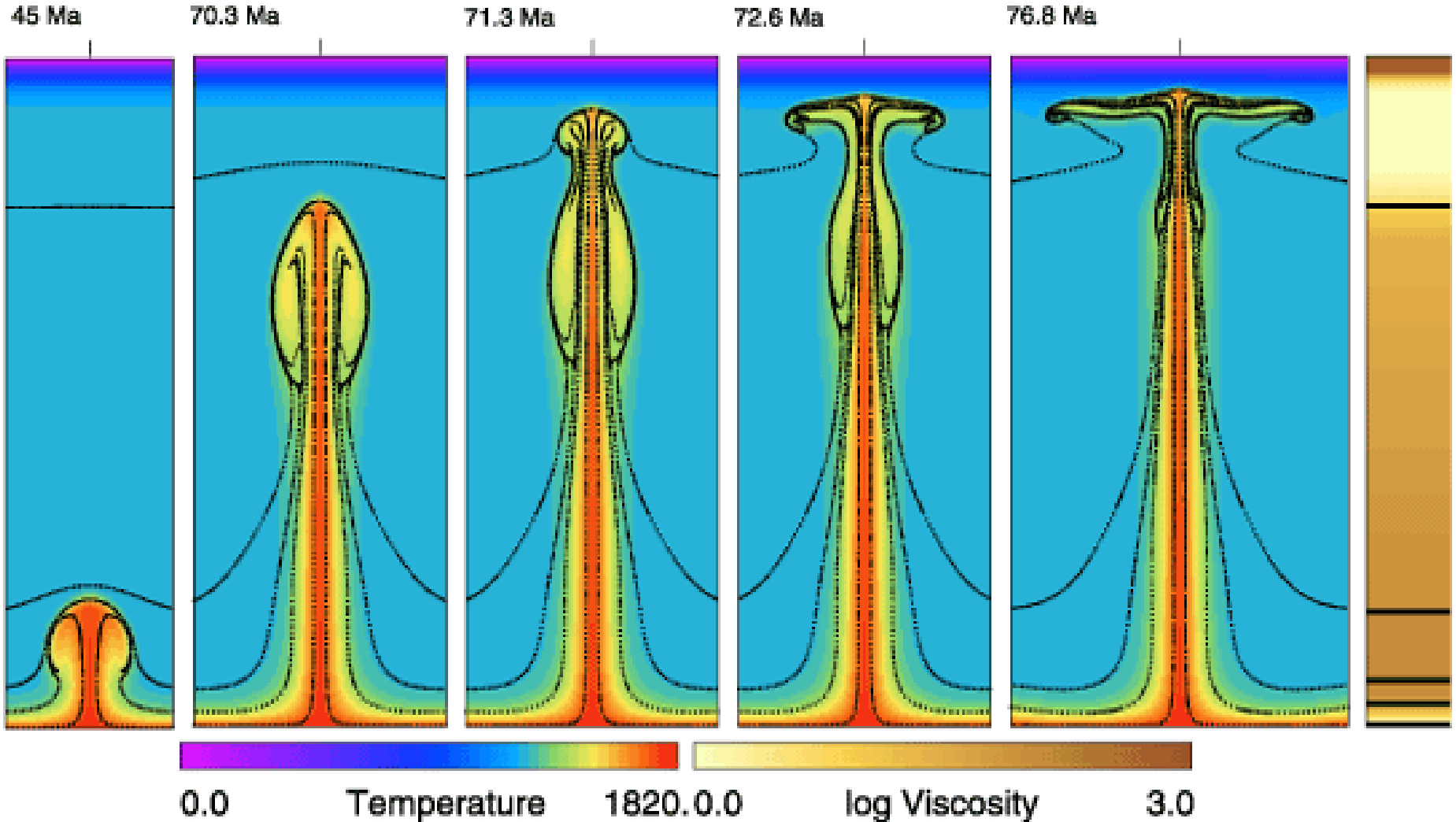


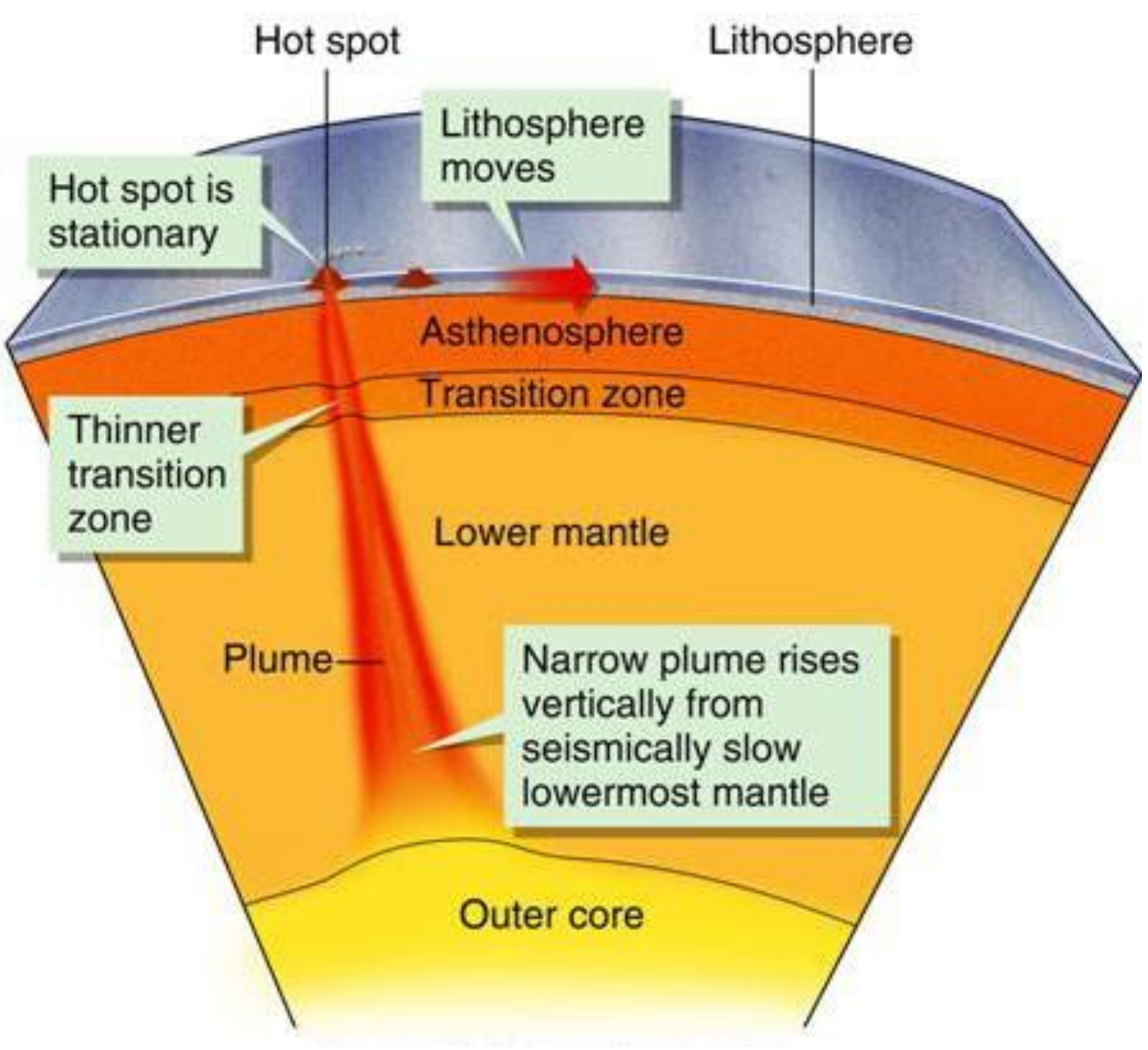

Spreading Plume
Rising Plume
Capa D''
core
mesosphere
crust & lithospheric mantle
Old Plume/ Hot Spot
asthenosphere

PENACHO TÉRMICO/PUNTO QUENTE

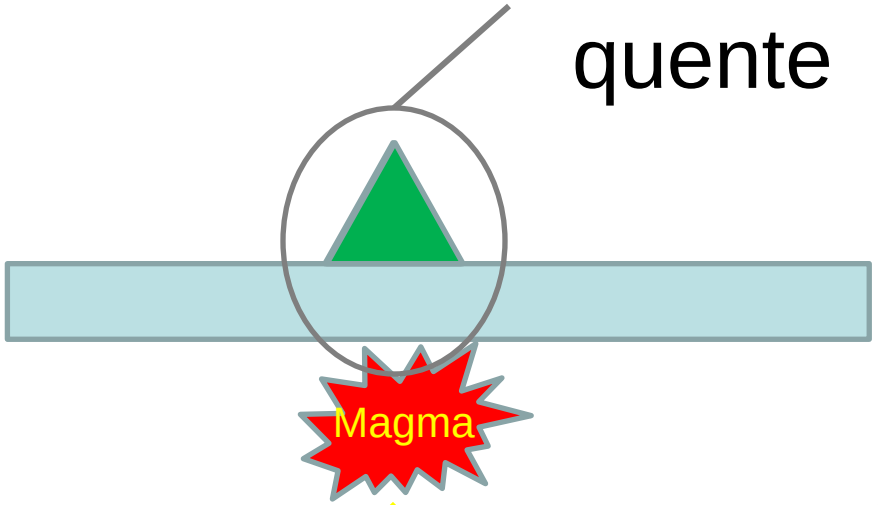


ESTIMACIÓN VELOCIDADE ?
50 CM /ANO




Hot spot
Lithosphere
Lithosphere moves
Hot spot is stationary
Asthenosphere
Transition zone
Thinner transition zone
Lower mantle
Plume
Narrow plume rises vertically from seismically slow lowermost mantle
Outer core

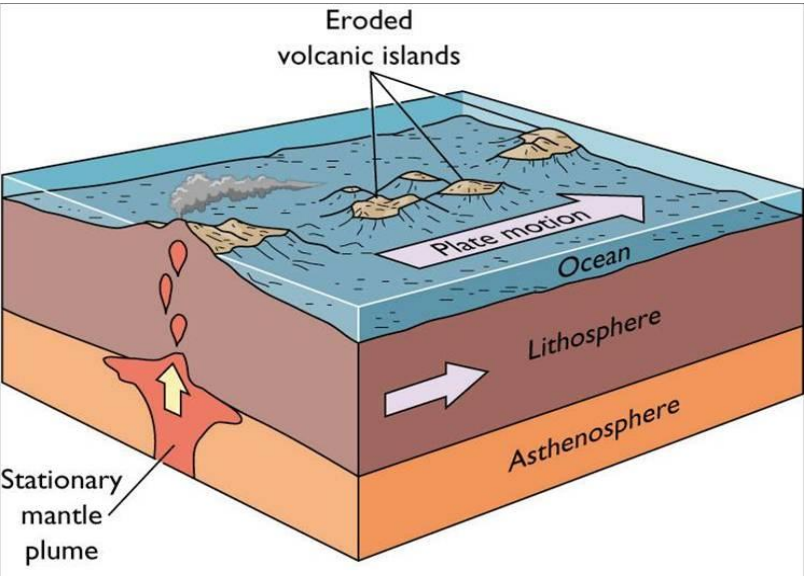
Punto quente



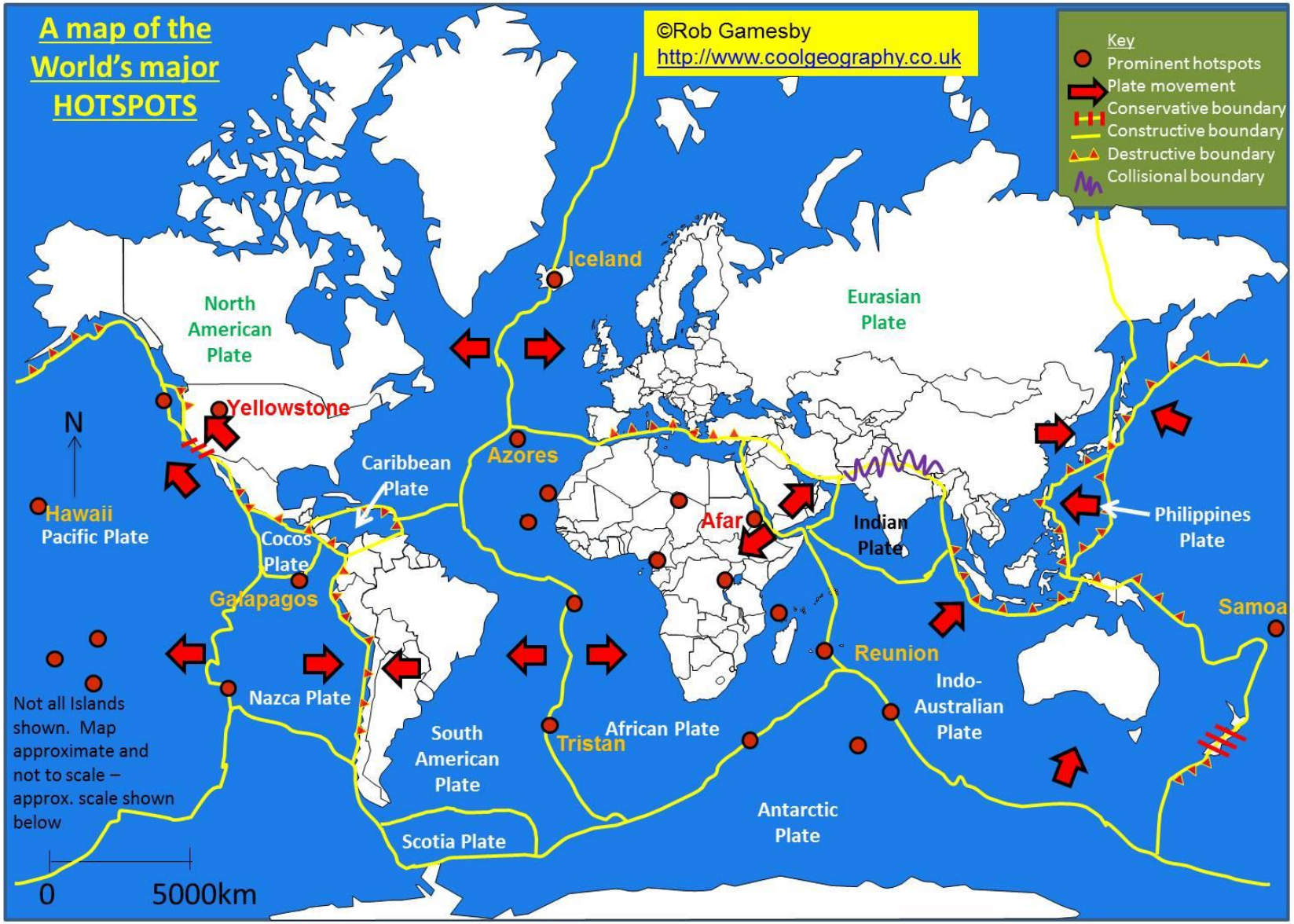
Litosfera

Astenosfera

Penacho térmico



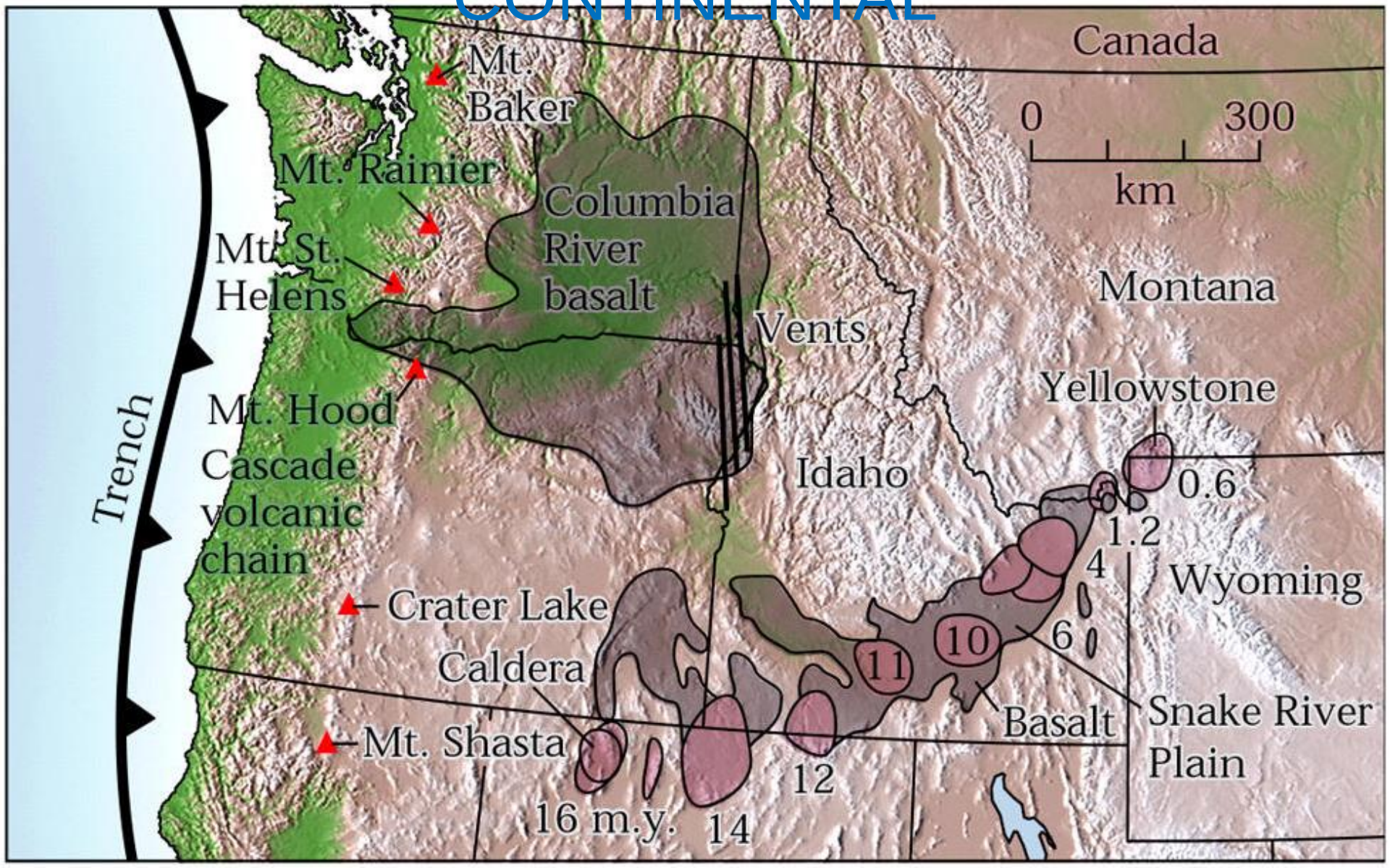
POSIBLES PUNTOS QUENTES



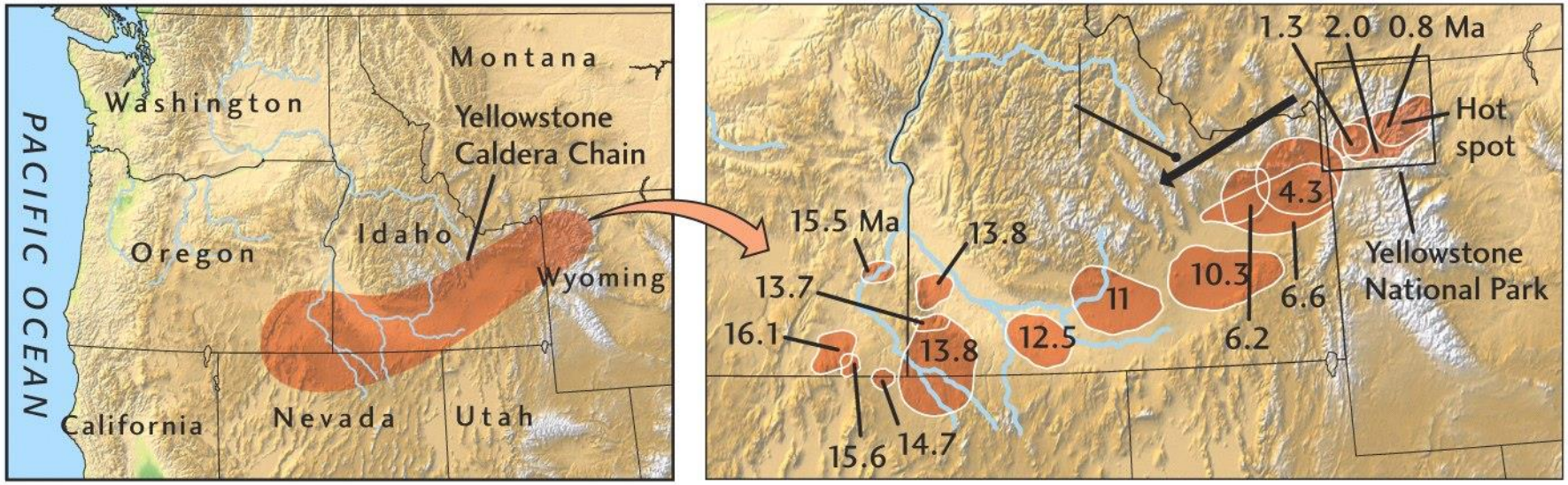
Hawai: punto quente oceánico

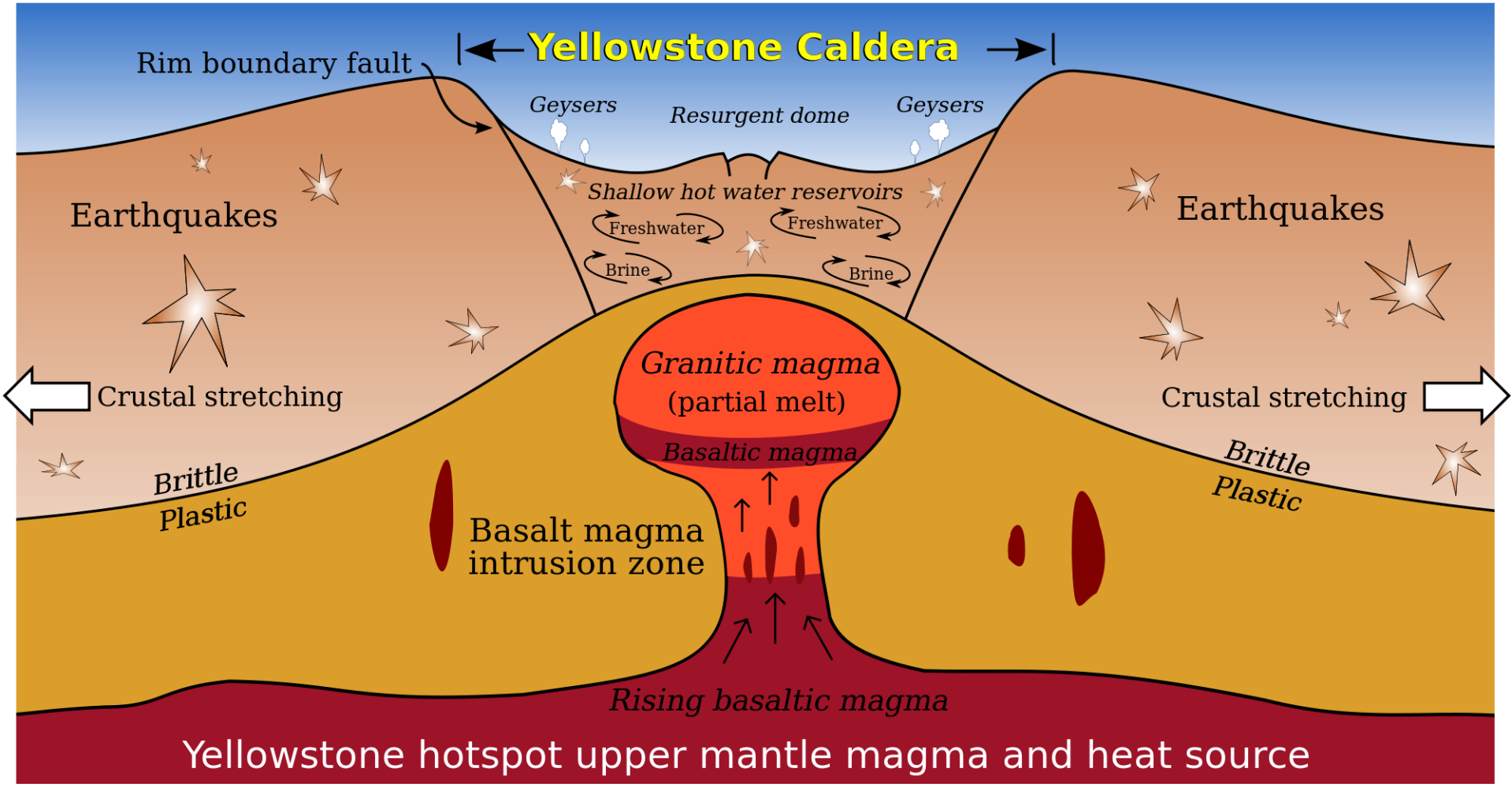

Hotspot Volcanism—A Thermal Plume
Simplified depiction of island chain model
IRIS
Scale, time, & processes are greatly exaggerated

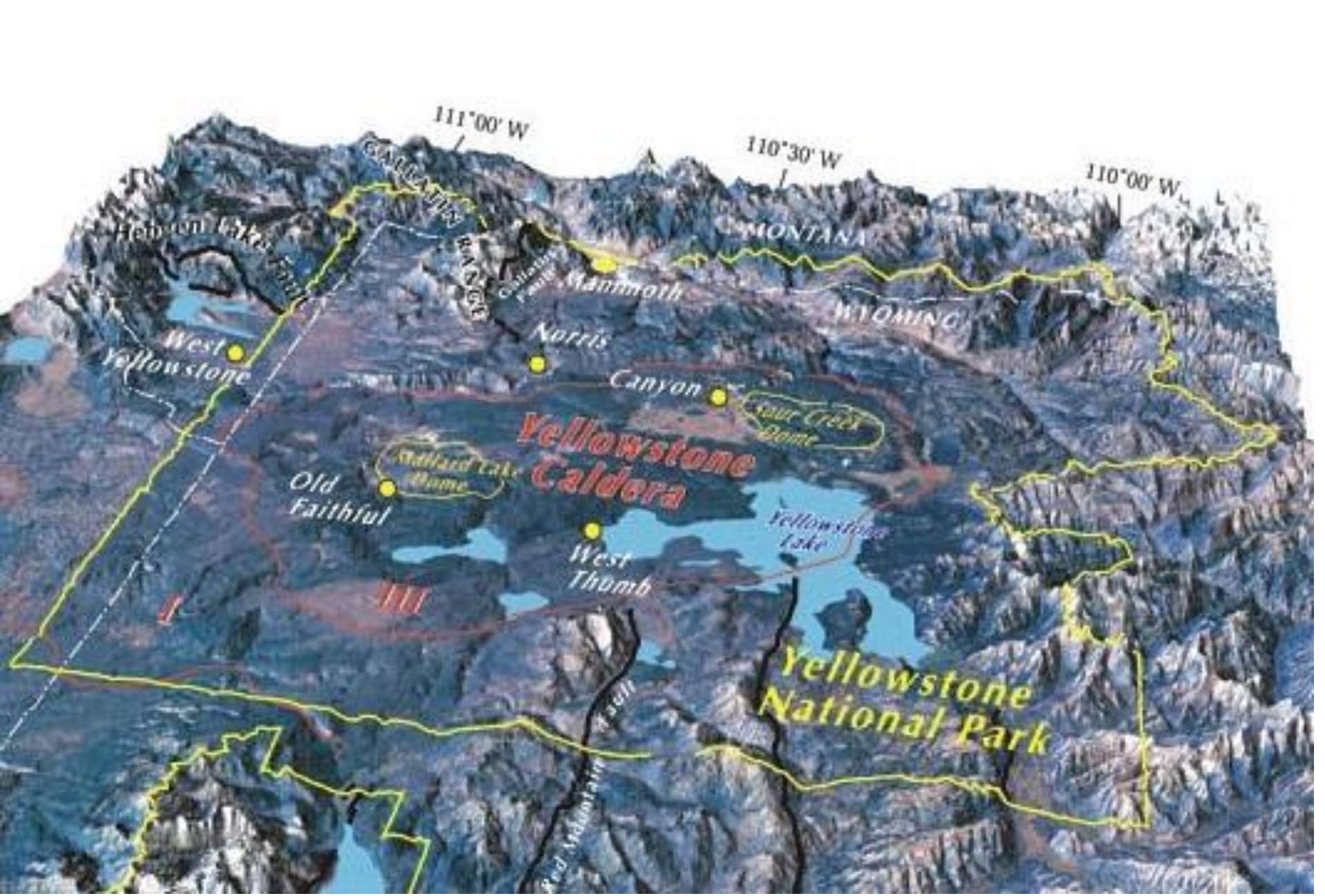
YELLOWSTONE: PUNTO QUENTE CONTINENTAL



Yellowstone Hotspot




Yellowstone Caldera
Rim boundary fault
Geysers
Resurgent dome
Geysers
Shallow hot water reservoirs
Freshwater
Freshwater
Brine
Brine
Earthquakes
Earthquakes
Crustal stretching
Crustal stretching
Granitic magma
(partial melt)
Basaltic magma
Brittle
Plastic
Brittle
Plastic
Basalt magma
intrusion zone
Rising basaltic magma
Yellowstone hotspot upper mantle magma and heat source

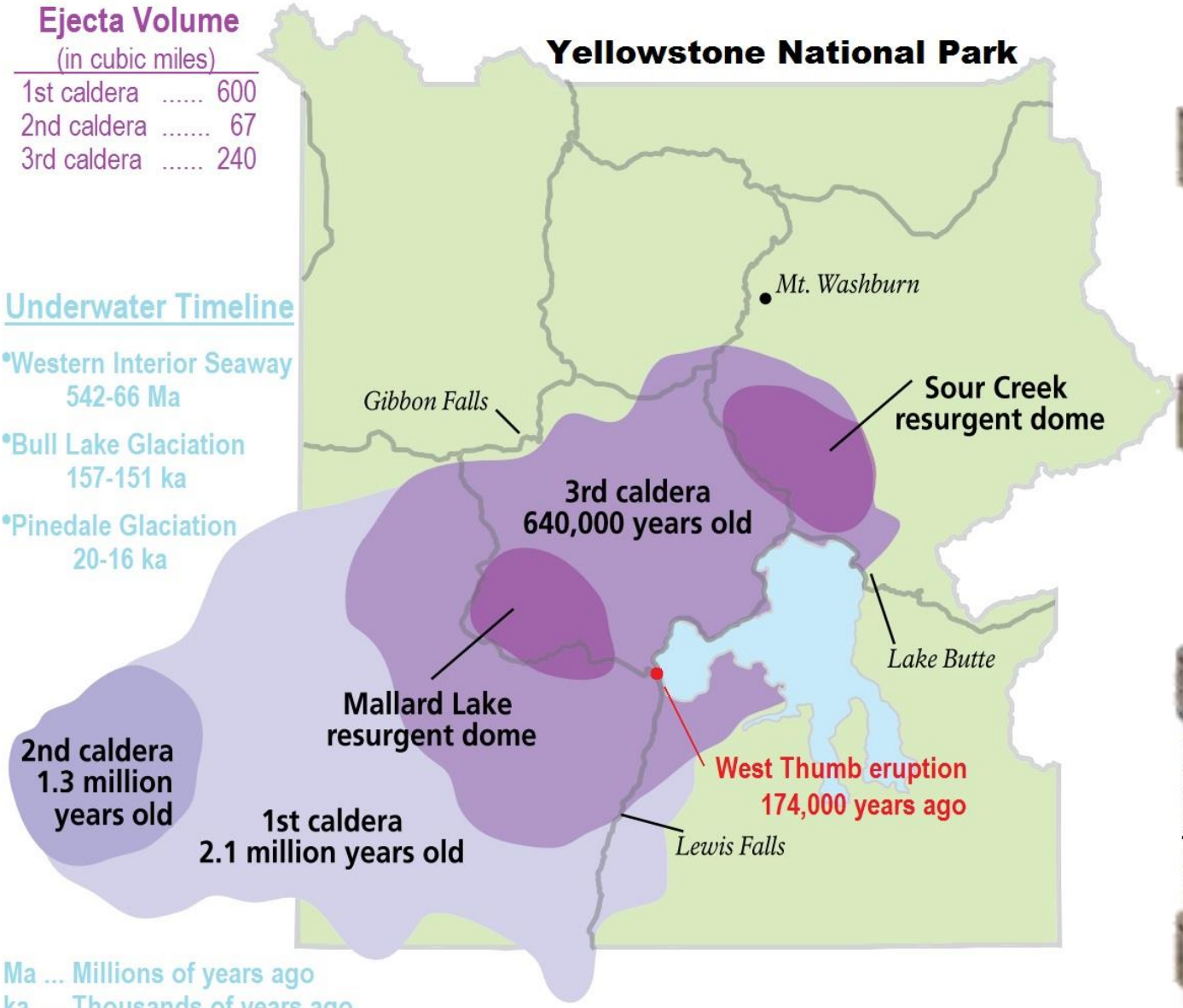

111°00' W
110°30' W
110°00' W
MONTANA
WYOMING
Mammoth
Norris
Canyon
West Yellowstone
Old Faithful
Yellowstone Caldera
West Thumb
Yellowstone Lake
Yellowstone National Park

Ejecta Volume
(in cubic miles)

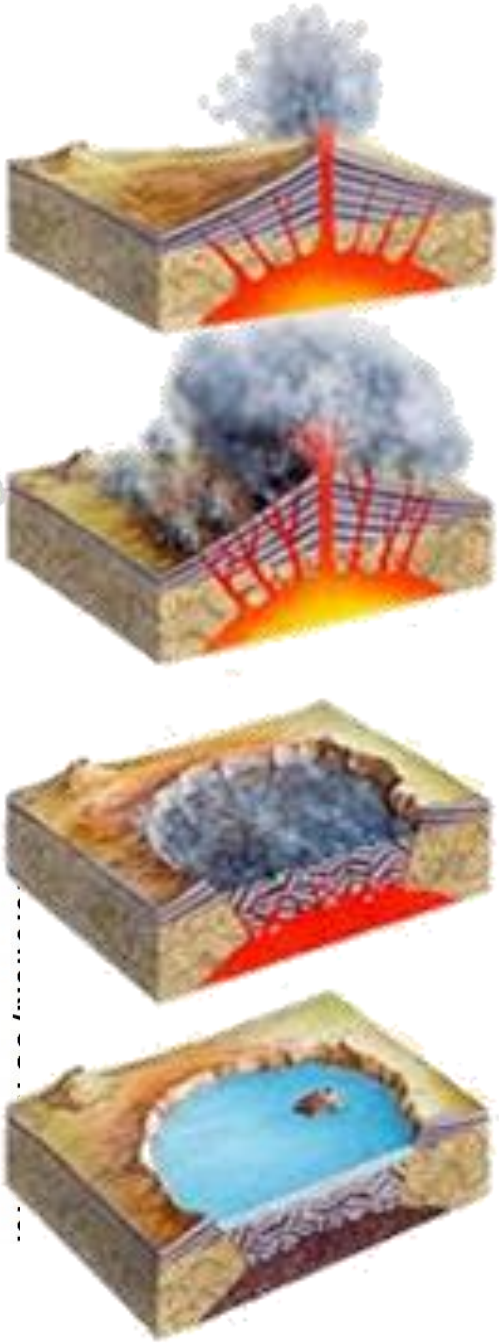
1st caldera	600
2nd caldera	67
3rd caldera	240

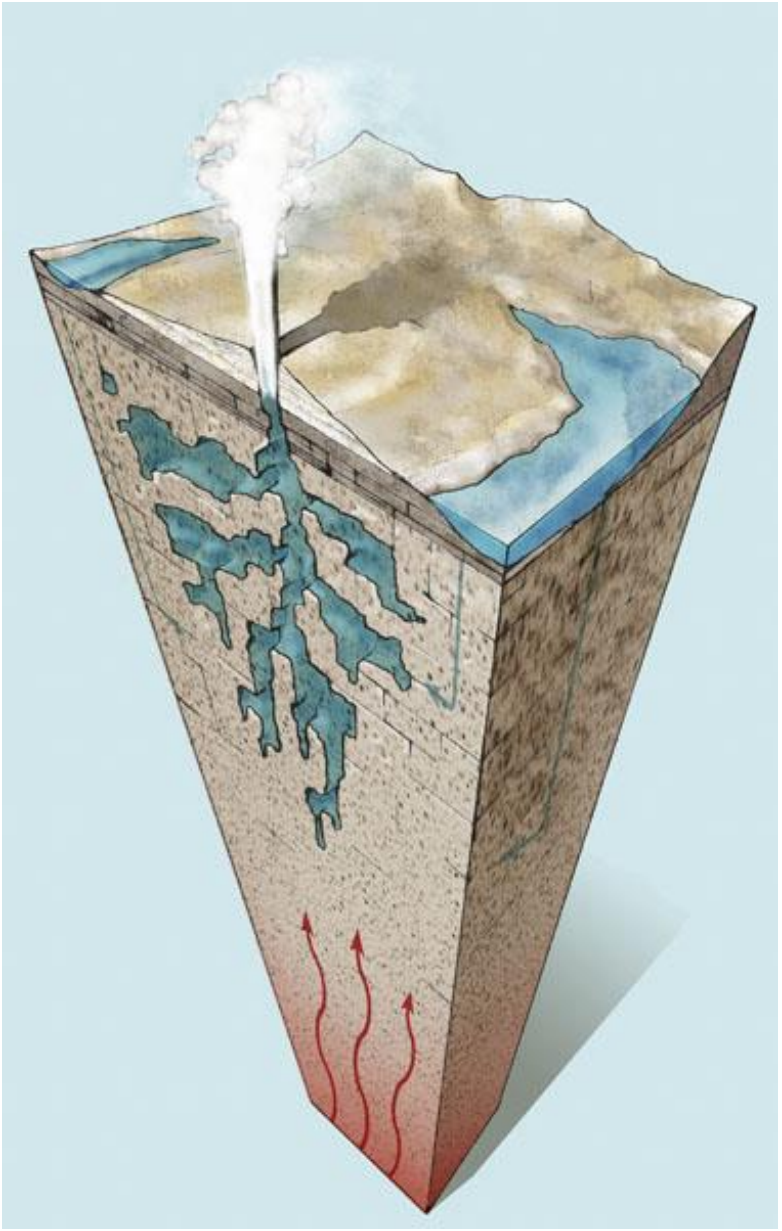
Underwater Timeline

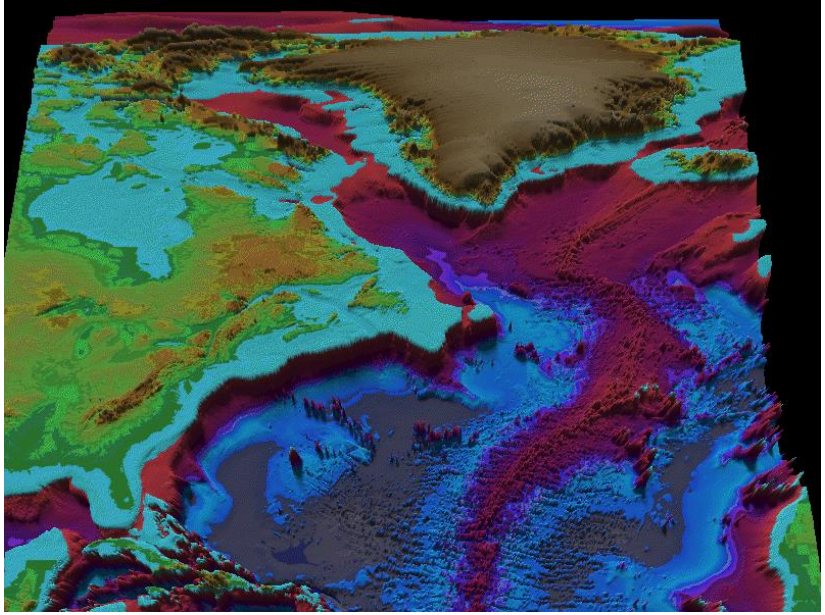
- Western Interior Seaway 542-66 Ma
- Bull Lake Glaciation 157-151 ka
- Pinedale Glaciation 20-16 ka



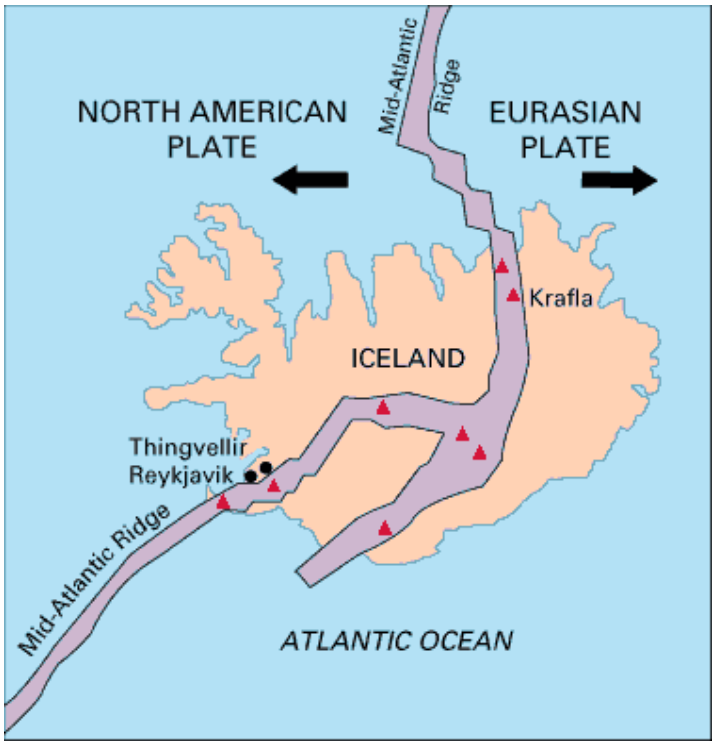
Ma ... Millions of years ago
ka ... Thousands of years ago

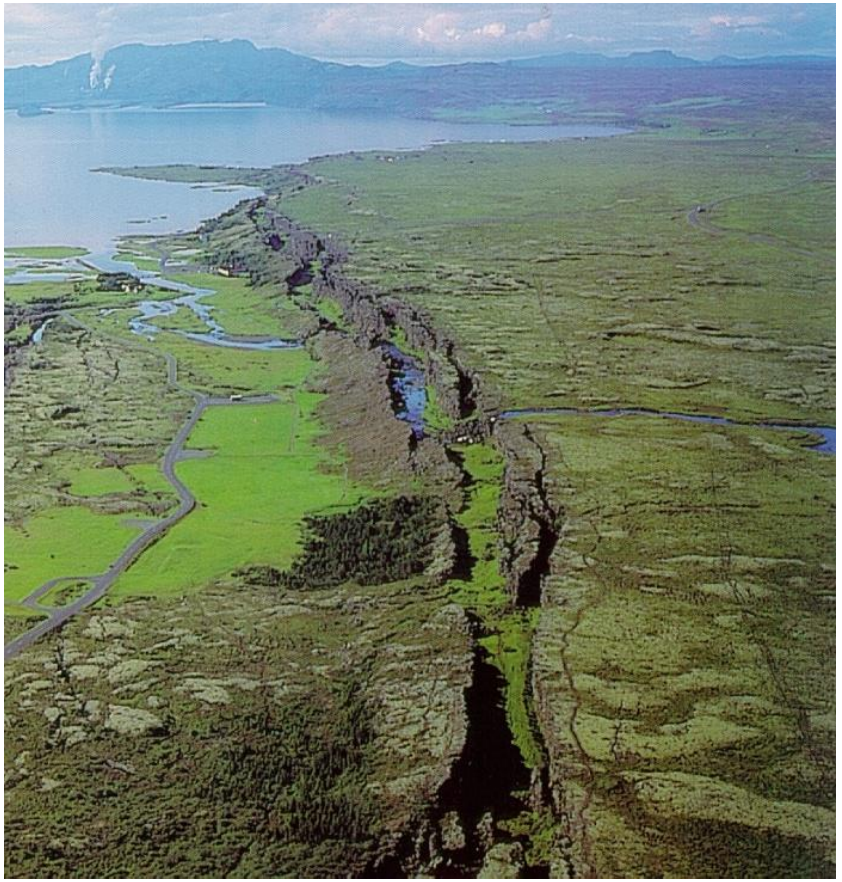






Iceland Hotspot: On the mid-Atlantic ridge





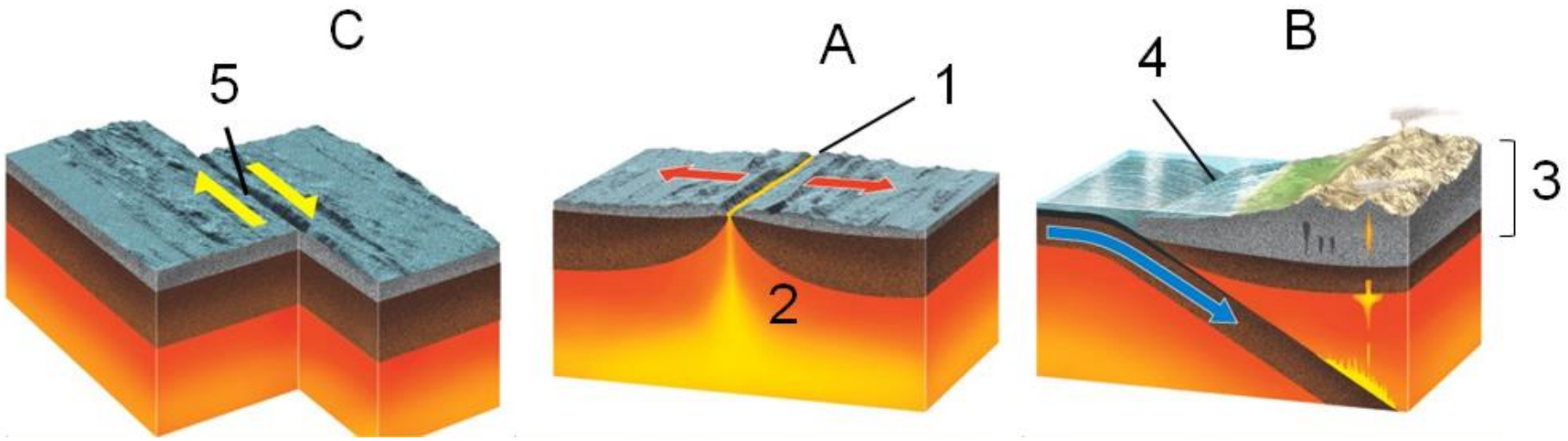
EXERCICIO 7

7. Observa a figura inferior e responde ás seguintes preguntas

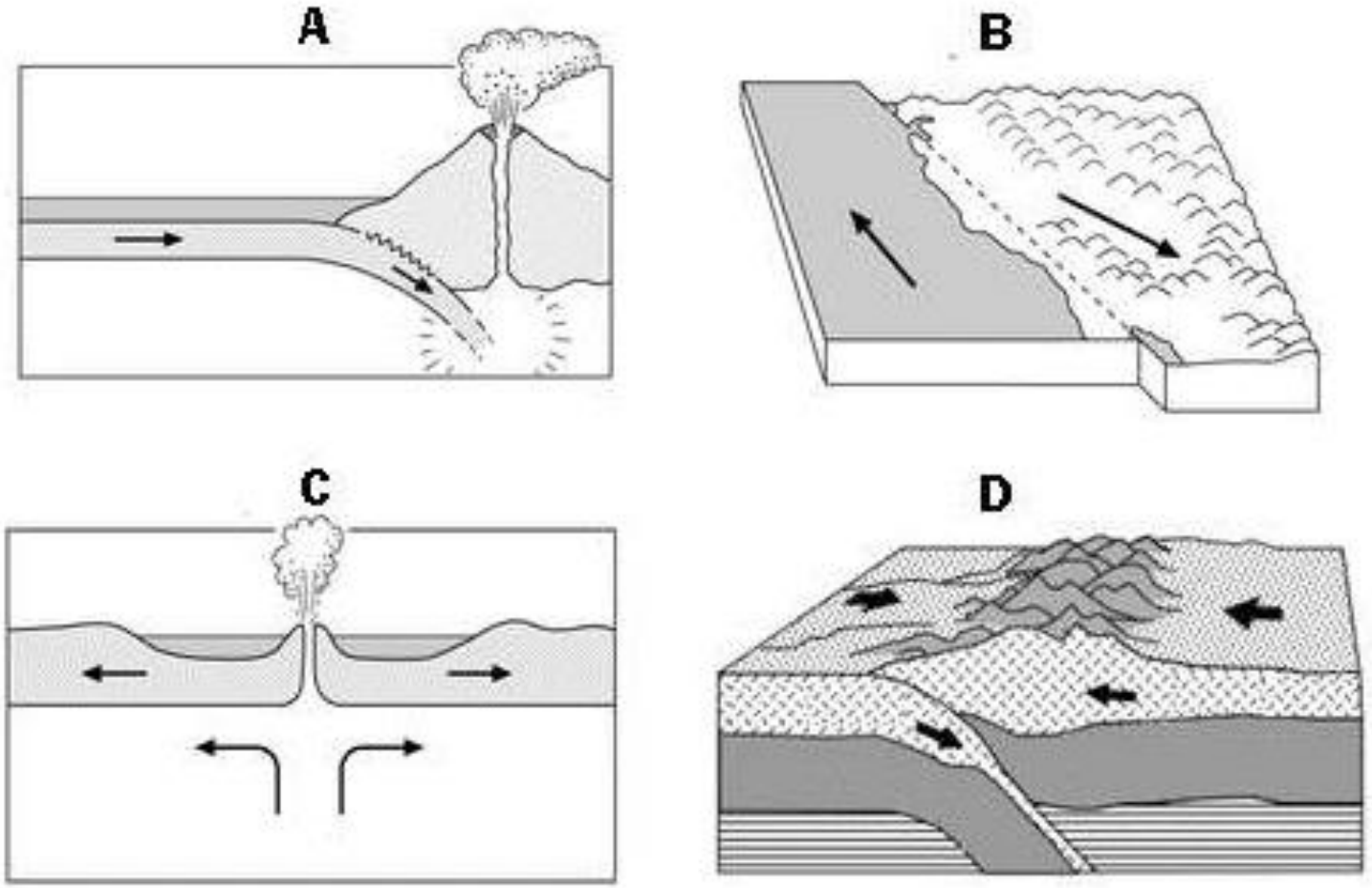
7.1- Asocia os números con seguintes termos: astenosfera, falla transformante, fosa oceánica, dorsal oceánica, litosfera continental.

7.2- Describe os procesos de formación de magma na figura A

7.3- Na figura B, indica a qué tipo de borde de placa corresponde e qué procesos xeolóxicos se producen nesa zona.



Exercicio 11



EXERCICIO 12

14. Observa a figura adxunta e responde as seguintes cuestións:

14. 1. Asocia as letras maiúsculas da Figura 1 (da A ao E) aos seguintes nomes: dorsal oceánica, arco illa, litosfera, astenosfera, zona de subdución.

14. 2. Indica a orixe e a composición do magma que se forma nas zonas 1 e 2.

14. 3. Explica como é o límite de placas na zona sinalada coa letra E, e cita os procesos xeolóxicos asociados a este tipo de bordo de placa.