

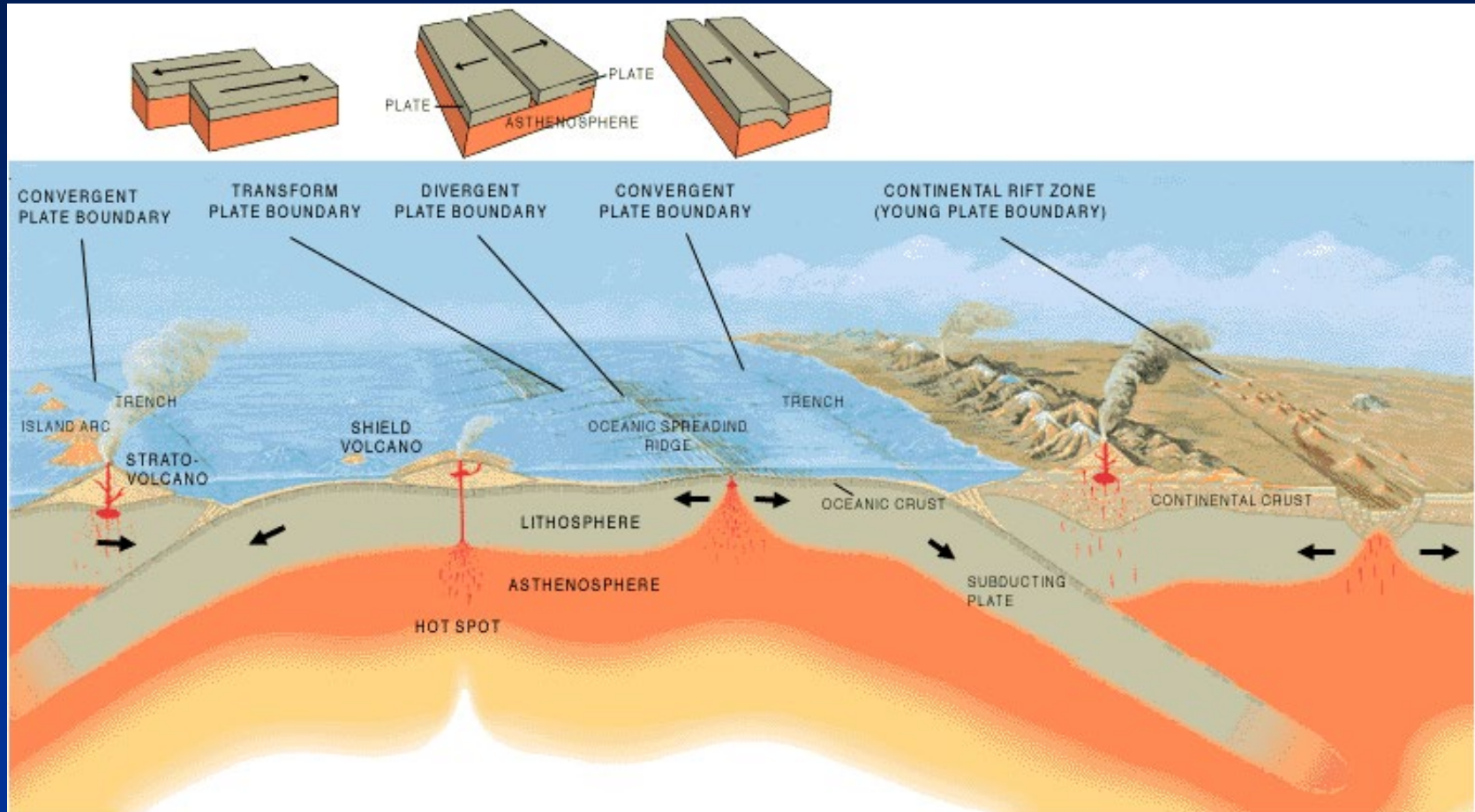
Associazioni di strutture tettoniche

**Dalla scala
dell'affioramento alla scala
regionale**

Immagini e fotografie tratte da:

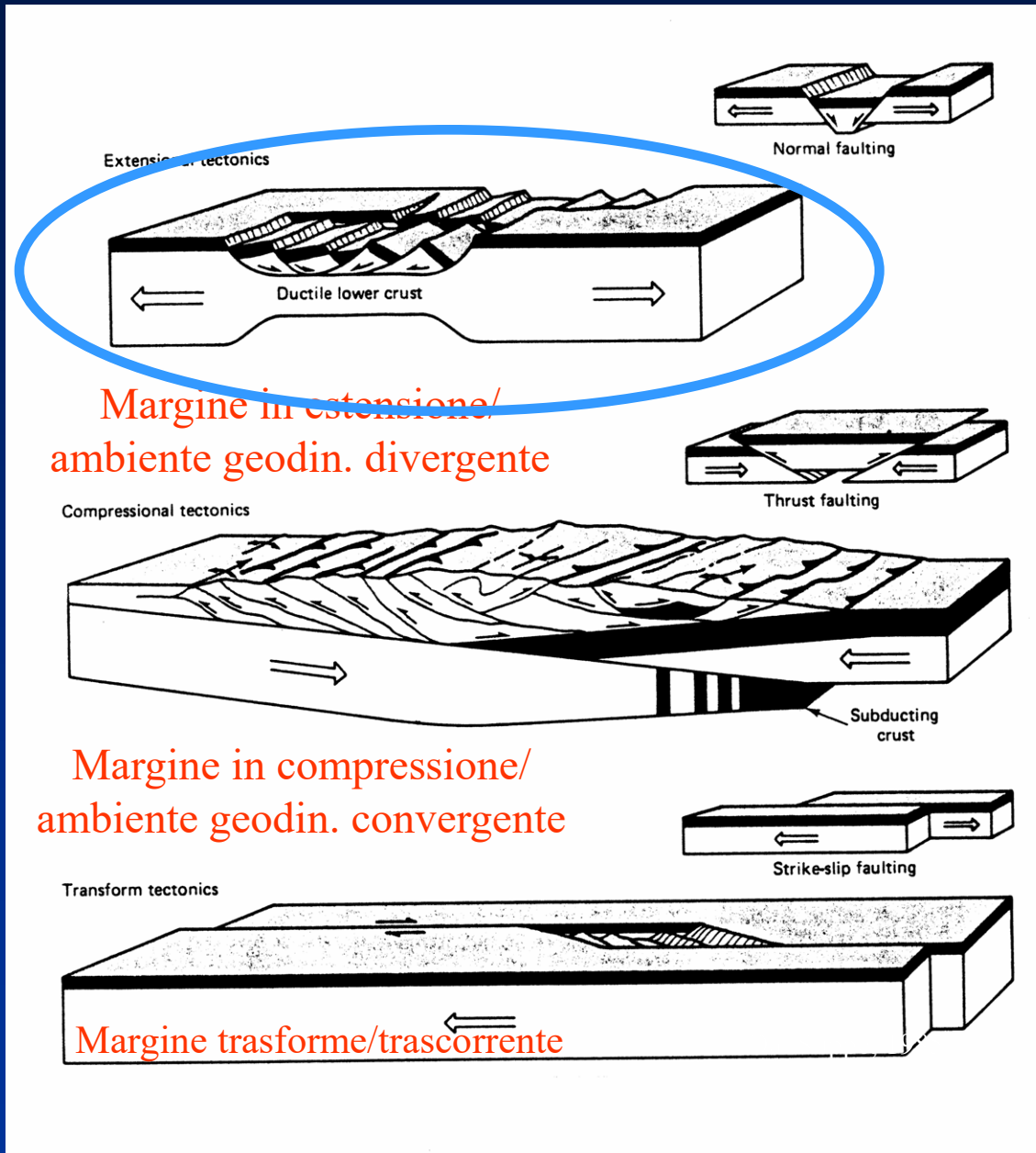
- Bally A.W., Catalano R., Oldow J.S., 1985. Elementi di tettonica regionale. Pitagora Editore.
- Buchanan P.G., McClay K.R., 1991. Sandbox experiments of inverted listric and planar fault systems. *Tectonophysics*, 188, 97-115.
- Chorowitz J., 2005. The East African rift system. *Journal of African Earth Sciences*, 43, 379–410.
- Dijkshoorn L, Clauser C., 2013. Relative importance of different physical processes on upper crustal specific heat flow in the Eifel-Maas region, Central Europe and ramifications for the production of geothermal energy. *Scientific Research*, 5, Article ID:28354.
- Guinot D., Segonzac M., 2018. A review of the brachyuran deep-sea vent community of the western Pacific, with two new species of *Austinograea* Hessler & Martin, 1989 (Crustacea, Decapoda, Brachyura, Bythograeidae) from the Lau and North Fiji Back-Arc Basins. *Zoosystema*, 40, 75-107.
- Hatcher R.D., 1995. *Structural Geology: Principles Concepts and Problems*. Prentice Hall International.
- Kuebler, S. 2013. *Active Tectonics of the Lower Rhine Graben (NW Central Europe): Based on New Paleoseismological Constraints and Implications for Rupture Processes in Unconsolidated Gravels*. PhD thesis, LMU Munich.
- Mantovani, E., Albarello, D., Babbucci, D., Tamburelli, C., Viti, M., 2002. Trench-Arc-BackArc systems in the Mediterranean area: examples of extrusion tectonics. *Journal of Virtual Explorer*, 8, 125–141.
- Mège D. et al., 2015. A major dyke swarm in the Ogaden region south of Afar and the early evolution of the Afar triple junction. In: *Magmatic Rifting and Active Volcanism*. Chapter: 7. Geological Society, London, Special Publications, 420.
- Mercier J., Vergely P., 1996. *Tettonica*. Pitagora Editore.
- Nicolas A., 1984. *Principes de tectonique*. Masson.
- Pini, materiale inedito.
- Ramsay J. G., Huber M. I., 1987. *The Techniques of Modern Structural Geology*. Volume 2: Folds and Fractures. Academic Press Inc.
- Stein S. et al., 2015. Challenges in assessing seismic hazard in intraplate Europe. In: *Geological Society, London, Special Publications*, 432.
- Suppe J., 1985. *Principles of Structural Geology*. Prentice-Hall Inc.
- van der Pluijm B., Marshak S., 2004. *Earth Structure: An Introduction to Structural Geology and Tectonics*, Second Edition. WW Norton & Company.

Tipo di margini di placca e ambienti geodinamici



<http://factsanddetails.com/world/cat51/sub323/item2212.html>

Tipo di margini di placca e ambienti geodinamici



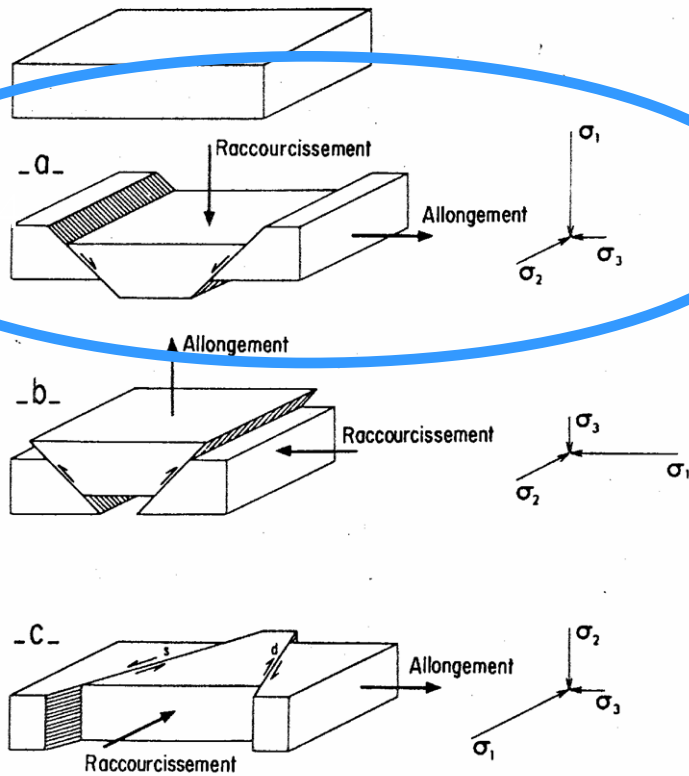
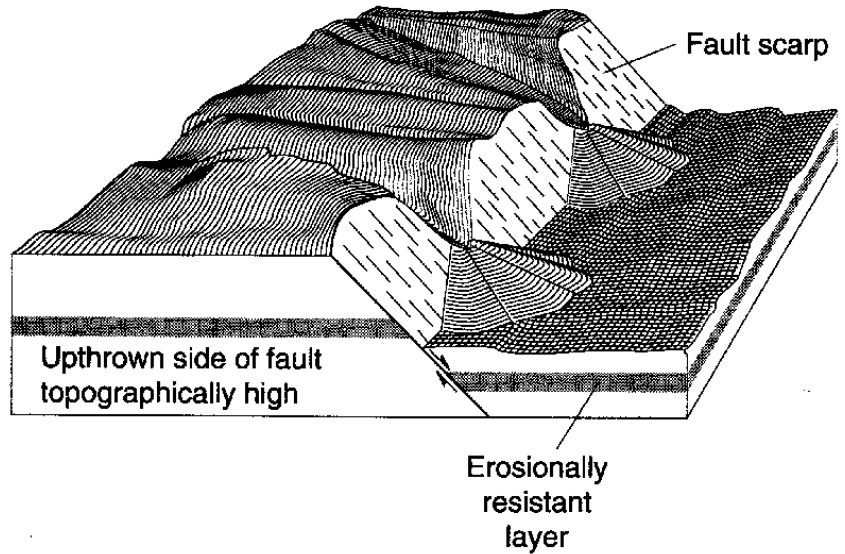
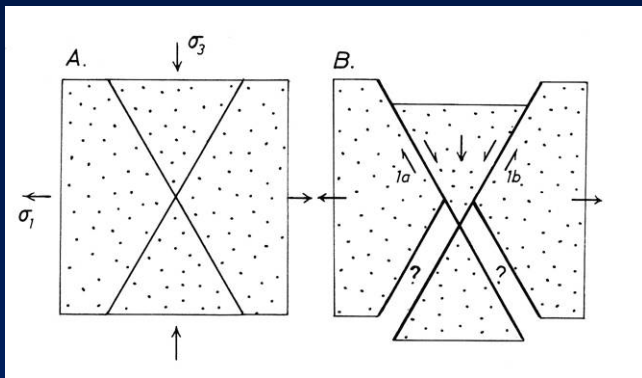


Fig. 5.12 - Systèmes de failles conjuguées. a- Failles normales conjuguées, b- Failles inverses conjuguées, horst. c- Décrochements dextre et senestre conjugués. (Blès et Feuga, 1981. BRGM éd., Orléans).

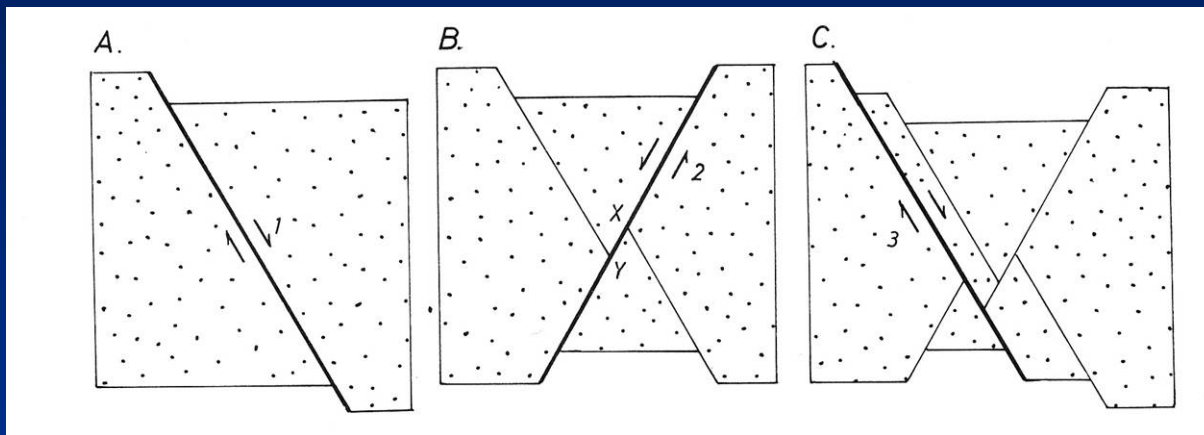
Da Nicolas, 1984



Da Hatcher, 1995



Da Ramsay and Huber, 1987

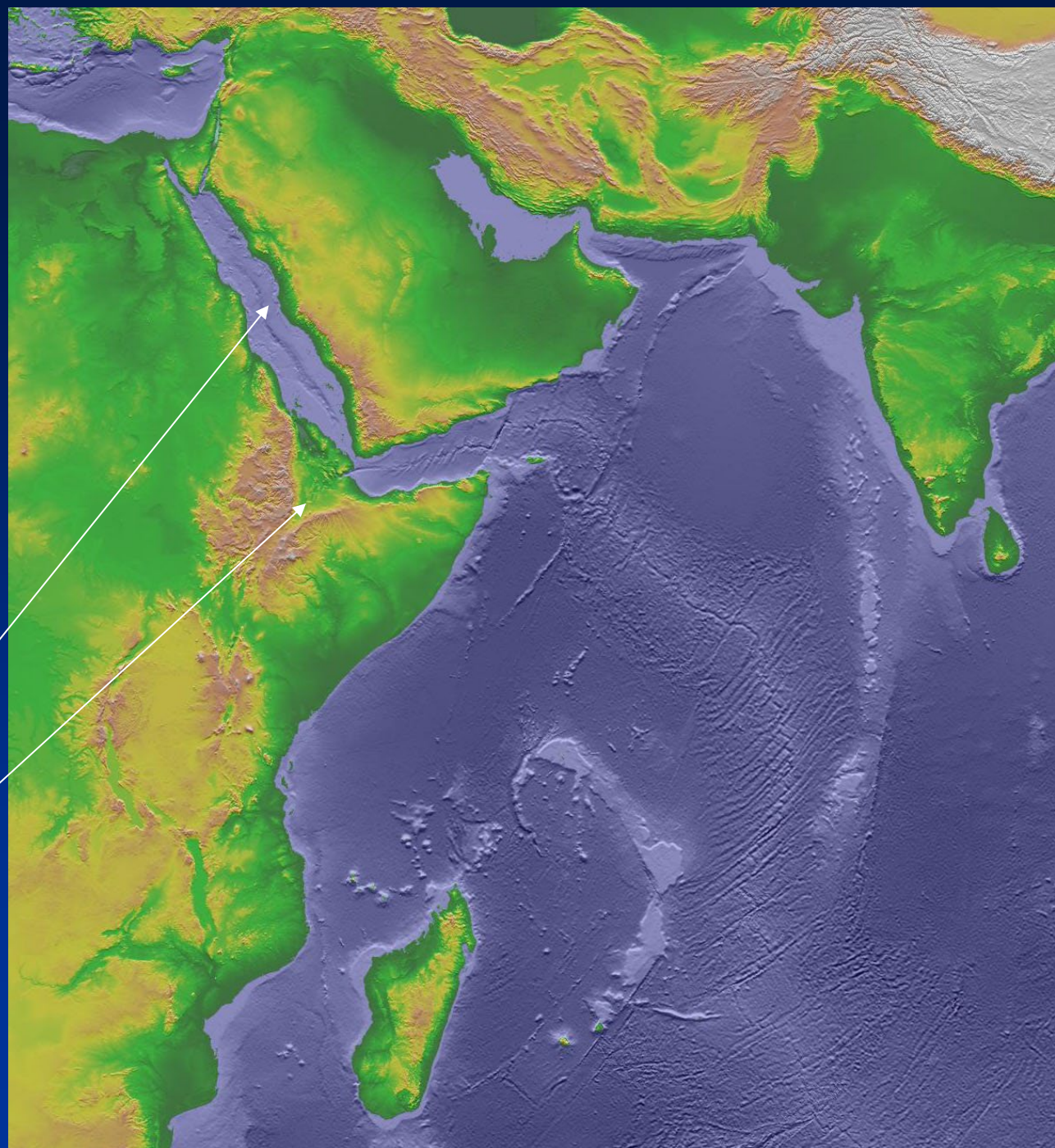


Solo le associazioni di faglie (coniugate) lavorano!!

1a) estensione e
assottigliamento
di crosta
continentale che
porta a crosta
oceanica (*from
rift to drift*)

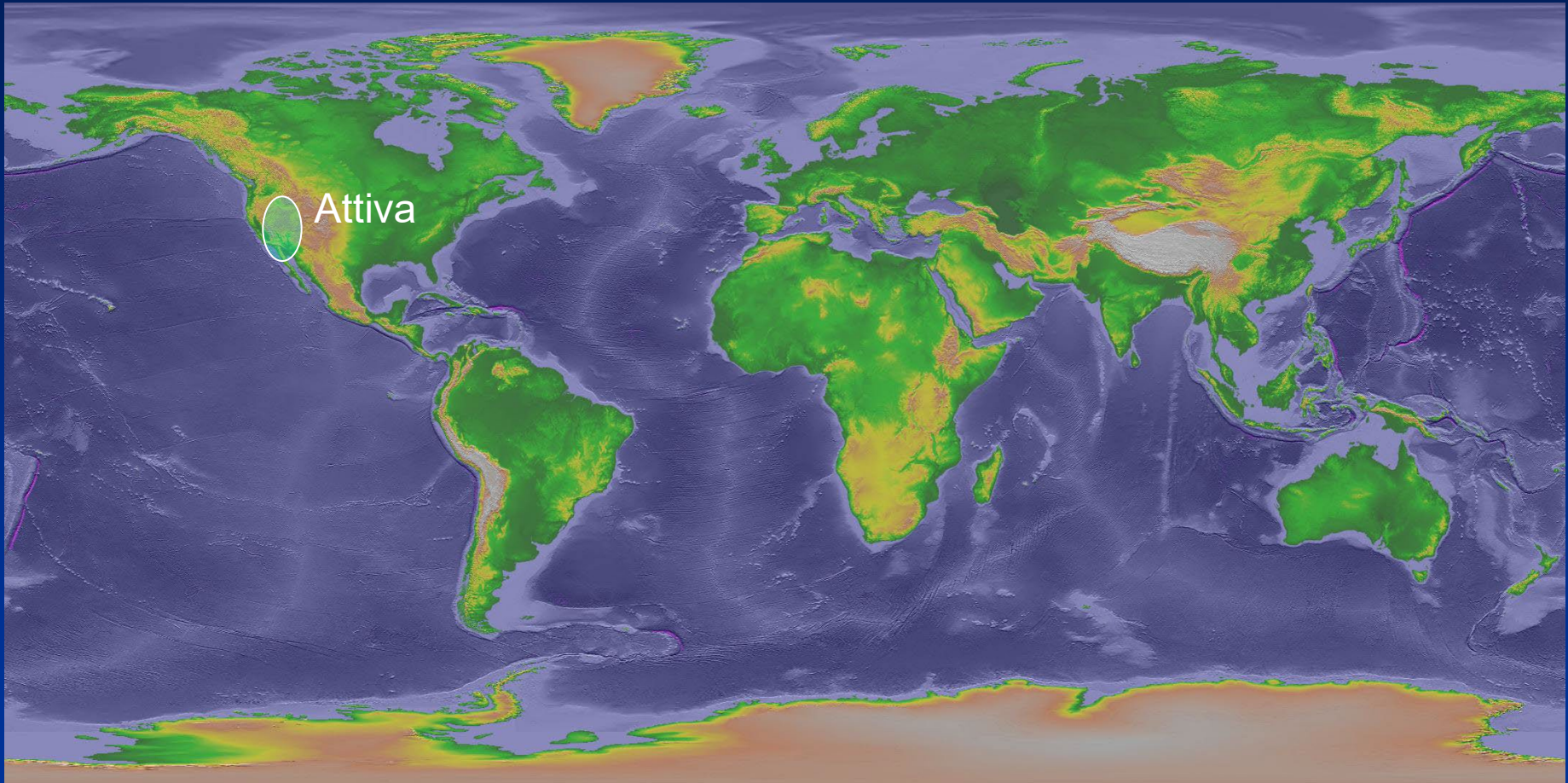
Mar Rosso

Afar, Etiopia, valle del Rift



Associazioni di faglie normali

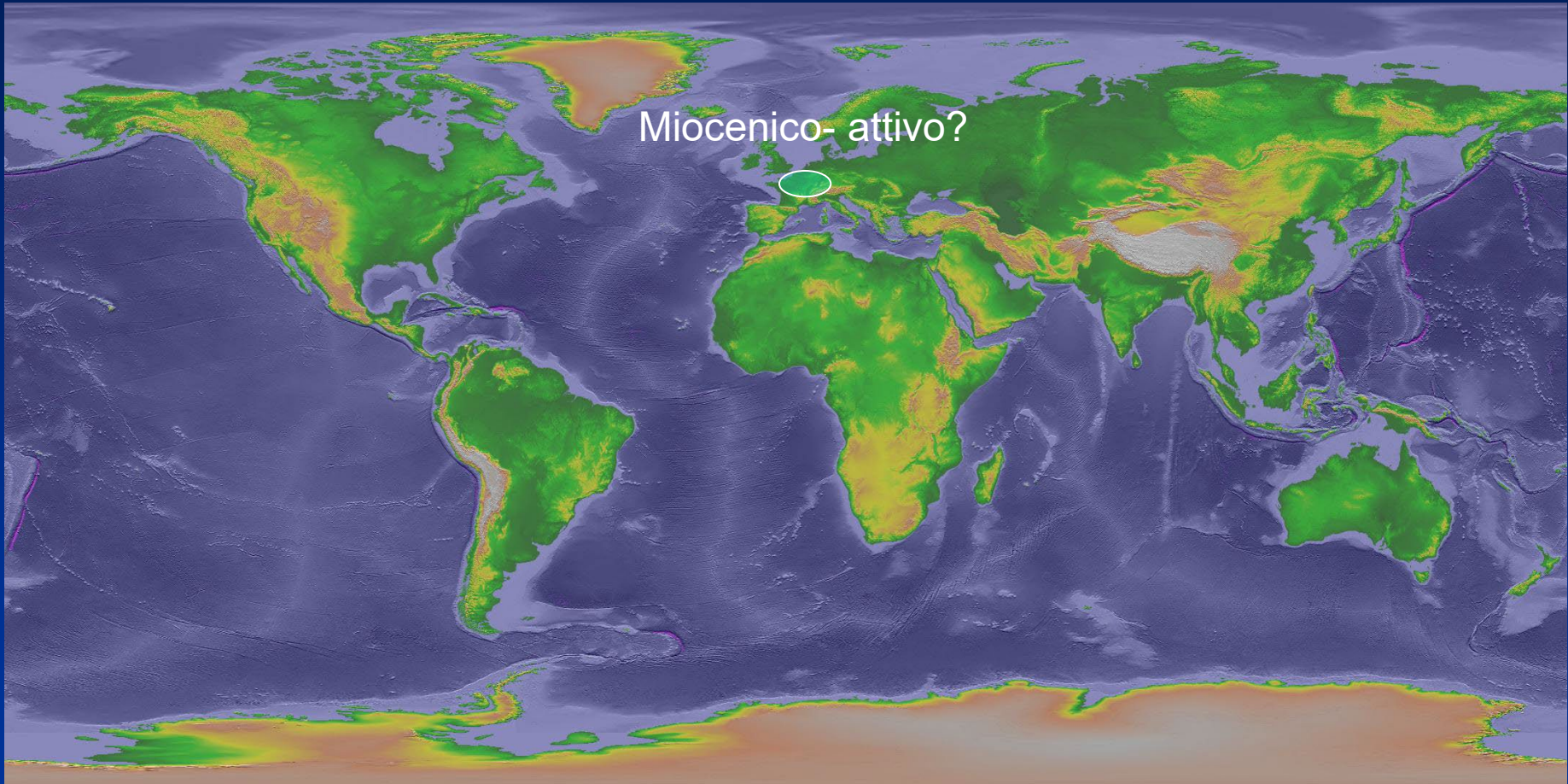
2a) associazioni estensionali in ambienti geodinamici divergenti prossimi a margini trascorrenti/convergenti



Shaded reliefs e batimetria da NOAA National Centers for Environmental Information (NCEI)

Associazioni di faglie normali

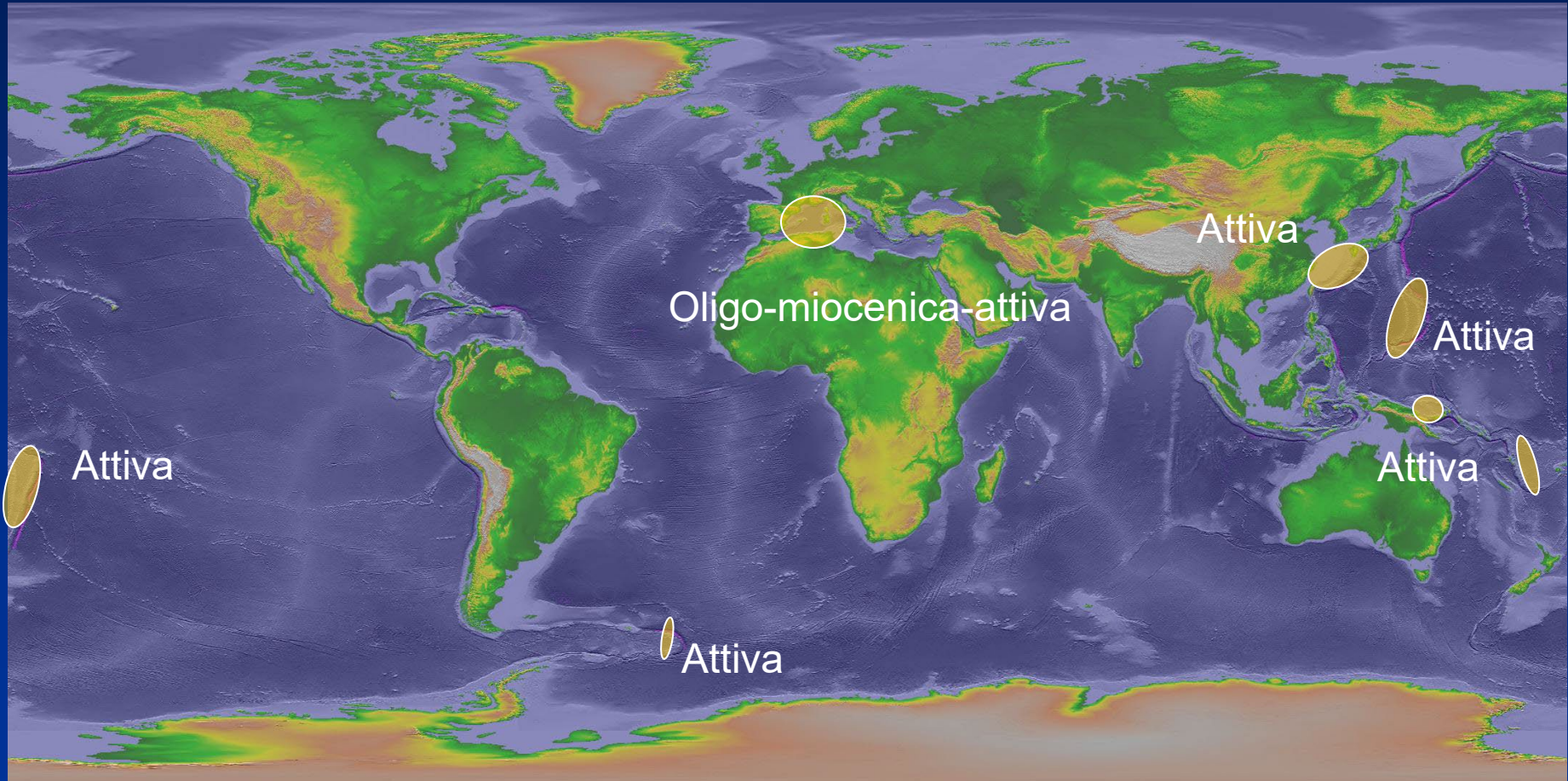
2b) associazioni estensionali in ambienti geodinamici divergenti prossimi a margini convergenti



Shaded reliefs e batimetria da NOAA National Centers for Environmental Information (NCEI)

Associazioni di faglie normali

3) associazioni estensionali dovute ad ambienti geodinamici convergenti!!!



Shaded reliefs e batimetria da NOAA National Centers for Environmental Information (NCEI)

FAGLIE NORMALI DIRITTE



a)

FAGLIE NORMALI LISTRICHE



b)

FAGLIE A "DOMINO"



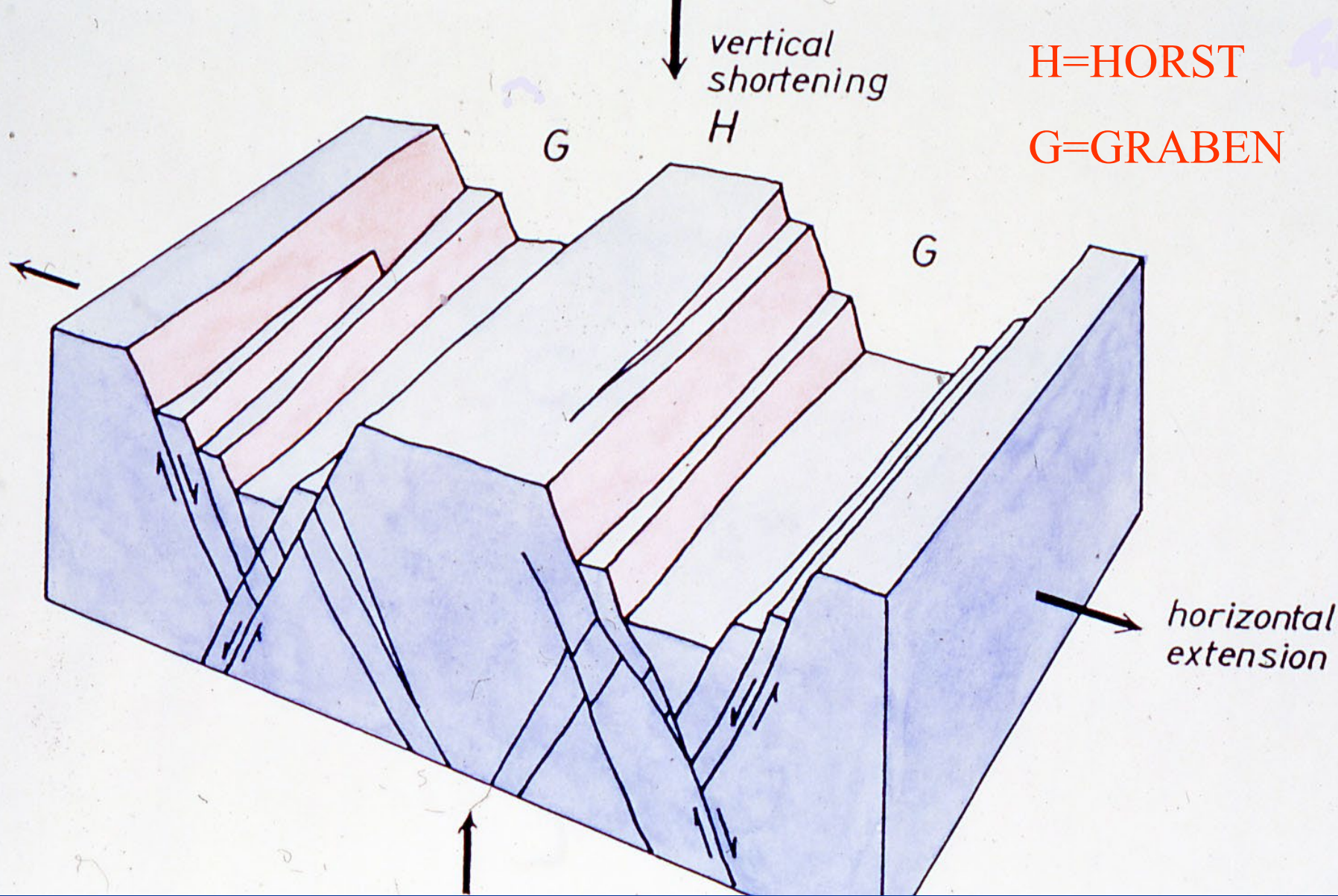
c)

FAGLIE DI DISTACCO (DETACHMENT) A BASSO ANGOLO



d)

Sistemi di
faglie normali:
il problema
della
continuazione
in profondità.
Diverse
geometrie in
superficie e
diversi modelli
concettuali



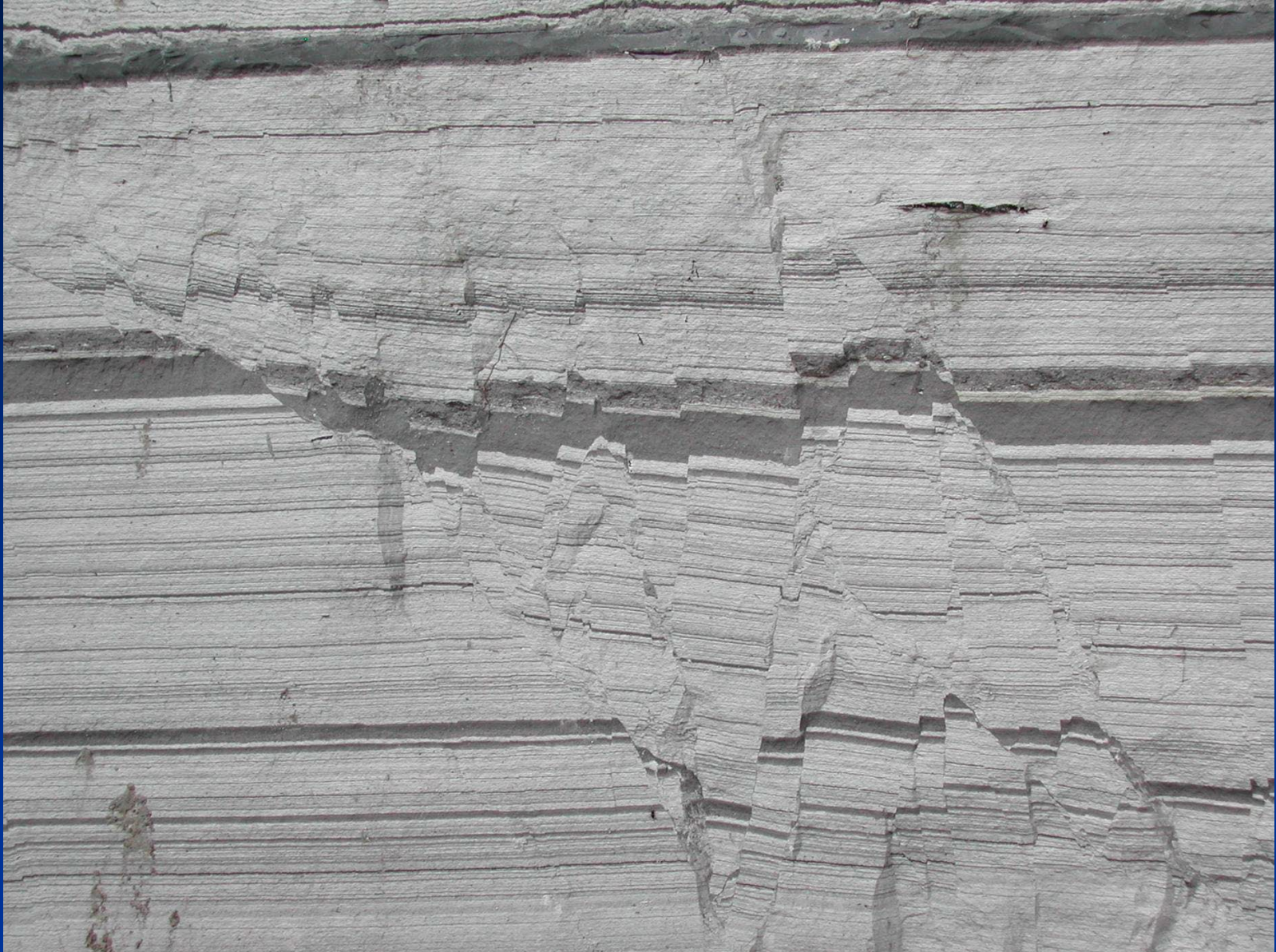
Da Ramsay and Huber, 1987

FAGLIE PIANE

Esempio di grabe (singola fossa) recentissimo e, presumibilmente, attivo



Sistemi di faglie normali: coniugate, faglia principale (master fault) e faglie curve!



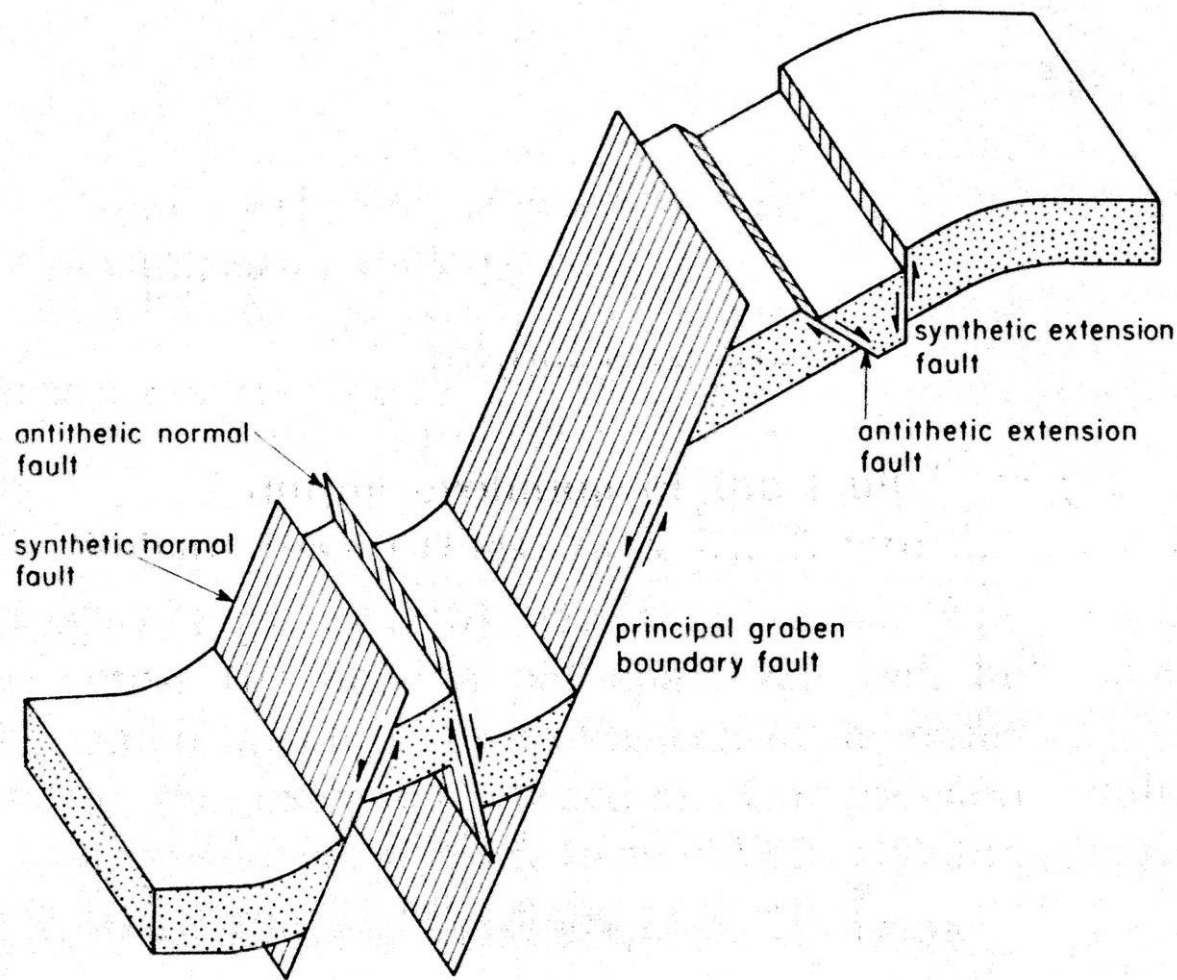


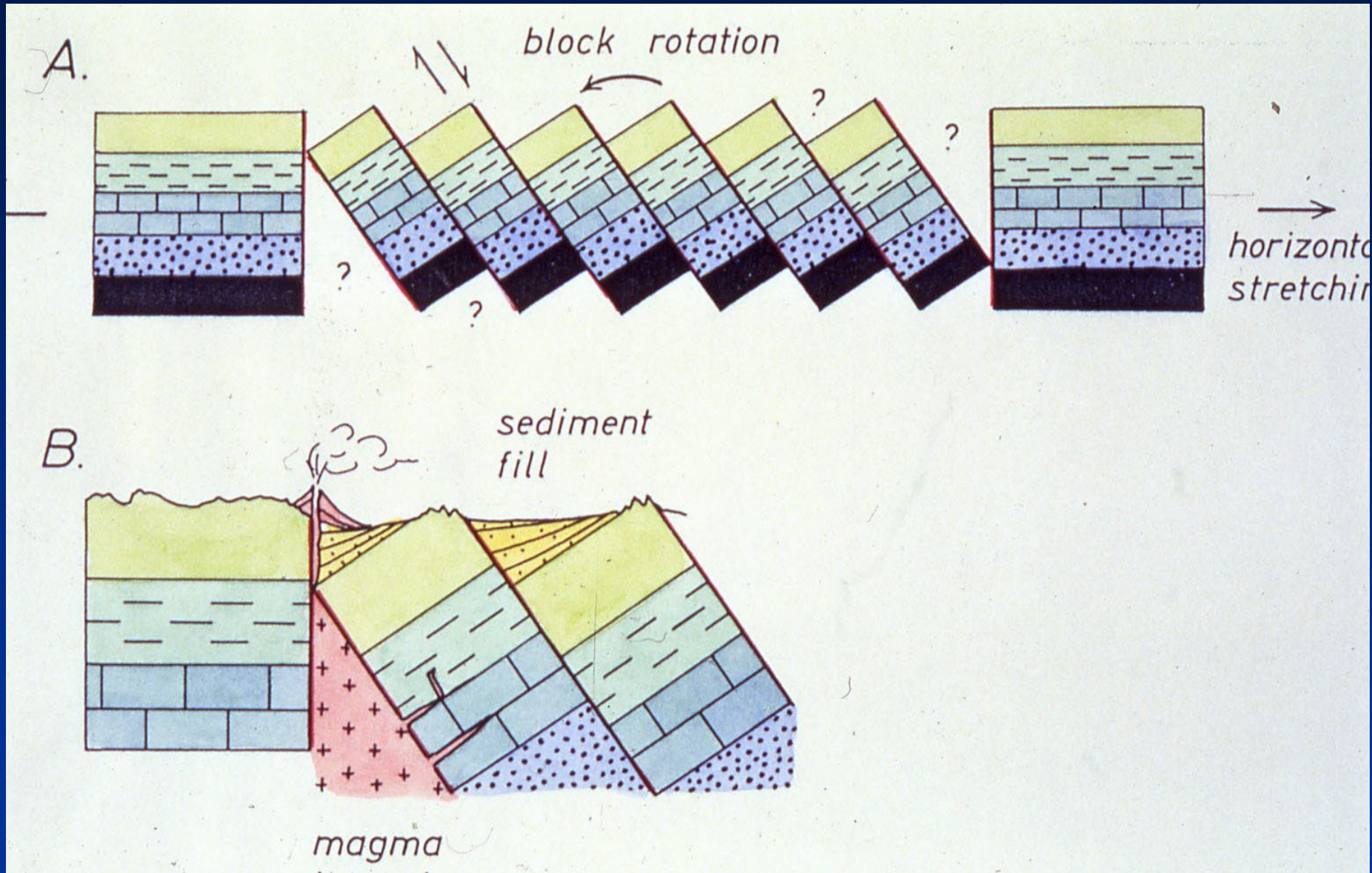
Fig. 6. Structures characteristic of planar high-angle normal fault zones such as those bounding grabens in terrains that have been inhomogeneously extended by a small percentage. After Al Kadhi & Hancock (1980, fig. 6).

Sistemi di faglie normali coniugate: faglia principale, faglie antitetiche e sintetiche

Come si vede in affioramento una faglia normale?
(foto L. Selli)



Sistemi di faglie normali coniugate sintetiche; sistema a domino!



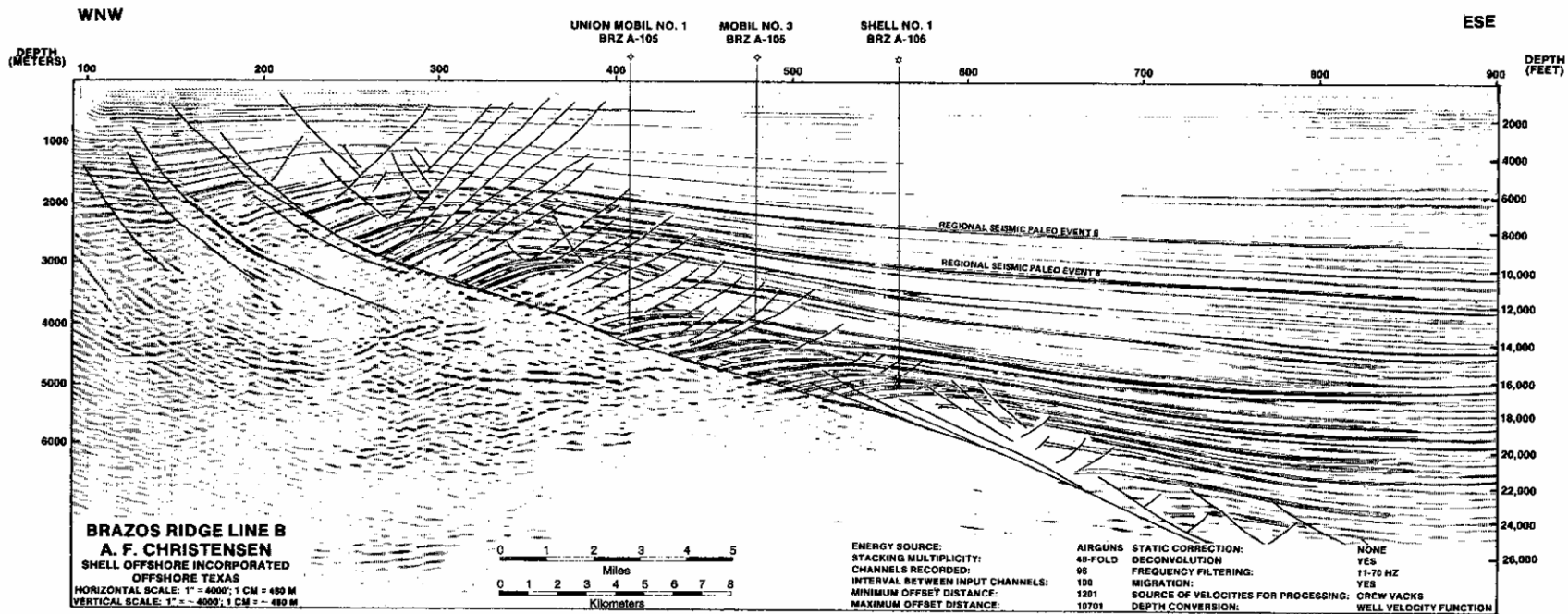
Sistemi di faglie normali coniugate sintetiche; sistema a domino!



Da Ramsay and Huber, 1987

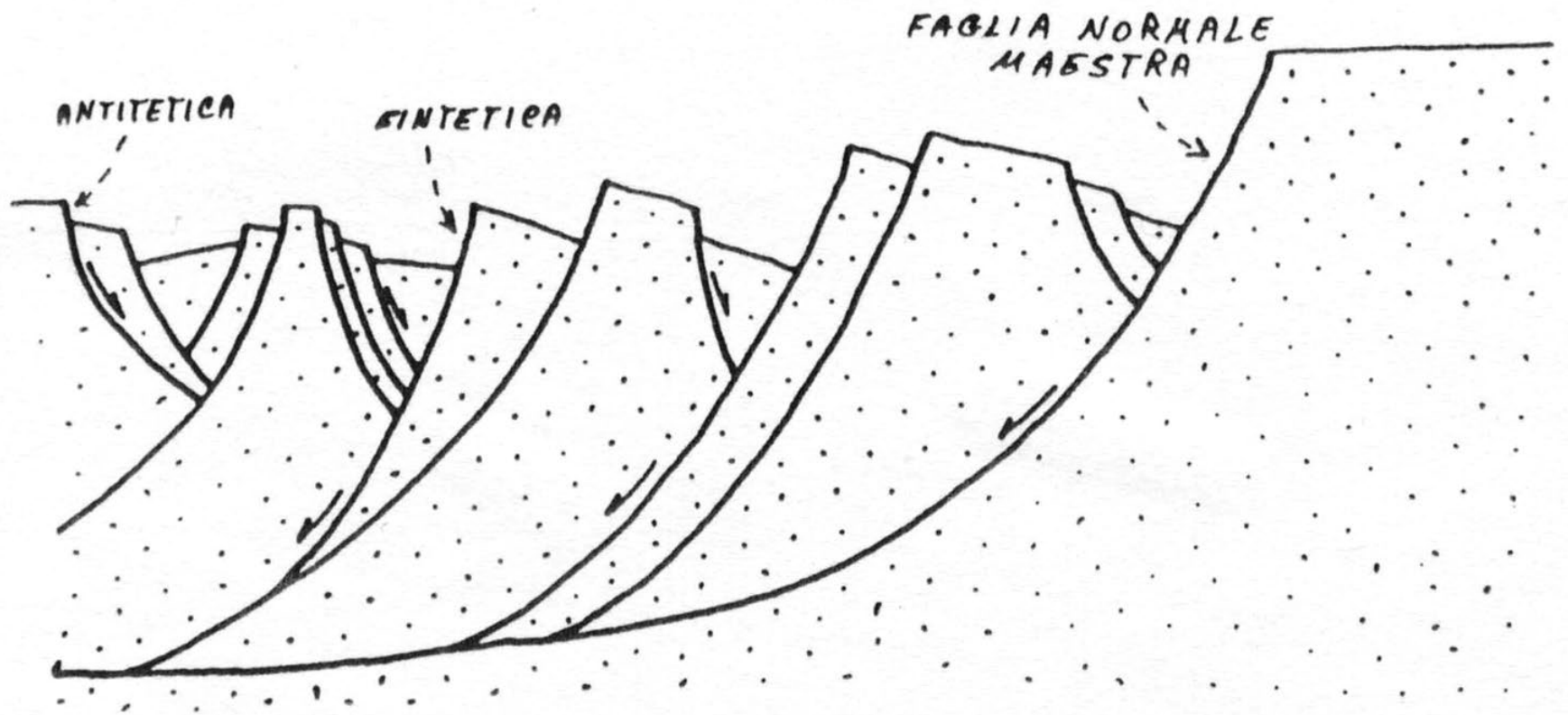


Da Ramsay and Huber, 1987

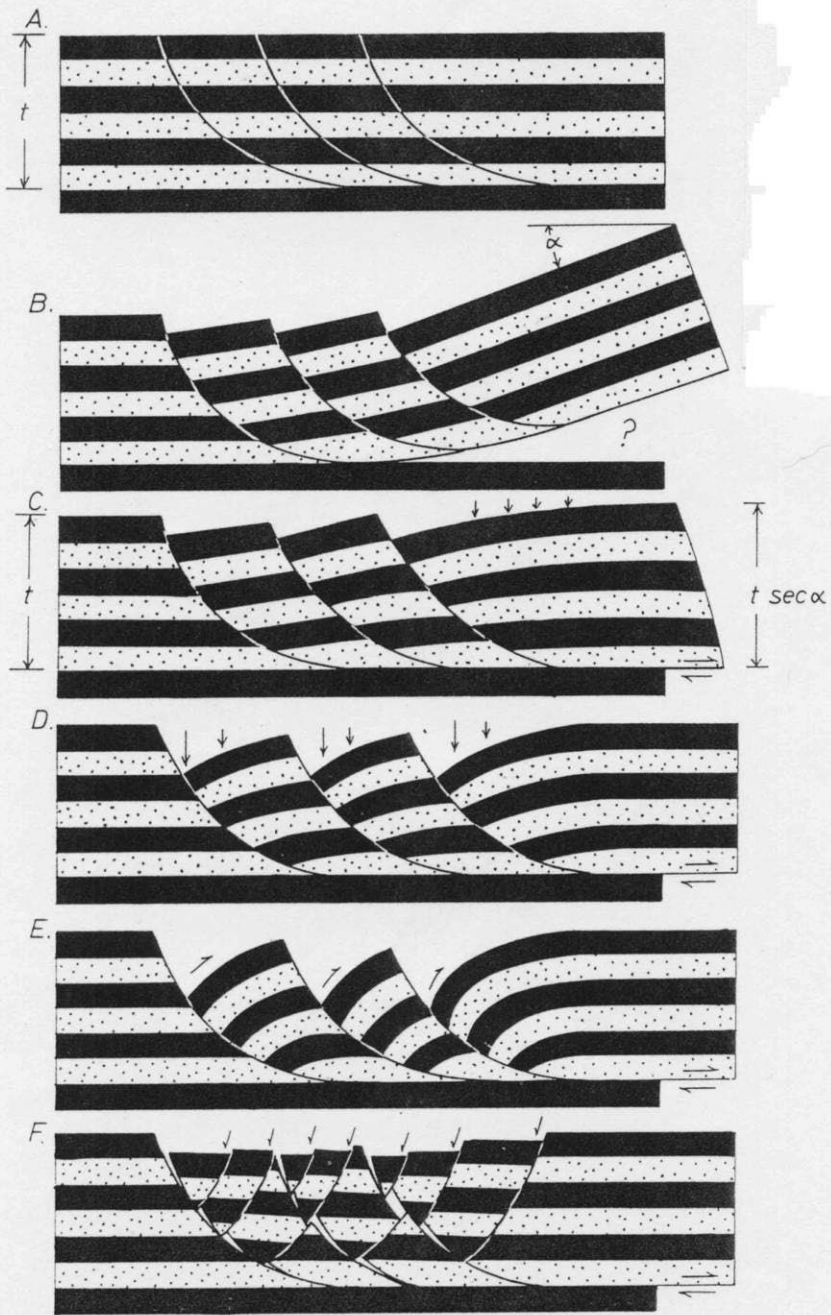


(b)

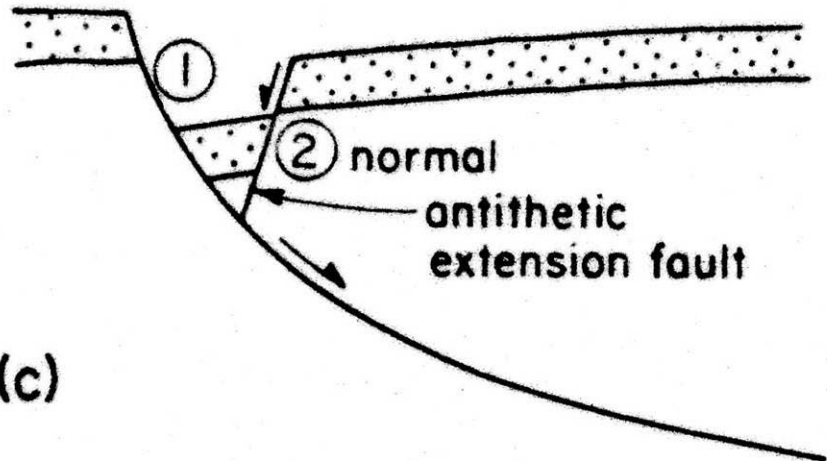
Da Hatcher, 1995



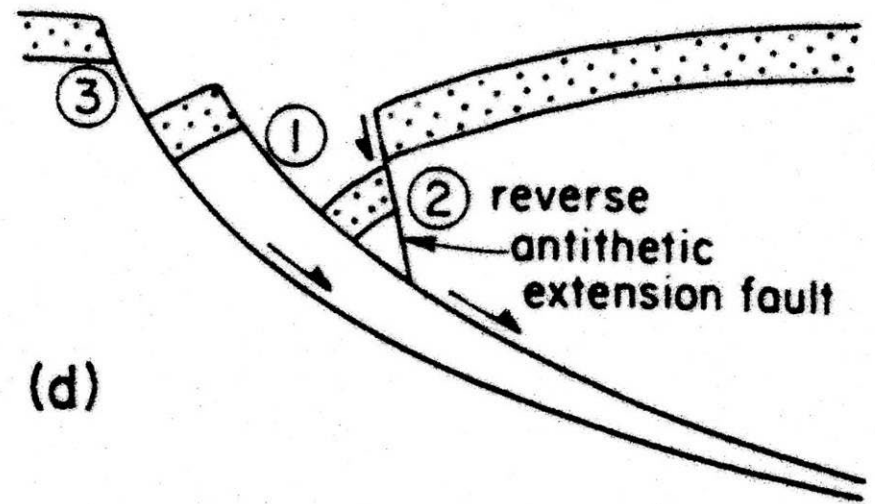
Faglia listrica



Da Ramsay and Huber, 1987

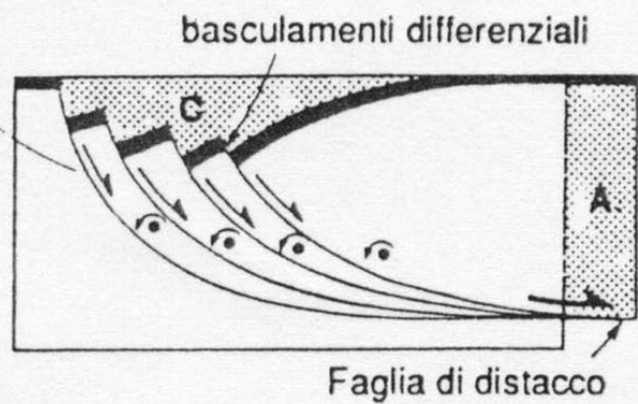
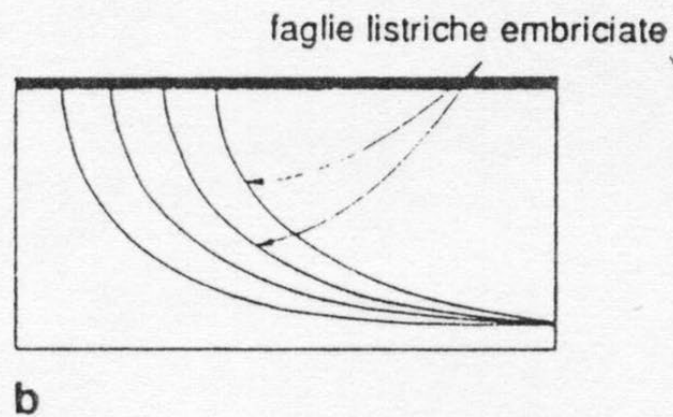
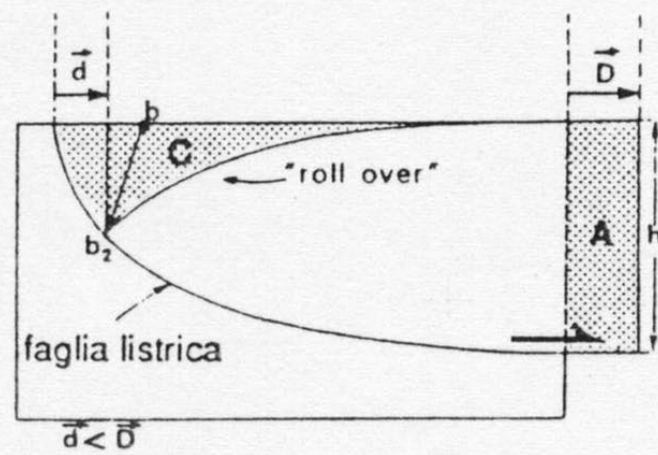
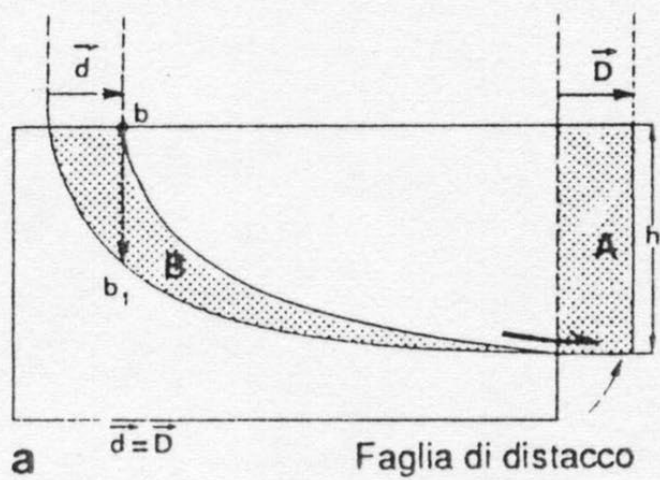


(c)

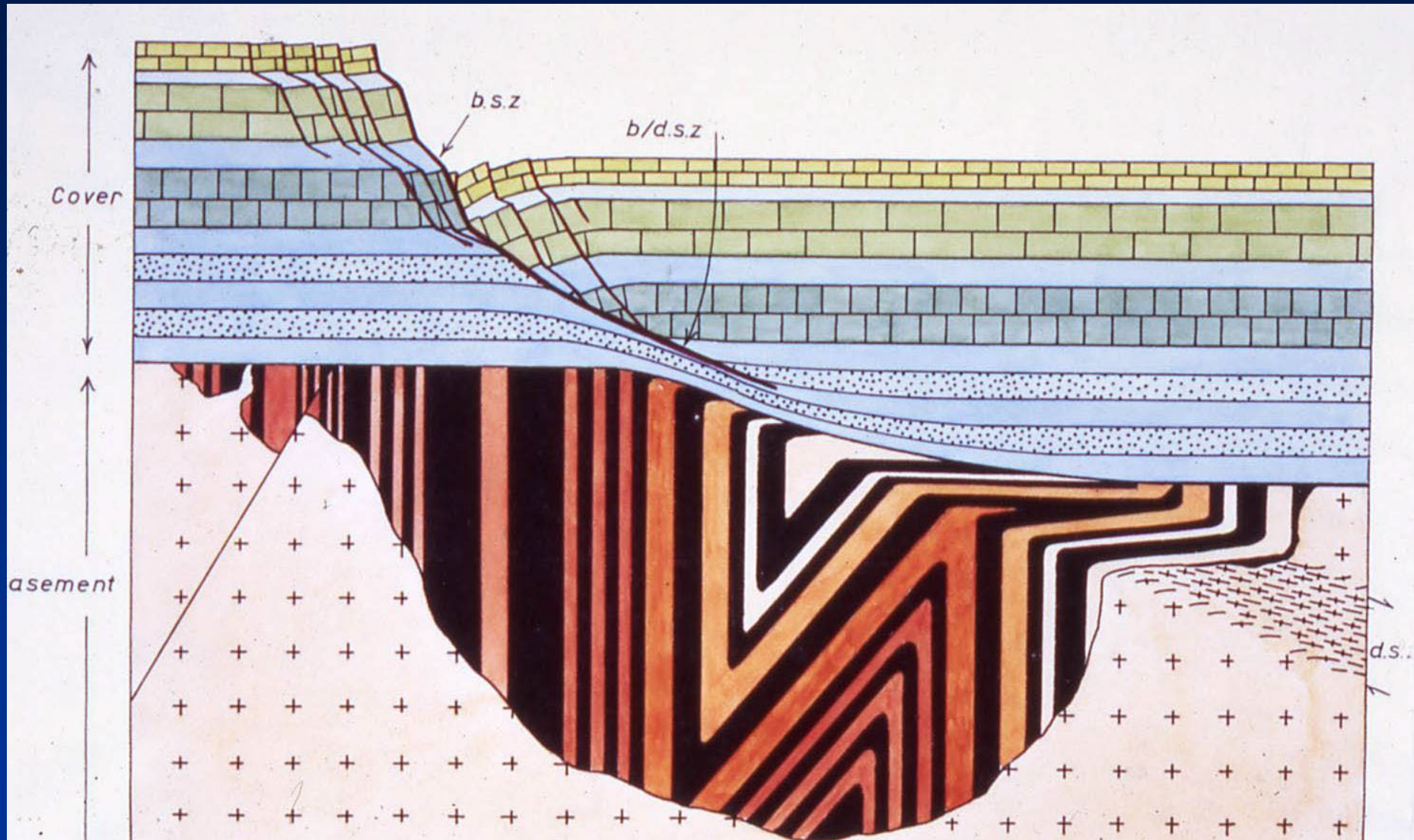


(d)

Da Hancock, 1985

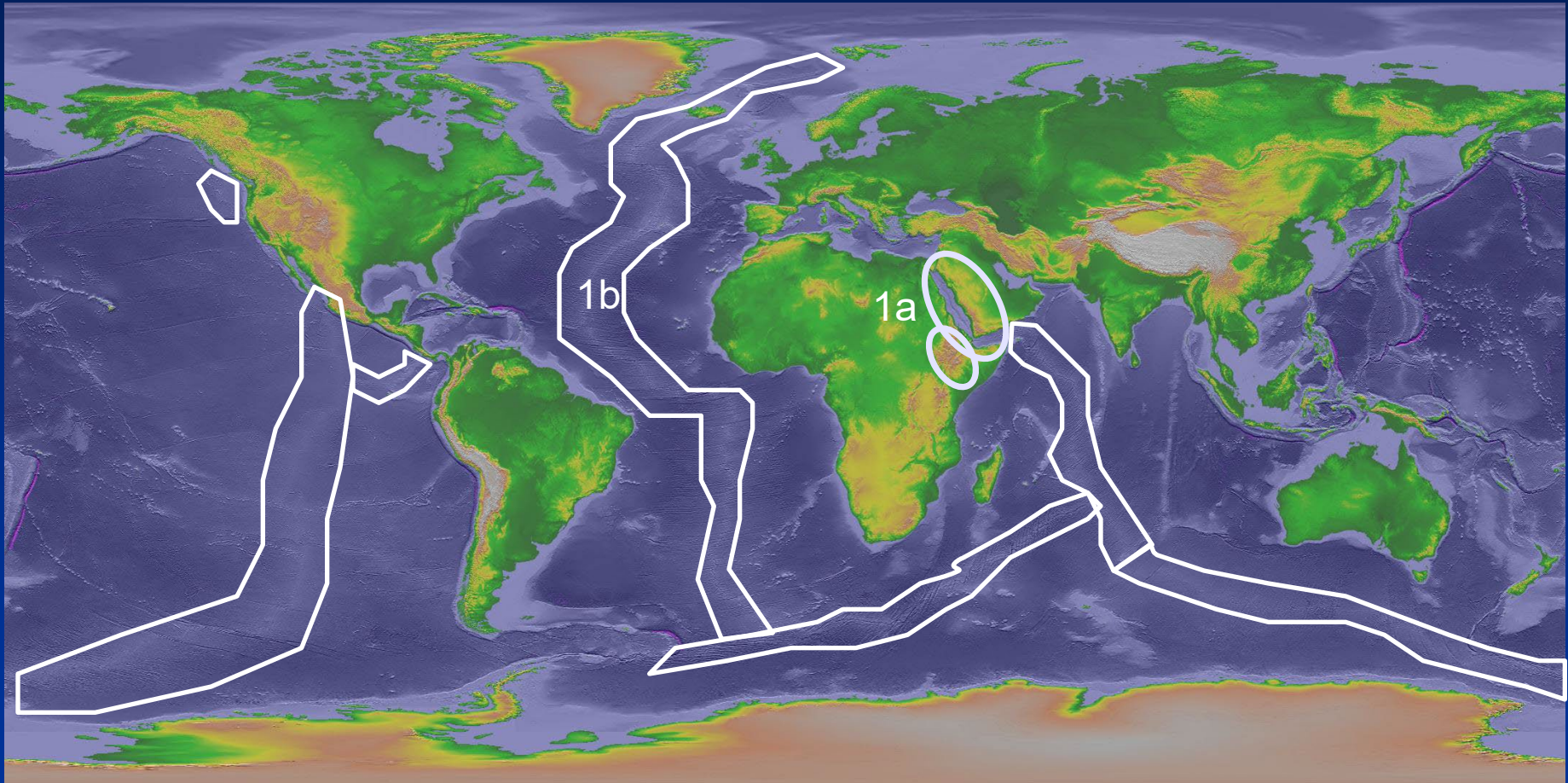


Estensione crostale



Associazioni di faglie normali

1) associazioni estensionali in ambienti geodinamici divergenti

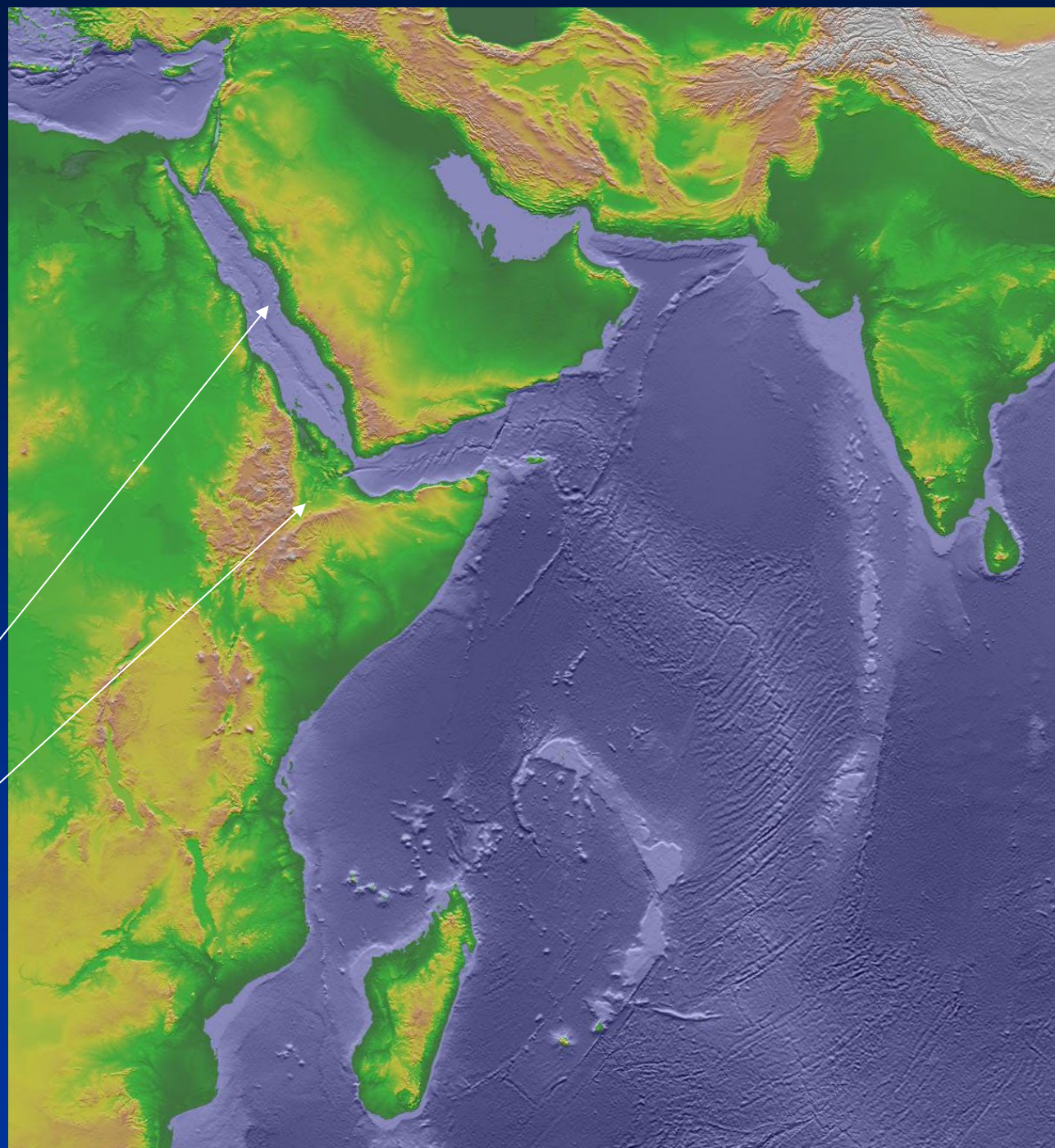


Shaded reliefs e batimetria da NOAA National Centers for Environmental Information (NCEI)

1a) estensione e
assottigliamento
di crosta
continentale che
porta a crosta
oceanica (*from
rift to drift*)

Mar Rosso

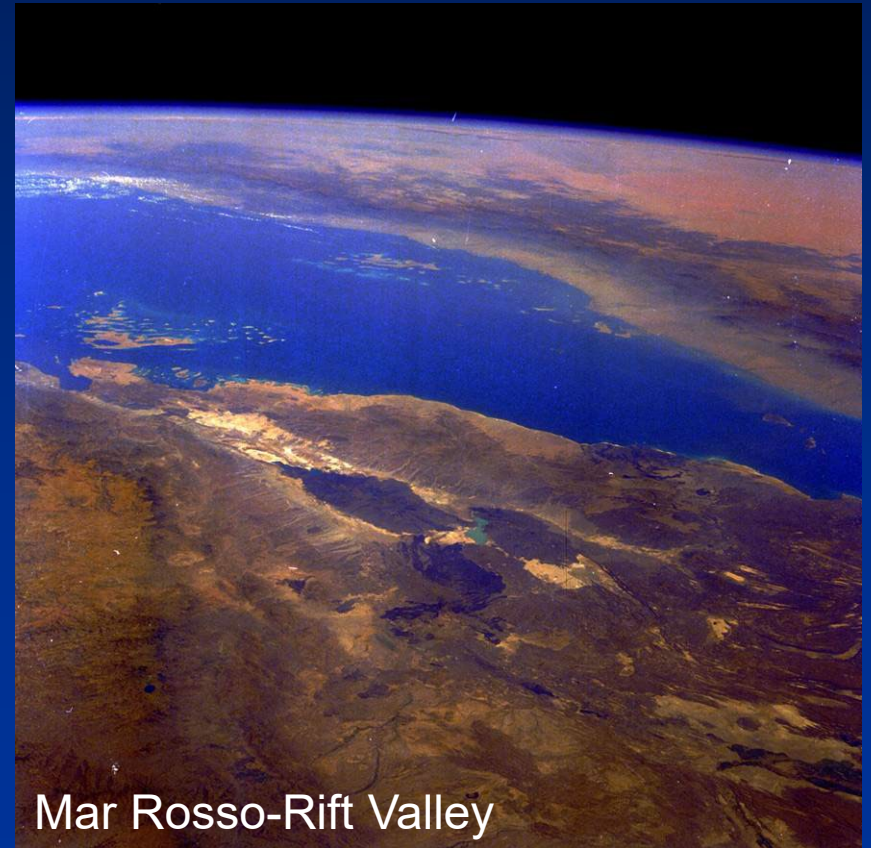
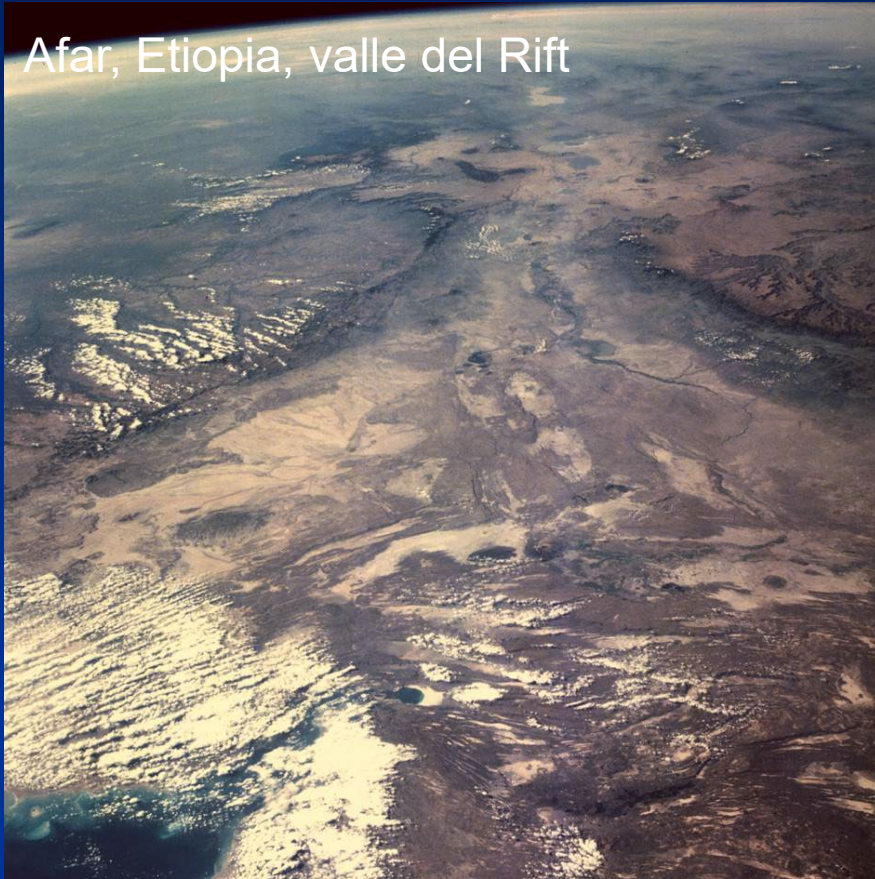
Afar, Etiopia, valle del Rift



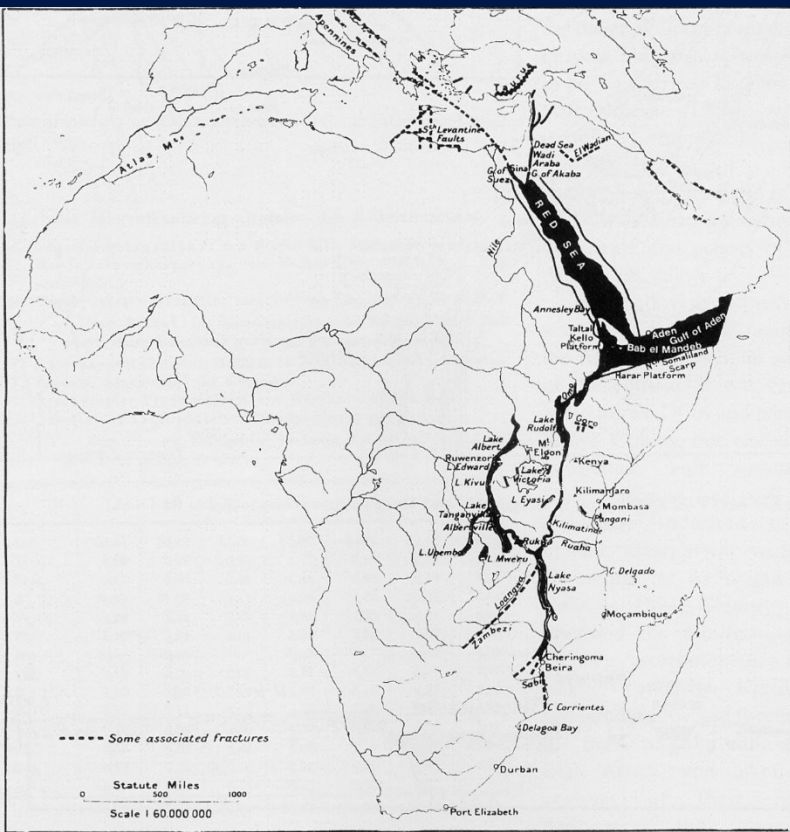
Associazioni estensionali, ambienti geodinamici divergenti

1a) estensione e assottigliamento crosta continentale che porta a crosta oceanica (*from rift to drift*)

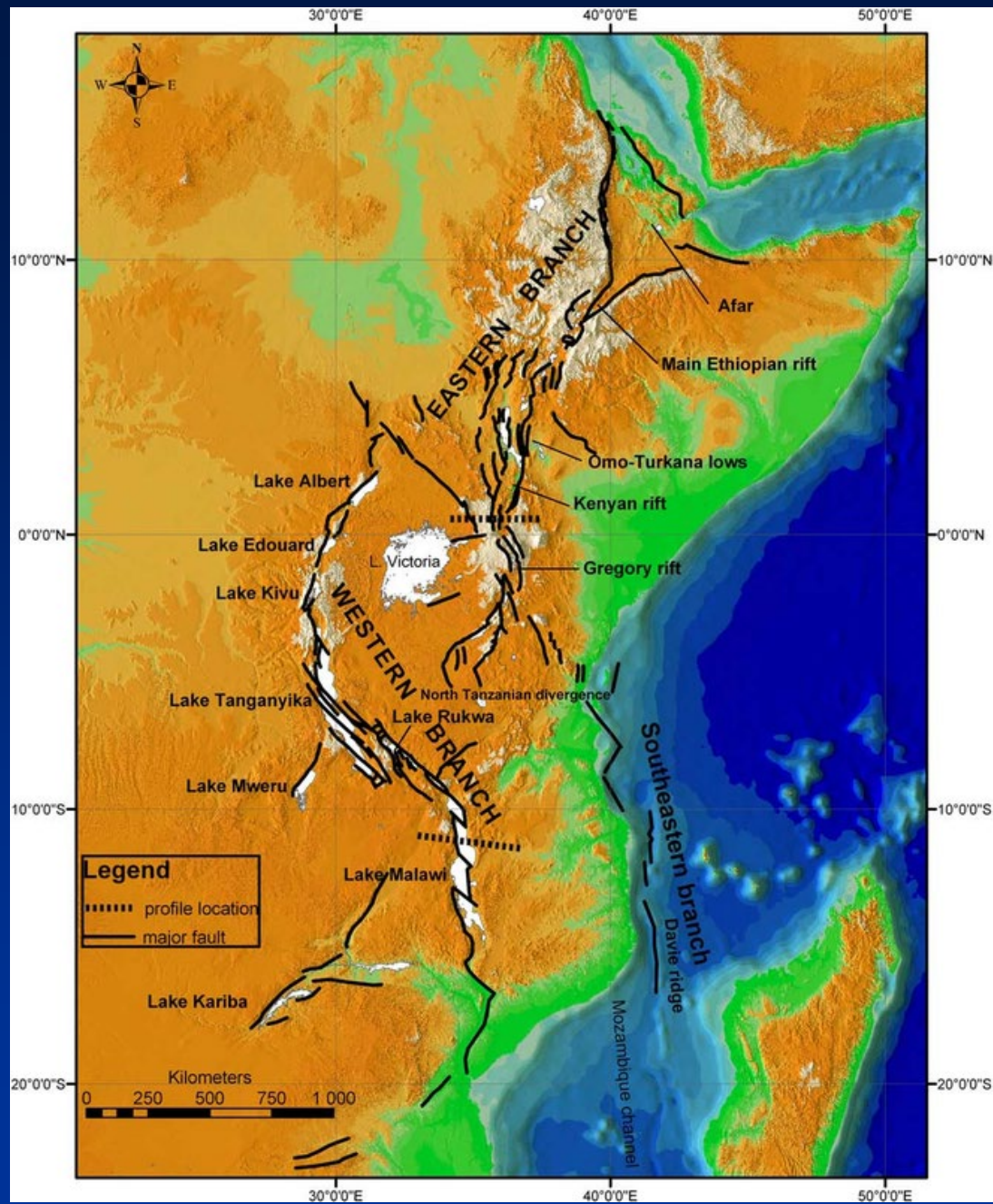
Afar, Etiopia, valle del Rift



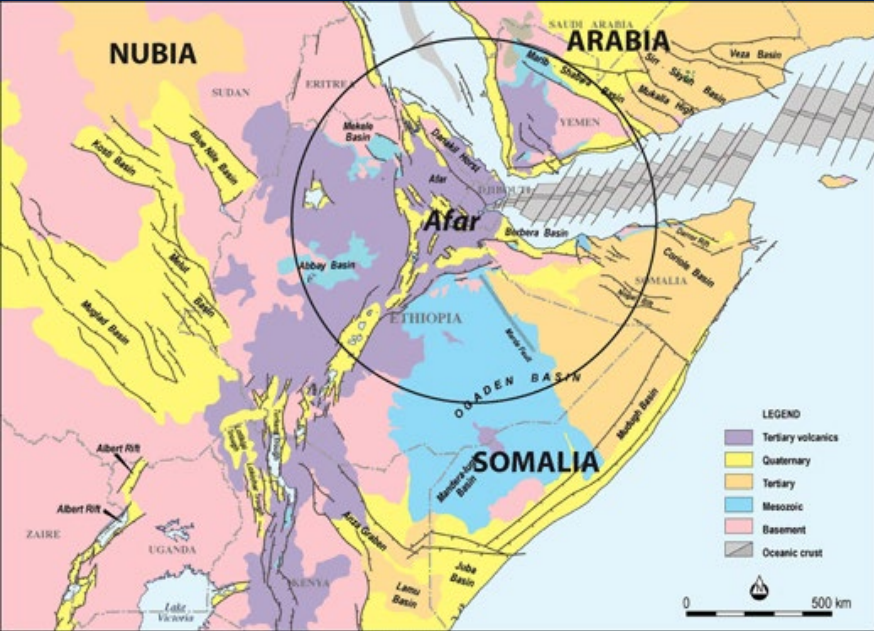
Mar Rosso-Rift Valley



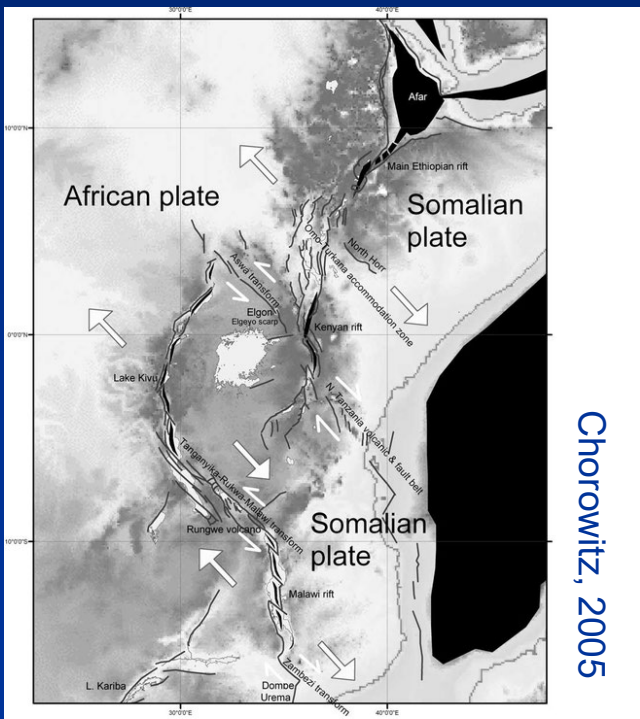
J. Gregory's 1920 map of the East African rift v.



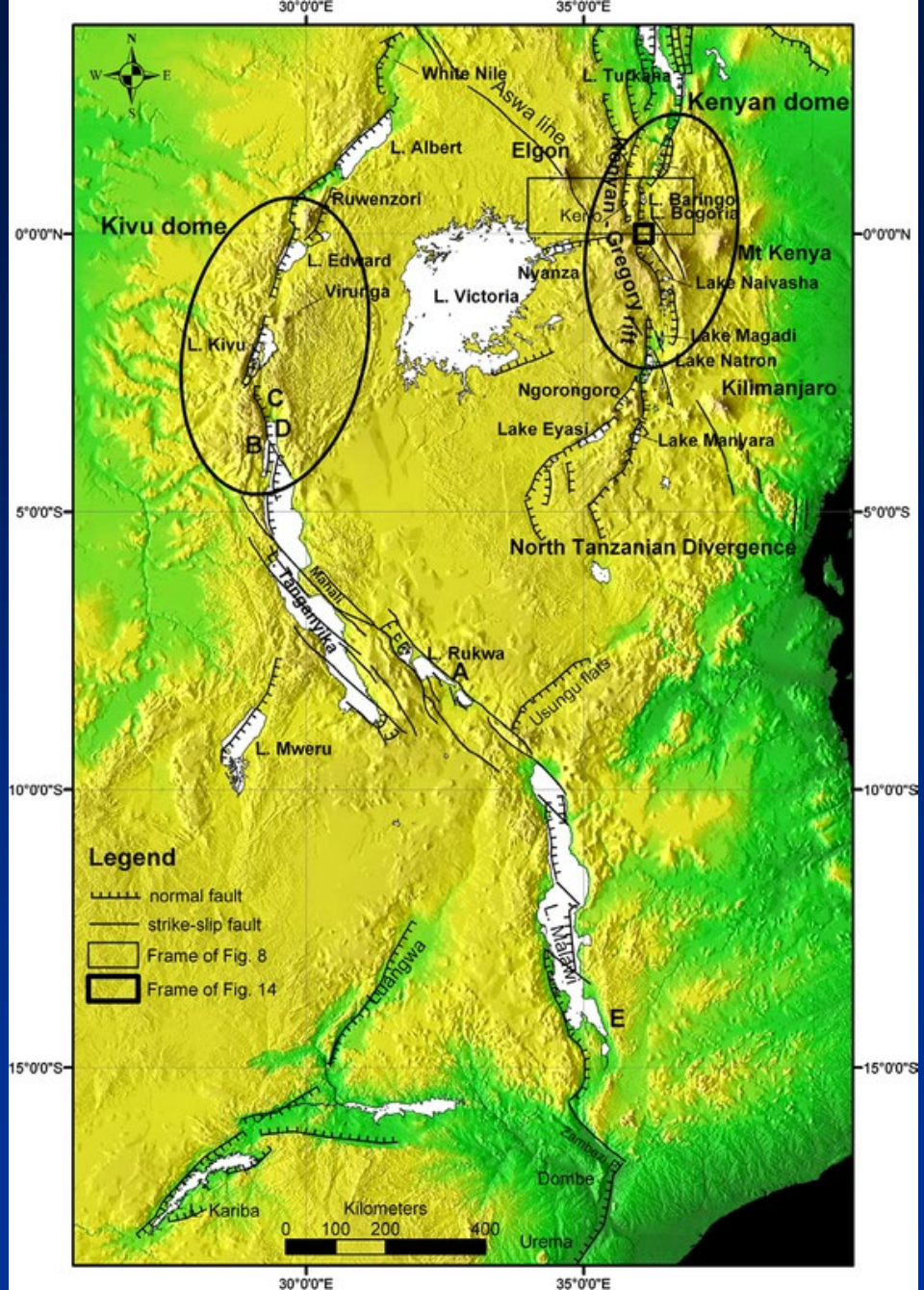
Chorowitz, 2005



Mège et al., 2015



Chorowitz, 2005



Chorowitz, 2005

associazioni estensionali, ambienti geodinamici divergenti

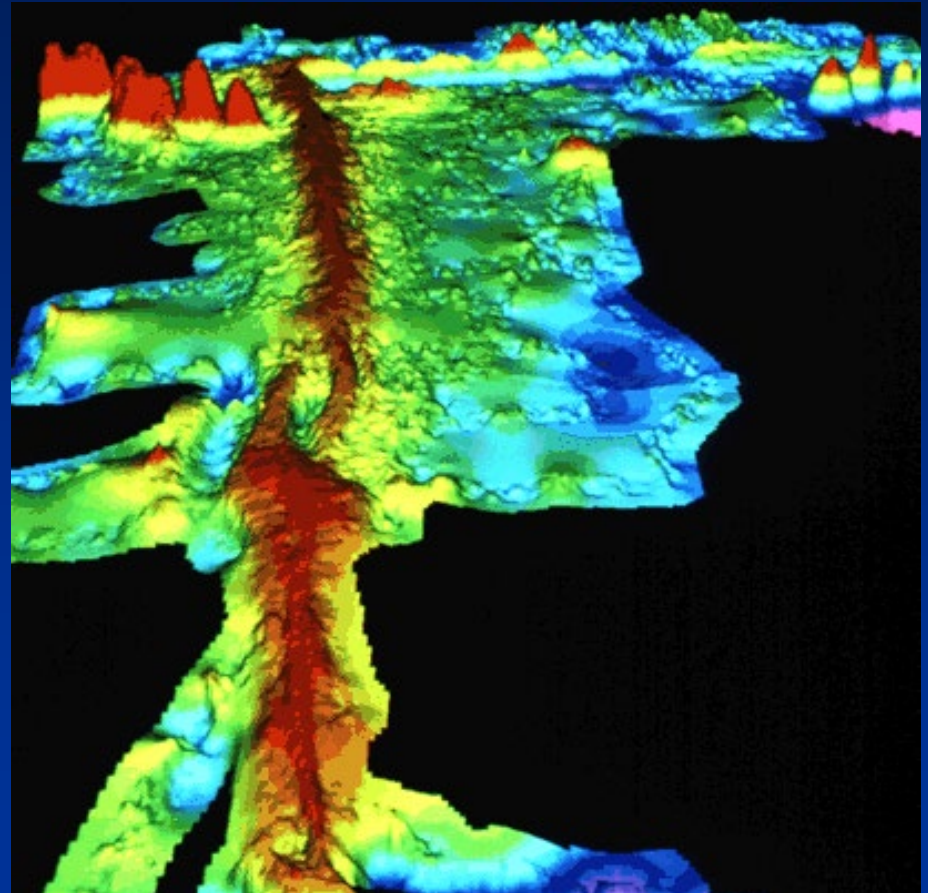
1b) formazione di crosta oceanica, dorsali !!

Islanda, zona di dorsale Thingvellir national park



Da Oddur Sigurdsson, National Energy Authority, Iceland

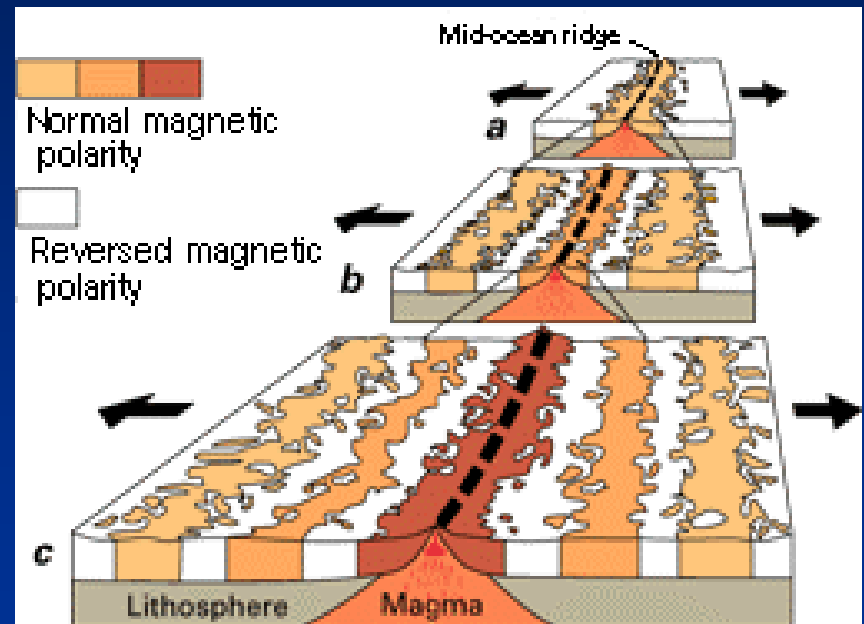
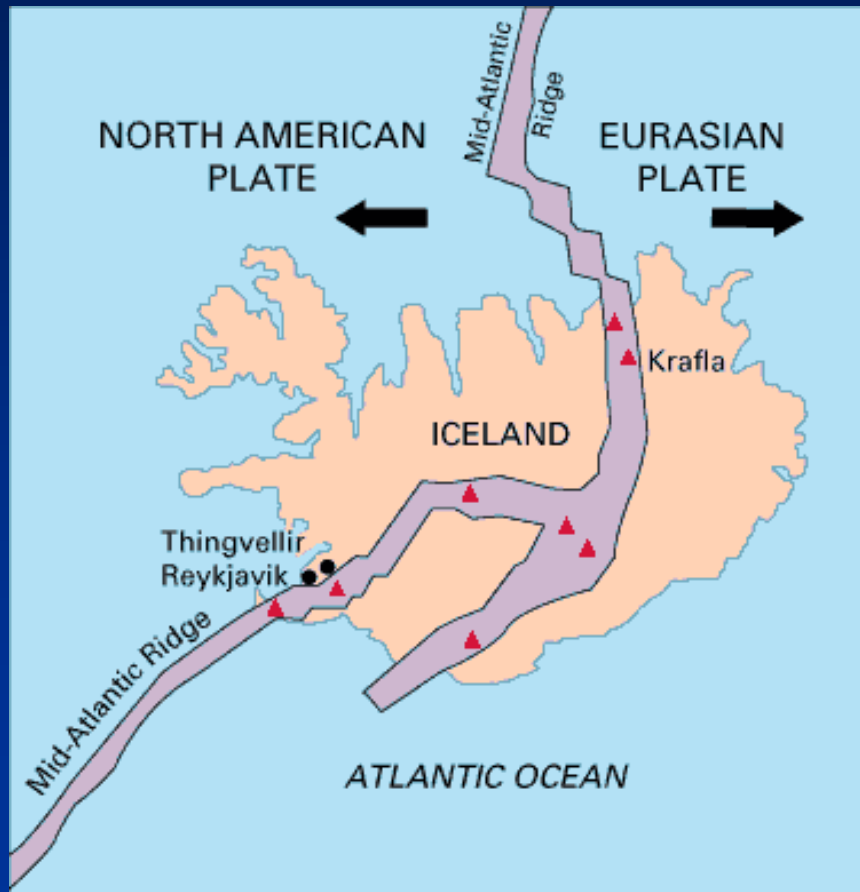
Zona di dorsale medio-oceanica pacifica



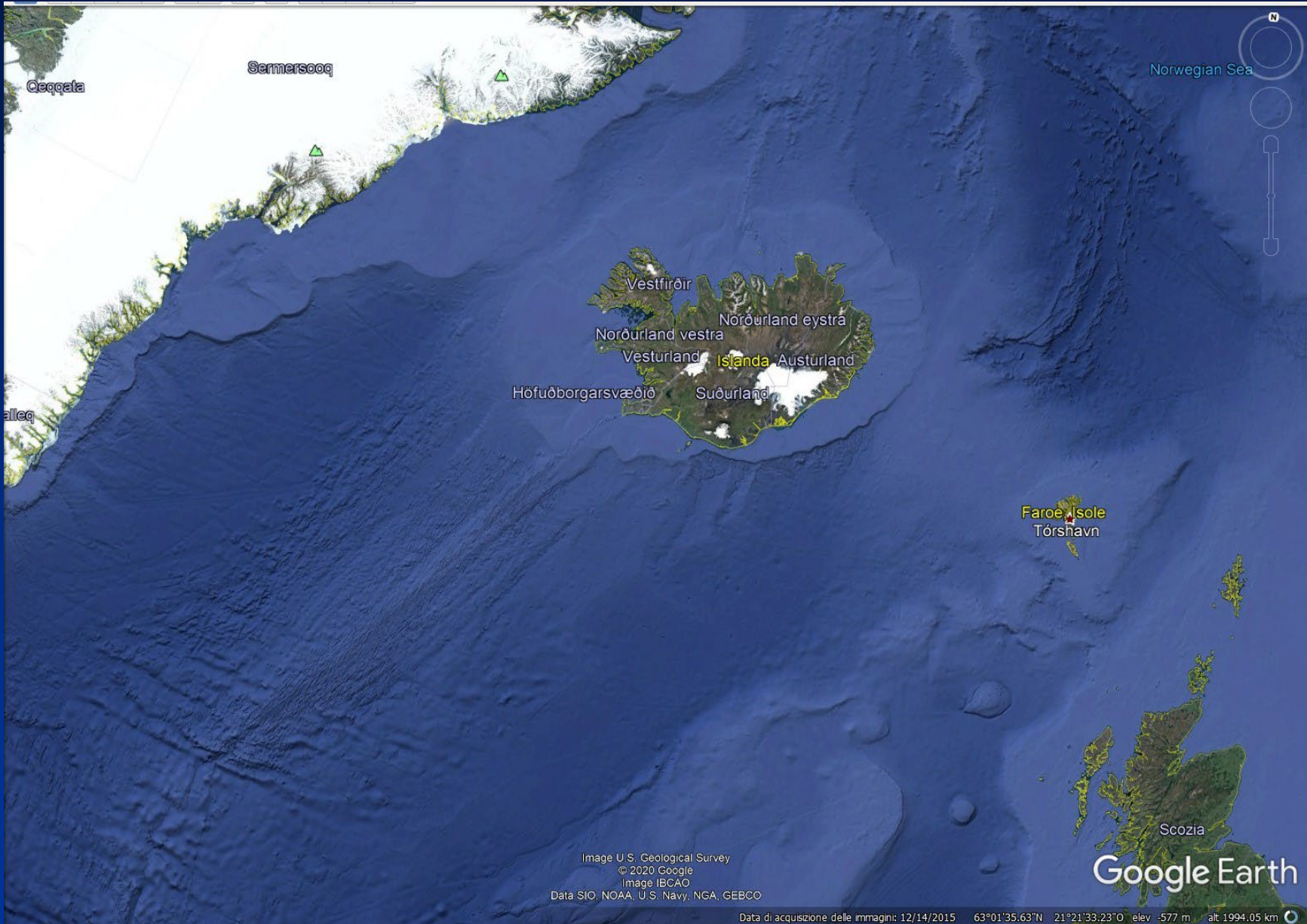
<https://pubs.usgs.gov/gip/dynamic/topomap.html> (from Stacey Tighe, University of Rhode Island)

associazioni estensionali, ambienti geodinamici divergenti

Formazione di crosta oceanica, dorsali !!



<http://factsanddetails.com/world/cat51/sub323/item2212.html>



Qeqqata

Sermersooq

Norwegian Sea

alleq

Vestfirðir
Norðurland eystra
Norðurland vestra
Vesturland
Islanda
Austurland
Höfuðborgarsvæðið
Suðurland

Faroe Isole
Tórshavn

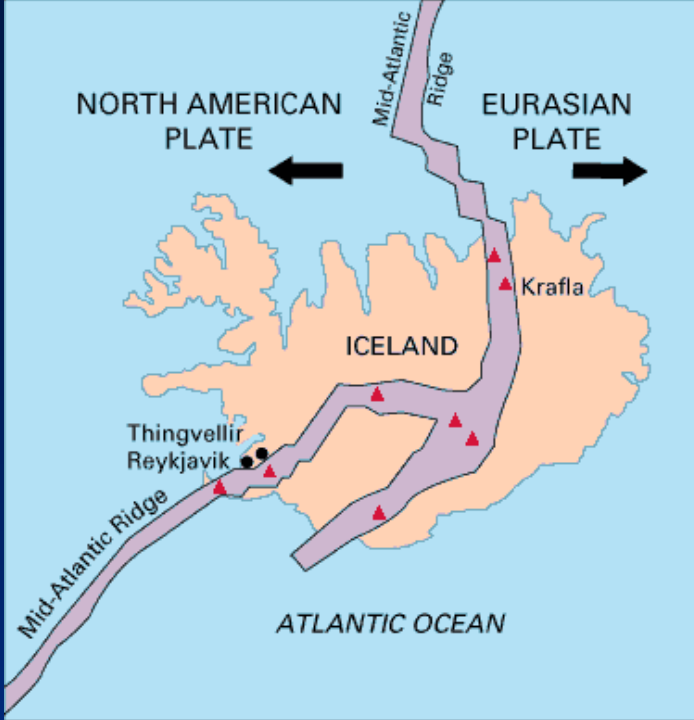
Scozia

Image U.S. Geological Survey
© 2020 Google
Image IBCAO
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google Earth

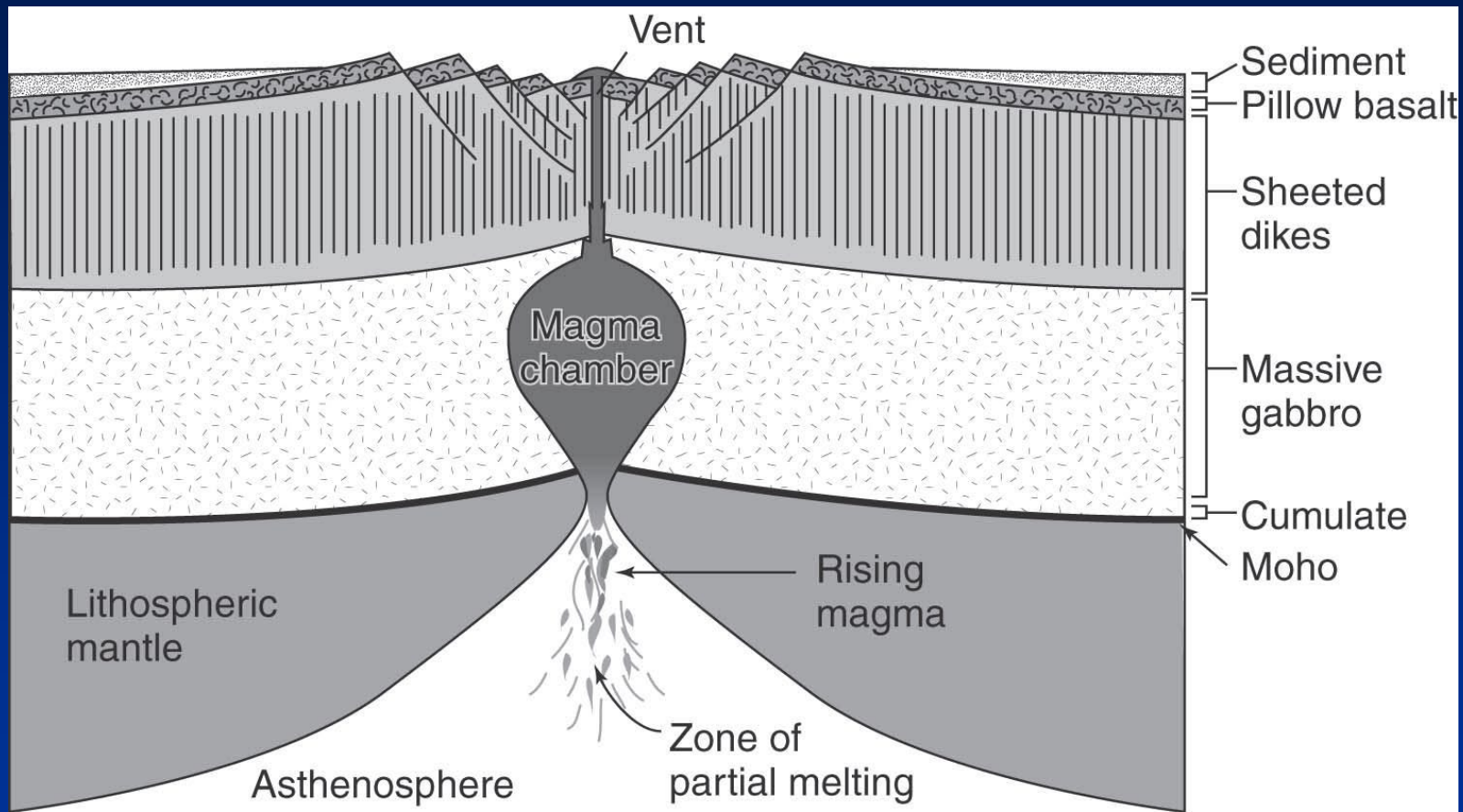
Data di acquisizione delle immagini: 12/14/2015 63°01'35.63"N 21°21'33.23"O elev -577 m alt 1994.05 km

USGS:
<https://pubs.usgs.gov/gip/dynamic/understanding.html>

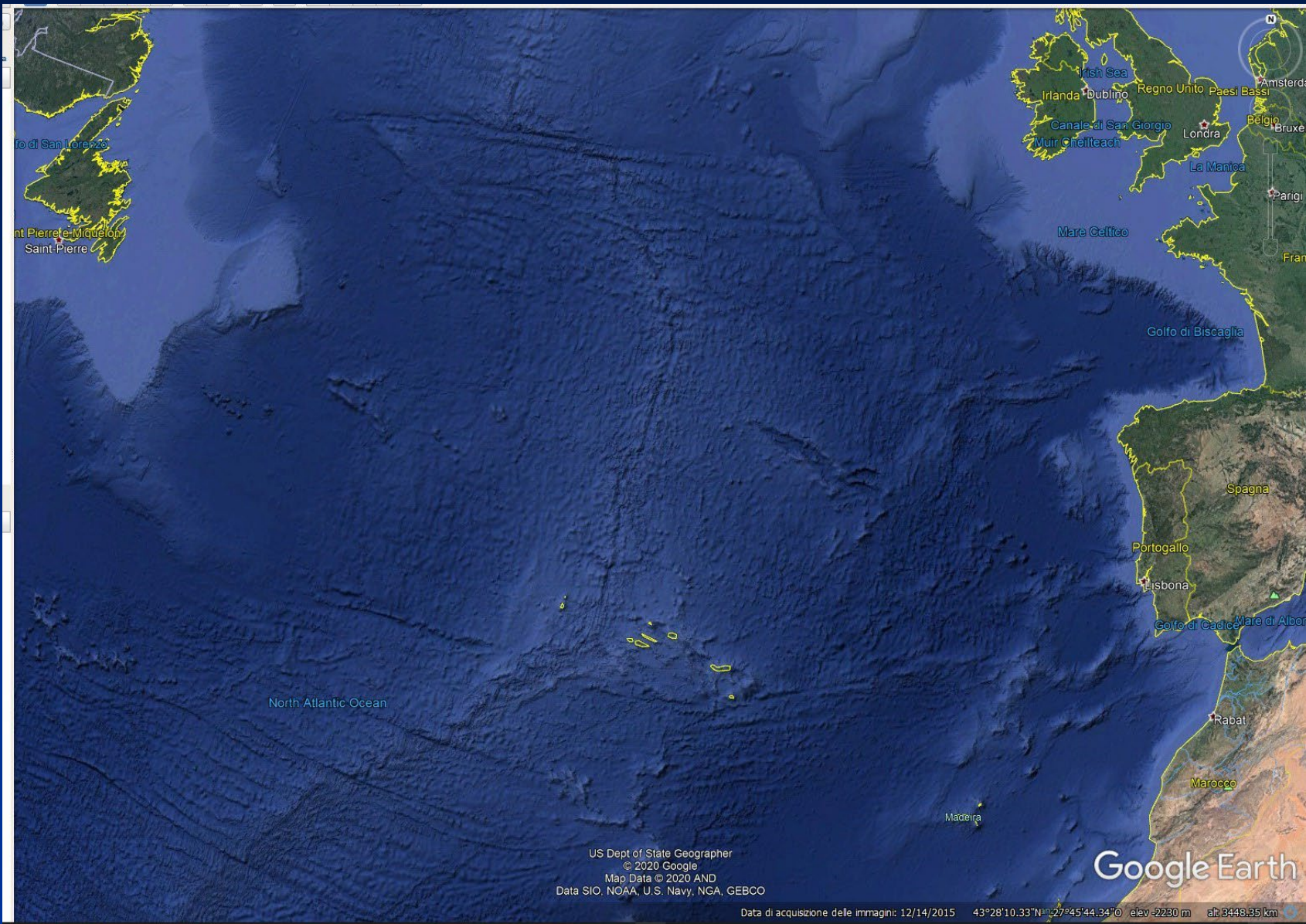


Thingvellir National Park, Iceland

https://commons.wikimedia.org/wiki/File:Iceland_mid_atlantic_ridge.JPG



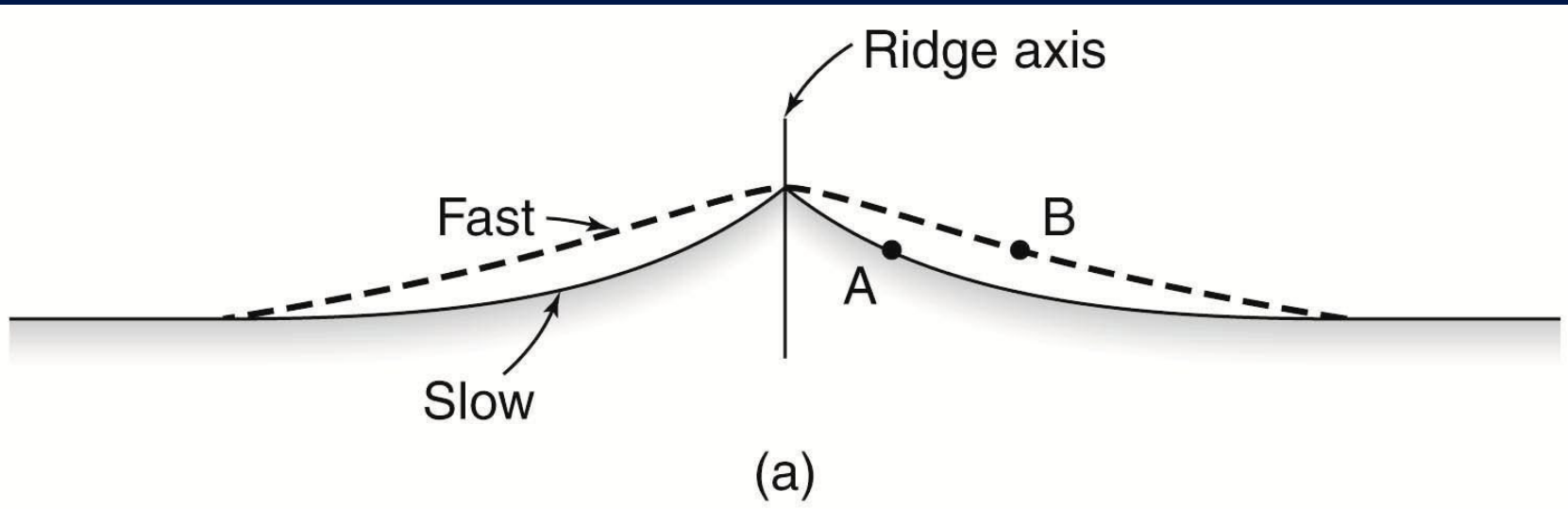
Da van der Pluijm & Marshak, 2004



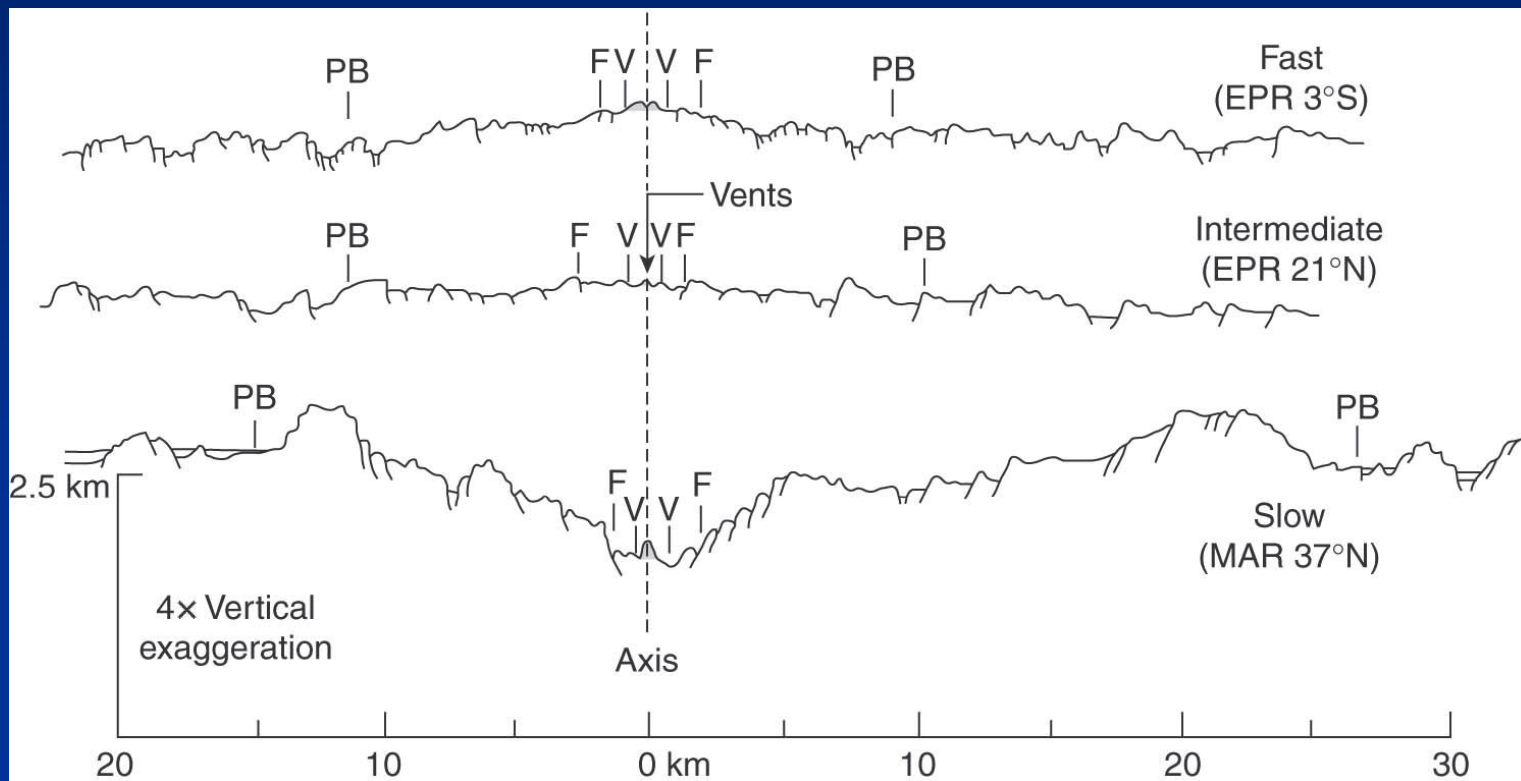
US Dept of State Geographer
© 2020 Google
Map Data © 2020 AND
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google Earth

Data di acquisizione delle immagini: 12/14/2015 43°28'10.33"N 127°45'44.34"O elev -2230 m alt 3448.35 km

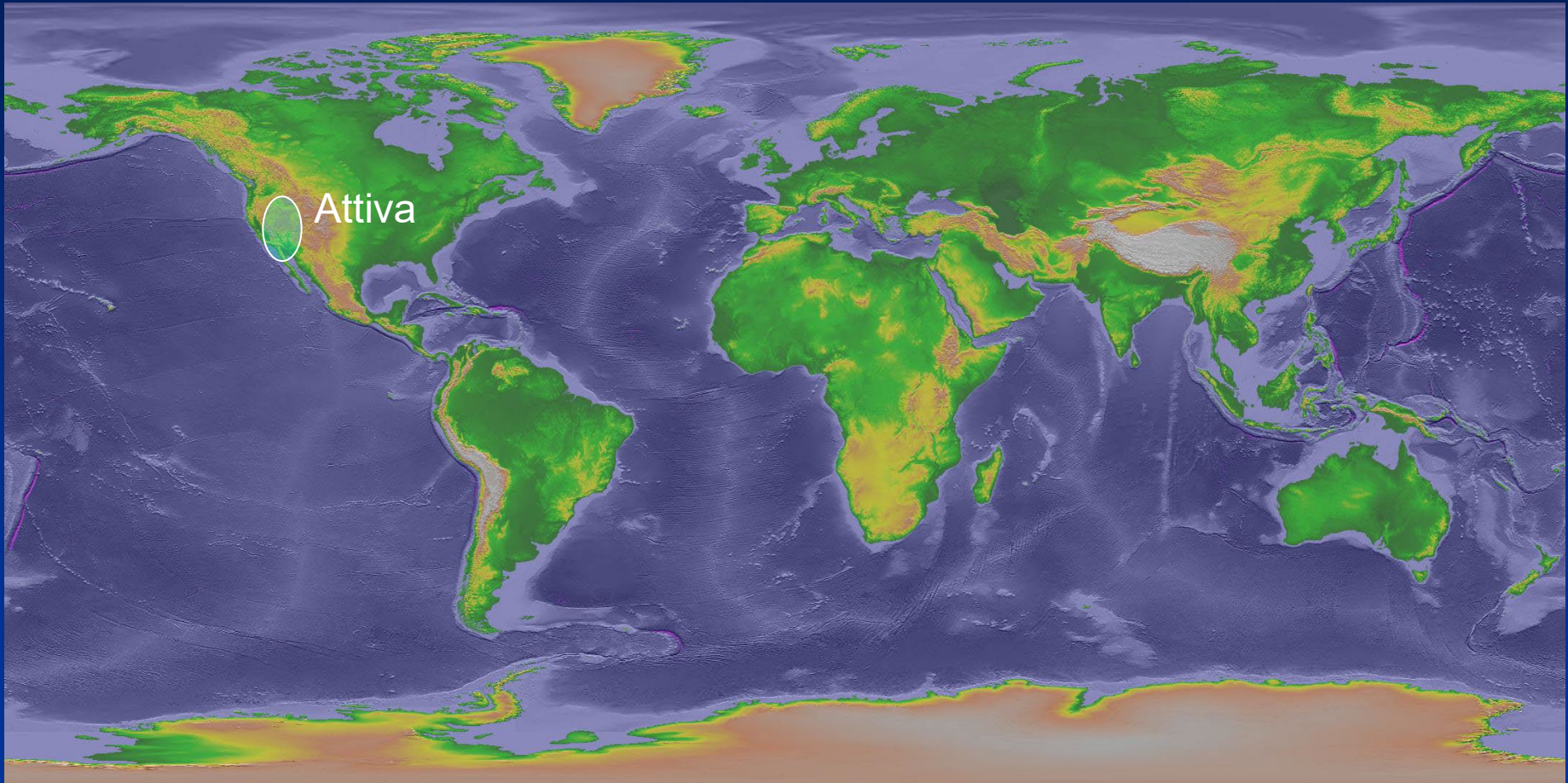


Da van der Pluijm & Marshak, 2004



Associazioni di faglie normali

2a) associazioni estensionali in ambienti geodinamici divergenti prossimi a margini trascorrenti/convergenti

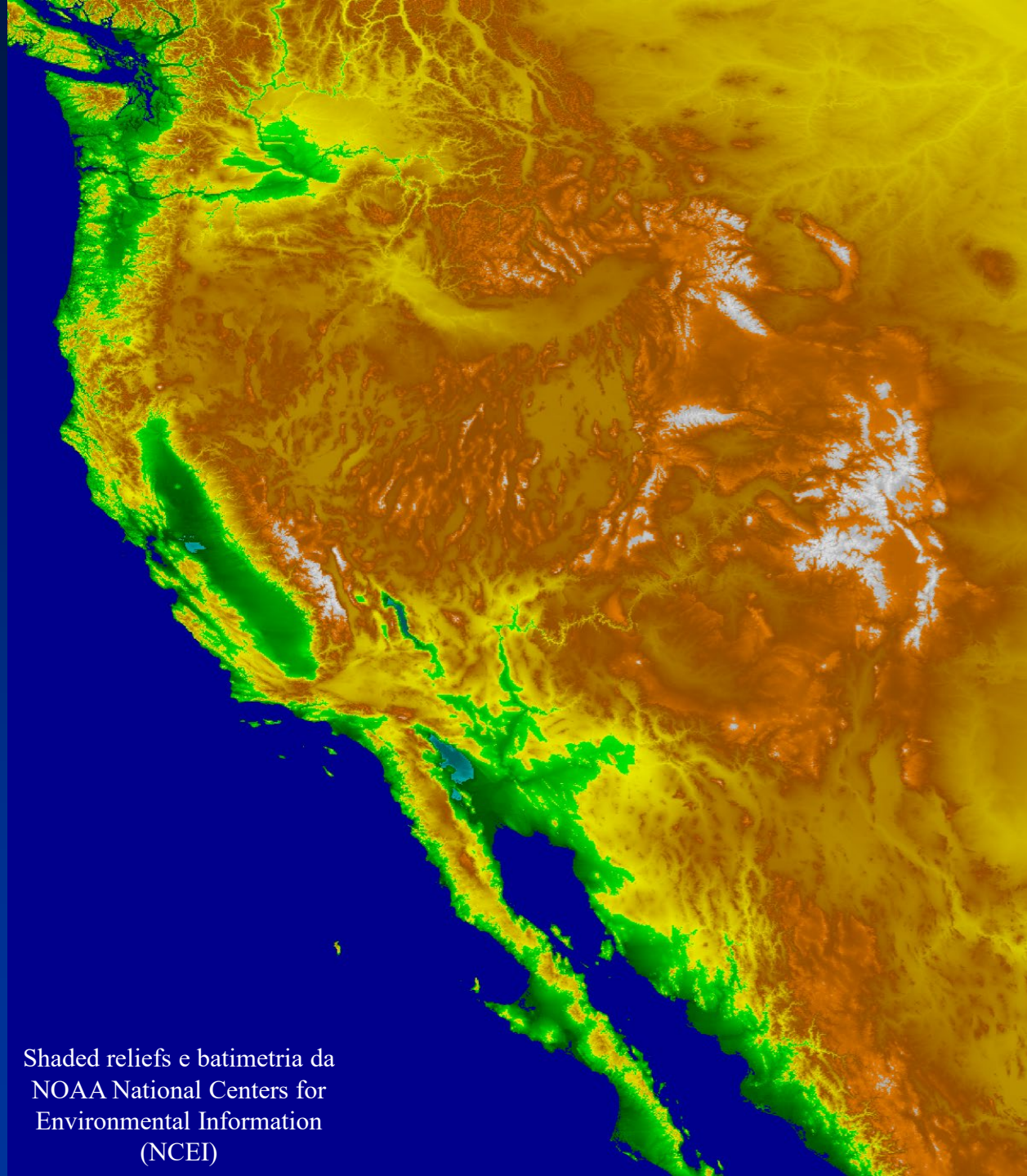


Shaded reliefs e batimetria da NOAA National Centers for Environmental Information (NCEI)

Associazioni
estensionali in
ambienti
geodinamici
divergenti
prossimi a
margini
trascorrenti/
convergenti

Basin & Range, estensione
intra-continentale

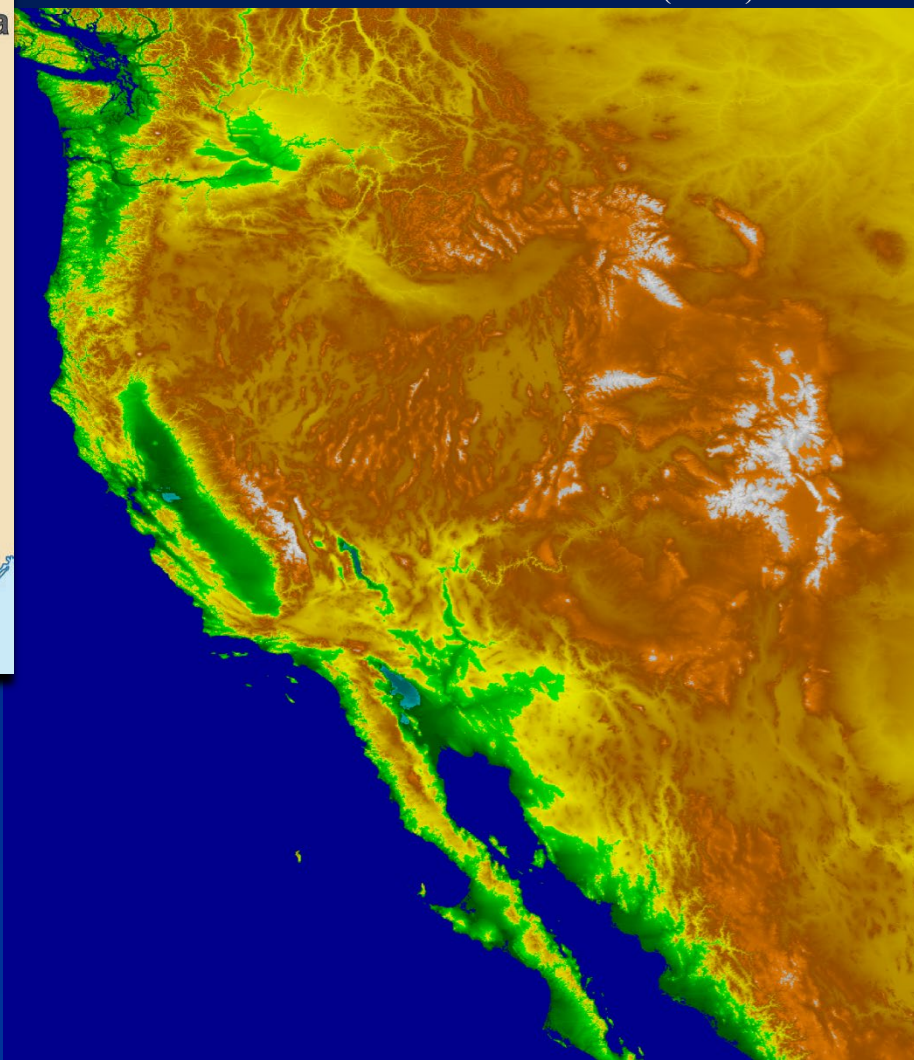
Shaded reliefs e batimetria da
NOAA National Centers for
Environmental Information
(NCEI)





https://commons.wikimedia.org/wiki/File:Tectonic_plates_boundaries_detailed-en.svg

Shaded reliefs e batimetria da NOAA National Centers for Environmental Information (NCEI)



Basin & Range, estensione intra-continentale

Death Valley National Park, California

compiled by Marli Bryant Miller

Sediments and Sedimentary Rocks

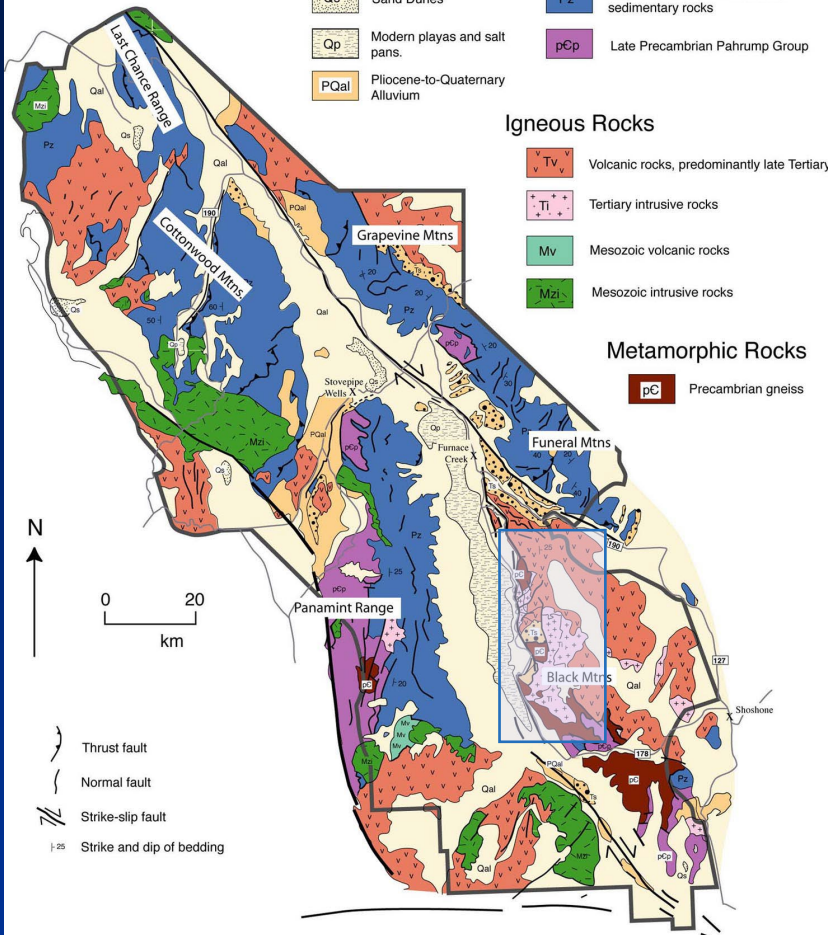
Quaternary Alluvium	Tertiary sedimentary rocks
Sand Dunes	Paleozoic and Late Proterozoic sedimentary rocks
Modern playas and salt pans.	Late Precambrian Pahrump Group
Pliocene-to-Quaternary Alluvium	

Igneous Rocks

Volcanic rocks, predominantly late Tertiary
Tertiary intrusive rocks
Mesozoic volcanic rocks
Mesozoic intrusive rocks

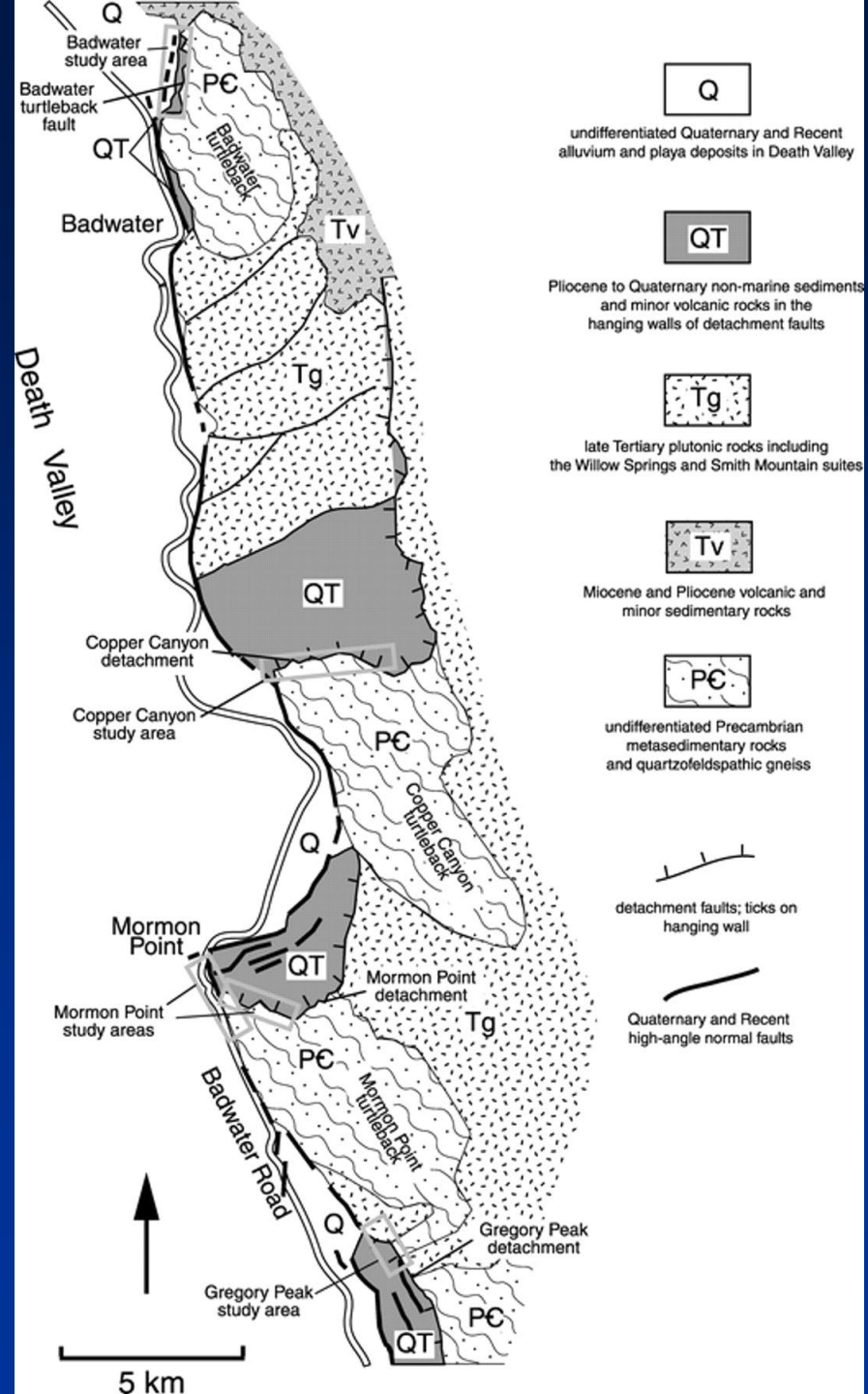
Metamorphic Rocks

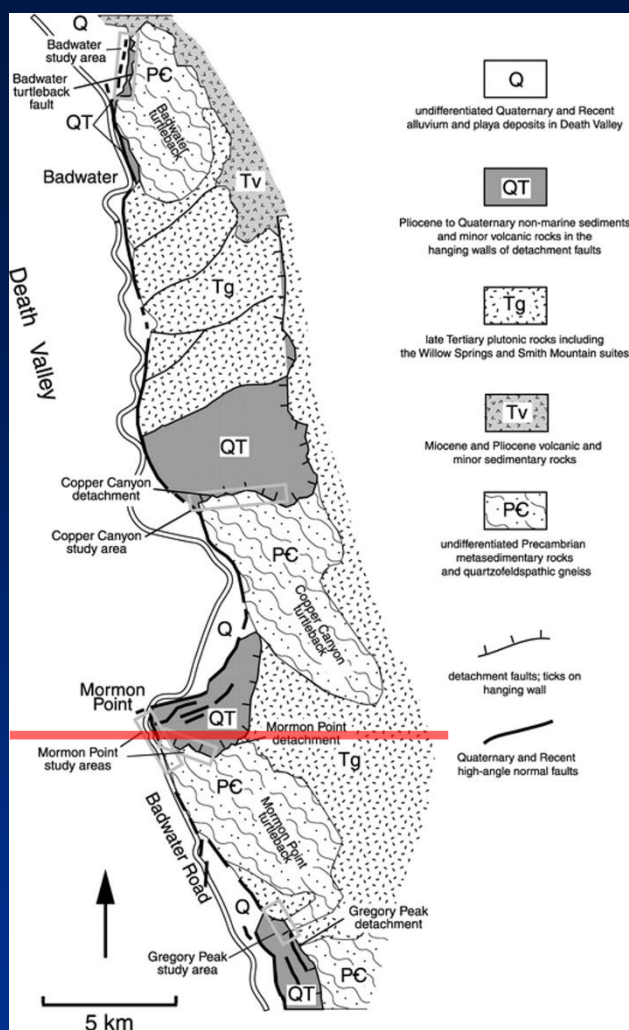
Precambrian gneiss



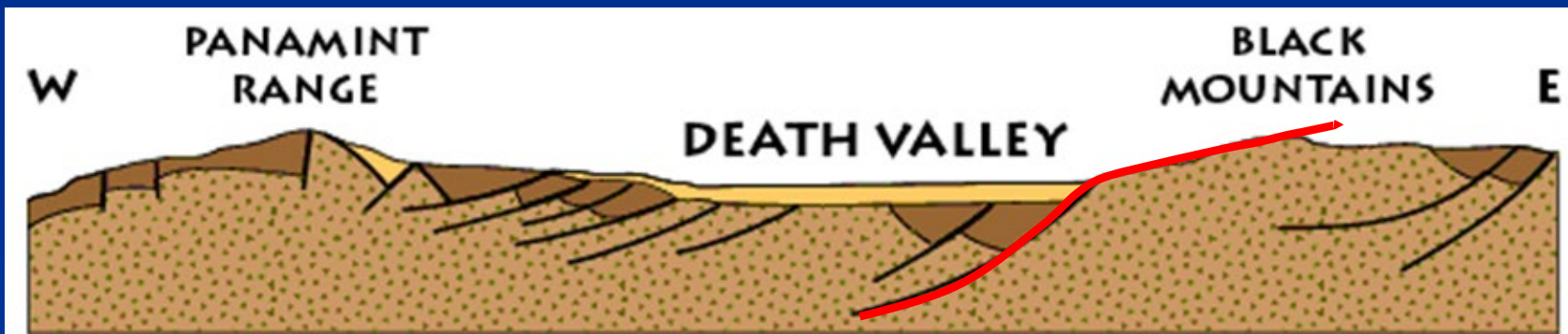
Da Bryant Miller M.

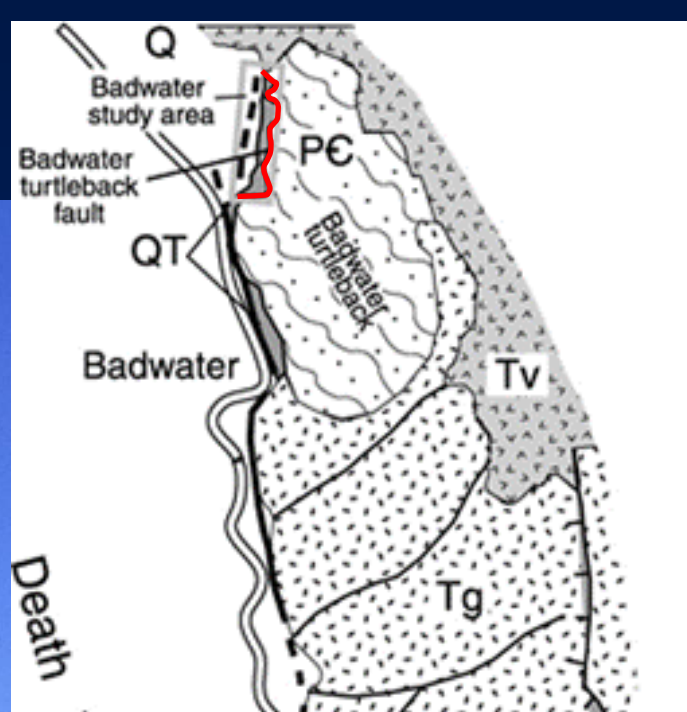
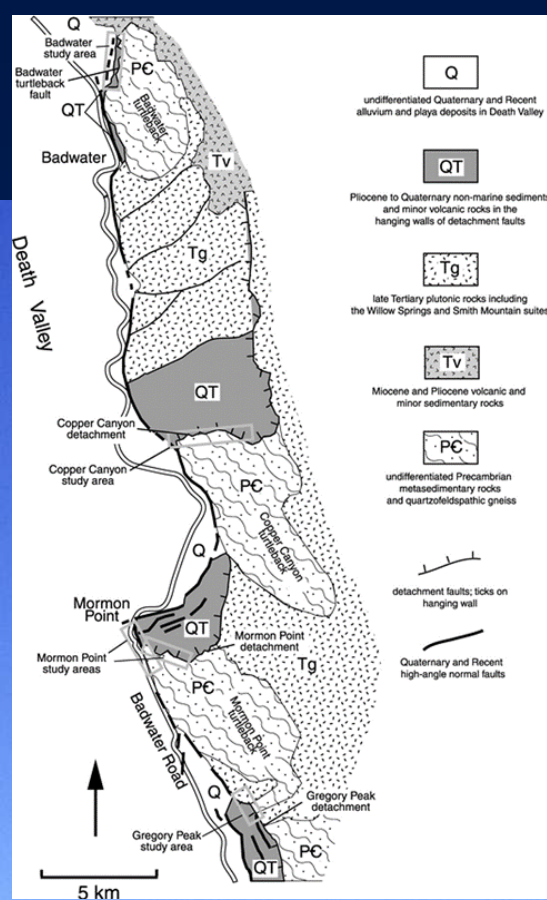
Valle della morte
(Basin & Range)



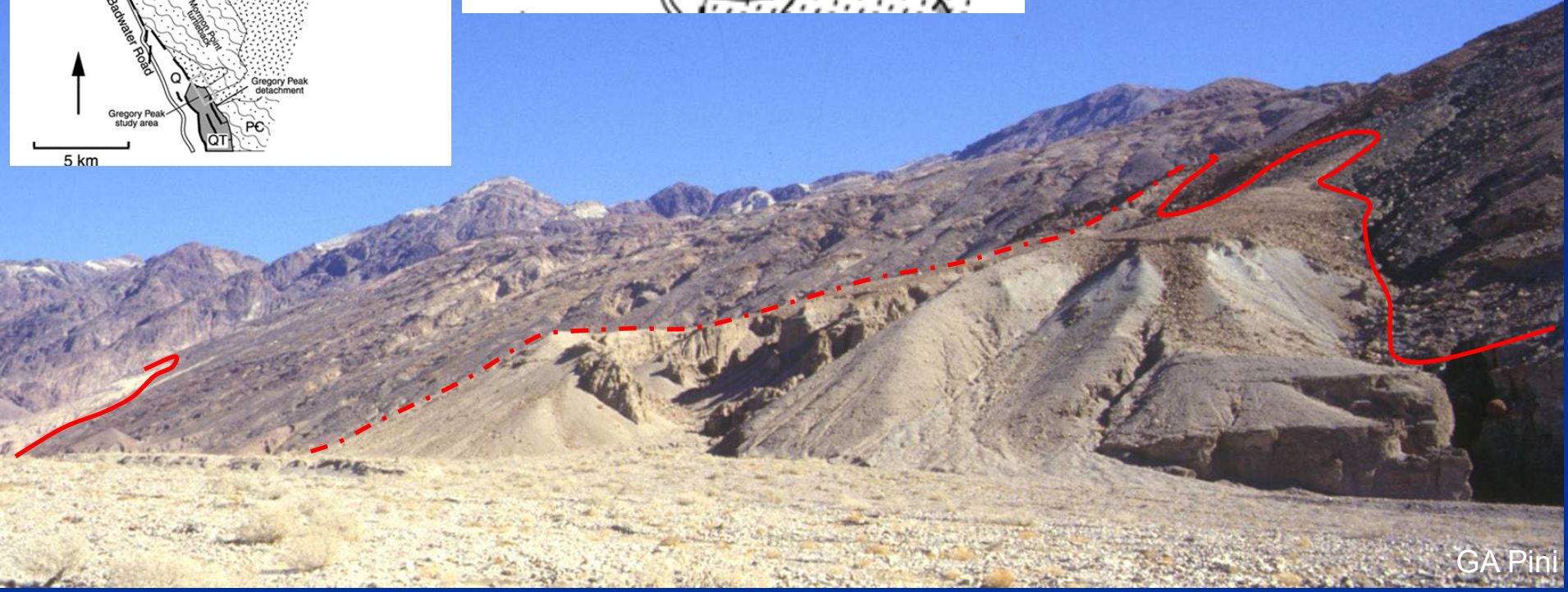


USGS Geology of Death Valley National Park

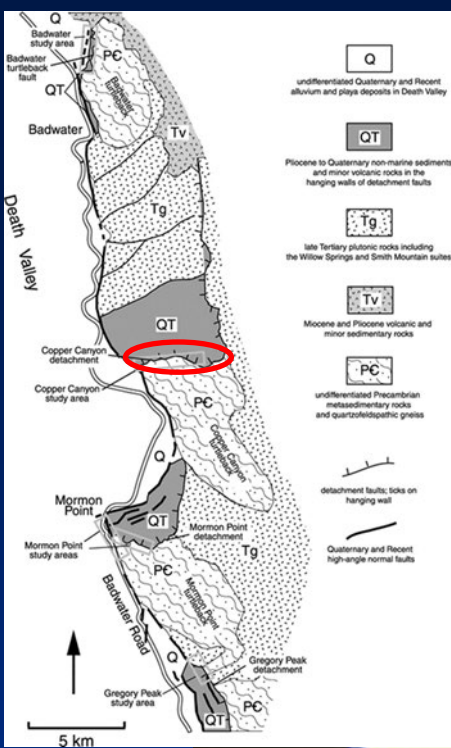




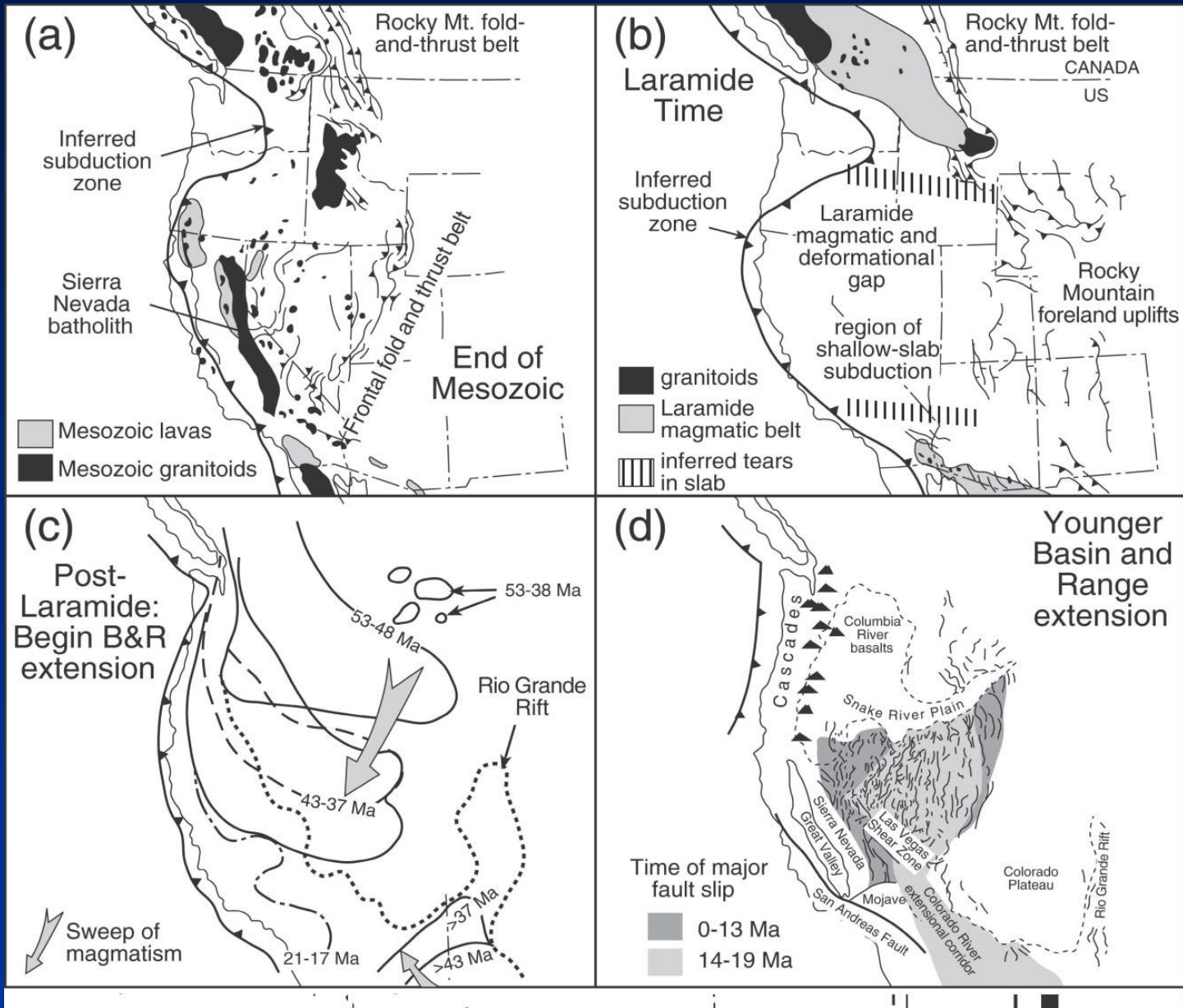
Badwater Turtleback normal fault



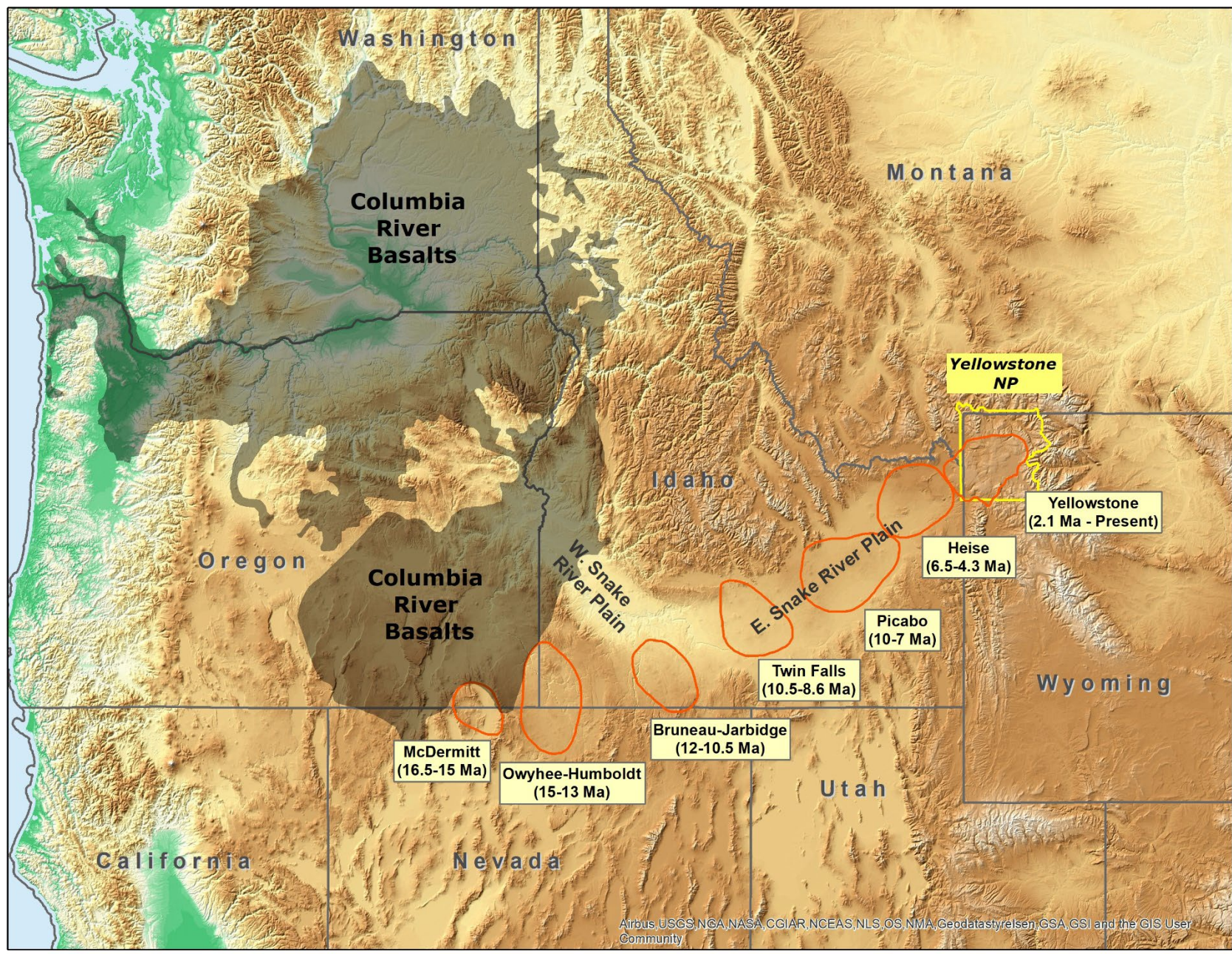
Badwater Turtleback normal fault: Copper Canyon fault zone



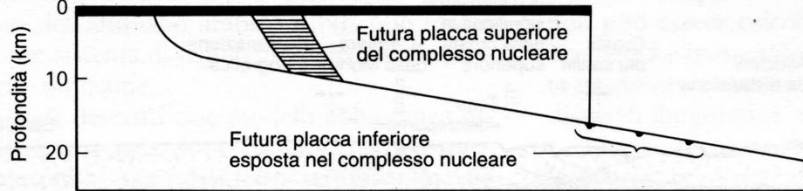




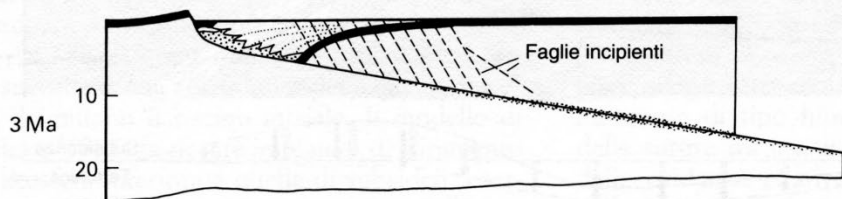
Orogenesi
Laramide
tardo
Cretacico,
80-70 Ma



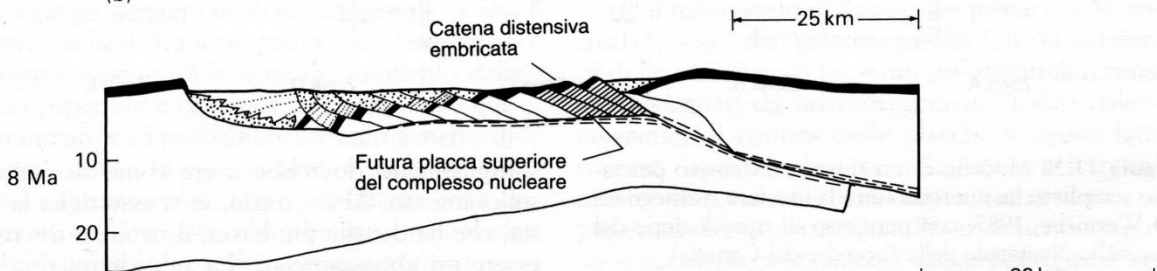
Tempo a 5 mm a^{-1}



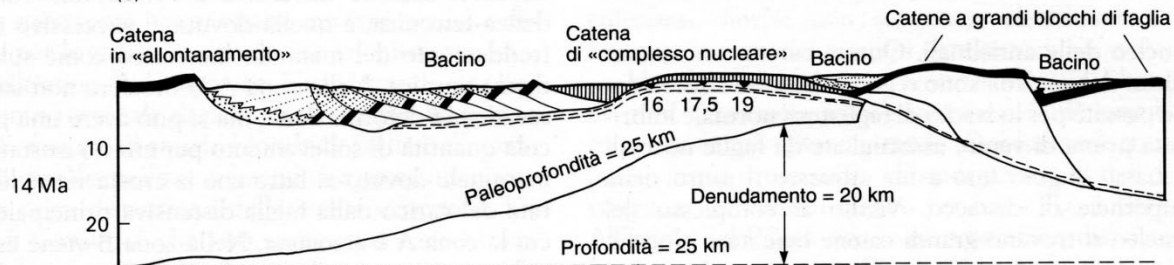
(a) $\leftarrow 15 \text{ km} \rightarrow$



(b)



(c)

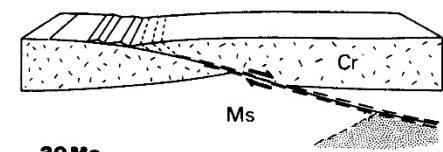


(d)

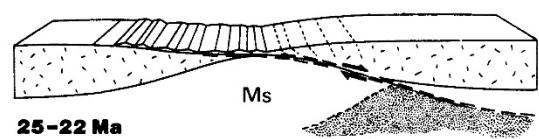
- Riferimento pre-orogenico
- Depositi clastici orogenici: fini-lacustri grossolani
- Rocce molto assottigliate e stirate
- Zona di taglio duttile
- 16,5 Paleopropfondità della placca inferiore del «complesso nucleare»

Estensione totale = 72 km (100%)

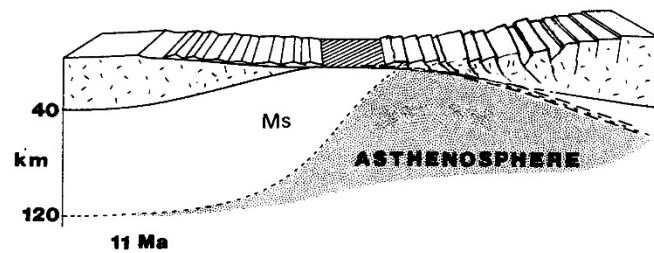
SW NE



30 Ma



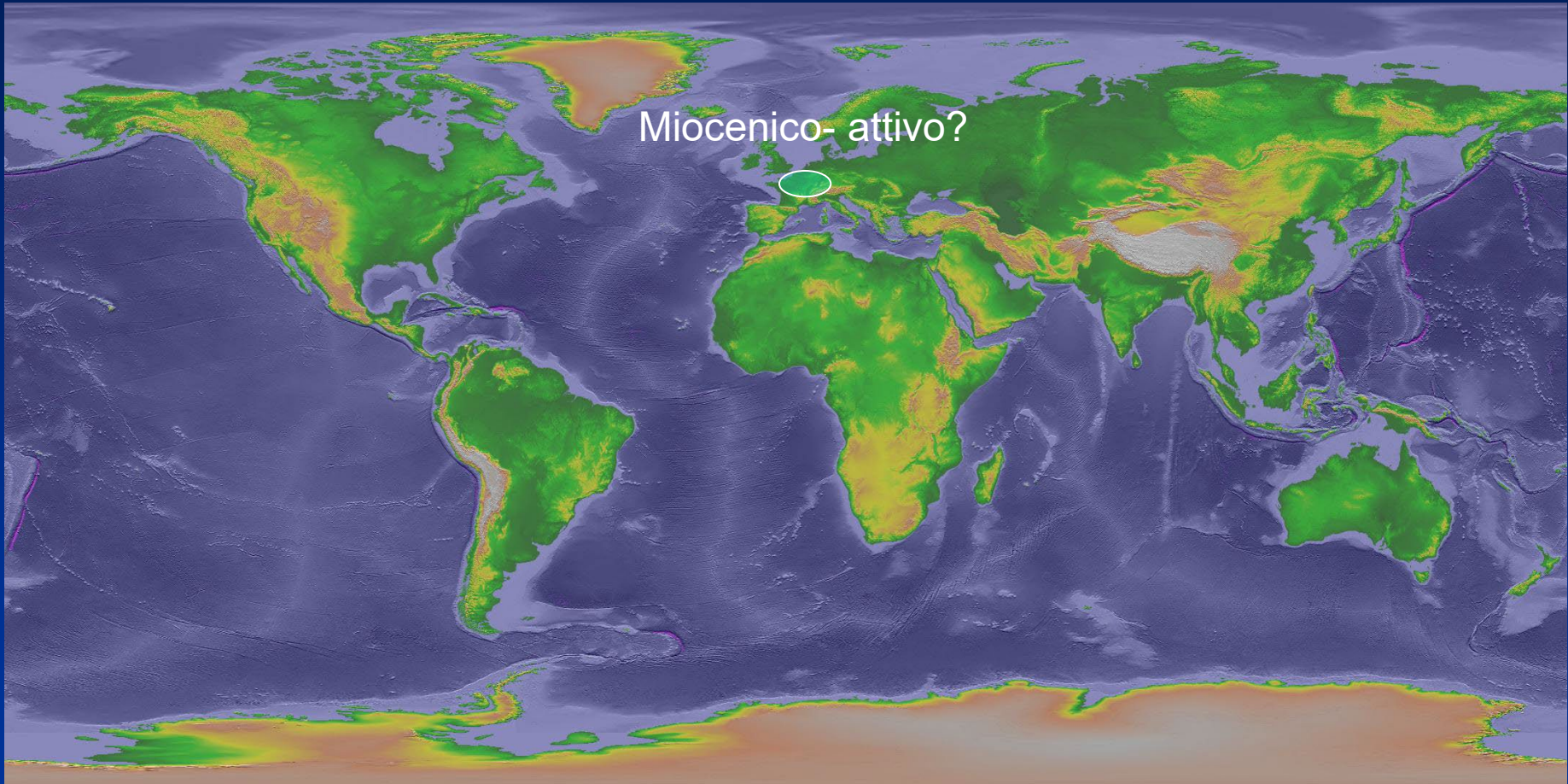
25-22 Ma



11 Ma

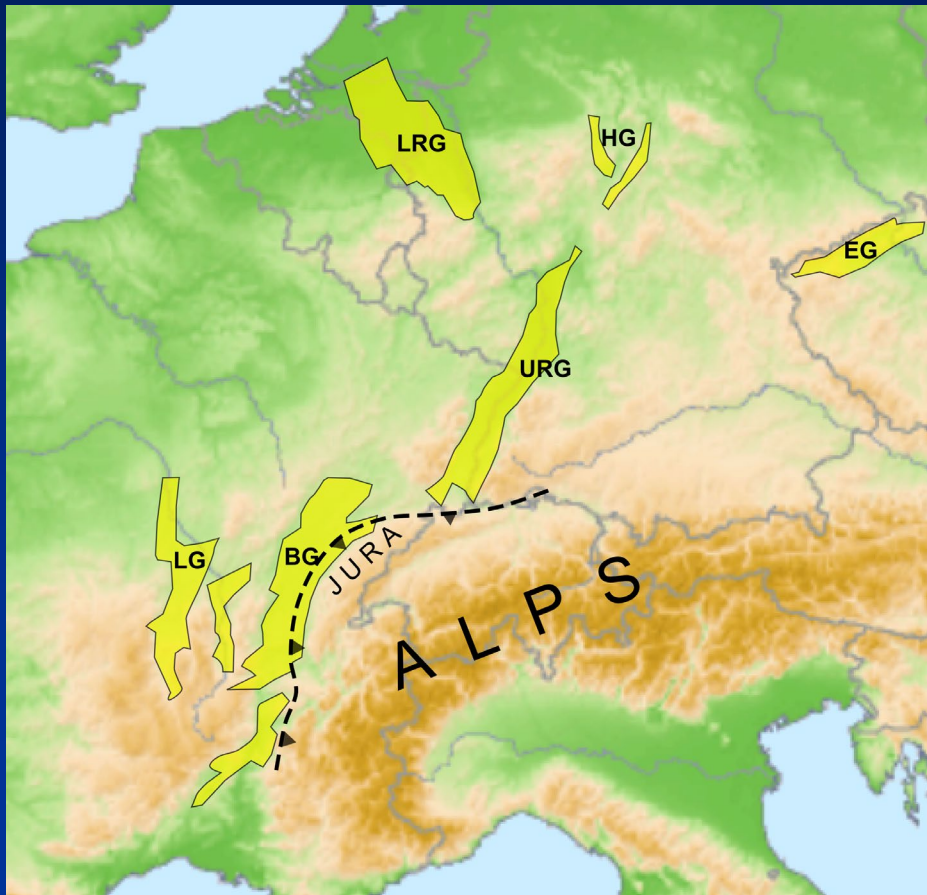
Associazioni di faglie normali

2b) associazioni estensionali in ambienti geodinamici divergenti prossimi a margini convergenti

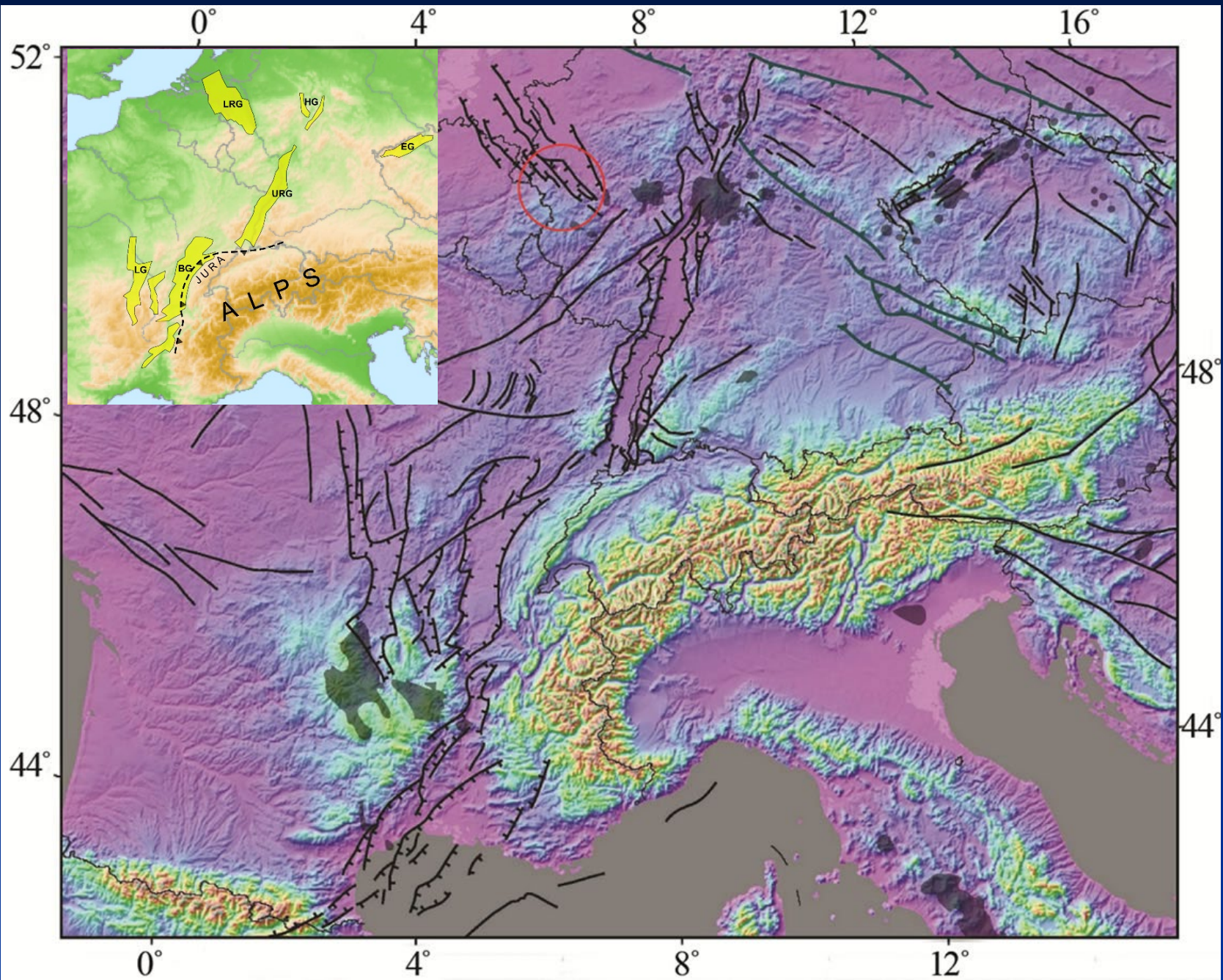


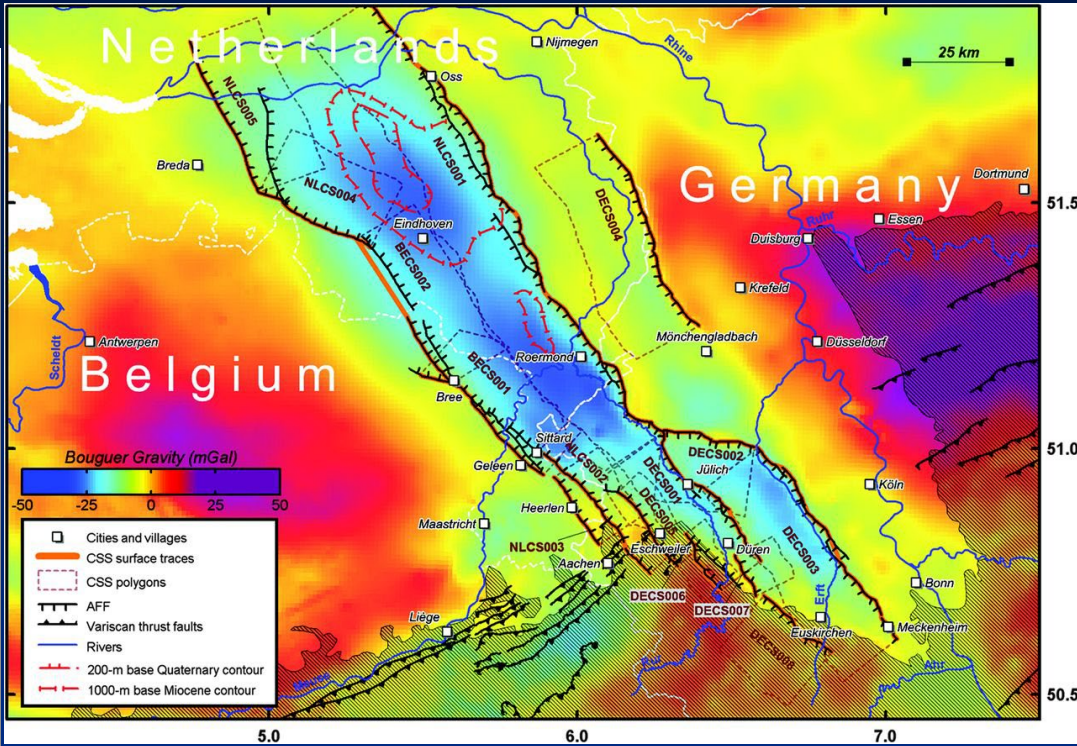
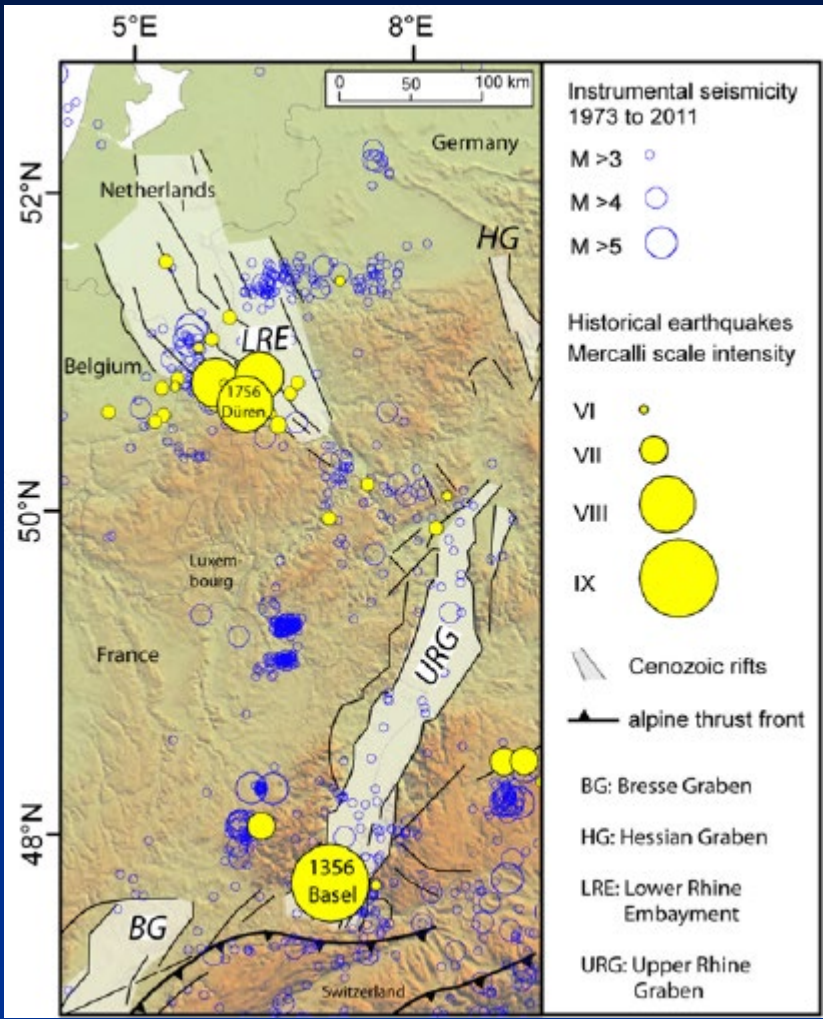
Shaded reliefs e batimetria da NOAA National Centers for Environmental Information (NCEI)

Associazioni estensionali in ambienti geodinamici divergenti prossimi a margini convergenti



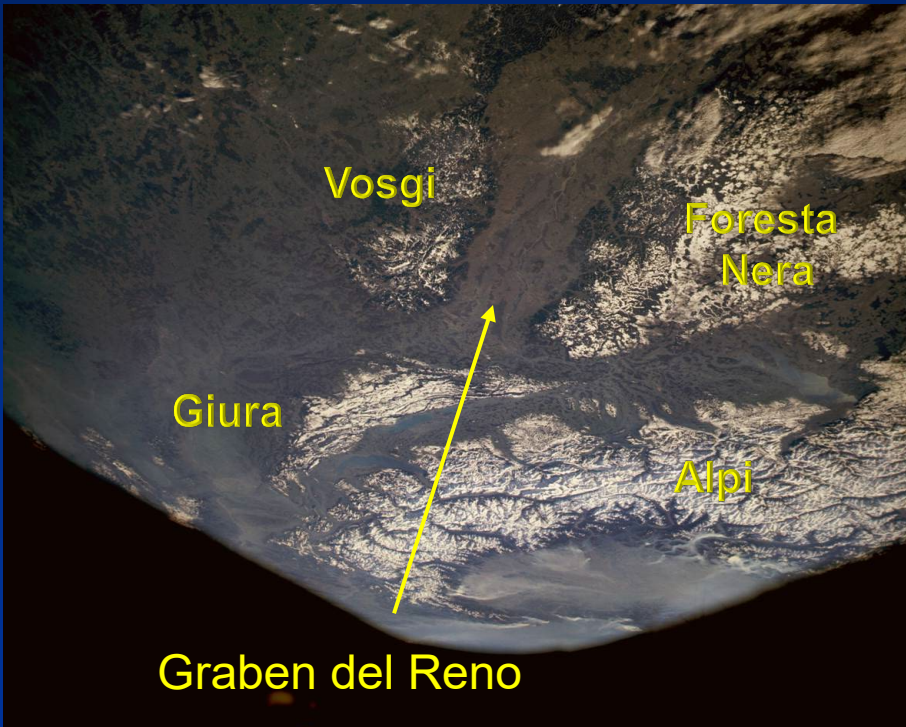
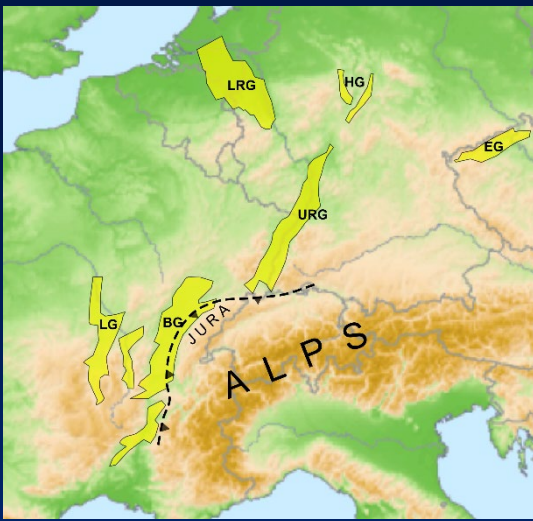
Sistema di graben
centro-europeo:
LG= g. di Limagne;
BG= g. della Bresse;
URG= Alto Reno;
LRG= Basso Reno;
HG= g. dell'Assia;
EG= g. di Eger.

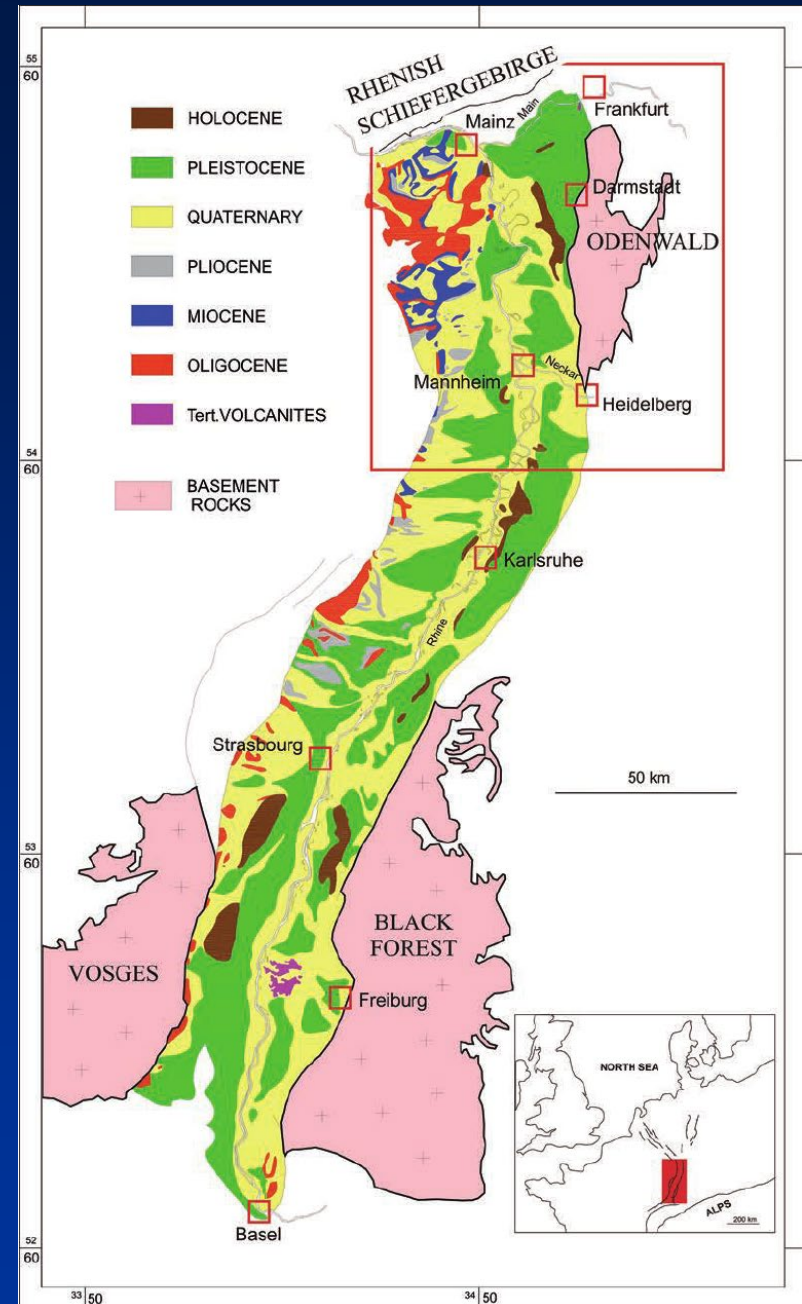
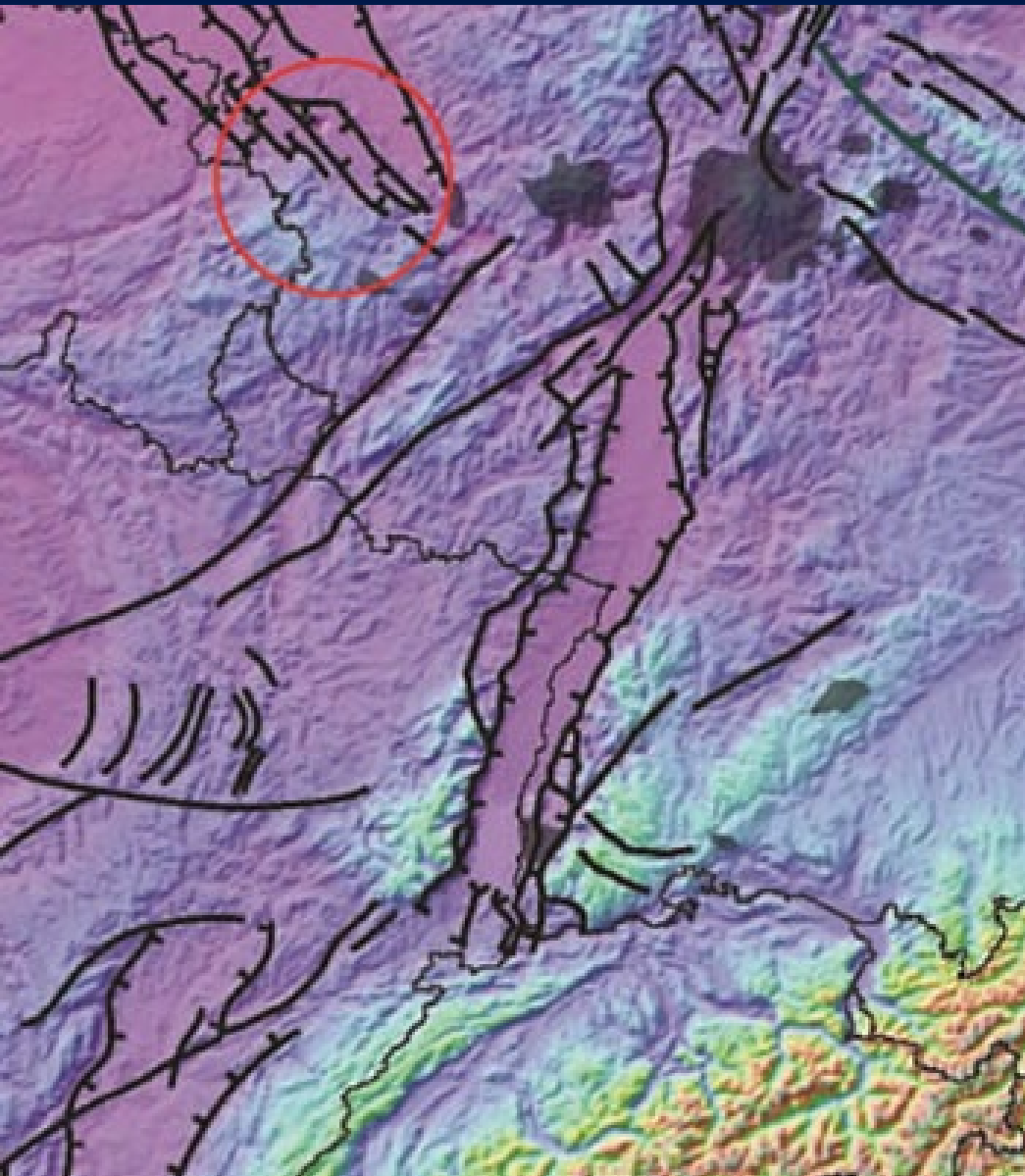




Da Kuebler, 2012

Graben del Reno

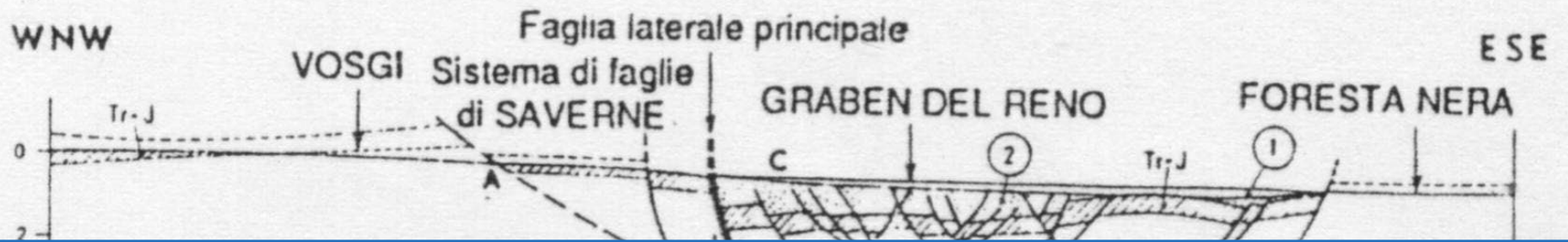


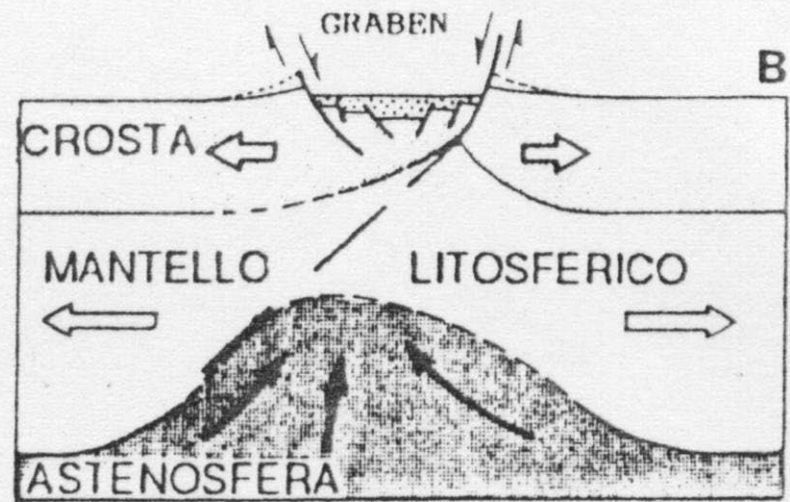
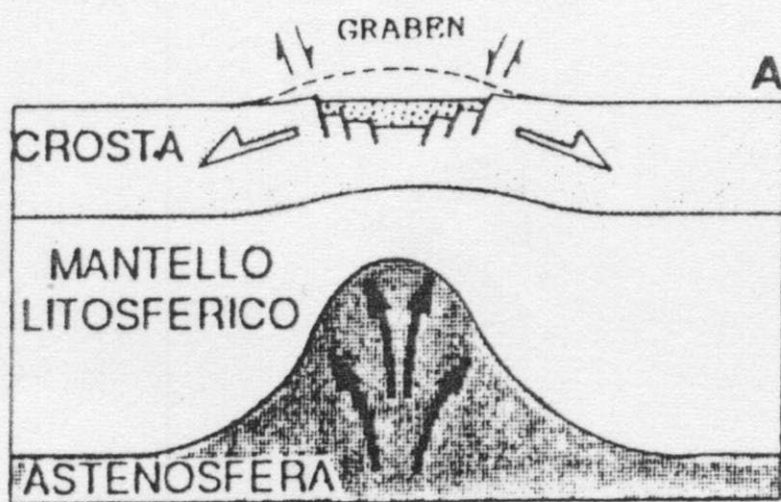


Da Dijkshoorn & Clauser, 2013

Przyrowski & Schäfer, 2015

Da Mercier & Vergely, 1996





Da Mercier & Vergely, 1996

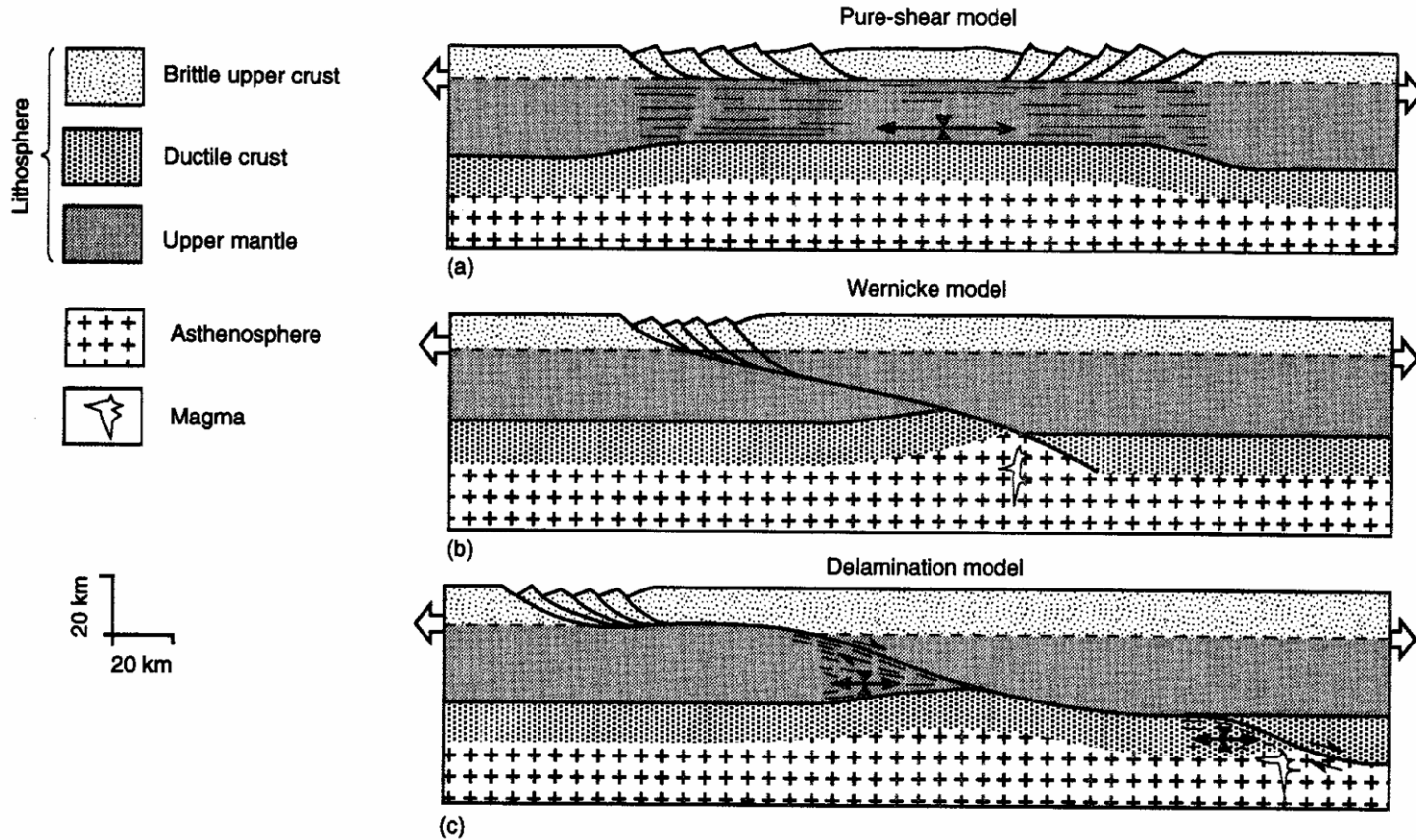
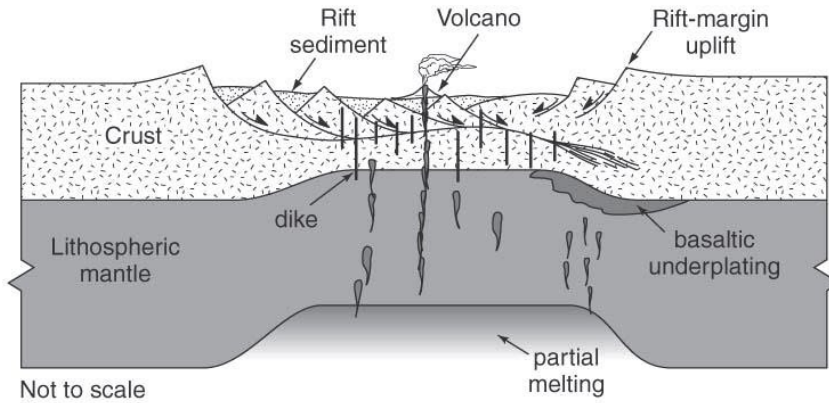


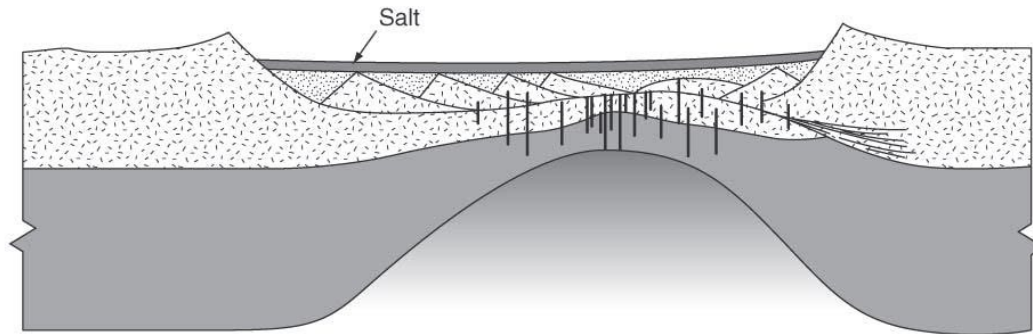
FIGURE 13-15

Three models of extension of continental crust. (a) McKenzie "pure-shear" model: symmetrical rifting and pure shear. (b) Wernicke model: asymmetric rifting with simple shear. (c) Delamination model: asymmetric rifting with simple shear and delamination. (From G. S. Lister, M. A. Etheridge, and P. A. Symonds, *Geology*, v. 14, 1986.)

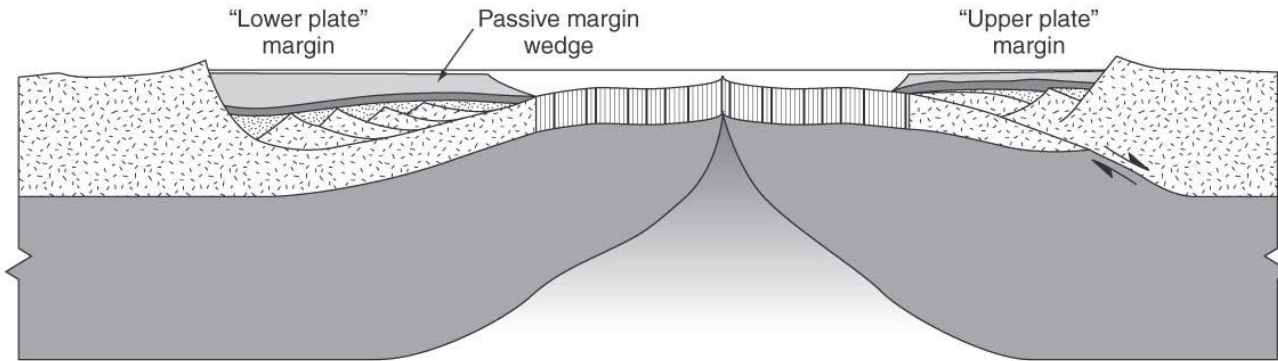
Da van der Pluijm & Marshak, 2004



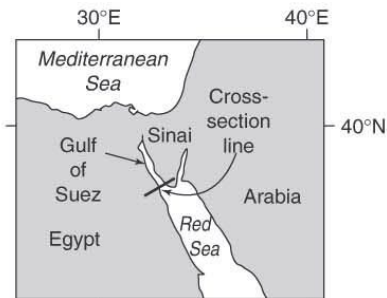
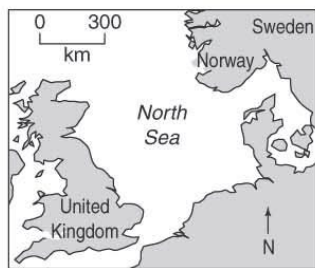
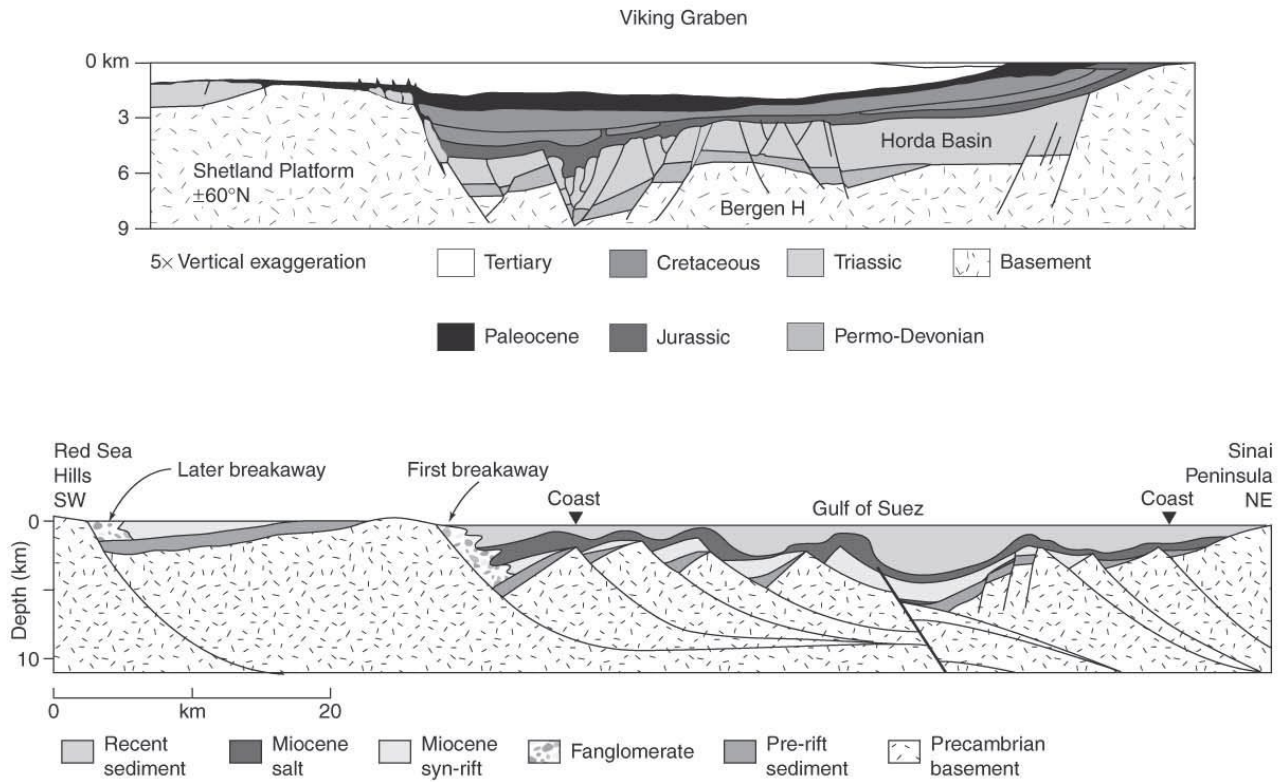
(a)



(b)



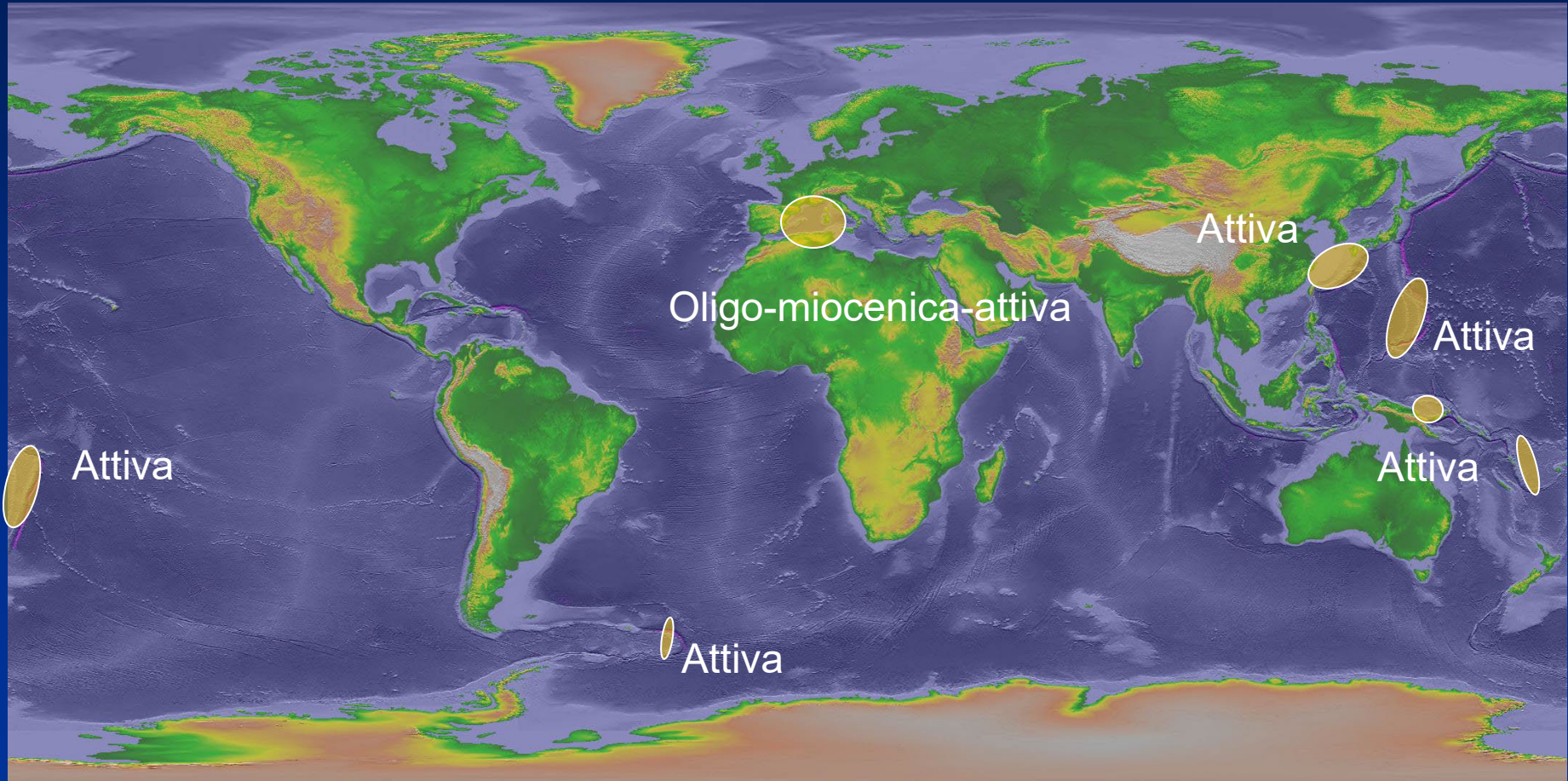
(c)



Da van der Pluijm & Marshak, 2004

Associazioni di faglie normali

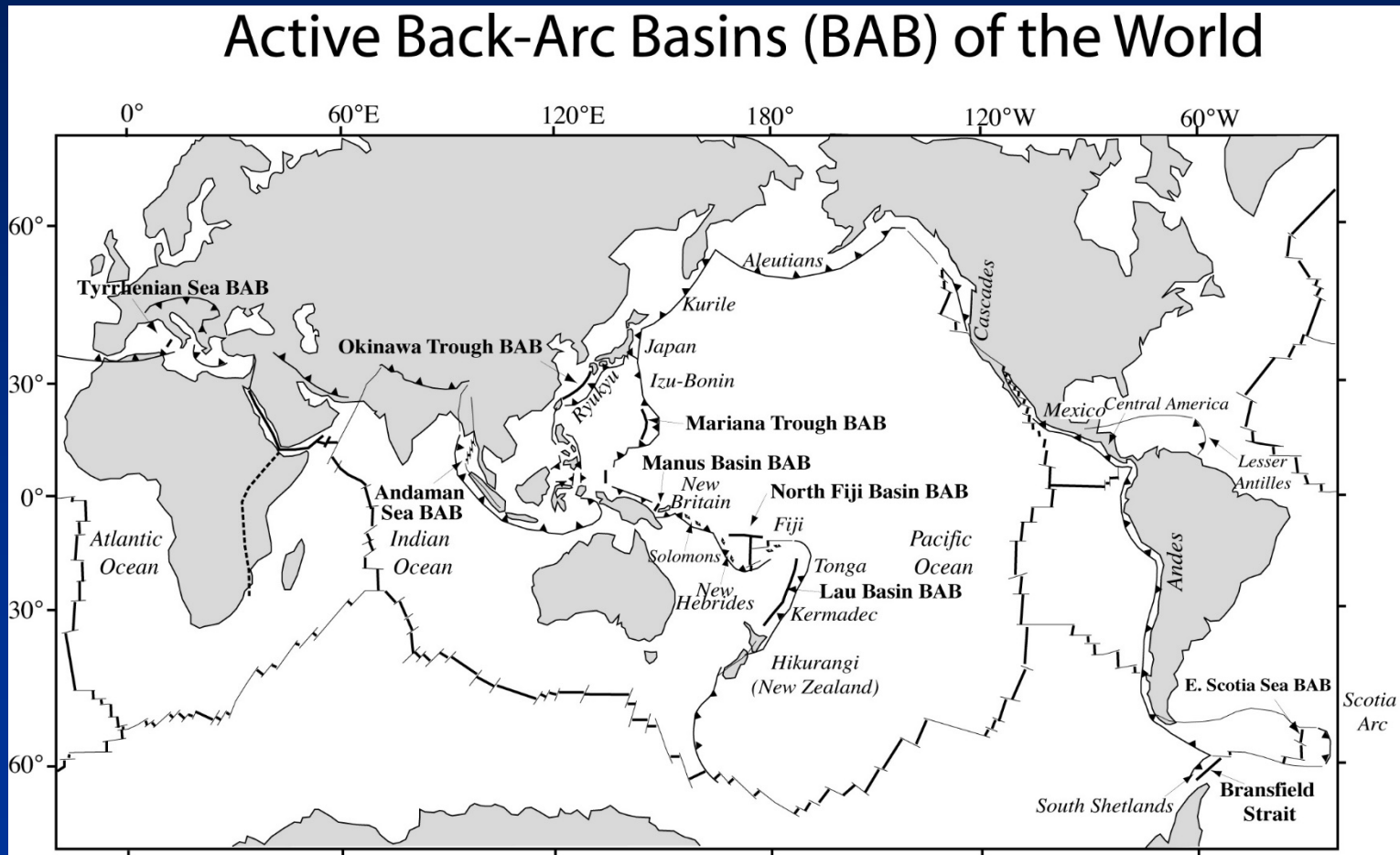
3) associazioni estensionali dovute ad ambienti geodinamici convergenti!!!



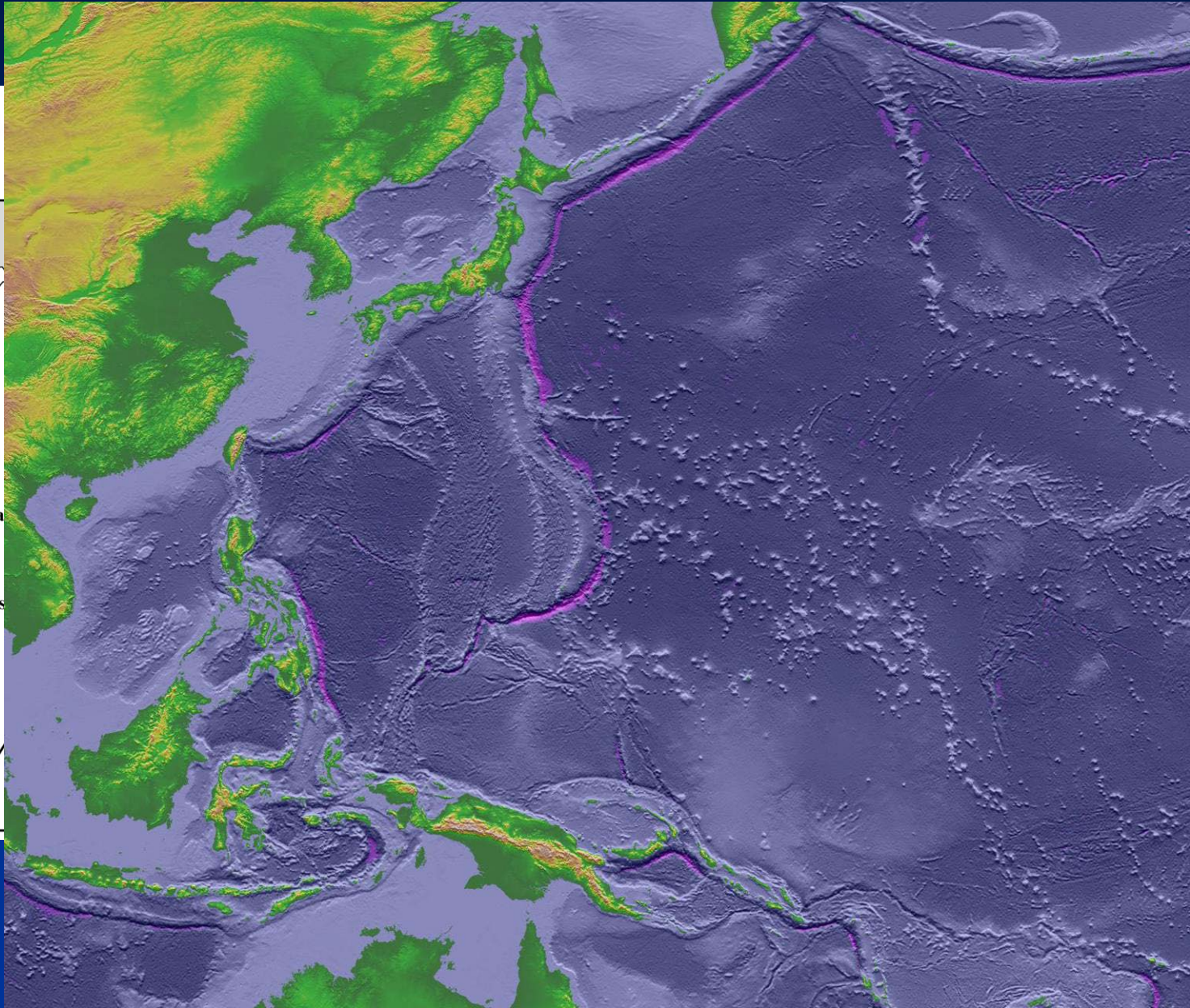
Shaded reliefs e batimetria da NOAA National Centers for Environmental Information (NCEI)

3) associazioni estensionali dovute ad ambienti geodinamici convergenti:

Estesi bacini di retroarco

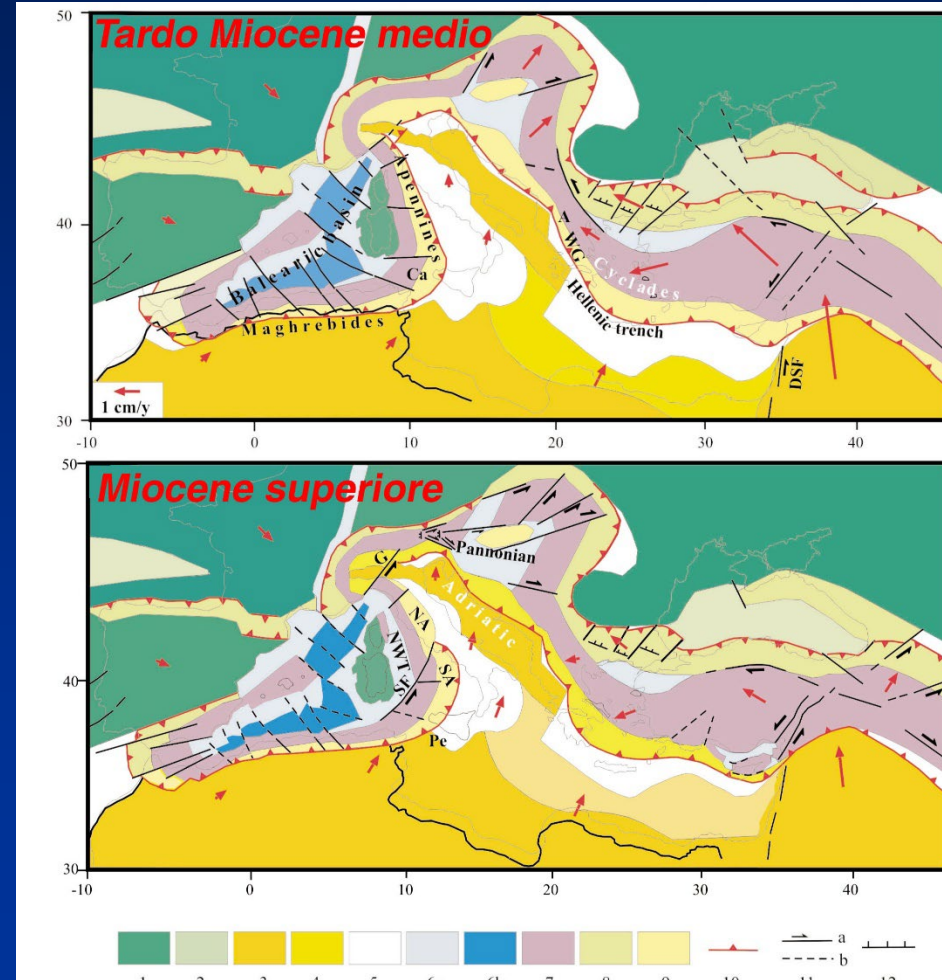
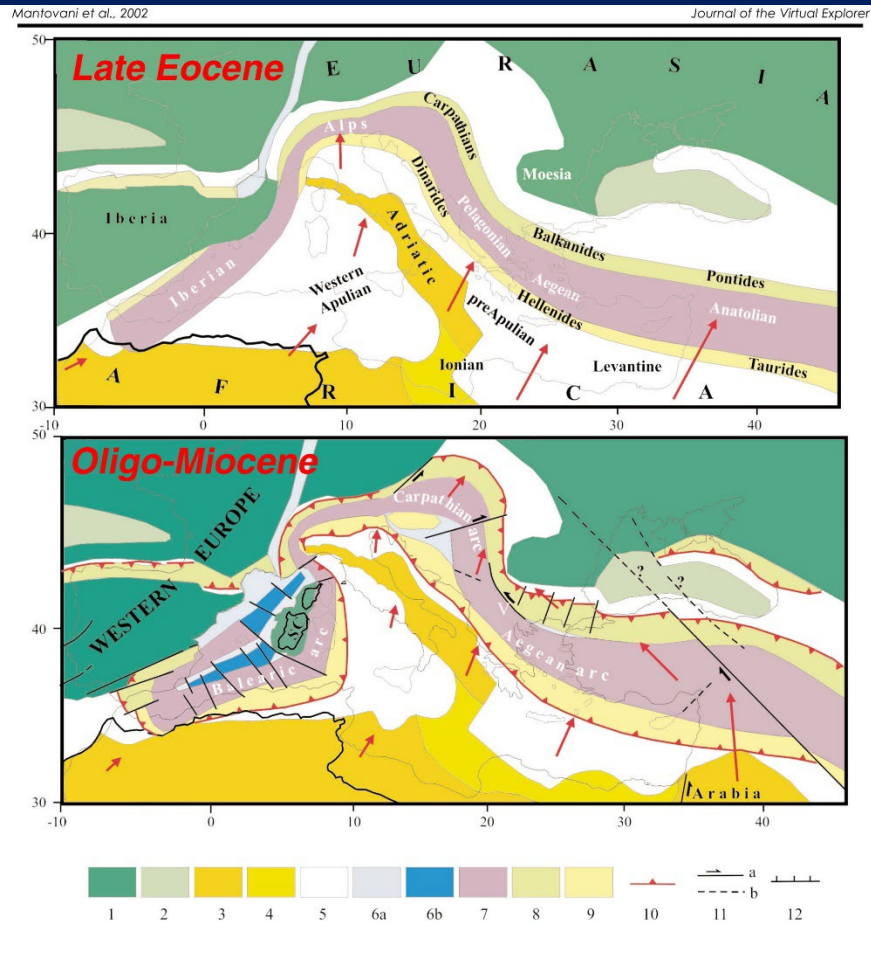


Back-Arc Basins (BAB)

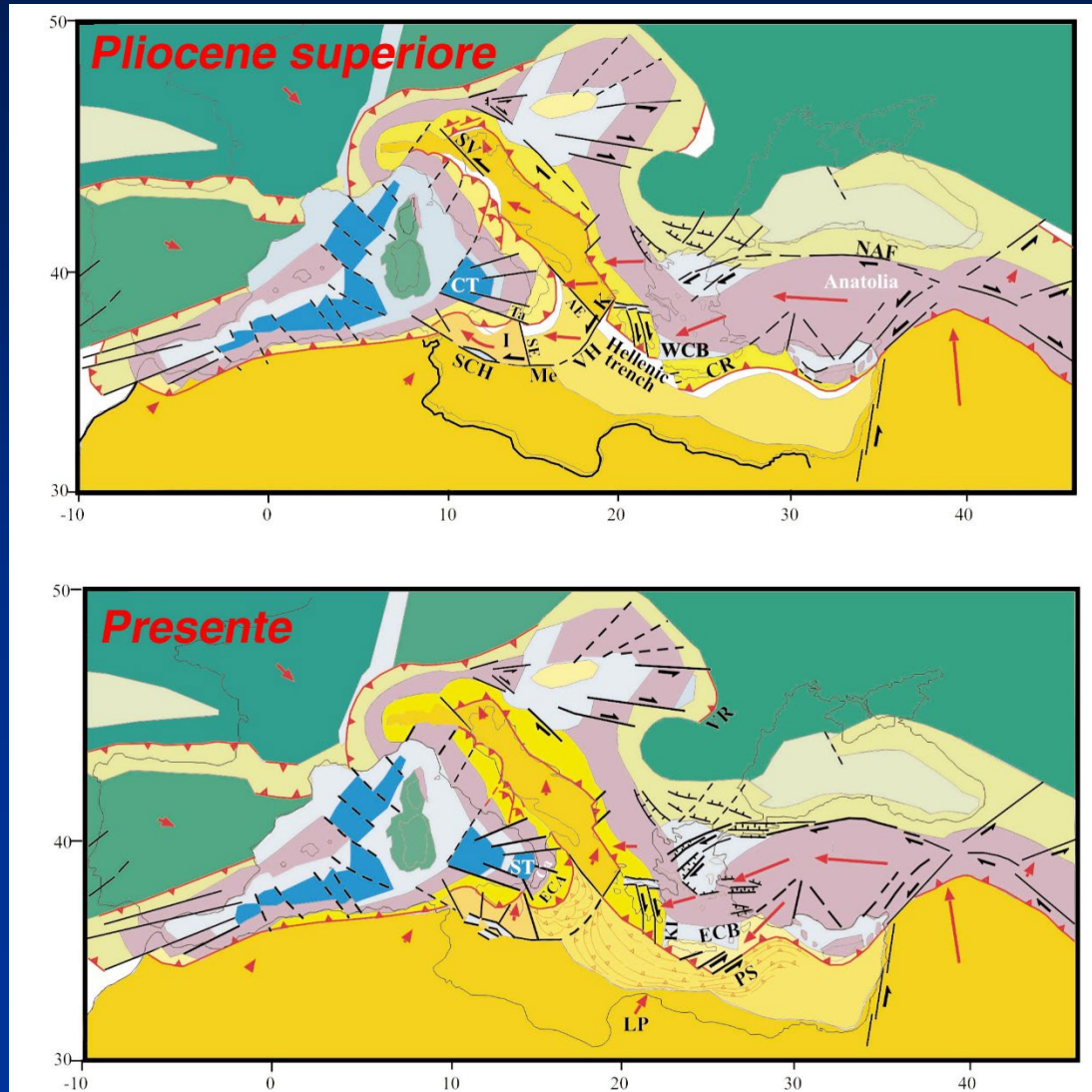


associazioni estensionali dovute ad ambienti geodinamici convergenti: evoluzione oligo-miocenica sino all'Attuale dell'Appennino

Da Mantovani et al., 2002

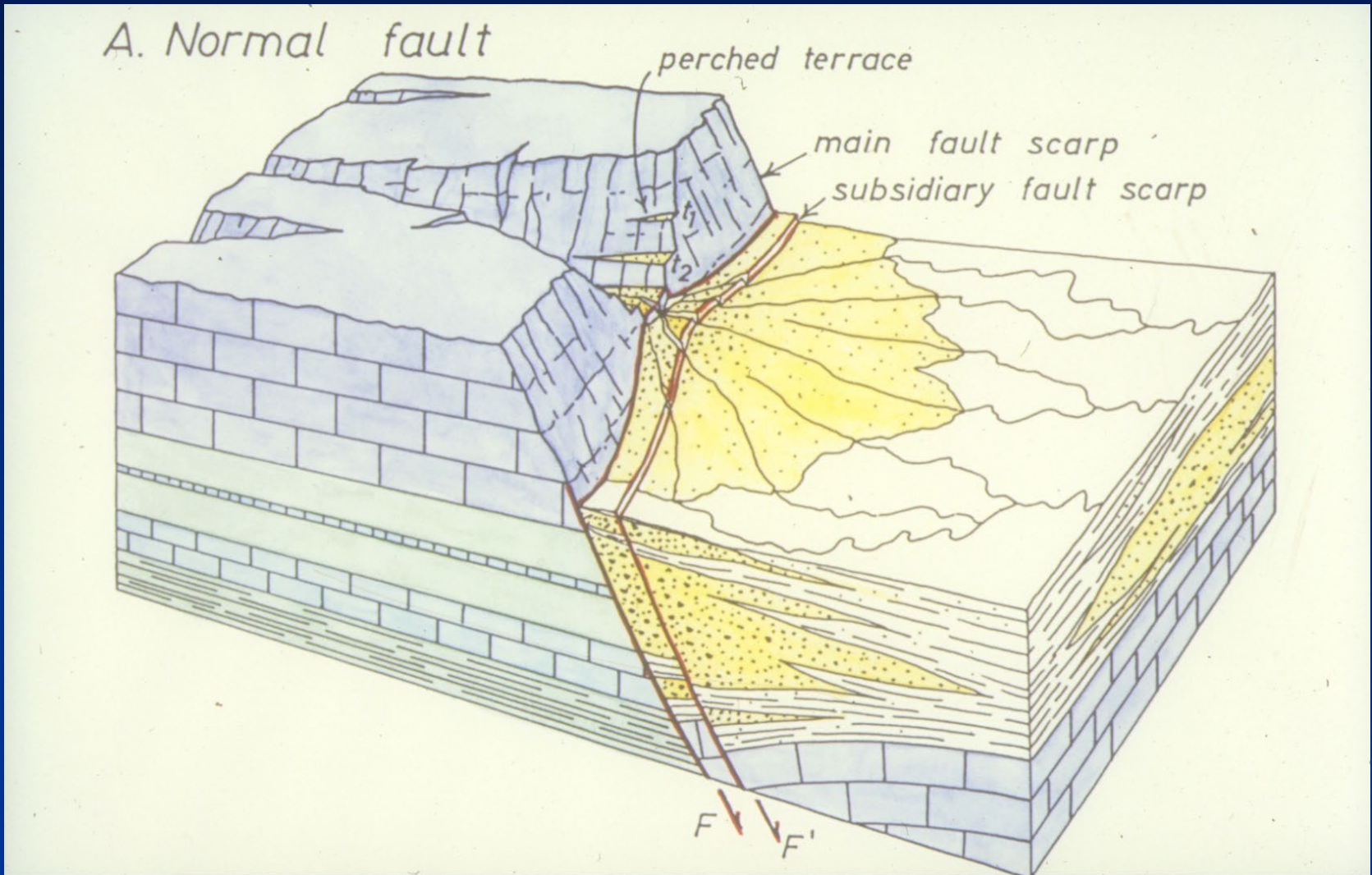


associazioni estensionali dovute ad ambienti geodinamici convergenti: evoluzione oligo-miocenica sino all'Attuale dell'Appennino

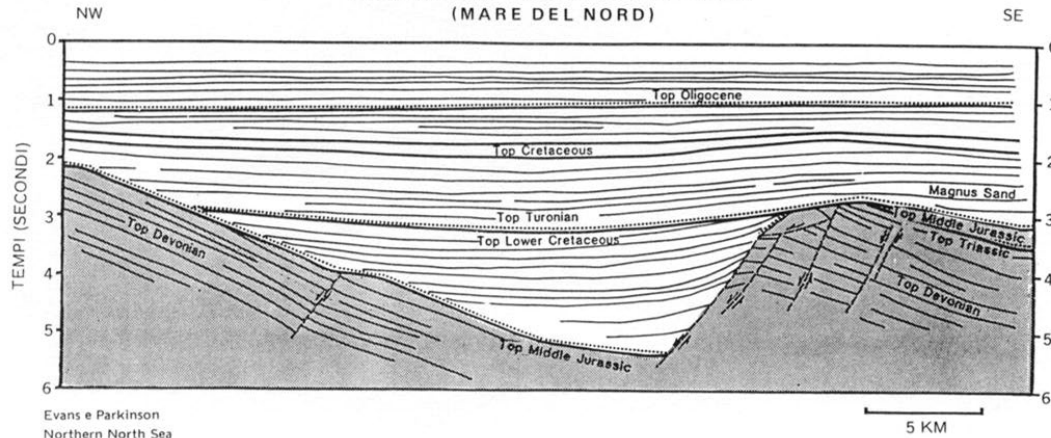


Da Mantovani et al., 2002

Faglia normale associata ad erosione (letto) e deposizione (sul lembo di tetto). La forma del bacino sedimentario e la stratigrafia dei depositi è controllata dalla attività della faglia



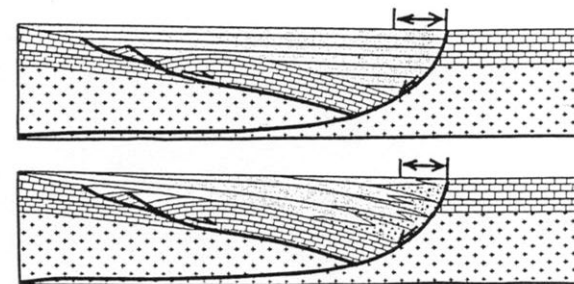
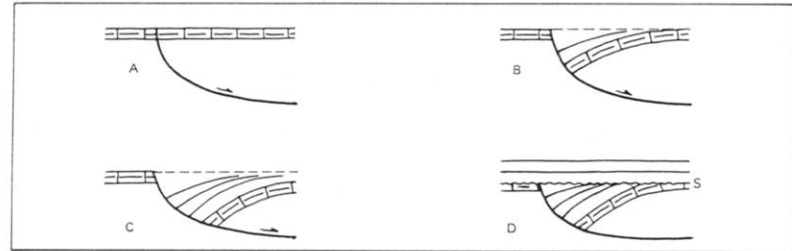
SEMIGRABEN DEL NORD SHETLAND
(MARE DEL NORD)



Velocità di attivazione della faglia elevata, basso tasso di sedimentazione

Da Bally et al., 1985

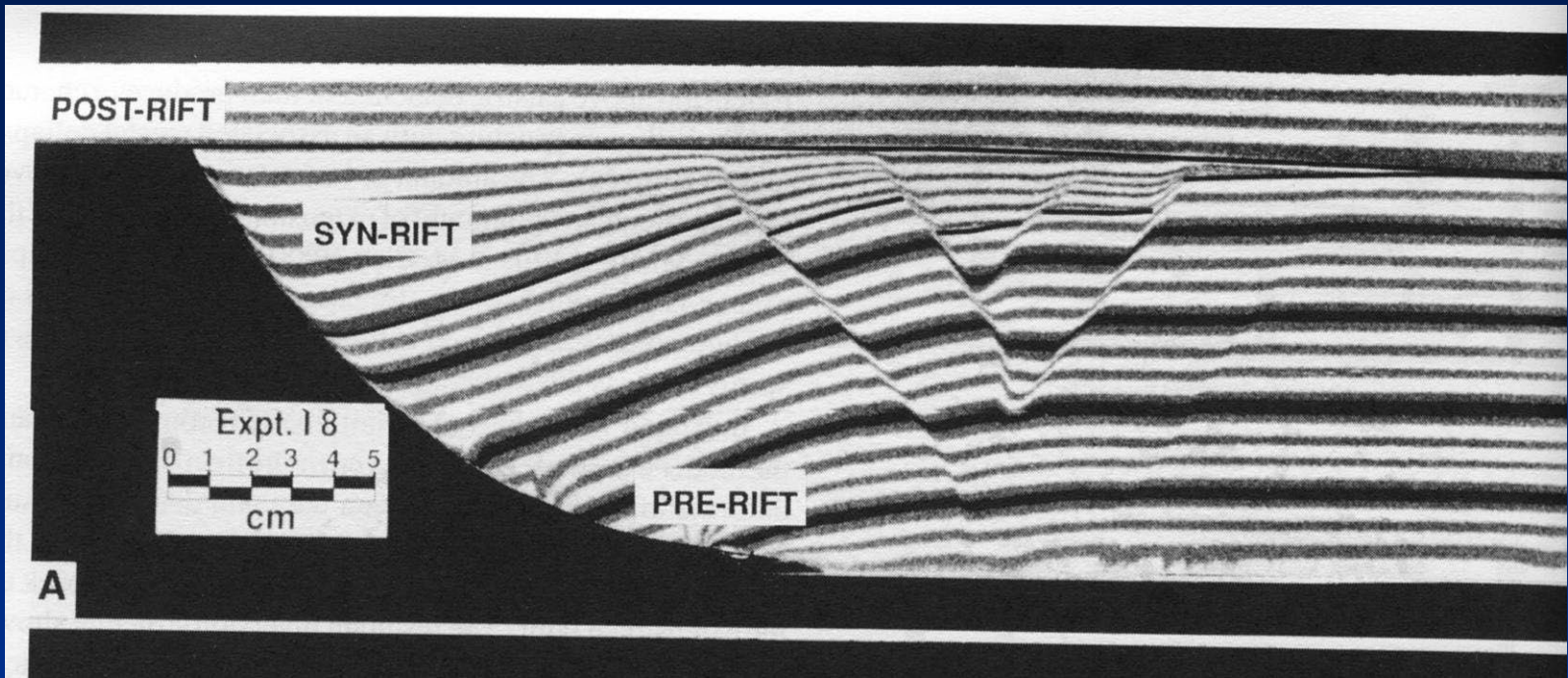
Tasso di sedimentazione elevato, movimento della faglia protratto nel tempo.



I due casi precedenti a confronto

Da Bally et al., 1985

Depositi di pre-, sin- e post-rift.



Da Buchanan & McClay, 1991