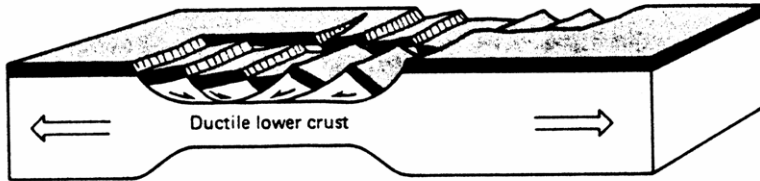


# Tettonica regionale

Extensional tectonics



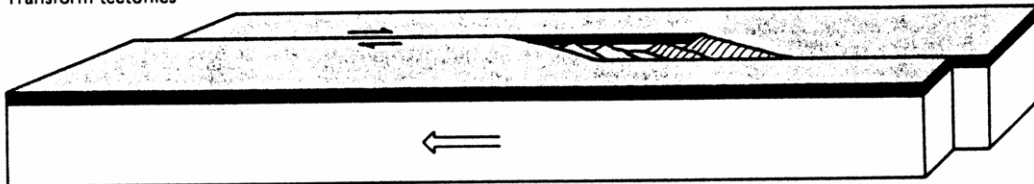
Margine in estensione/  
ambiente geodin. divergente

Compressional tectonics



Margine in compressione/  
ambiente geodin. convergente

Transform tectonics

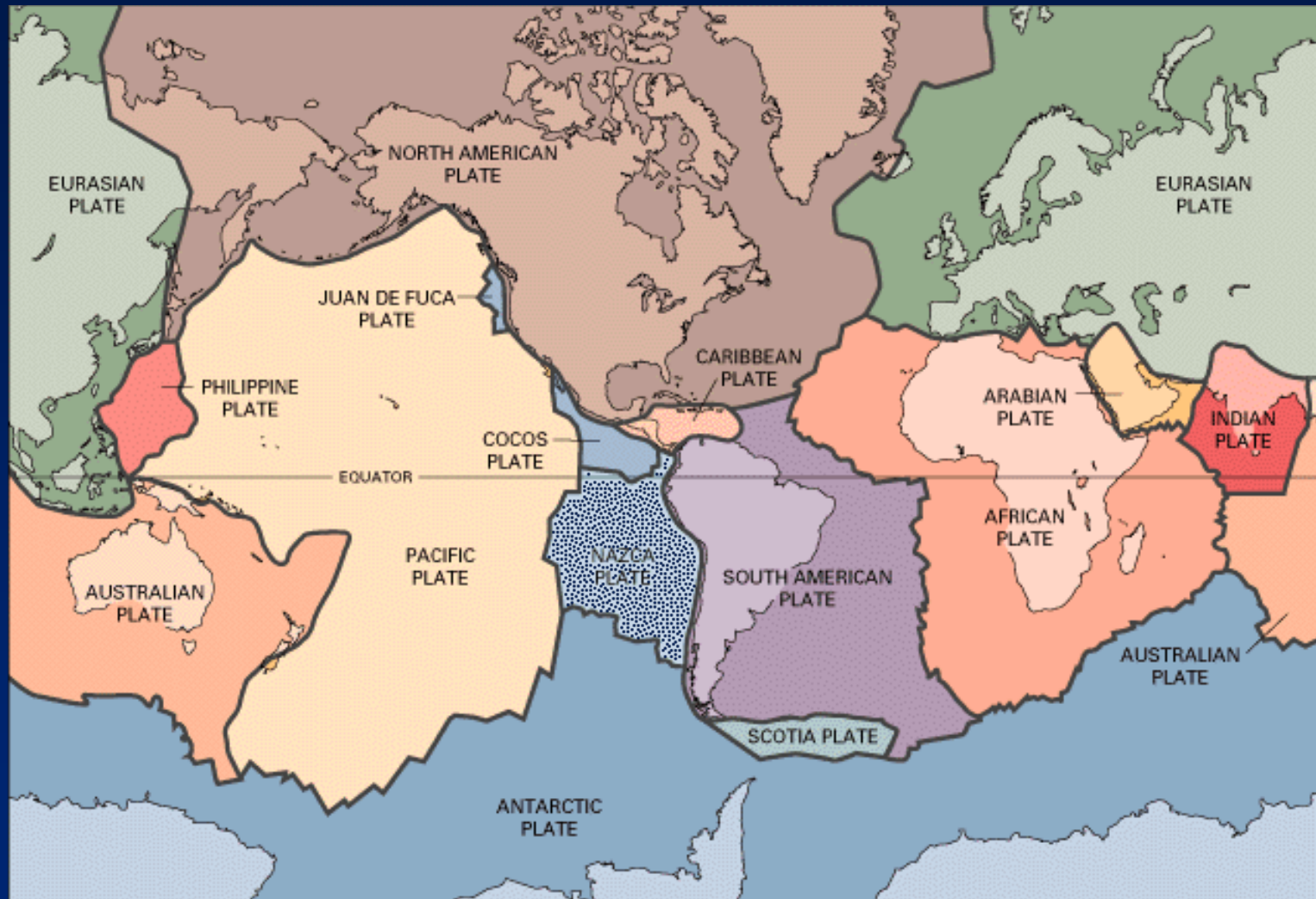


Margine trasforme/trascorrente

- ◇ Ambienti tettonici (o geodinamici) e relative associazioni di strutture tettoniche.
- ◇ Attenzione: non sempre esiste una relazione univocal tra ambiente e tipo di strutture tettoniche in esso contenute
- ....

*Esempio: associazioni di strutture estensionali (faglie normali) associate ad ambienti compressivi*

# Placche tettoniche (semplificate)



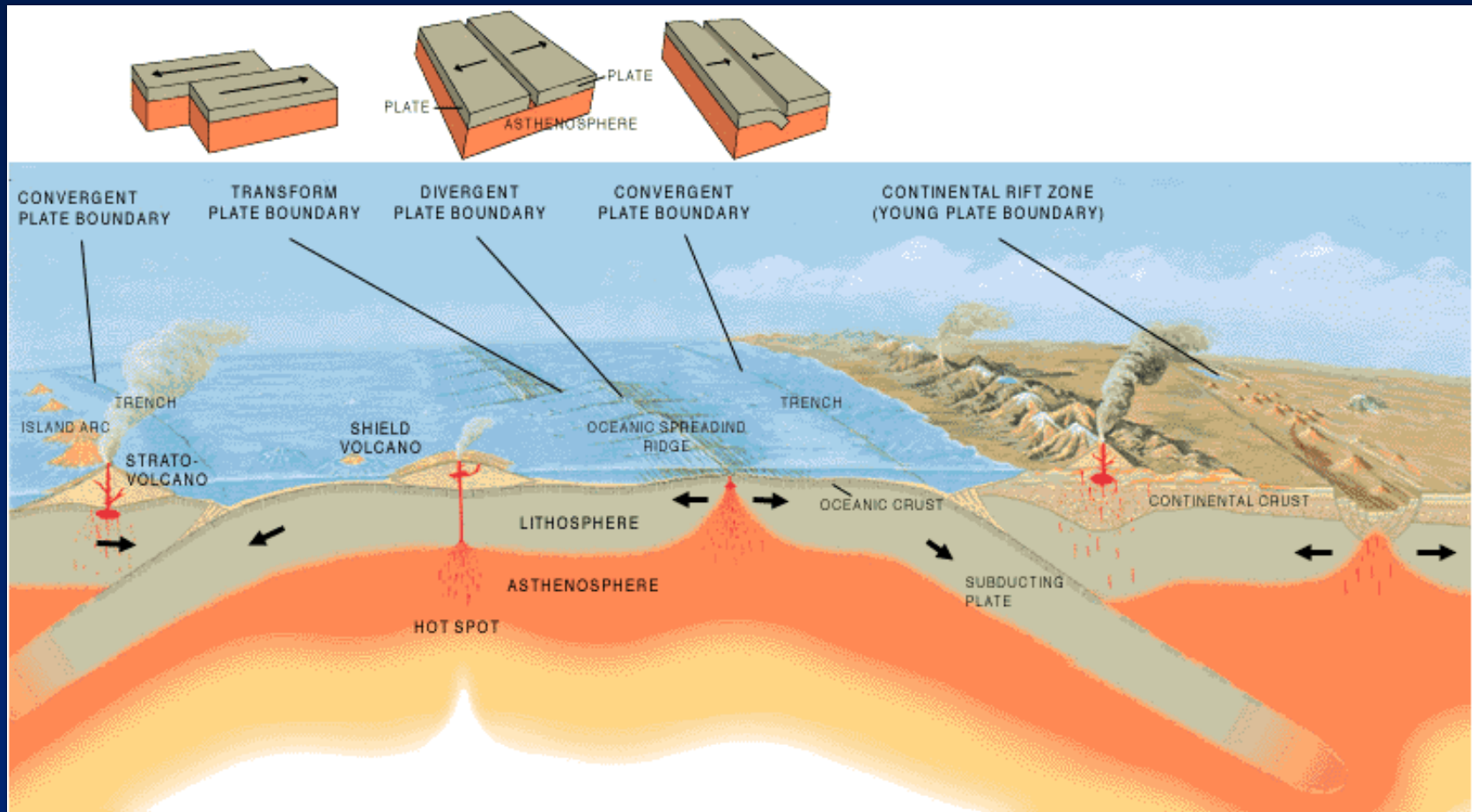
Da "The dynamic Earth" in USGS Web Site

# Placche tettoniche e limiti tra placche

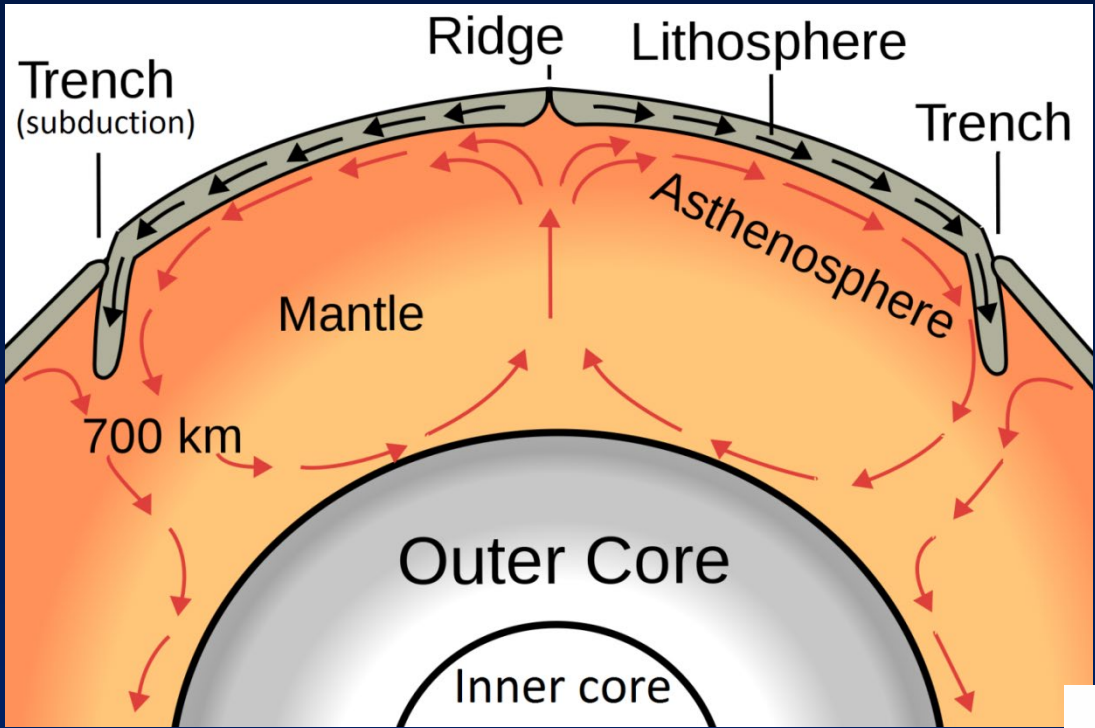


[https://commons.wikimedia.org/wiki/File:Tectonic\\_plates\\_boundaries\\_detailed-en.svg](https://commons.wikimedia.org/wiki/File:Tectonic_plates_boundaries_detailed-en.svg)

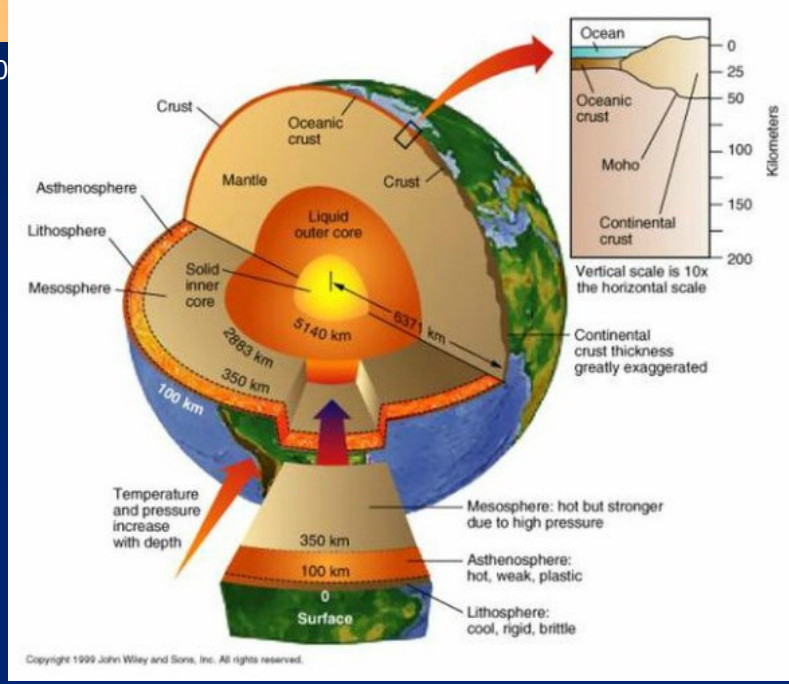
# Tipo di margini di placca e ambienti geodinamici



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



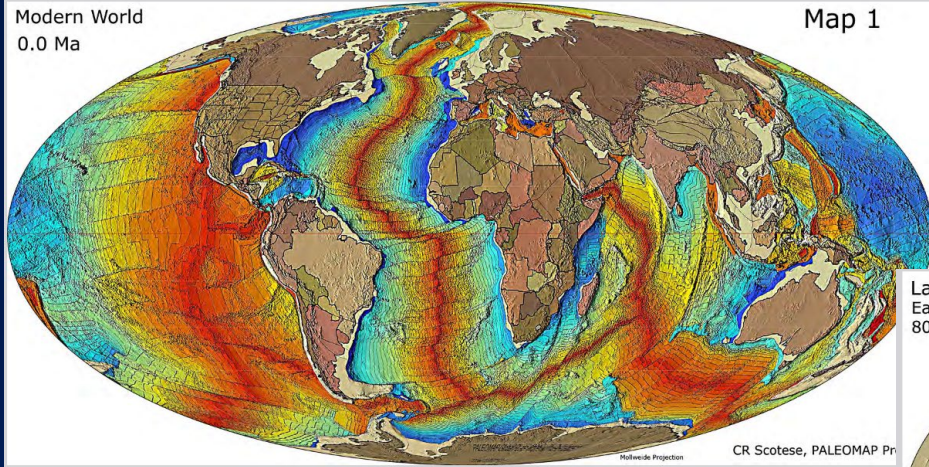
[[http://upload.wikimedia.org/wikipedia/commons/thumb/2/27/Oceanic\\_spreading.svg/1280Oceanic\\_spreading.svg.png](http://upload.wikimedia.org/wikipedia/commons/thumb/2/27/Oceanic_spreading.svg/1280Oceanic_spreading.svg.png)]



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Modern World  
0.0 Ma

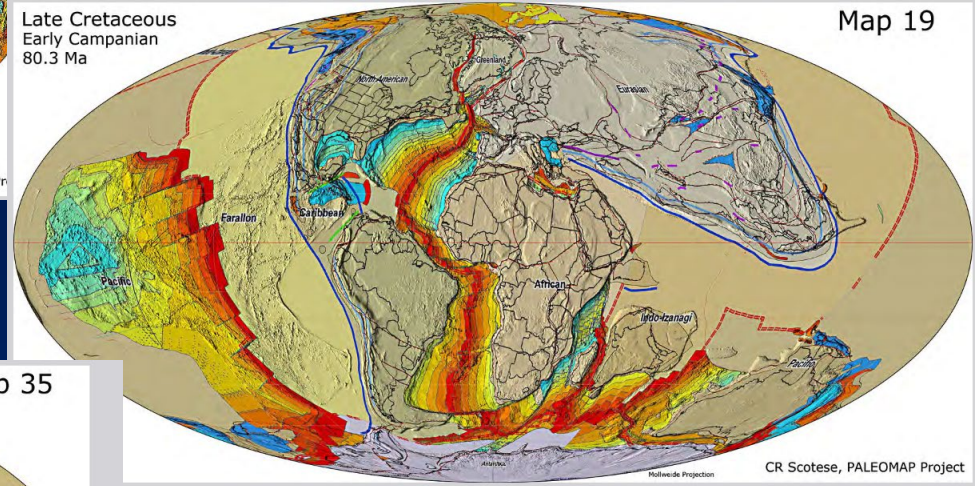
Map 1



Mappe paleogeografiche e movimento (ricostruito) delle placche nel tempo

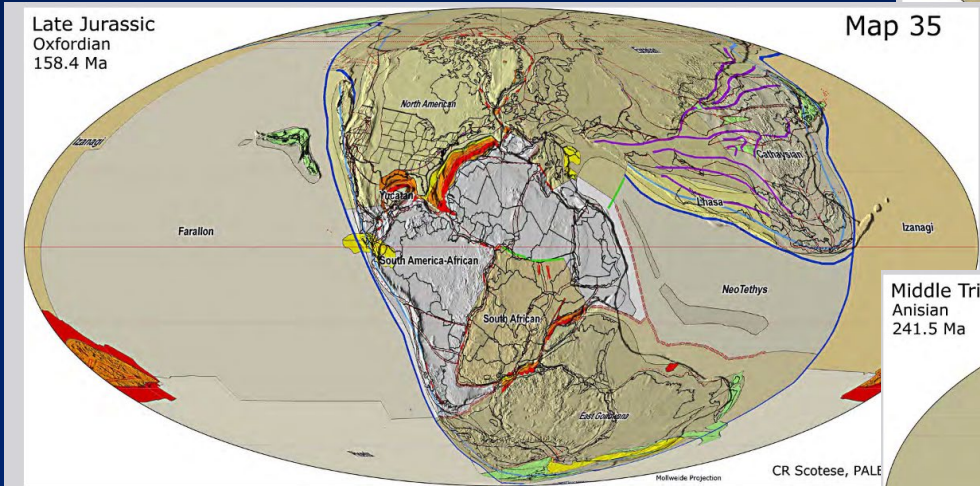
Late Cretaceous  
Early Campanian  
80.3 Ma

Map 19



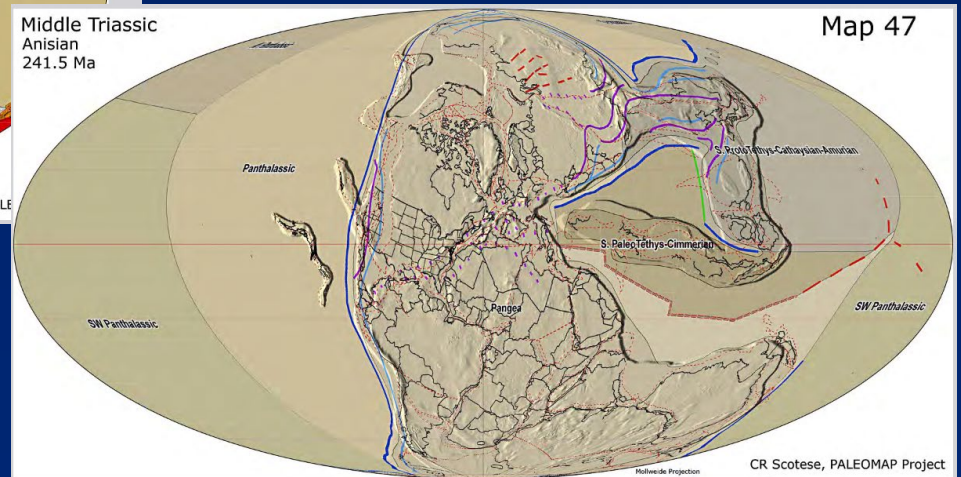
Late Jurassic  
Oxfordian  
158.4 Ma

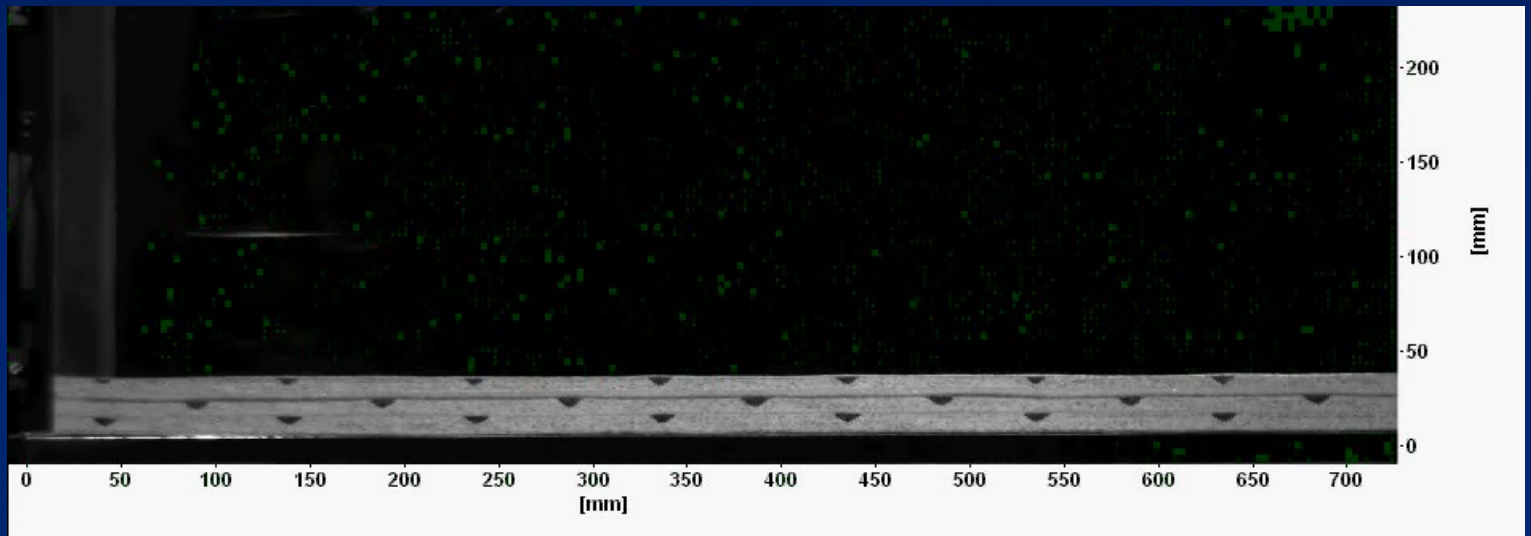
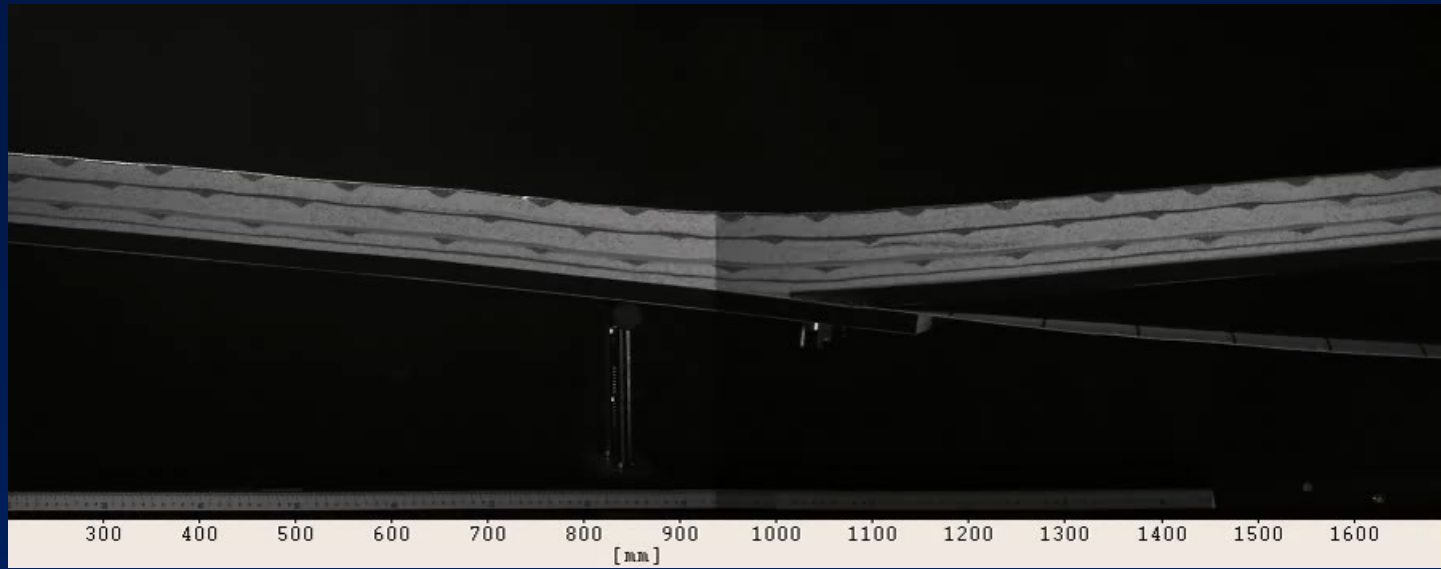
Map 35

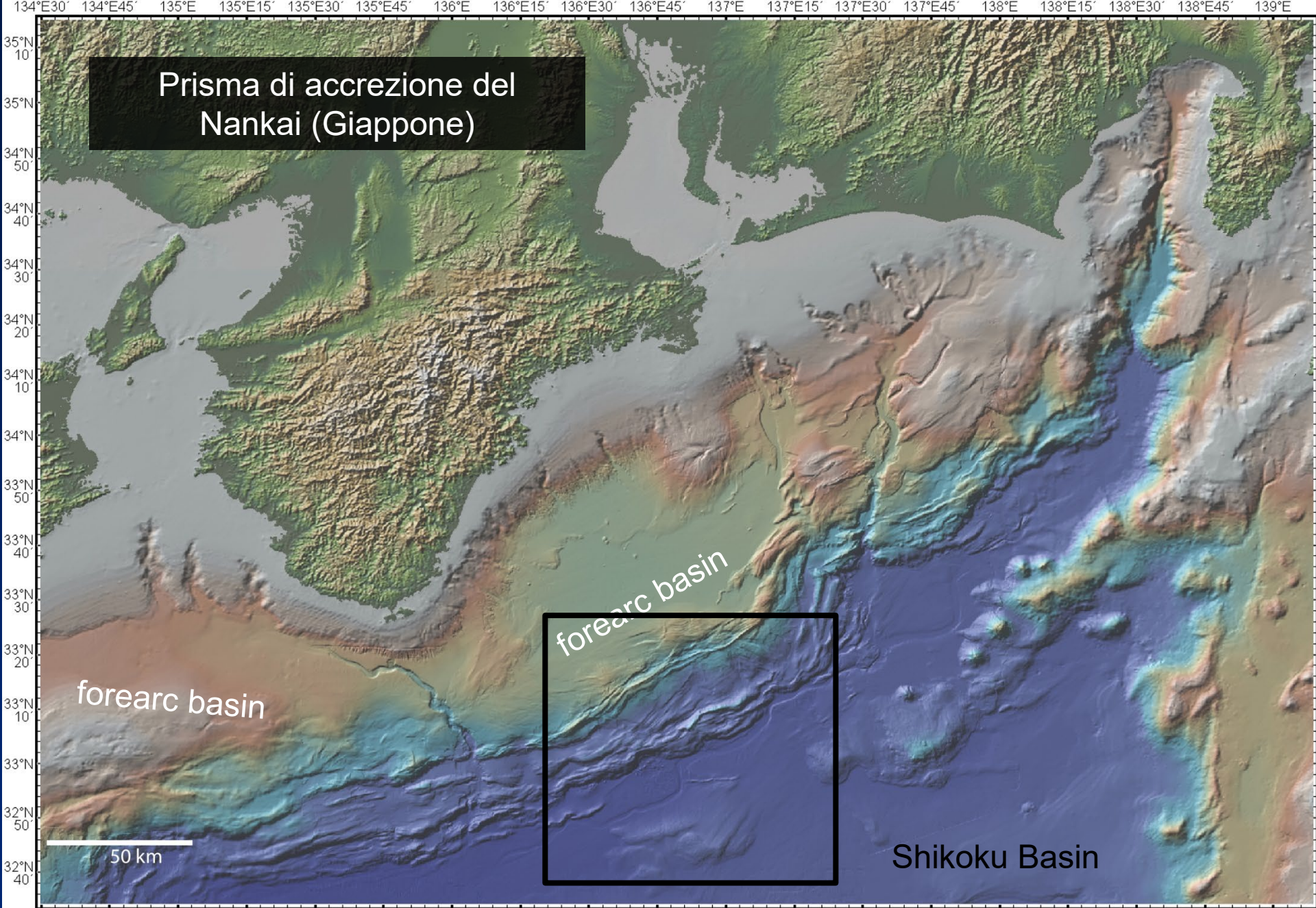


Middle Triassic  
Anisian  
241.5 Ma

Map 47



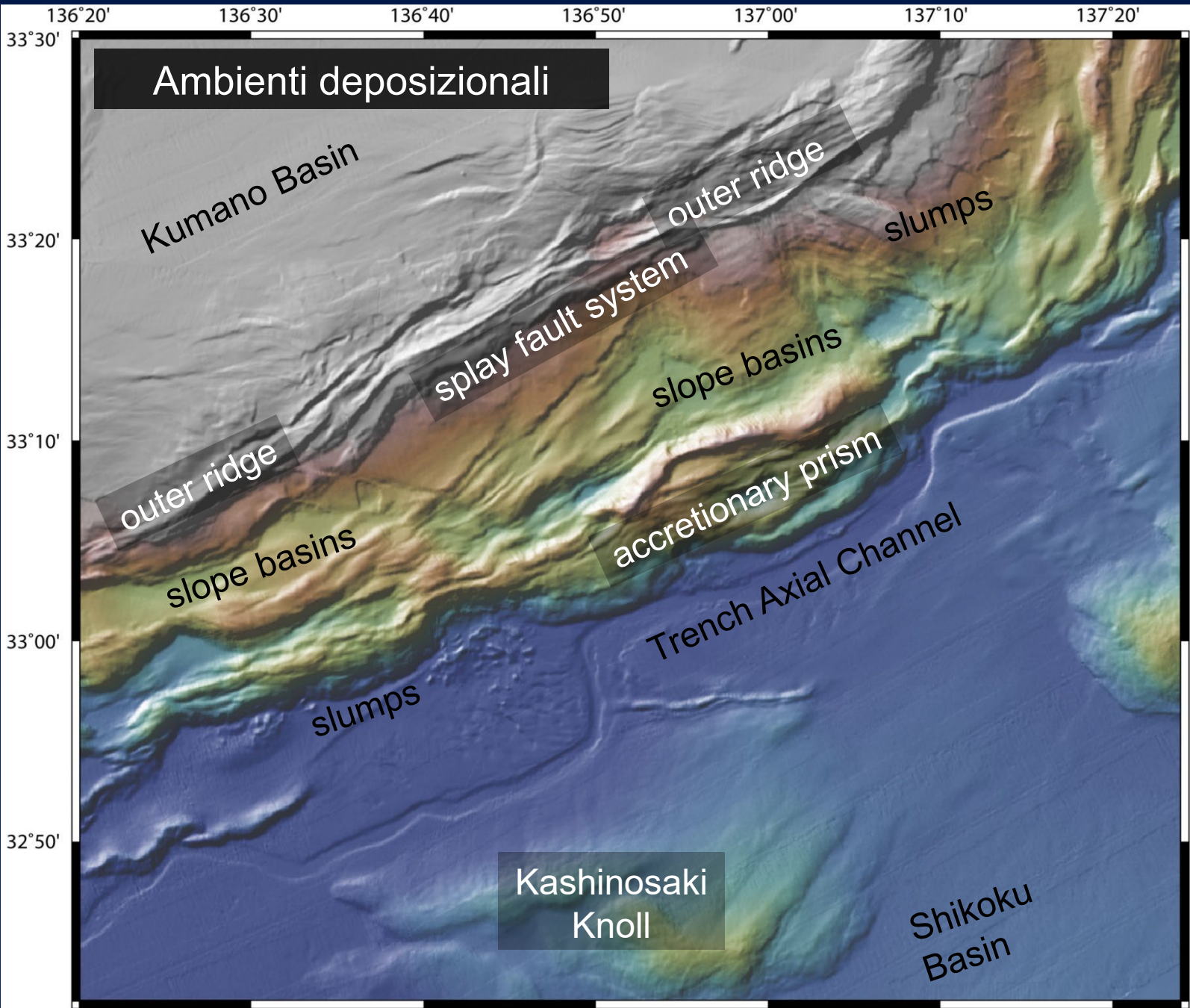




Sistemi convergenti: catene sottomarine

Cortesy G.Moore





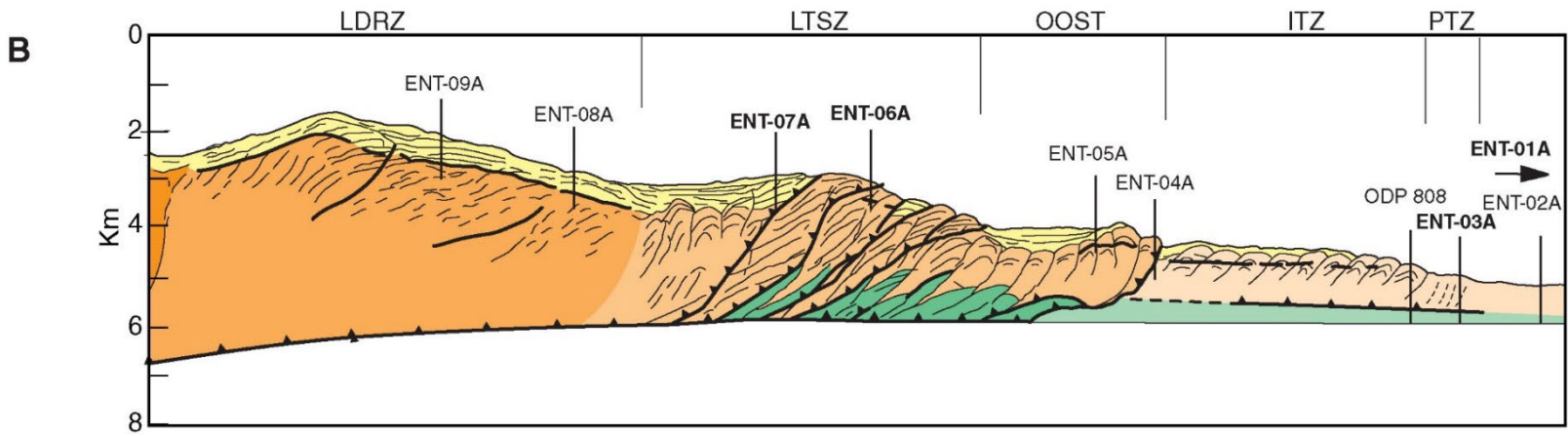
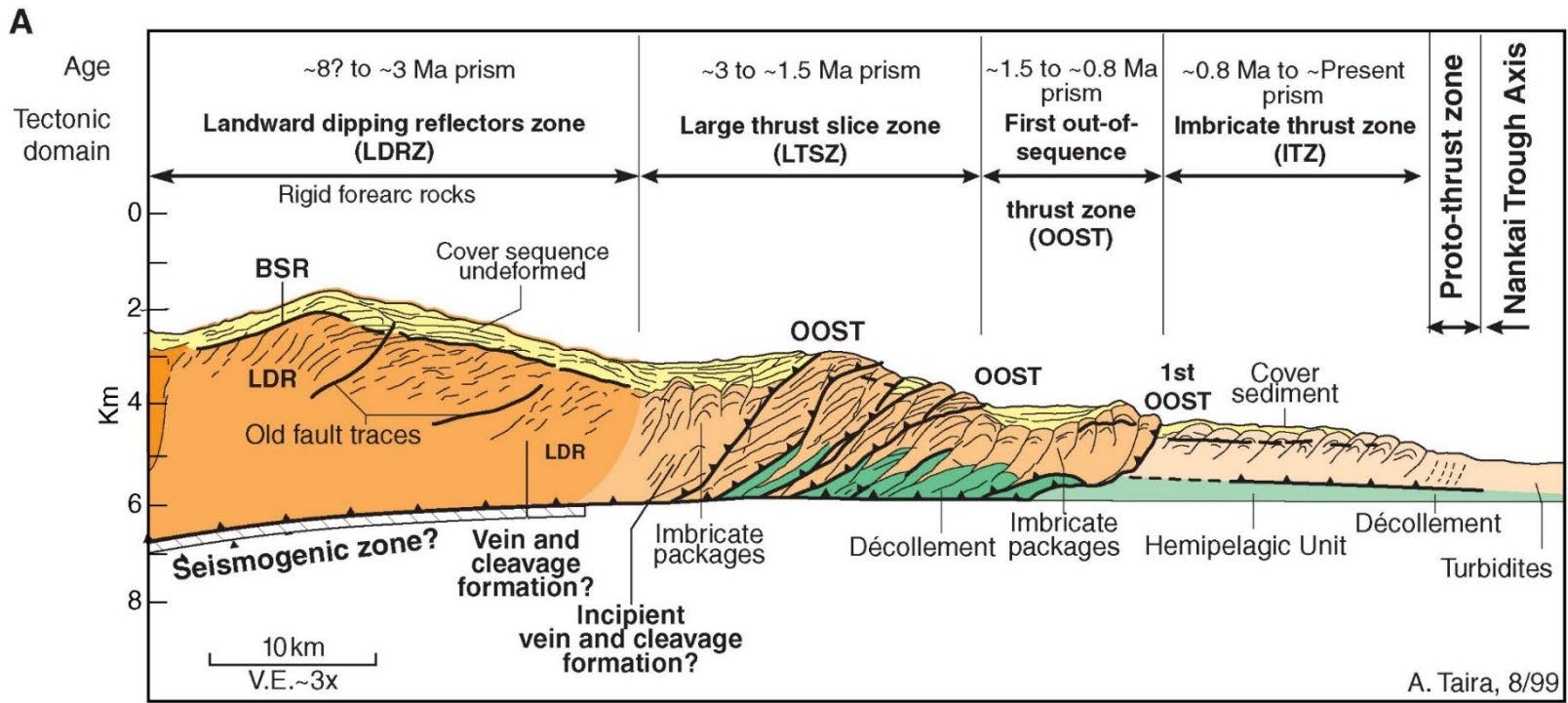
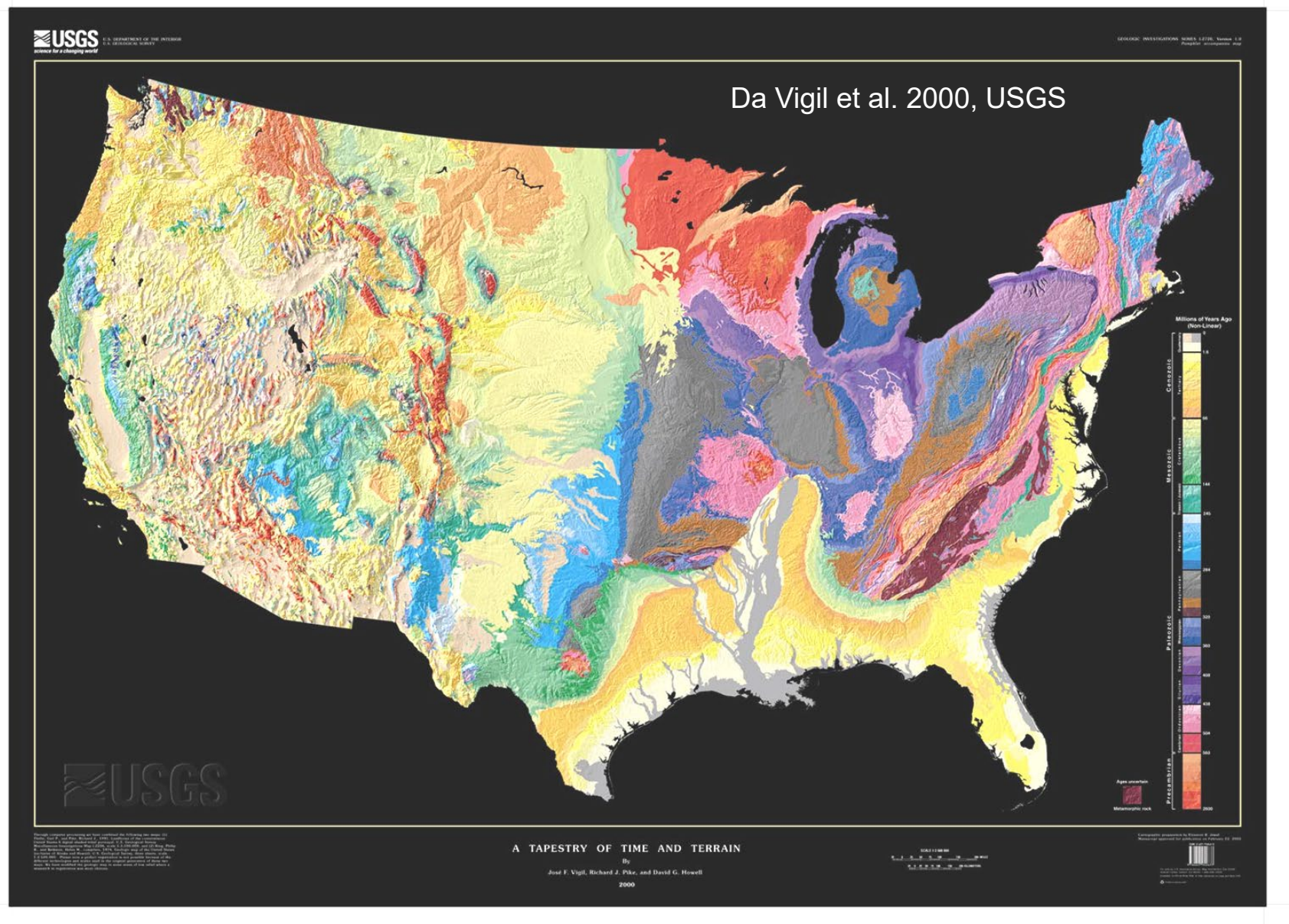


Figure 3

# Sistemi convergenti: diversi sistemi di catene collisonali



Intero continente, migliaia di chilometri, più catene montuose.

# Associazioni di sovrascorrimenti-accavallamenti: Le Rocky Mountains



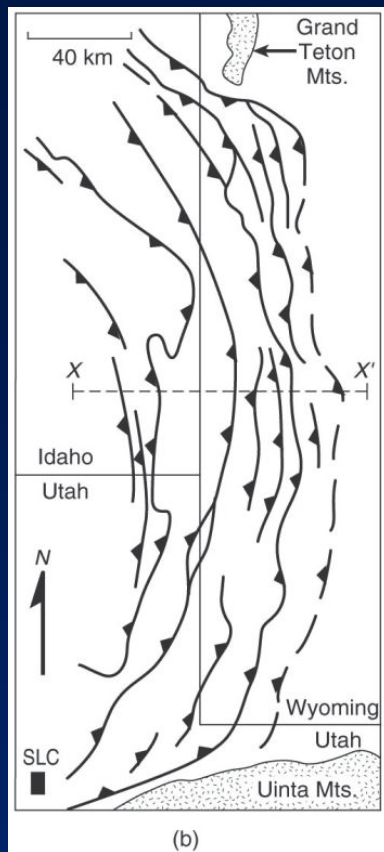
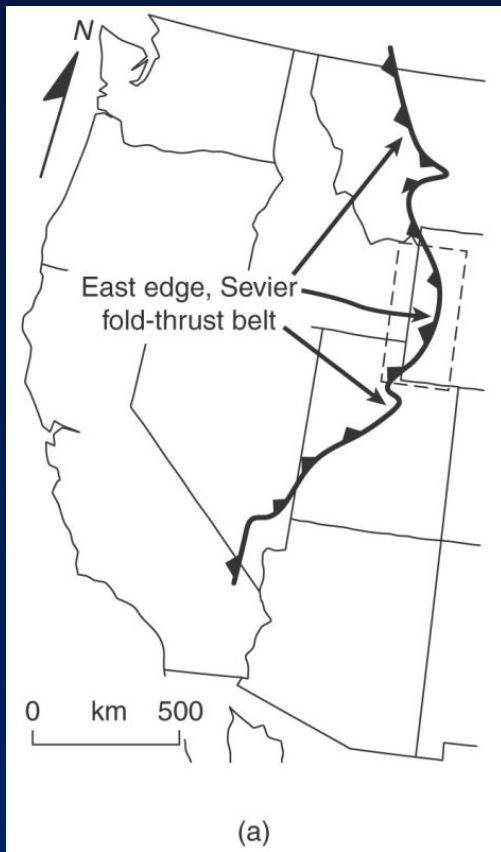
Pointer 49°36'00.09" N 114°53'04.45" W elev 6394 ft

Image © 2005 EarthSat

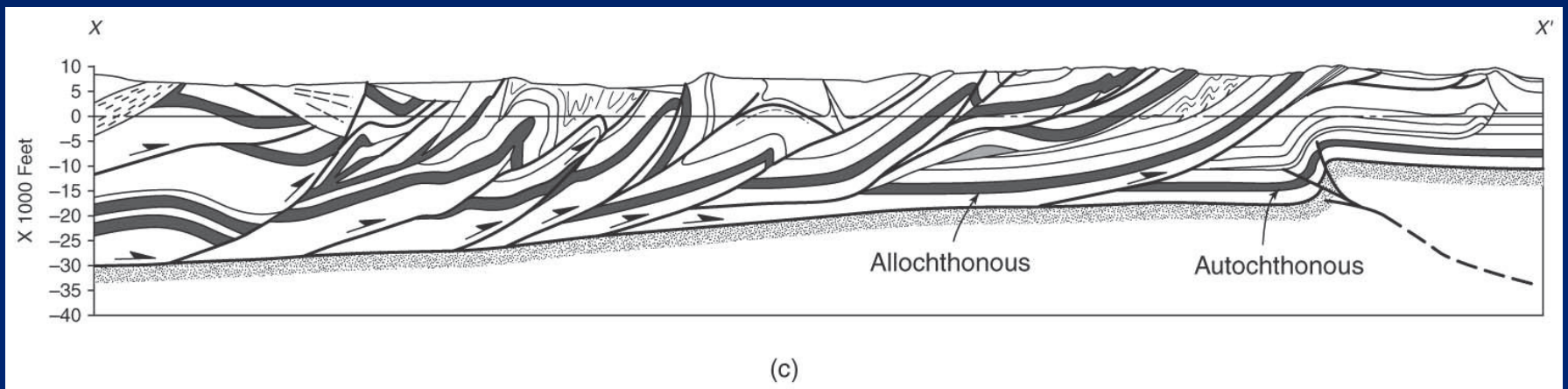
Streaming ||||| 100%

© 2005 Google

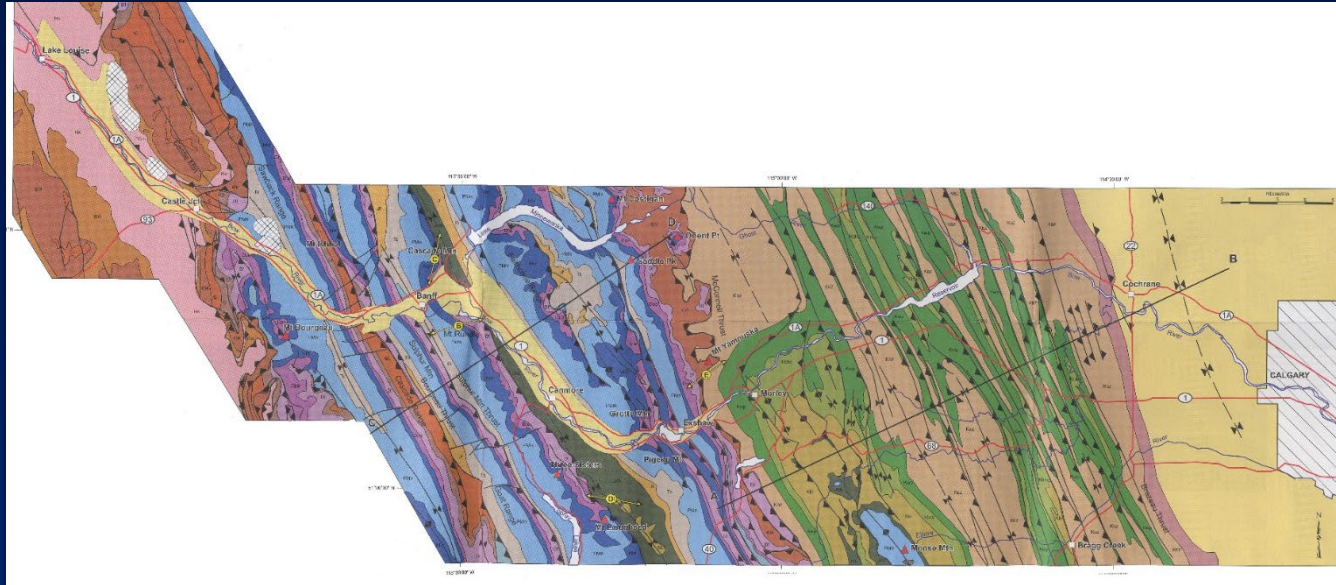
Eye alt 176.03 mi



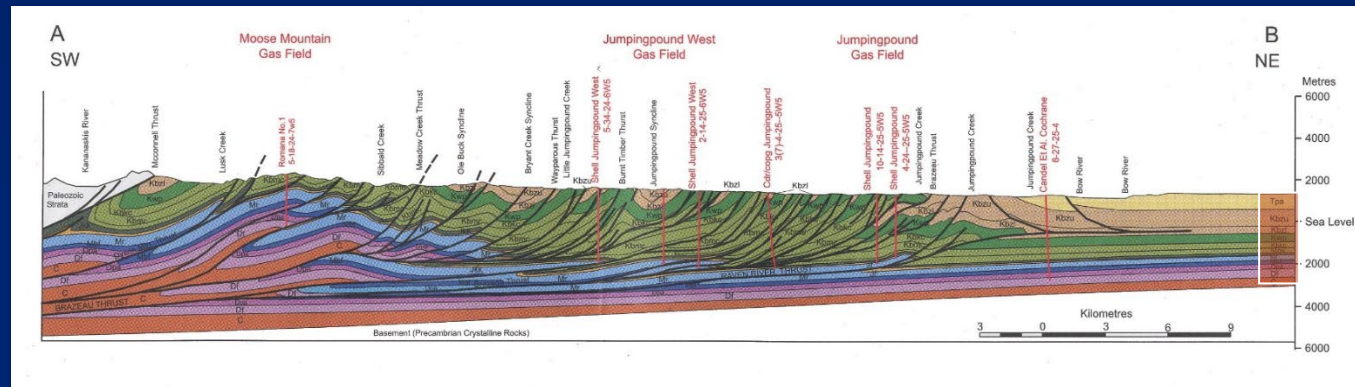
Ben van der Pluijm, 2004



# Strutture tettoniche (accavallamenti-sovrascorrimenti e pieghe) che deformano un successione stratigrafica (il mattone)



Da Price, 2000; Ollerenshaw, 1978



Da Price, 2000; Ollerenshaw, 1978

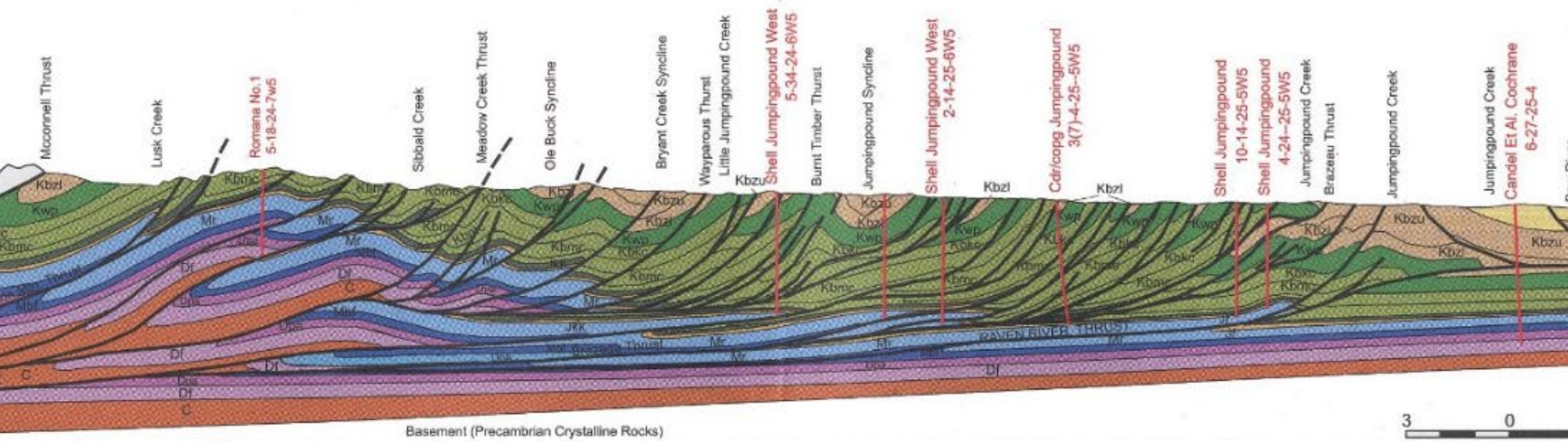
Successione non deformata Dal Cambriano al Terziario!!

BANFF AREA STRATIGRAPHIC SUCCESSION							
ERA	PERIOD	EPOCH-STAGE	COLOR	LITHOLOGY and MAP COLOUR	FORMATION	GROUP	
Mesozoic	Tert.	Paleo.			PASKAPOO	Tp	
					COALSPUR	Tkc	
	Cretaceous	Maas.	Camp.			KbZ - u KbZ - l	BRAZEAU
		Cont.	Tur.	CARDIUM	Kct		
		Ceno.		BLACKSTONE	Kbmc		
		Albian		BLAIRMORE Gp.	Kbl		
		Aptian		CADOMIN			
		Neo.		KOOTENAY	JKk		
		Jurassic		FERNIE	Jf		
		Triassic		SULPHUR MTN	Ts		
		Paleozoic	Permian			ISHBEL GP.	
	Penn.			KANANASKIS			
	Mississippian		Chest.	TUNNEL MTN			
			Mera.	ETHERINGTON			
Osaq.			MT. HEAD				
Devonian	Kinder.		BANFF	Mbr			
	Fam.		PALLISER	Dpa			
Cambrian	Fras.		ALEXO				
			SOUTHESK				
			CAIRN				
		FLUME					
		SKOKI					
	Ordovician		OUTRAM SURVEY PEAK	Co			
	Cambrian	Croix.	ARCTOMYS				
			PIKA	Cepa			
		Alber.	ELDON				
			STEPHEN				
		CATHEDRAL	Cwcs				
	Wauc.	MT. WHYTE	Cg				
Precambrian			HA	METTE			

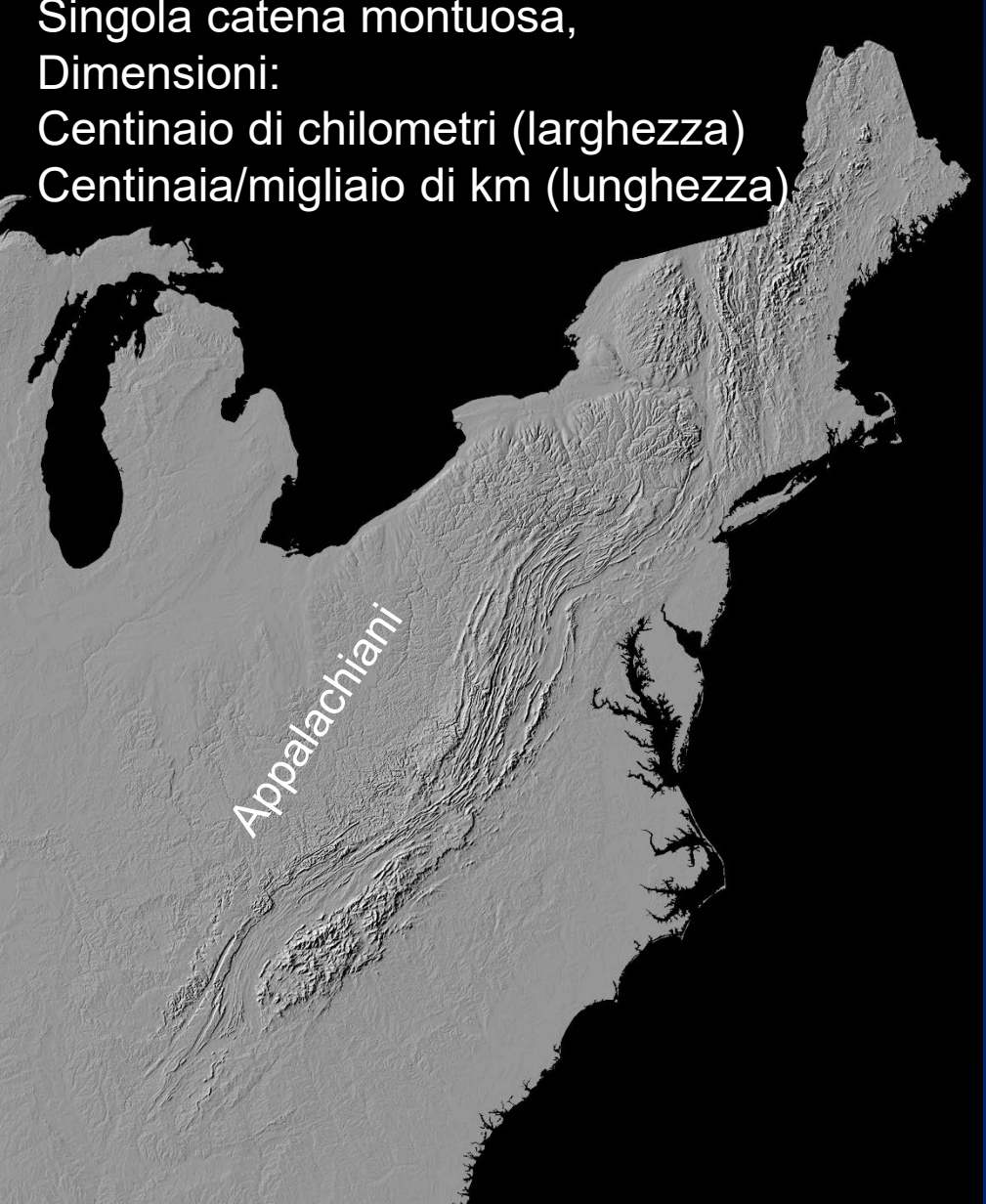
Moose Mountain Gas Field

Jumpingpound West Gas Field

Jumpingpound Gas Field



# Appalachiani (Appalachians Mts.)



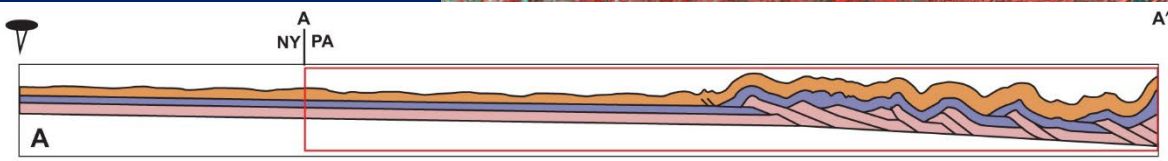
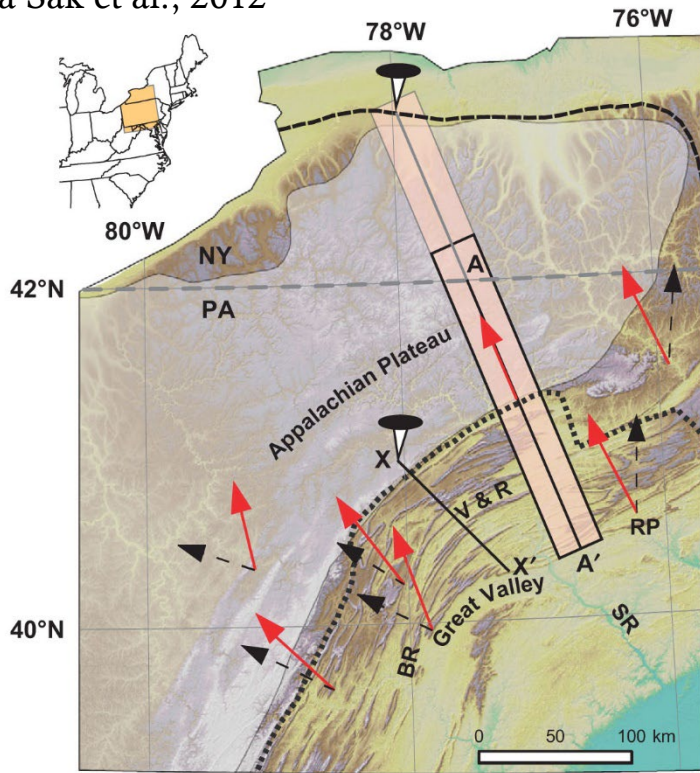
Singola catena montuosa,  
Dimensioni:  
Centinaio di chilometri (larghezza)  
Centinaia/migliaia di km (lunghezza)

Da mosaico foto satellitari NOAA  
(fonte USGS)

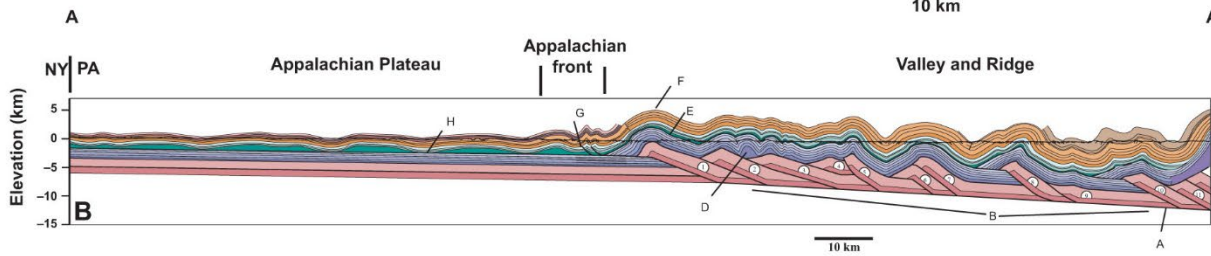
Shaded relief da DEM, Theling & Pike, 1991,  
Miscellaneous Investigations Series Map I-2206USGS



# Pieghe, duplex e sovrascorrimenti: Appalachians

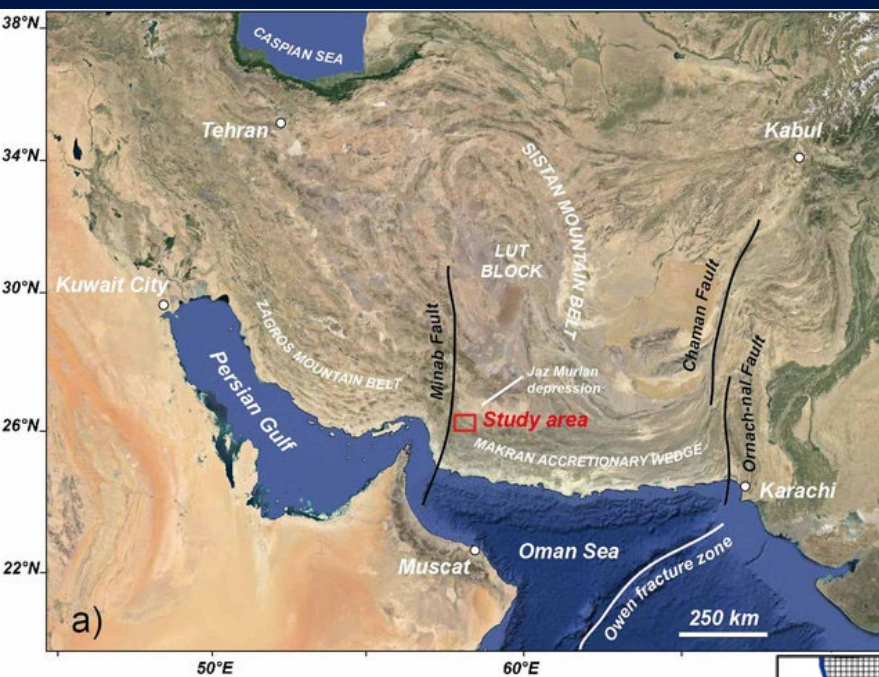


Cover sequence strata (younger than Swc)  
 Cover sequence strata (older than Swc)  
 Imbricated carbonate sequence

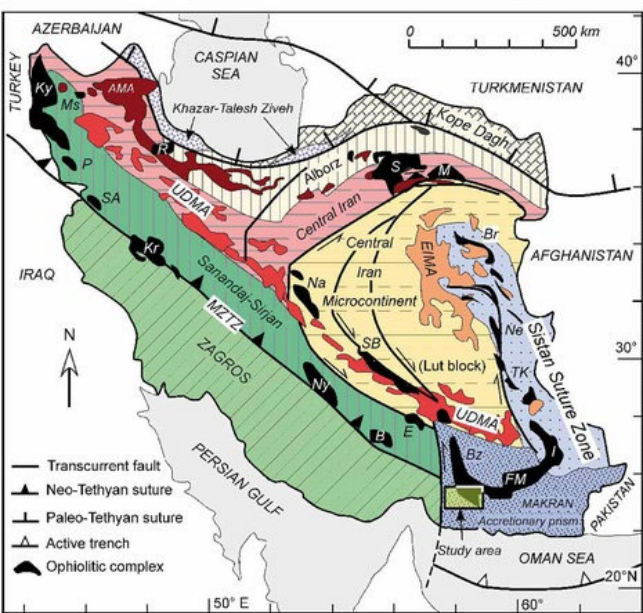


Explanation	
<span style="display: inline-block; width: 15px; height: 10px; background-color: #d9534f; border: 1px solid black;"></span> Mmc	Mauch Chunk
<span style="display: inline-block; width: 15px; height: 10px; background-color: #8c564b; border: 1px solid black;"></span> Mb	Burgoon Fm
<span style="display: inline-block; width: 15px; height: 10px; background-color: #54278f; border: 1px solid black;"></span> Mp	Pocono Fm
<span style="display: inline-block; width: 15px; height: 10px; background-color: #2ca02c; border: 1px solid black;"></span> Mdh	Huntley Mtn Fm
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> MDsk	Specky Kopf Fm
<span style="display: inline-block; width: 15px; height: 10px; background-color: #17becf; border: 1px solid black;"></span> Dcbr	Buddies Run Mbr
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> Dcd	Duncannon Mbr
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> Dccf	Clarks Ferry Mbr
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> Dcsc	Shermans Creek Mbr
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> Dciv	Irish Valley Mbr
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> Dclh	Lock Haven Mbr
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> Dtr	Trimmers Rock
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> Dh	Hamilton Gp
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> Doo	Onondaga/Old Port Fms
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> DSKt	Keyser/Tonoloway Fms
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> Swc	Wills Creek Fm
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> Smb	Millintown and Bloomsburg Fms, undivided
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> Sc	Clinton Gp
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> St	Tuscarora Fm
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> Oj	Junata Fm
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> Obe	Bald Eagle Fm
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> Or	Reedsville Fm
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> Om	Martinsburg Fm
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> O	Stonehendge – Coburn/Salona Fms, undivided
<span style="display: inline-block; width: 15px; height: 10px; background-color: #1f77b4; border: 1px solid black;"></span> W	Waynesboro – Gatesburg Fms, undivided

**Note.**  
Vertical color bars reflect groupings depicted in the restored cross section.



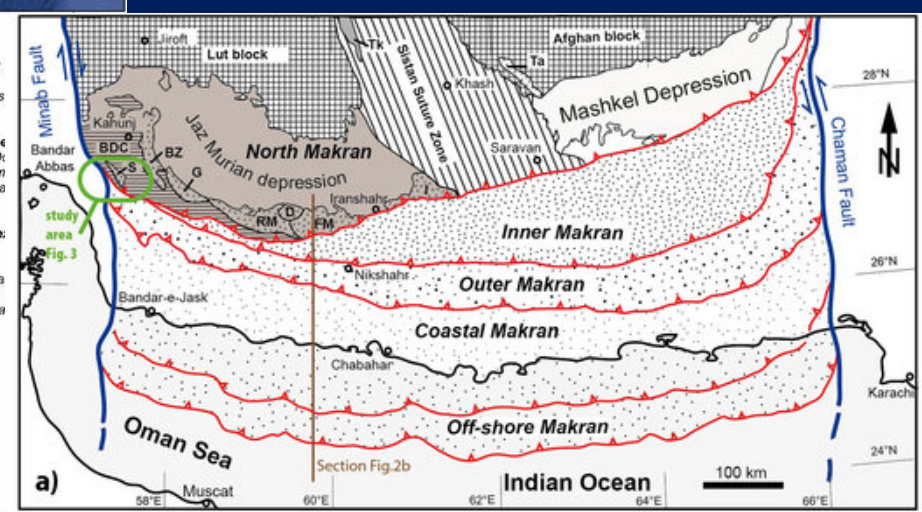
# Sistemi di accavallamenti e pieghe: il Makran



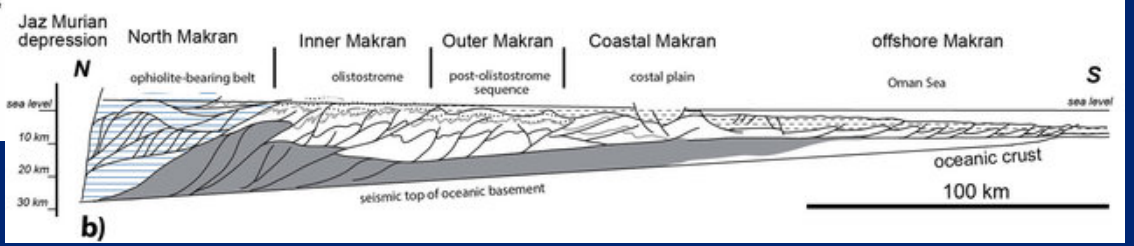
- ABBREVIATIONS:**
- MZTZ: Main Zagros
- Eocene-Oligocene**  
 UDMA: Urumieh-Di  
 AMA: Alborz magm  
 EIMA: East Iran ma
- Ophiolitic comple:**  
 B: Baft;  
 Br: Birjand  
 BZ: Band-e-Zeyrat  
 E: Esphandogheh  
 FM: Fanuj-Maskuta  
 I: Iranshahr  
 Ky: Khoy  
 Kr: Kermanshah  
 M: Mashhad  
 Ms: Misho  
 Na: Nain  
 Ny: Neyriz  
 Ne: Nehbandan  
 P: Piranshahr  
 R: Rasht  
 S: Sabzevar  
 SA: Sarve-Abad  
 SB: Shahr-Babak  
 TK: Tehehel-Kureh

- Transcurrent fault
- ▲ Neo-Tethyan suture
- ▲ Paleo-Tethyan suture
- ▲ Active trench
- ▲ Ophiolitic complex

b)



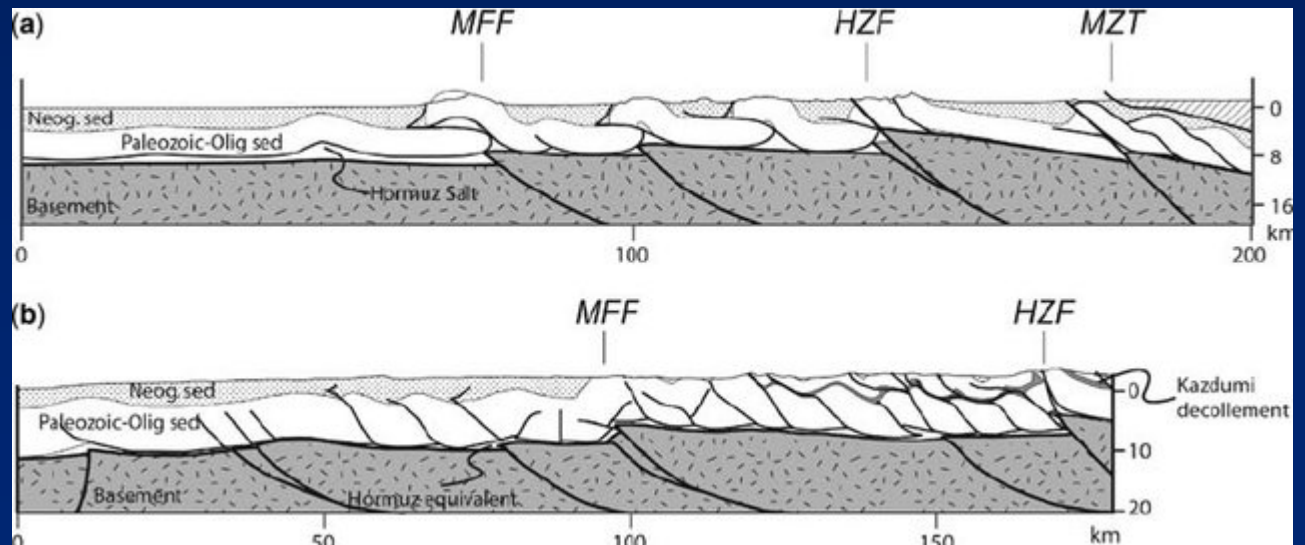
- Main ophiolite massifs**
- S: Sorkhband
  - BZ: Band-e-Zeyrat / Dar Anar
  - G: Ganj
  - RM: Remeshk-Mokhtarabad
  - D: Dyader
  - FM: Fanuj-Maskutan
  - I: Iranshahr
  - Ta: Talkhab
  - TK: Tehehel-Kureh
  - BDC: Bajgan-Durkan complexes and Coloured Mélange

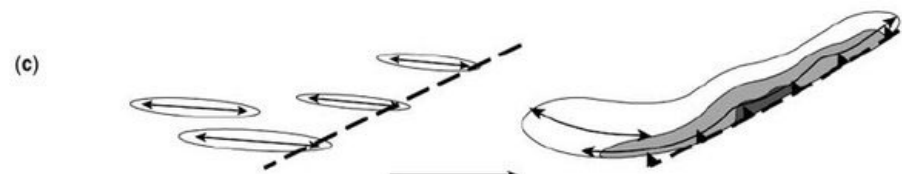
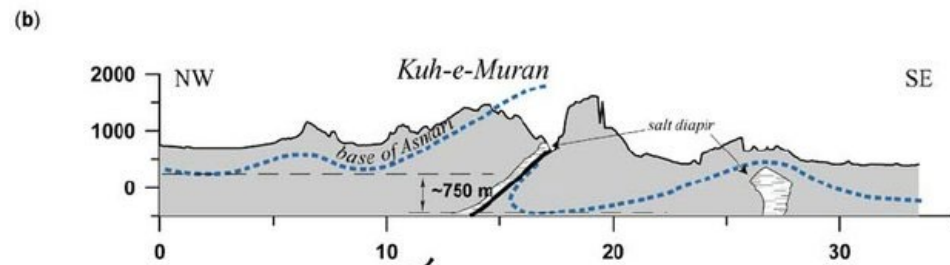
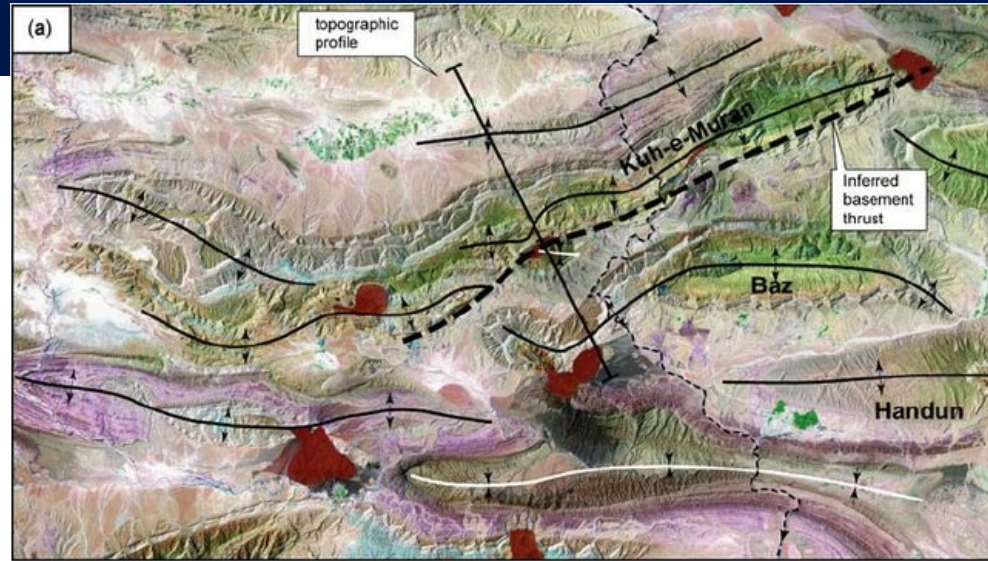
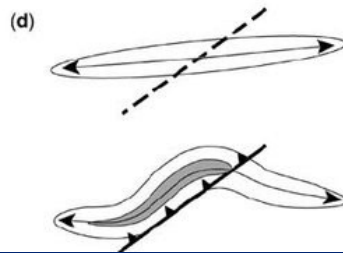
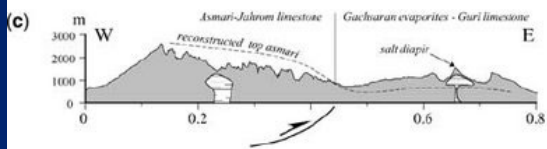
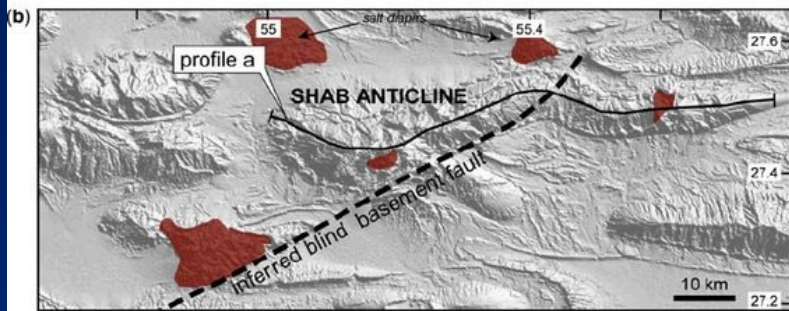
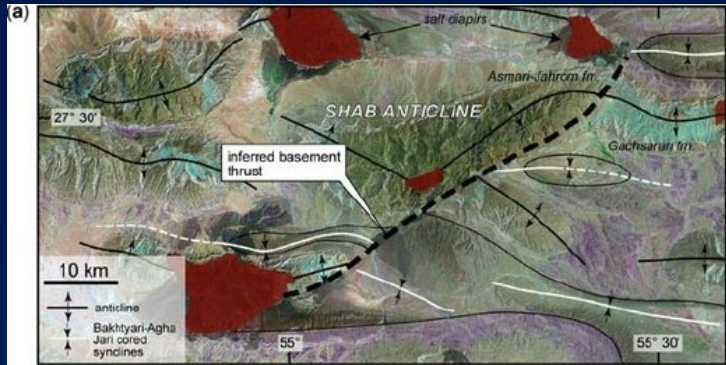


b)



Sistemi di pieghe scala regionale associate a scollamento basale e accavallamenti: i Zagros







James Mountains, Australia - NASA Photo ID  
PSTS61B-44-6,  
<https://eol.jsc.nasa.gov/SearchPhotos/>



Zagros Folded Belt, Fars, Iran - Da Google Earth

Pieghe da foto da satellite  
Decine di chilometri

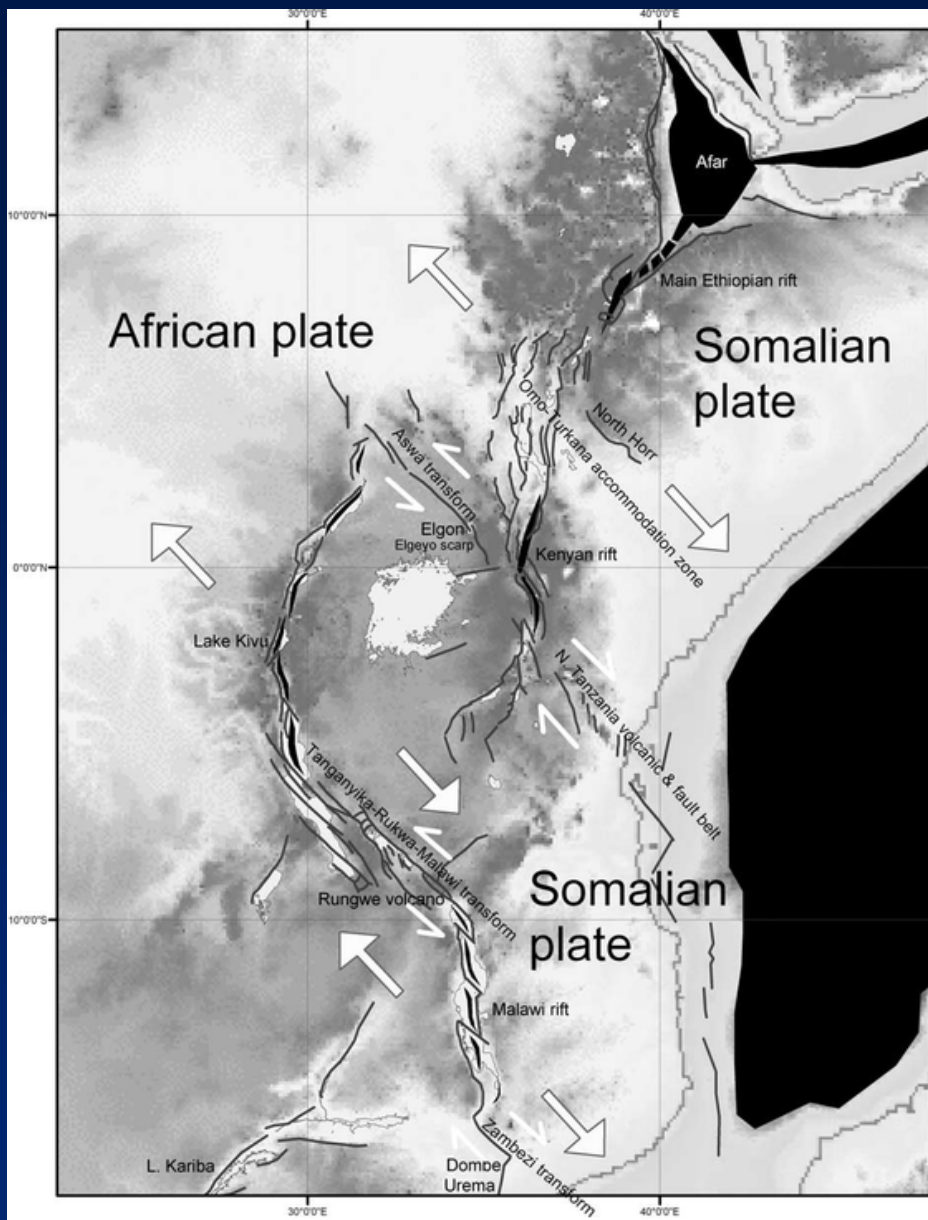


Pieghe da foto da satellite  
Decine di chilometri-chilometri

© 2010 Europa Technologies  
© 2010 Cnes/Spot Image  
© 2010 Google  
Image © 2010 GeoEye

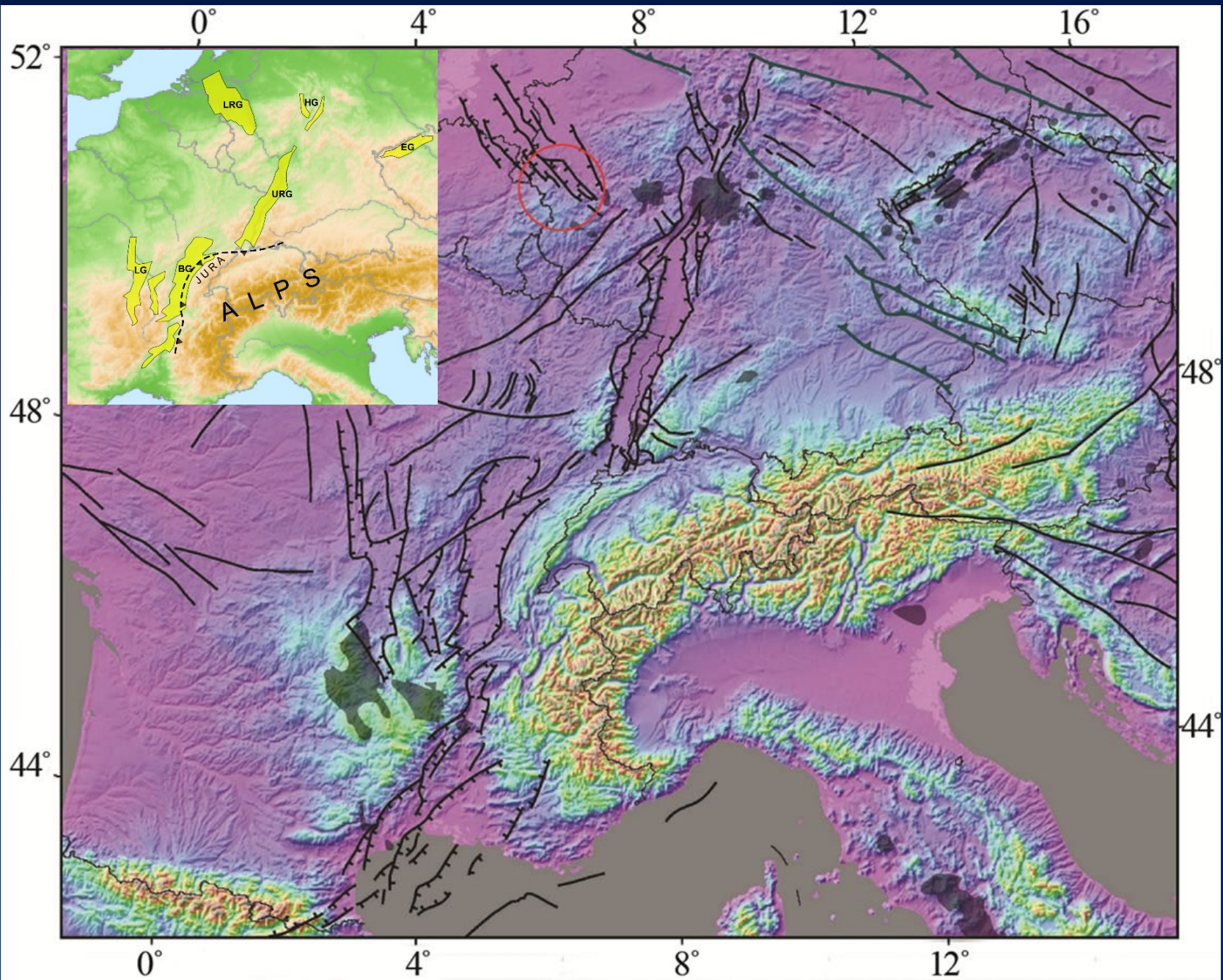
© 2009 Google

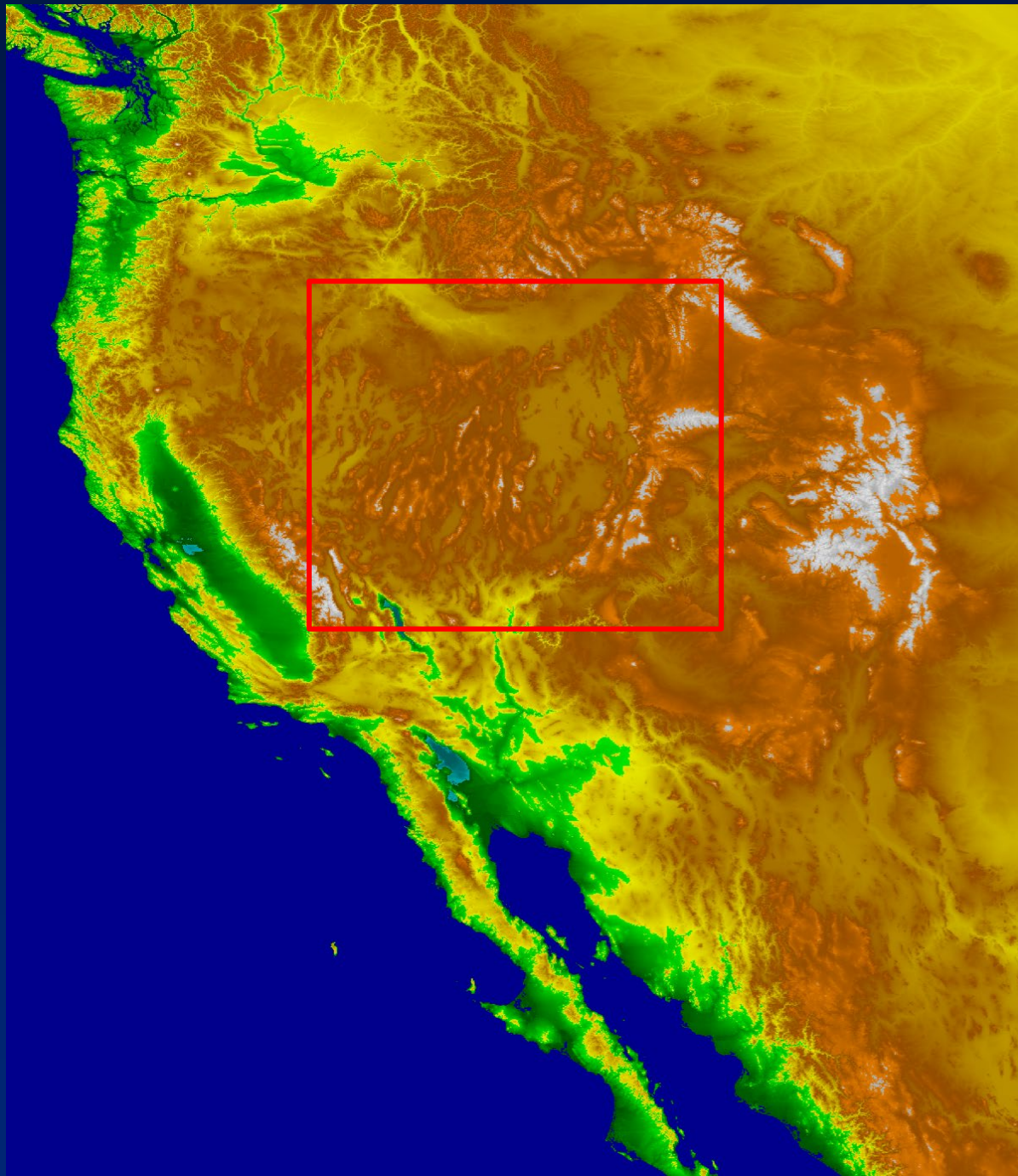




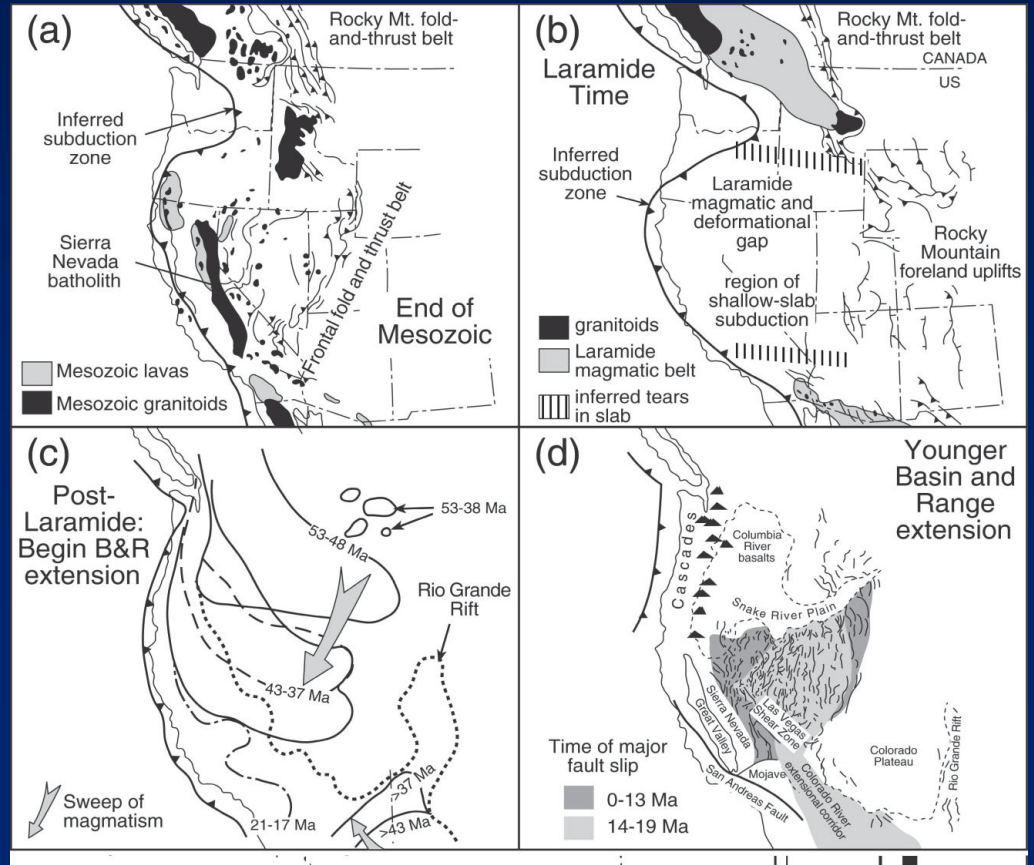
Chorowitz, 2005



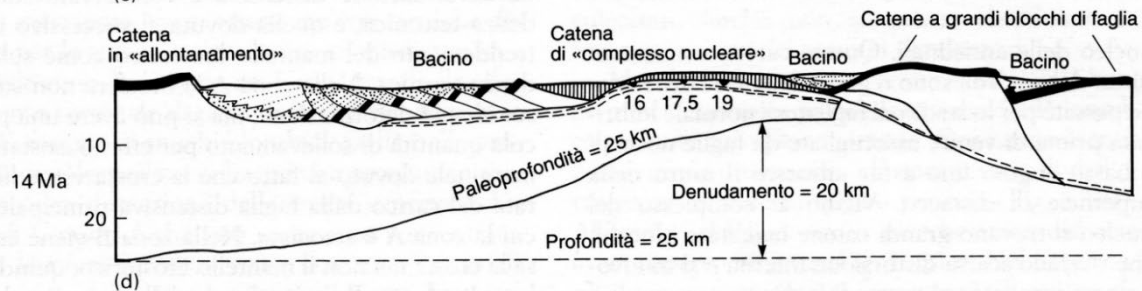
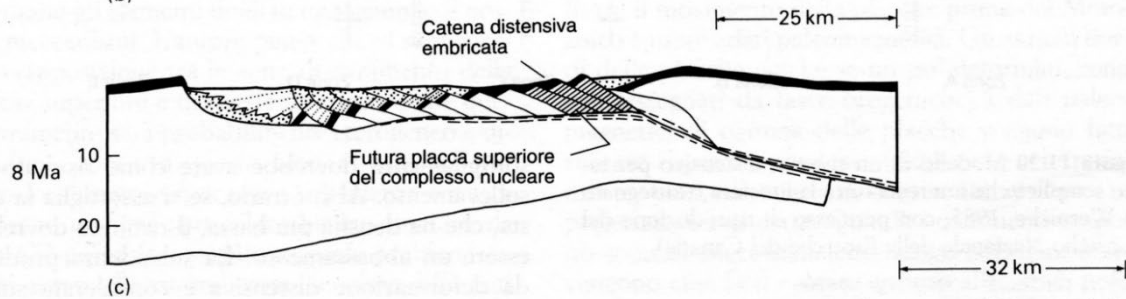
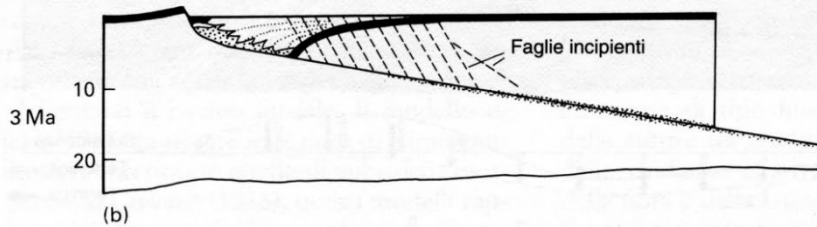
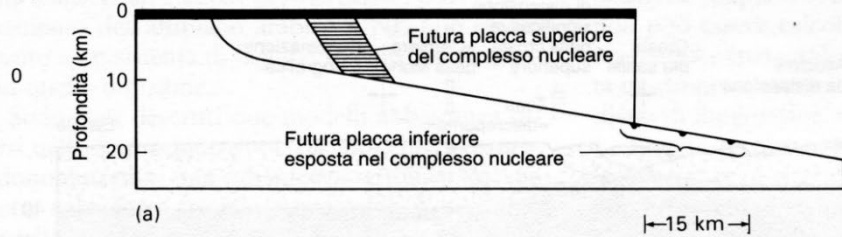








Associazioni da estensione  
crostale: il Basin and Range



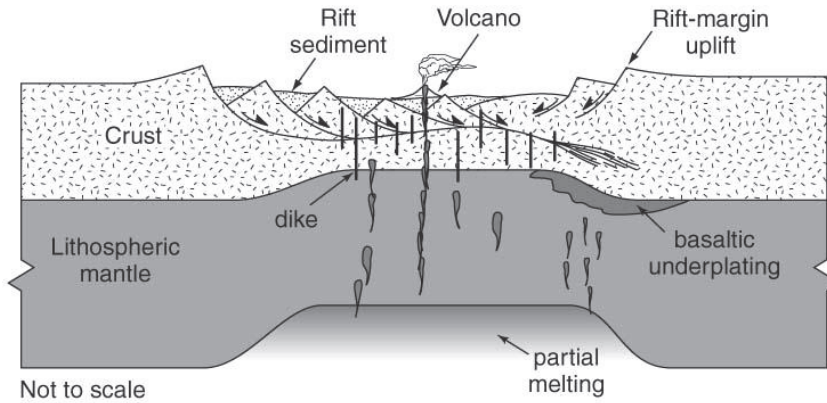
Tempo a  $5 \text{ mm a}^{-1}$



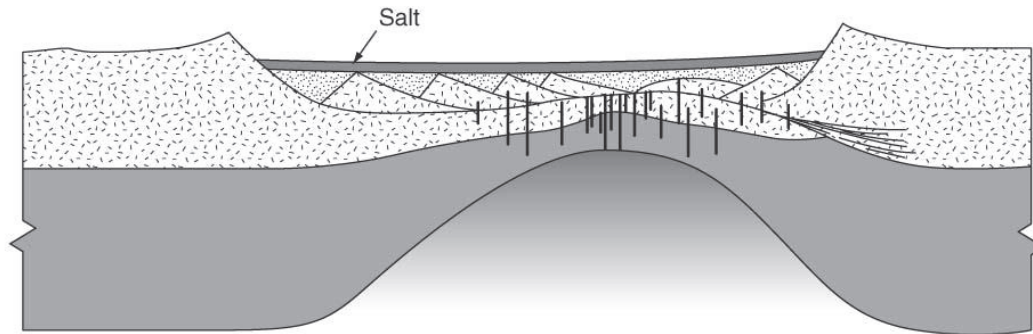
-  Riferimento pre-orogenico
-  Depositi clastici orogenici: fini-lacustri grossolani
-  Rocce molto assottigliate e stirate
-  Zona di taglio duttile
- 16,5 Paleoproprietà della placca inferiore del «complesso nucleare»

Estensione totale = 72 km (100%)

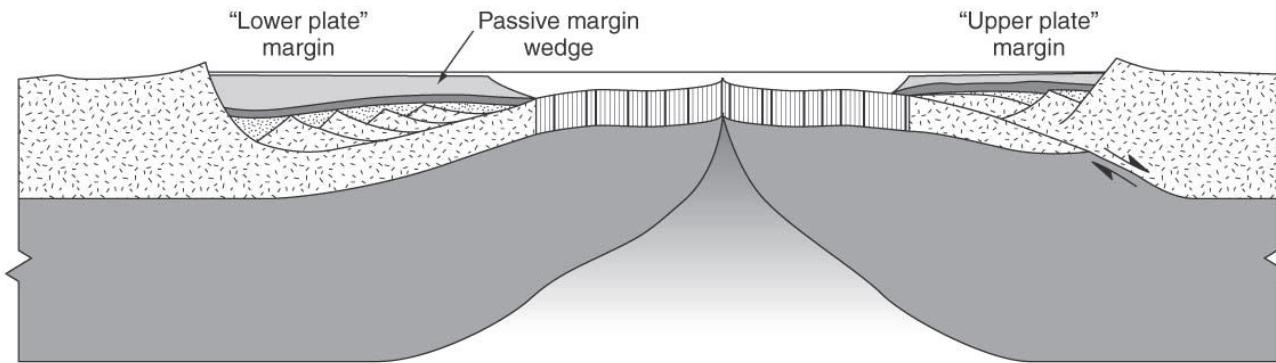
Da van der Pluijm & Marshak, 2004



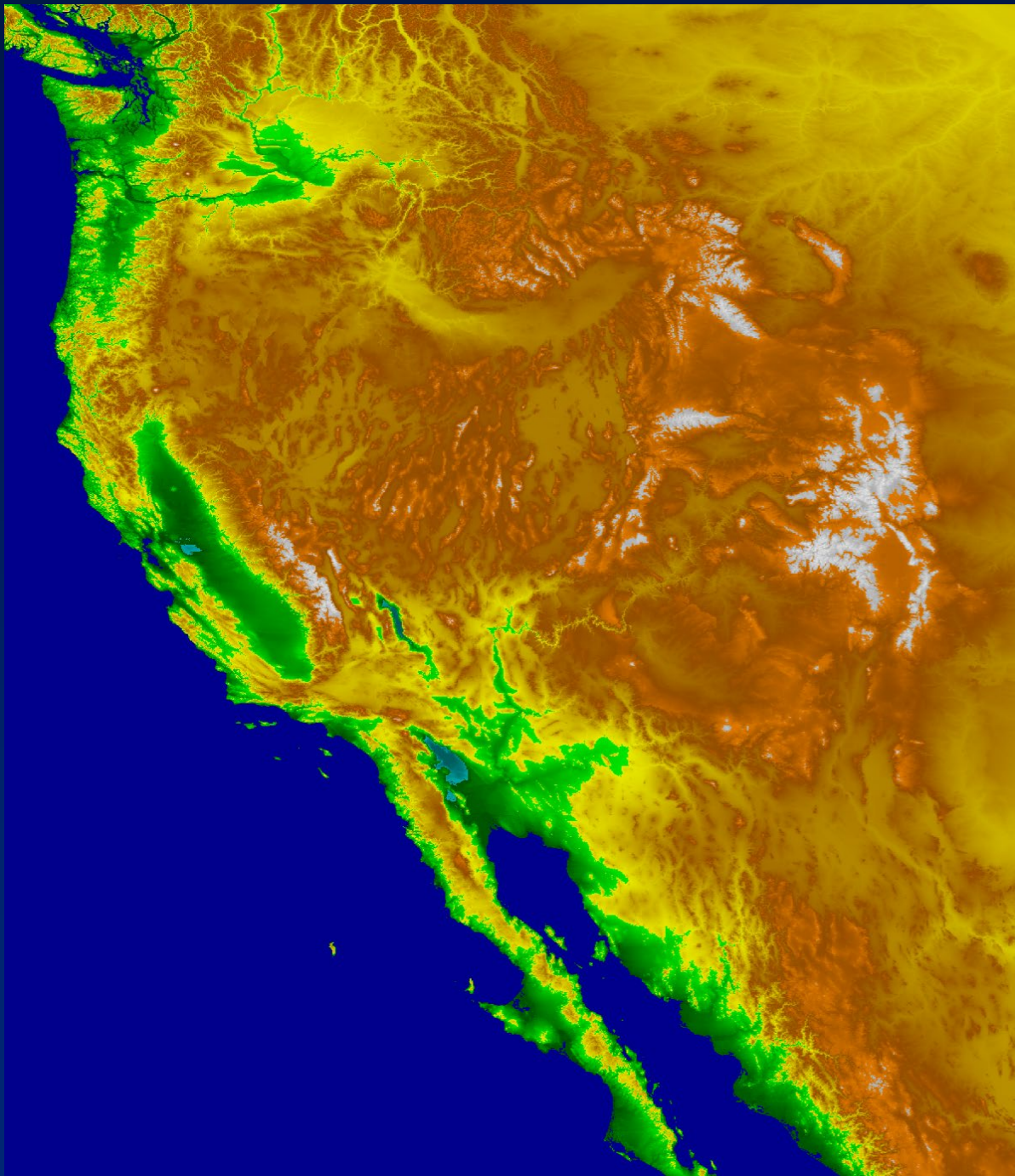
(a)



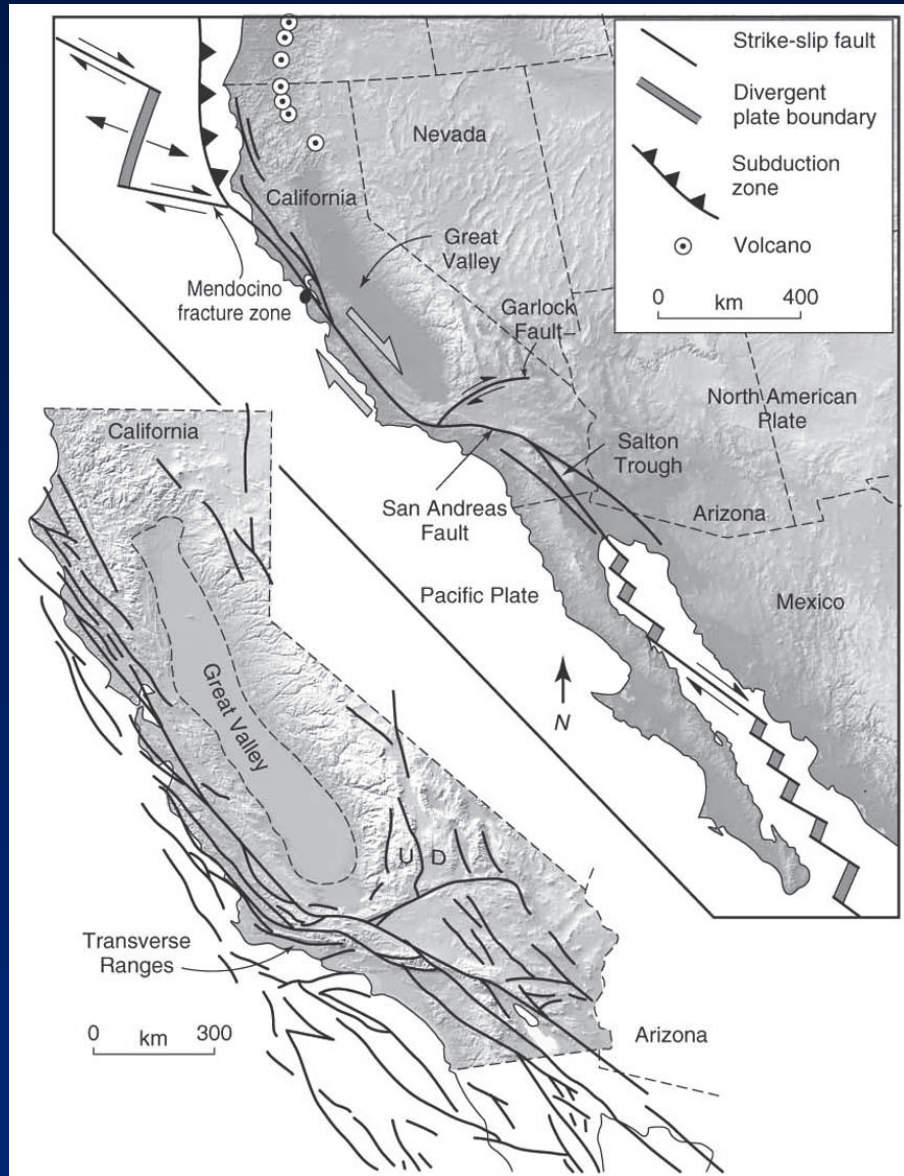
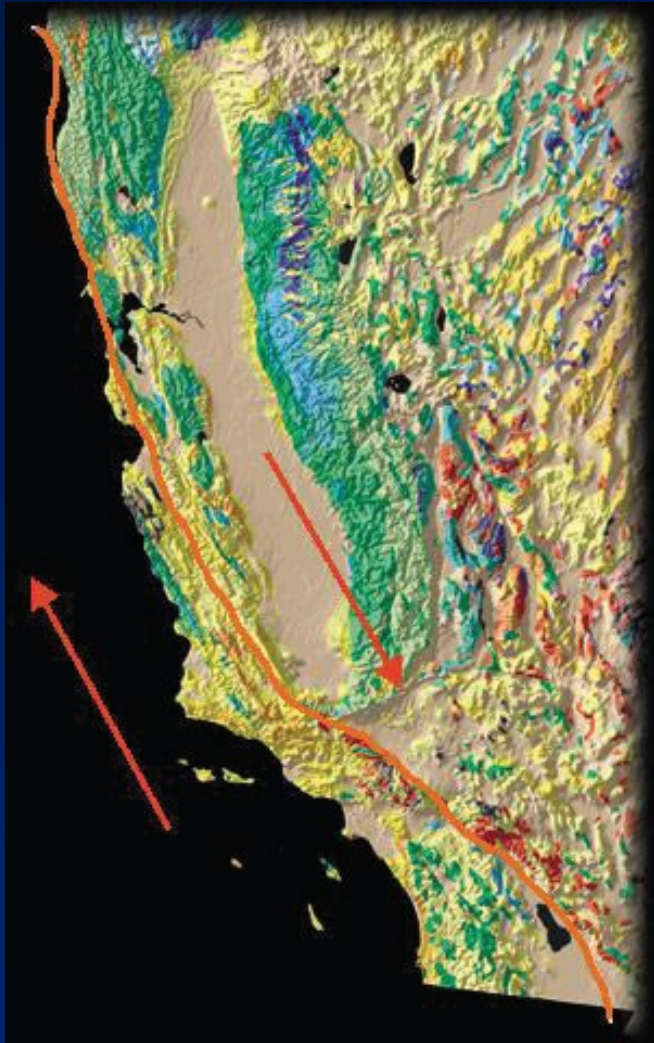
(b)

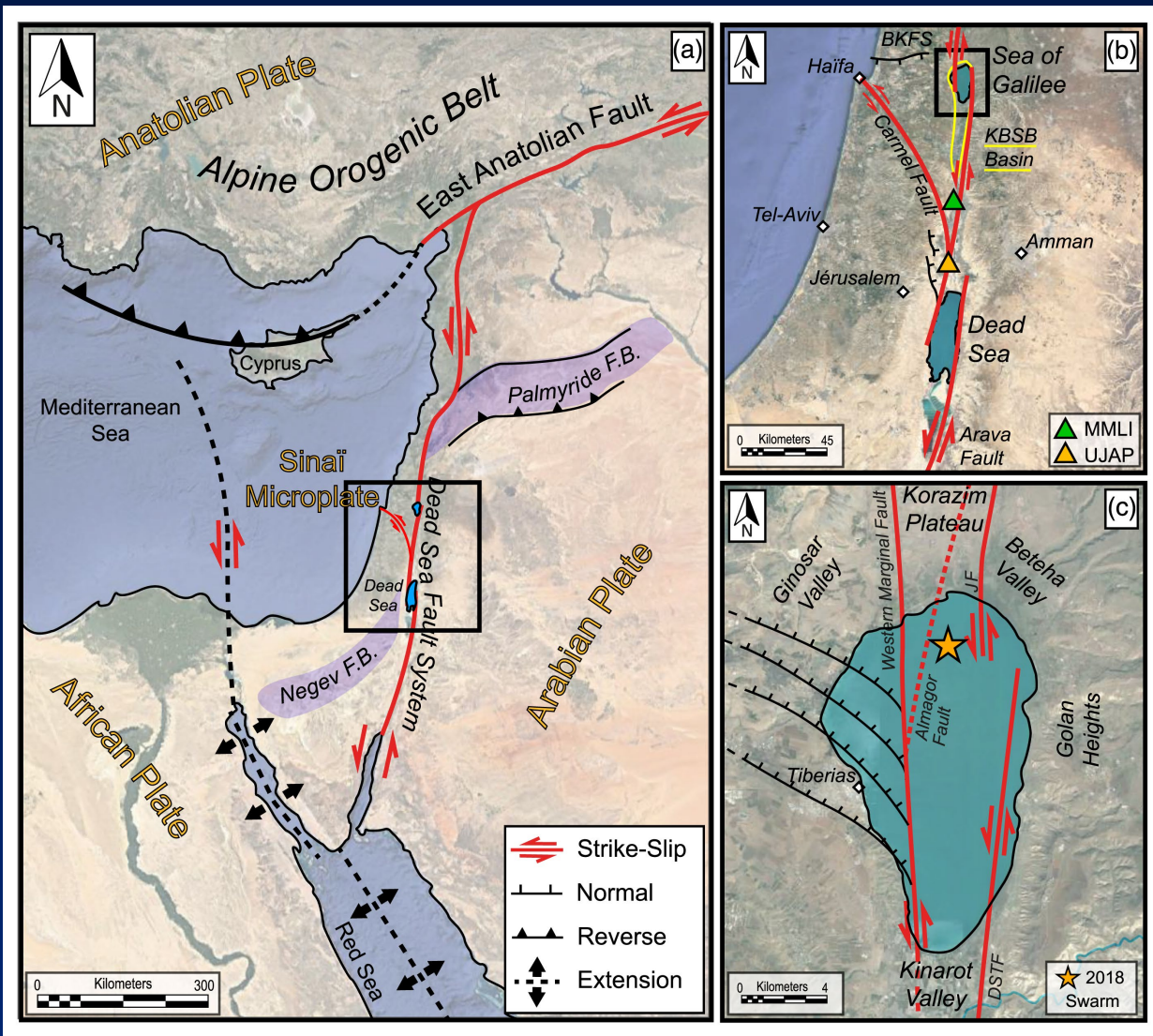


(c)



Associazioni di sistemi  
trascorrenti: la San Andreas  
fault (limite di placca)





Associazioni di sistemi trascorrenti: i sistemi di trascorrenti sinistre del Mar Morto (limiti di placca)

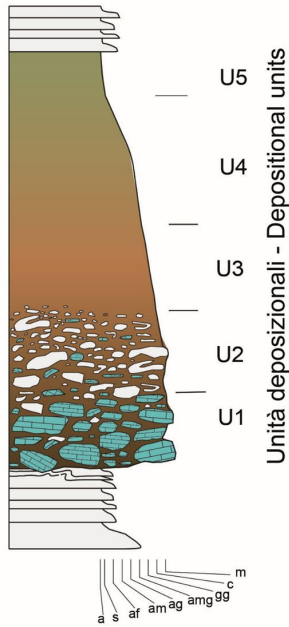
Da Hadad et al., 2020



Associazioni di sistemi  
compressivi (sistemi di  
pieghe):

due esempi italiani, ovvero,  
dalla carta geologica alle  
sezioni geologiche alla  
ricostruzione 3D





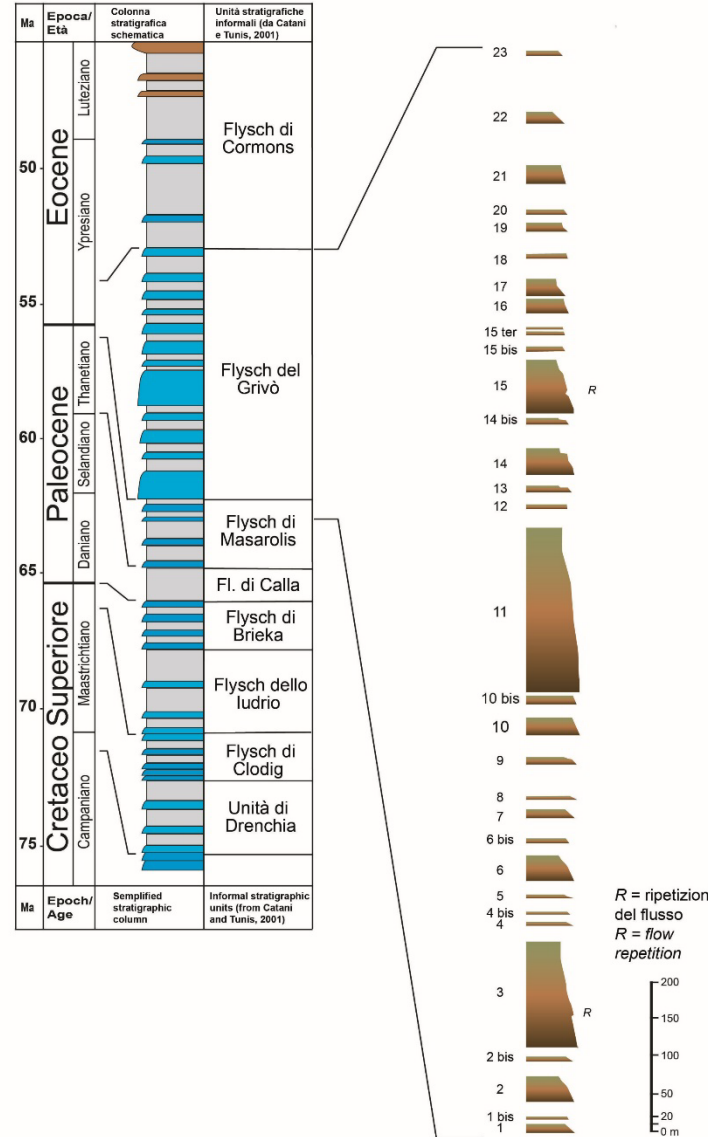
Unità deposizionali - Depositional units

a = argilla, s = silt, sf = sabbia fine, sm = sabbia media, sg = sabbia grossolana, smg = sabbia molto grossolana, gg = ghiaia grossolana, c = ciottoli, m = massi  
 a = clay, s = silt, sf = fine sand, sm = medium sand, sg = coarse sand, smg = very coarse sand, gg = coarse gravel, c = cobble, m = boulder  
 (ISO 14688, 2002)

Flysch

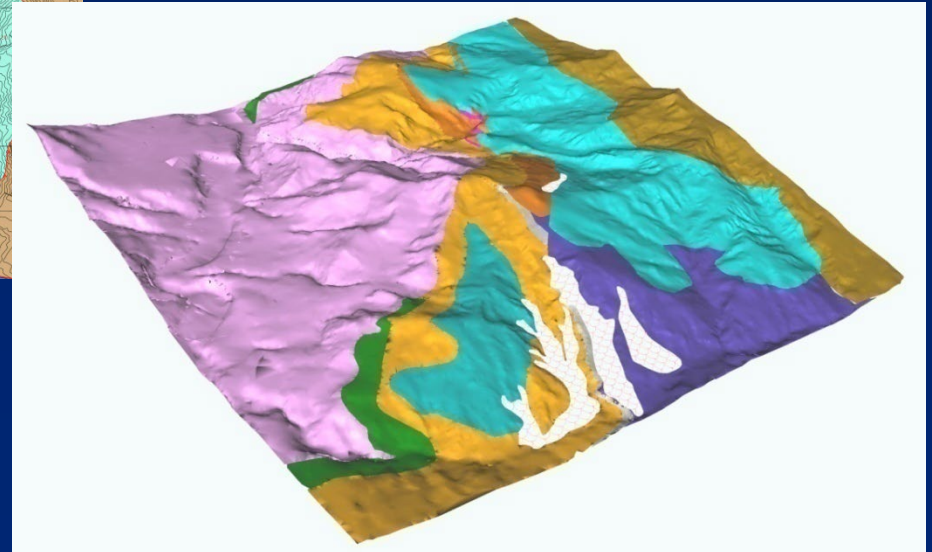
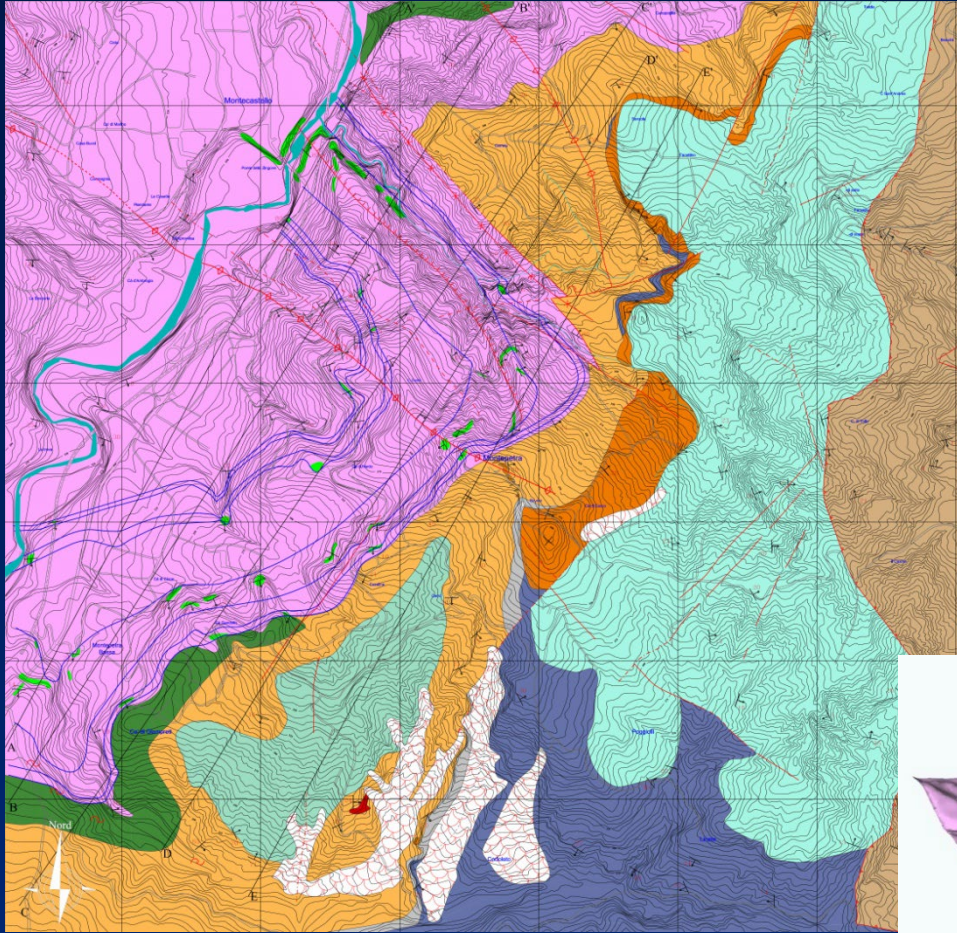
Blocchi di substrato (flysch)  
 Blocks eroded from substratum (flysch)  
 Olistoliti:  
 Olistoliths:  
 Calcarei di piattaforma  
 Platform carbonates

Diagramma concettuale di distribuzione delle unità deposizionali e della granulometria in un megabanco. Le classi tessiturali si riferiscono alla matrice e non ai megablocchi (olistoliti).  
 Conceptual distribution diagram of grain size and depositional units within a megabank. The textural classes refer to the matrix and not to the megablocks (olistoliths).





# Sistemi compressivi: le pieghe nei corpi grossolani della Marnoso-arenacea (Miocene, Appennino emiliano-romagnolo)



Immagini e fotografie tratte da:

- Ahmadi R. et al., 2006. The geomorphologic responses to hinge migration in the fault-related folds in the Southern Tunisian Atlas. *Journal of Structural Geology* 28, 721–728.
- Allmendinger R.W., 2008-2012  
[http://www.geo.cornell.edu/geology/classes/RWA/GS\\_326/photo\\_galleries/thrust\\_faults/mcconnell.html](http://www.geo.cornell.edu/geology/classes/RWA/GS_326/photo_galleries/thrust_faults/mcconnell.html)
- Banerjee S., Mitra S., 2005. Fold–thrust styles in the Absaroka thrust sheet, Caribou National Forest area, Idaho–Wyoming thrust belt. *Journal of Structural Geology* 27, 51–65.
- Kinoshita M., Tobin H., Thu M.K., and the Expedition 314 Scientists, 2009. NanTroSEIZE Stage 1A: NanTroSEIZE LWD Transect, Integrated Ocean Drilling Program Expedition 314 Preliminary Report [http://publications.iodp.org/preliminary\\_report/314/314PR.PDF](http://publications.iodp.org/preliminary_report/314/314PR.PDF)
- Moore G.F., Bangs N.L., Taira A., Kuramoto S., Pangborn E., Tobin H.J., 2007. Three-Dimensional Splay Fault Geometry and Implications for Tsunami Generation. *Science* 318, 1128.
- Moore G.F. et al., 2009. Structural and seismic stratigraphic framework of the NanTroSEIZE Stage 1 transect. *Proceedings of the Integrated Ocean Drilling Program, Volume 314/315/316.*
- ODP Publications <http://www-odp.tamu.edu/publications/>
- Ollerenshaw, N.C., 1978, *Geology, Calgary, West of the Fifth Meridian, Alberta-British Columbia: in Geological Survey of Canada, Map 1457A, scale:1/250,000.*
- Price R.A., 2000. *The Southern Canadian Rockies: Evolution of a Foreland Thrust and Fold Belt.*
- Ramsay J. G., Huber M. I., 1984. *The Techniques of Modern Structural Geology. Volume 1: Strain analysis.* Academic Press Inc.
- Ramsay J. G., Huber M. I., 1987. *The Techniques of Modern Structural Geology. Volume 2: Folds and Fractures.* Academic Press Inc.
- Selli L., 2006. *Appunti dalle lezioni di Geologia Strutturale.*
- Strasser M. et al., 2013. A slump in the trench: Tracking the impact of the 2011 Tohoku-Oki earthquake. *Geology*, 41 (8), 935–938.