



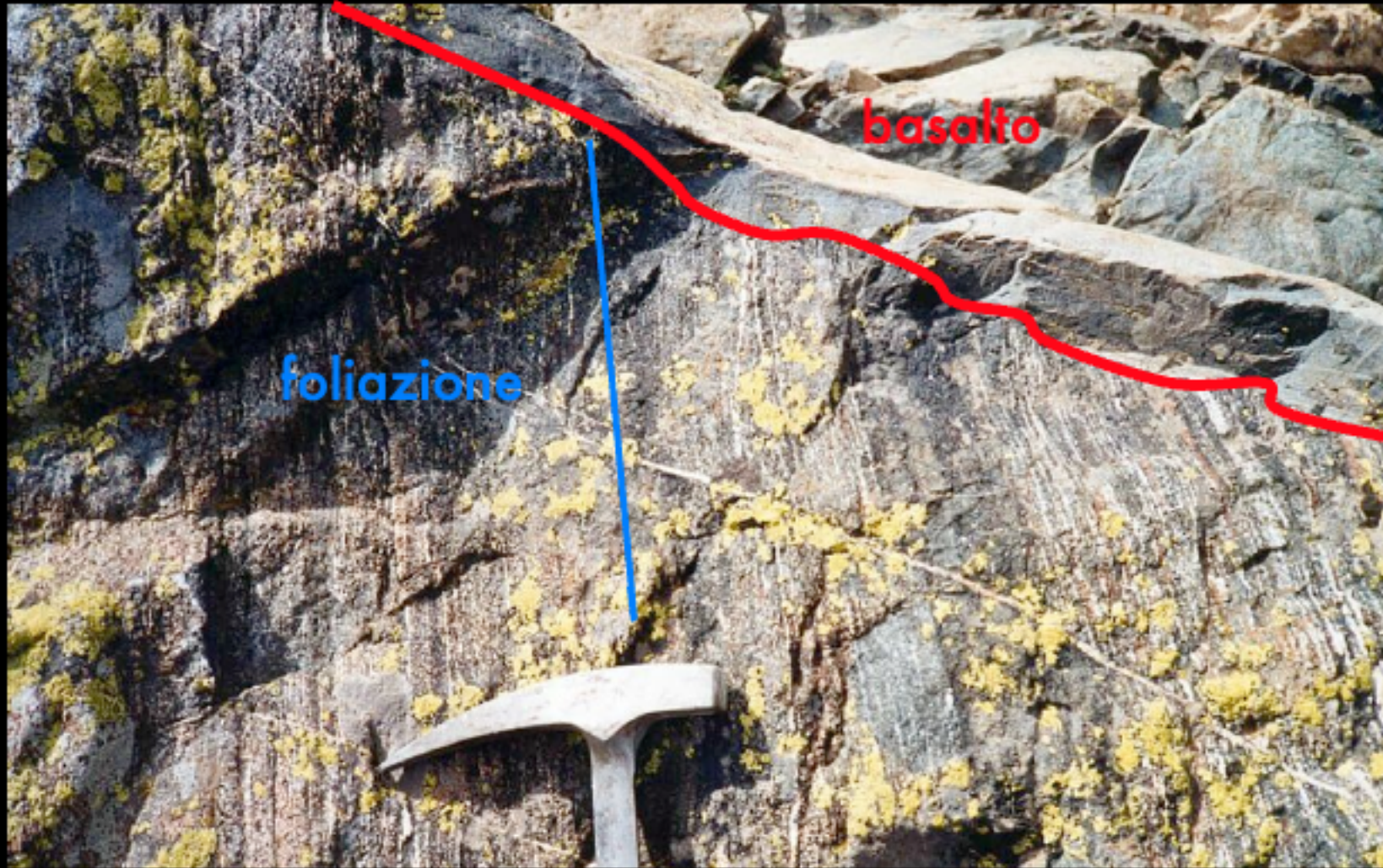
## Maria Iole Spalla

“Le Alpi: un filo di Arianna della storia geologica del cuore d’Europa”

40<sup>o</sup>  
anniversario  
1982-2022







foliazione

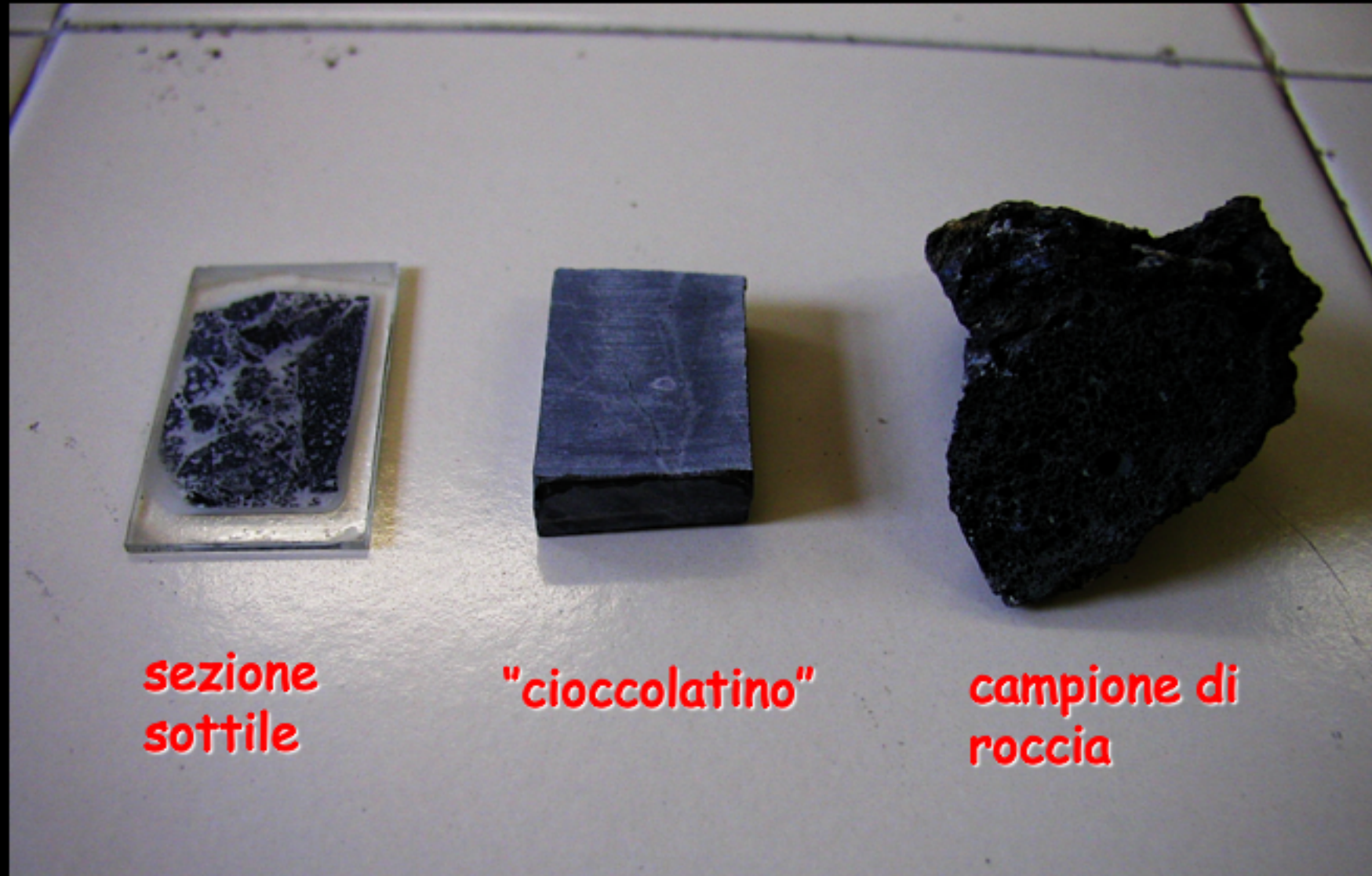
basalto







Dal campione di roccia al "cioccolato" e, infine, alla sezione sottile



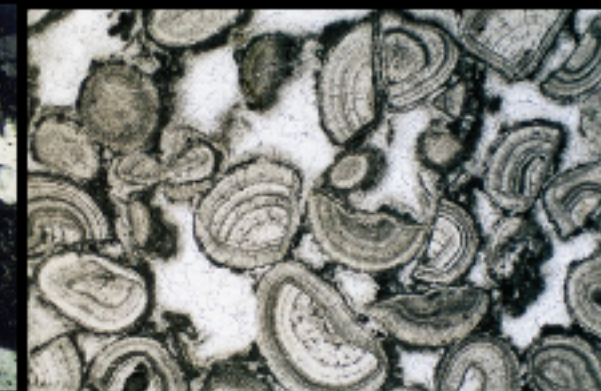
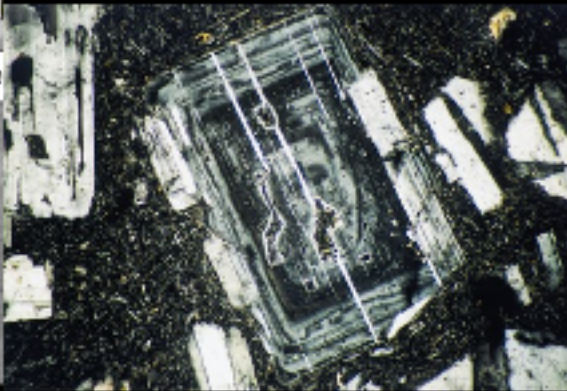
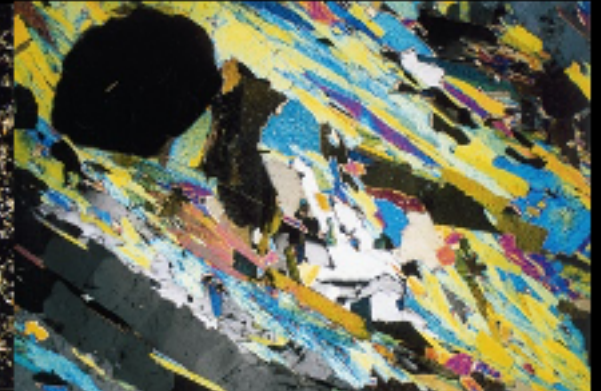
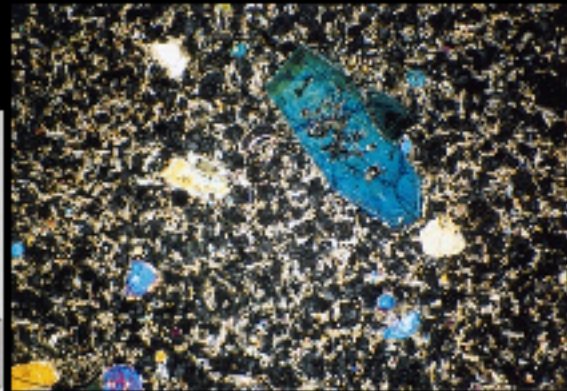
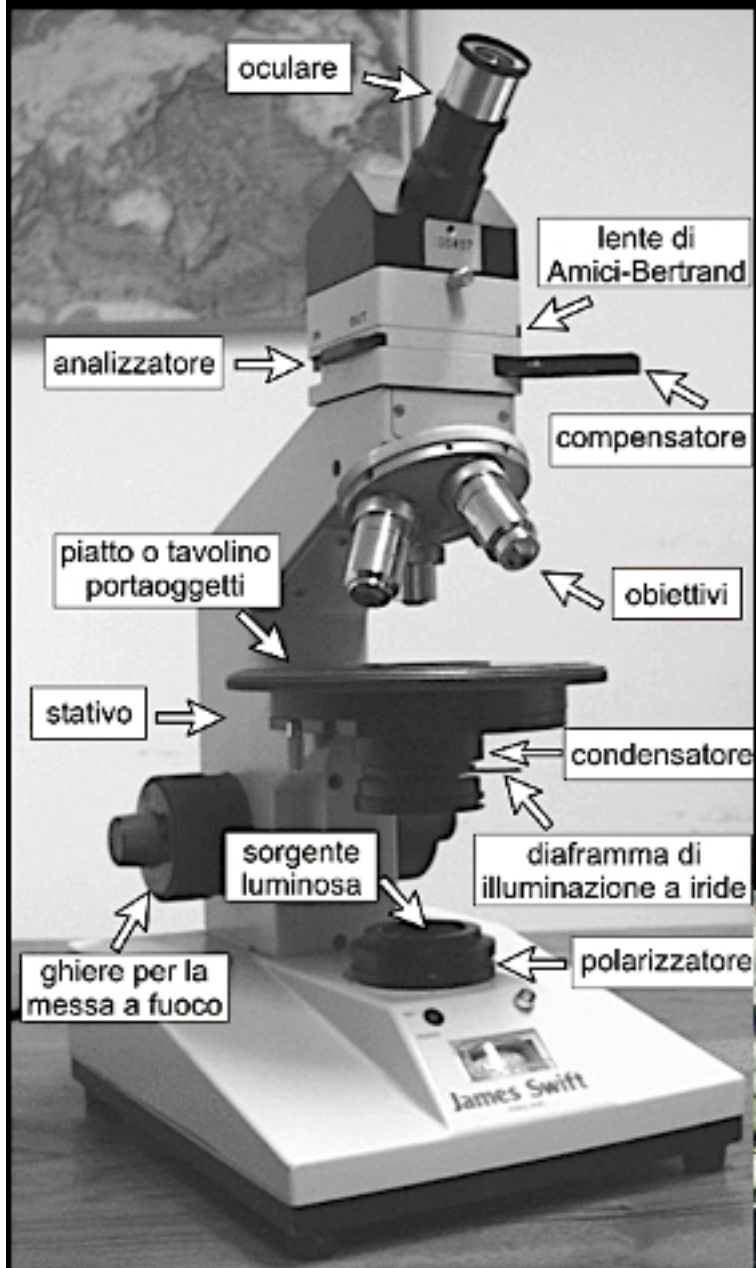
sezione  
sottile

"cioccolato"

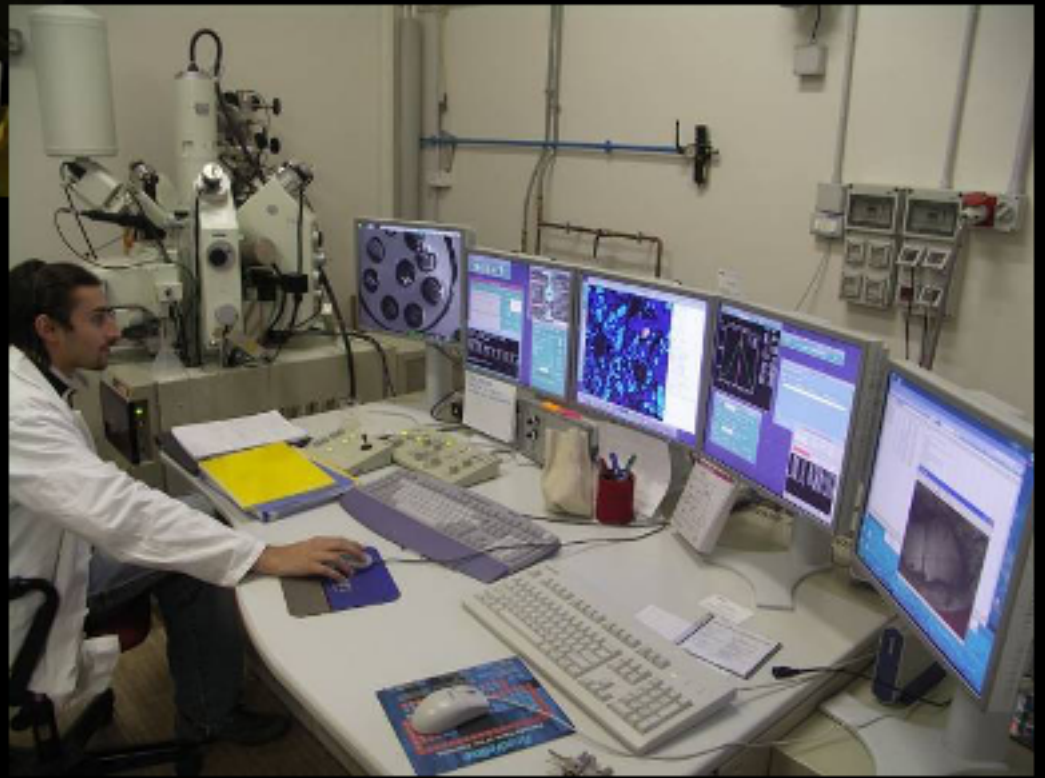
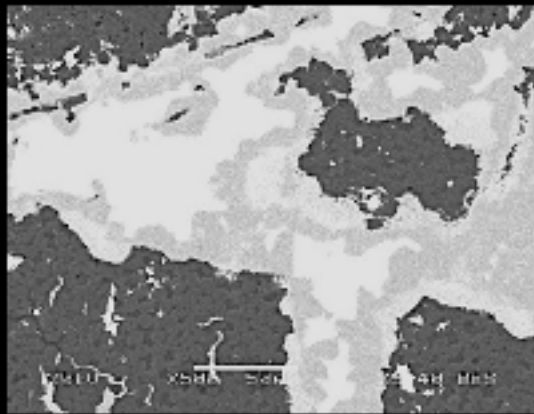
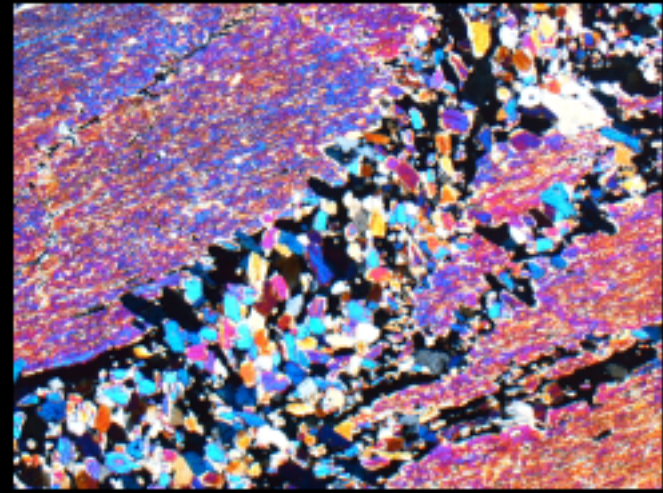
campione di  
roccia



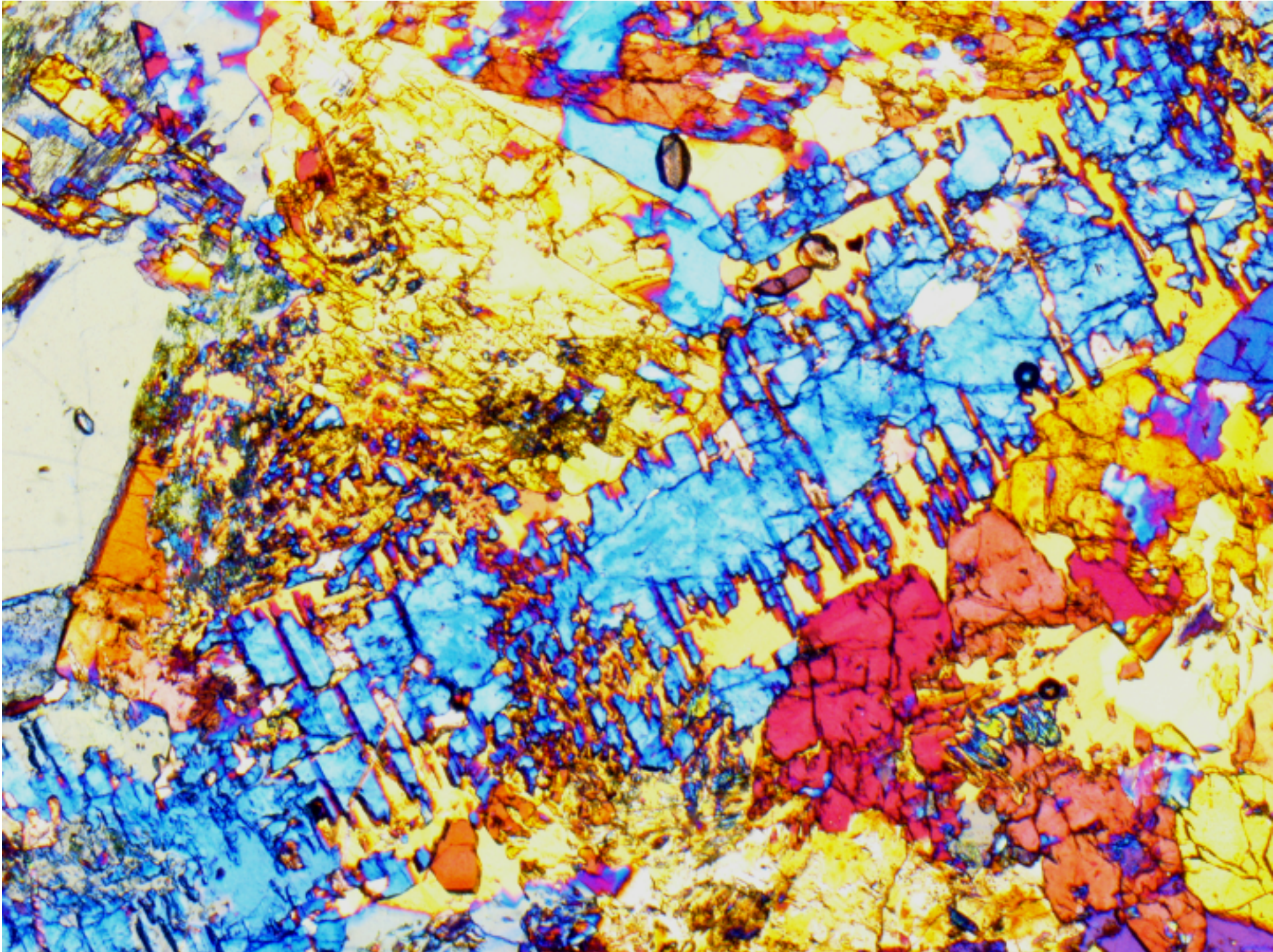
# Il Microscopio



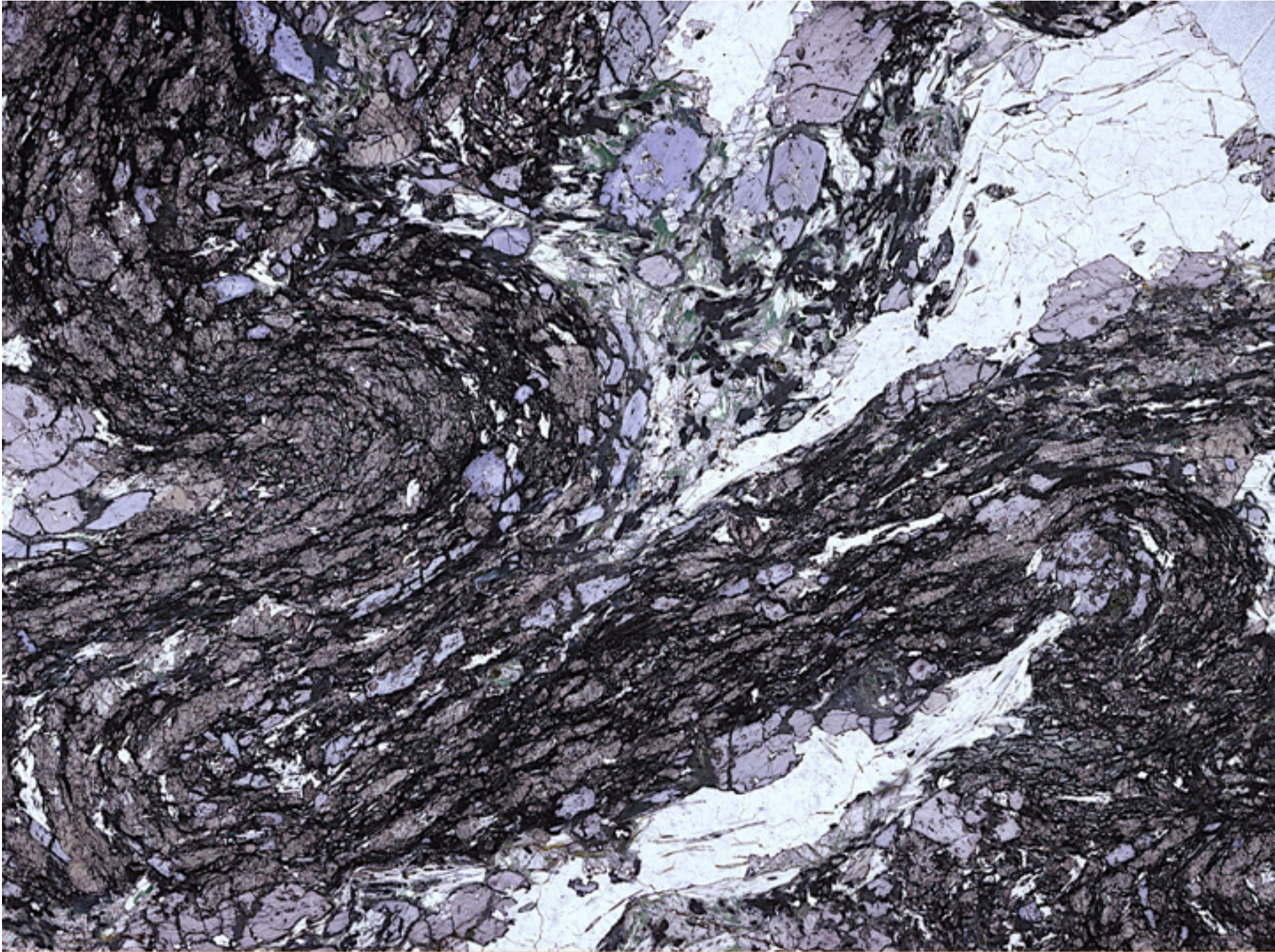




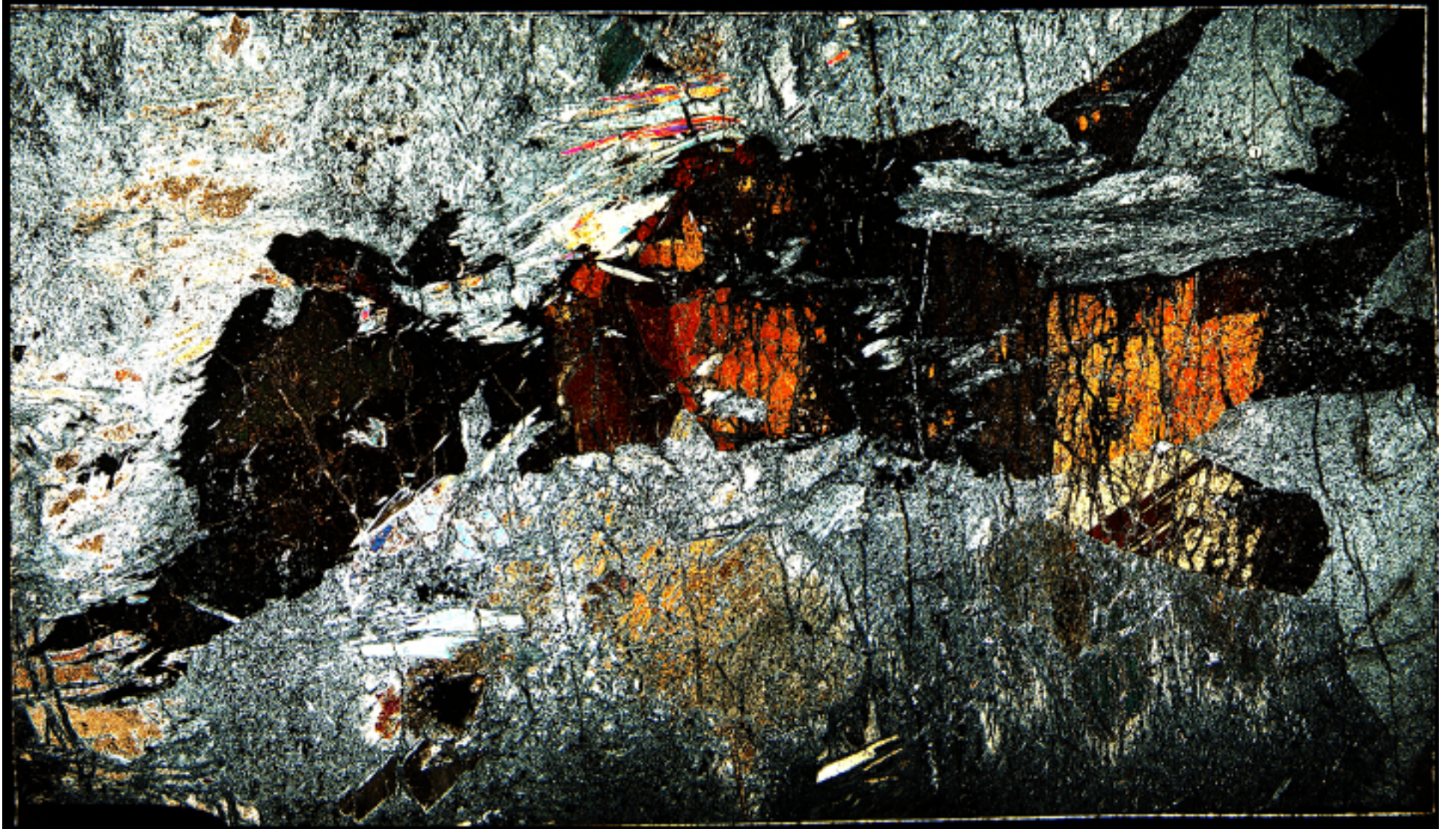
















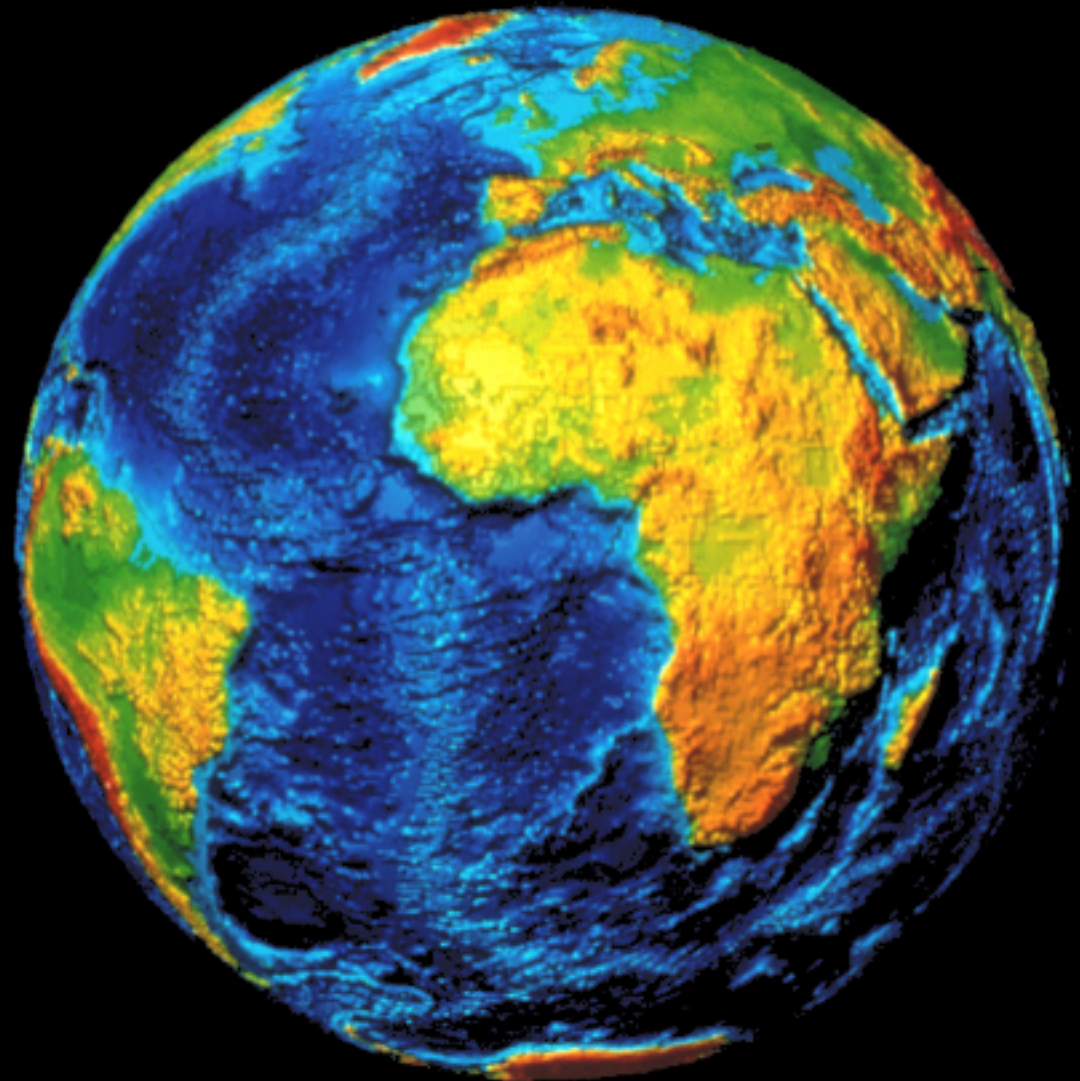


**La Terra è un pianeta in movimento con trasferimento di materia e di calore dall'interno alla superficie e viceversa come è testimoniato da:**

**Attività sismica**  
**Attività vulcanica**

**Topografia**  
**Età della crosta**

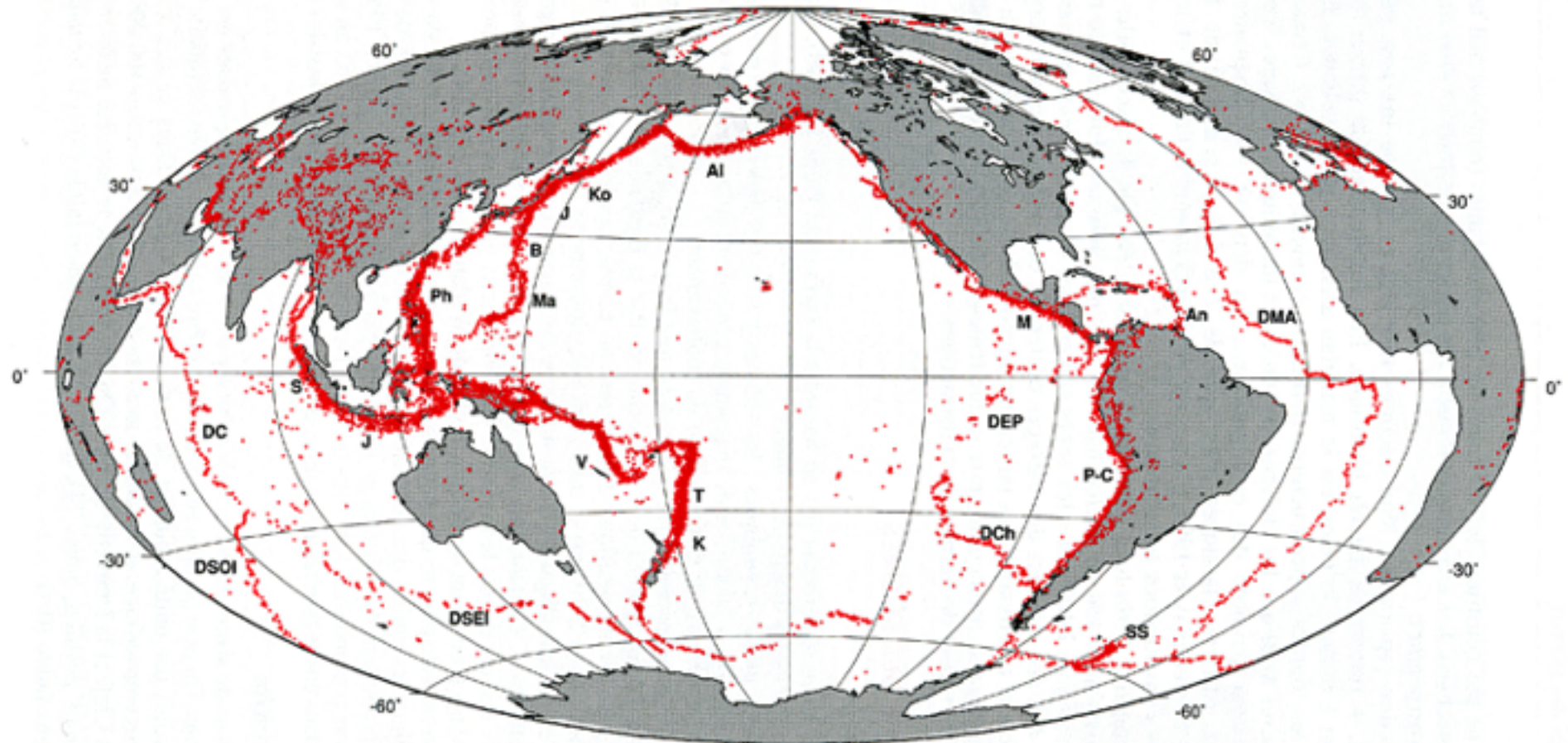
**Magnetismo**  
**Metamorfismo**





# SISMICITA'

La traccia più immediata della dinamica interna del globo è la sismicità.



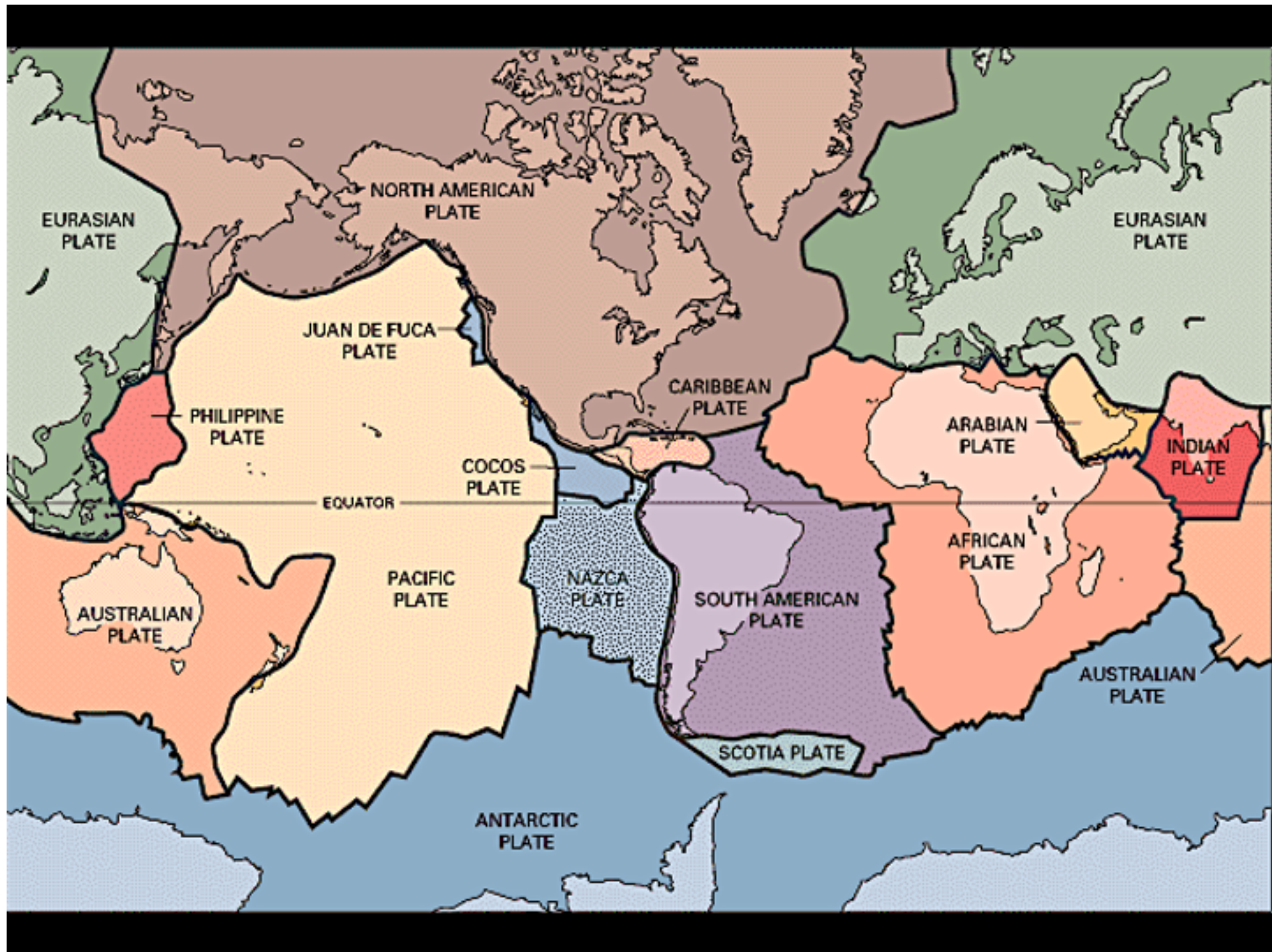
**FIGURE 3.8** – Carte de la sismicité mondiale (compilation logiciel GMT, UMR Dynamique de la Lithosphère, Montpellier).

La répartition des séismes souligne les zones de déformation active dans les océans ou sur les continents. On a indiqué le nom des principales zones de subduction et des dorsales océaniques. Fosses de Kermadec (K), Tonga (T), Vanuatu (V), Philippines (Ph), Mariannes (Ma), Bonin (B), Japon (J), Kouriles (Ko), Aléoutiennes (Al), Mexique (M), Pérou-Chili (P-C), Java (J) Sumatra (S), Antilles, (An), Sandwichs du Sud (SS). Dorsale Médio-Atlantique (DMA), dorsale Est-Pacifique (DEP), dorsale Sud-Ouest Indienne (DSOI), dorsale Sud-Est Indienne (DSEI), dorsale de Carlsberg (DC), dorsale du Chili (DCh).





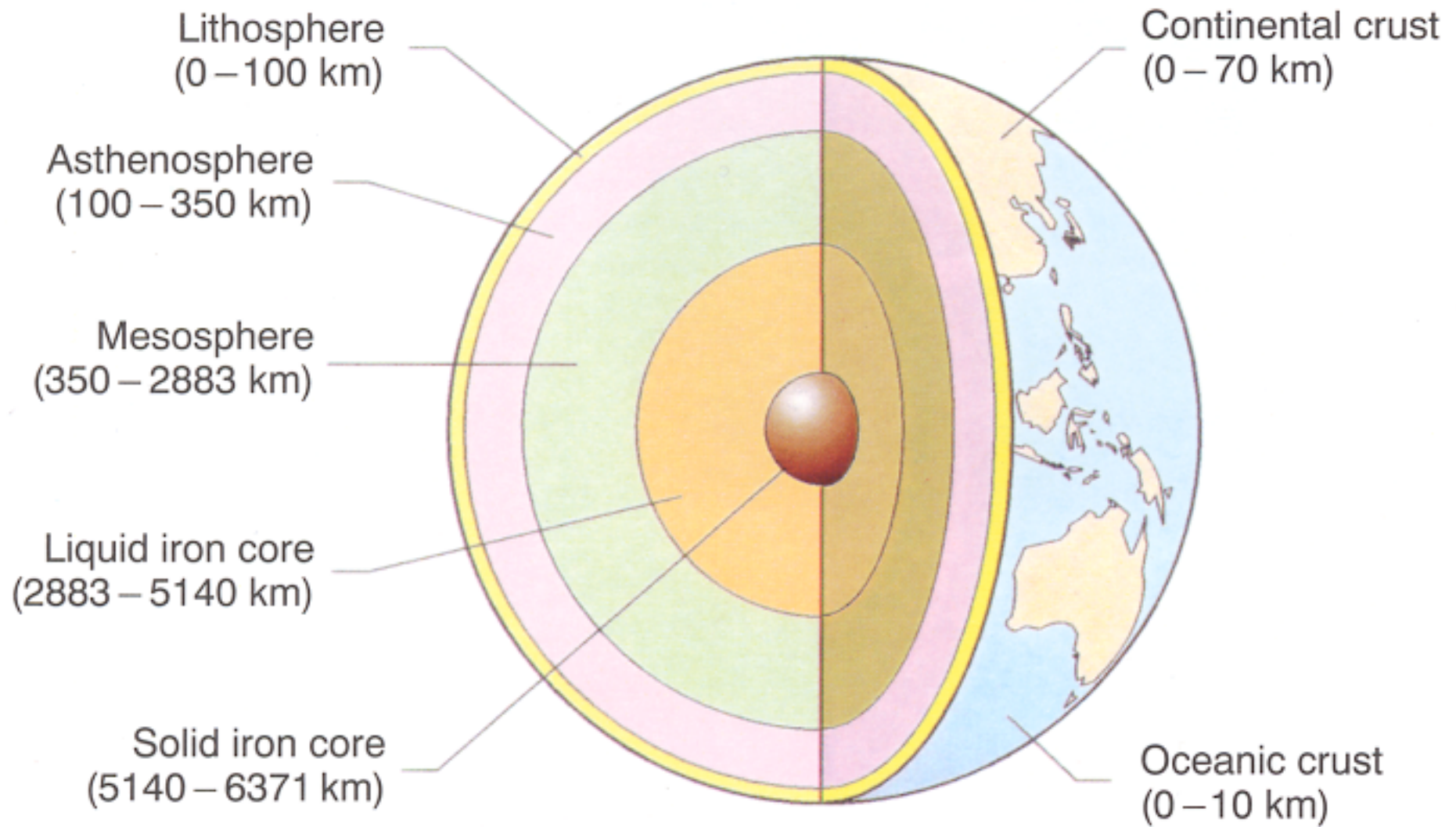








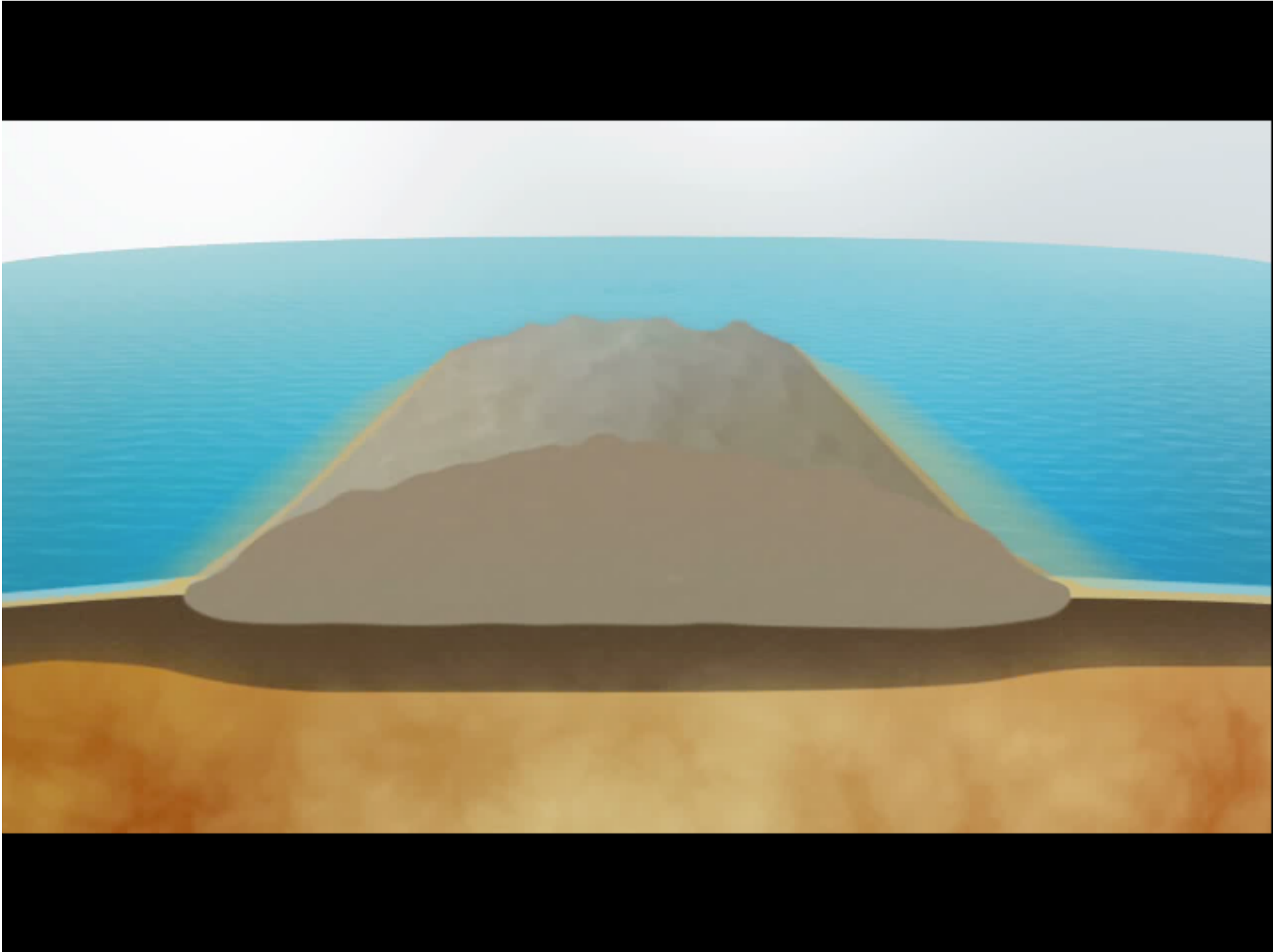




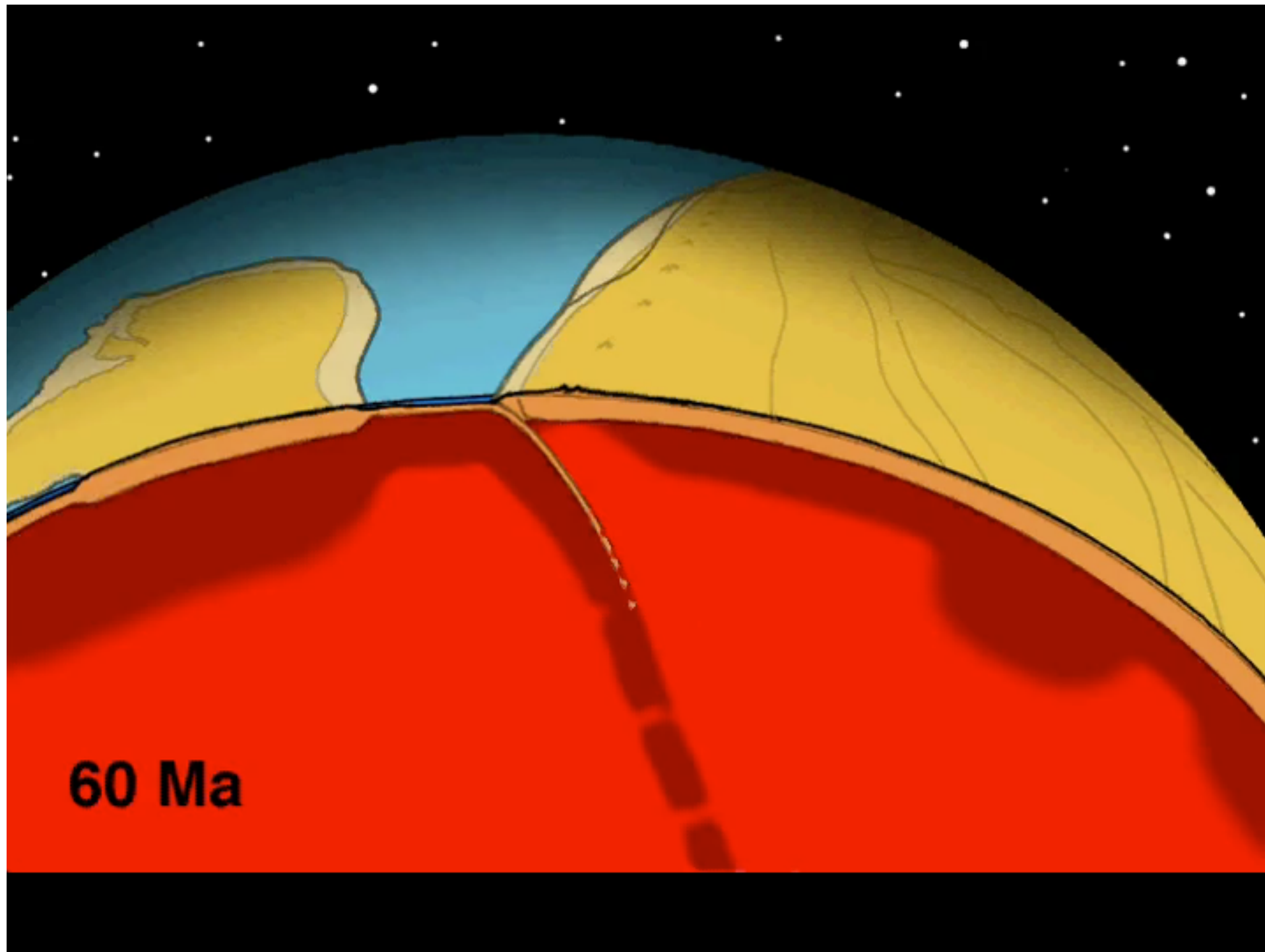




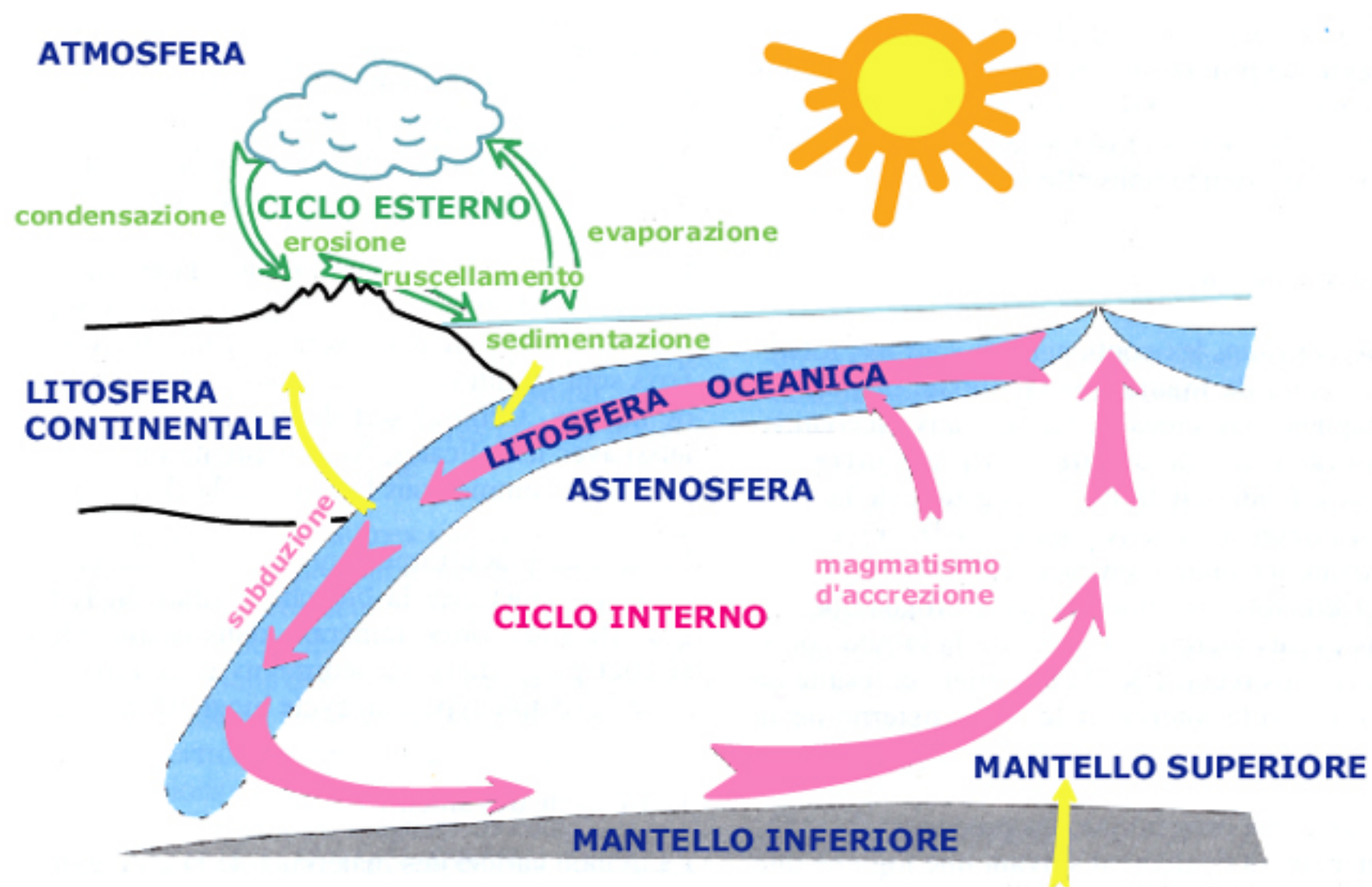






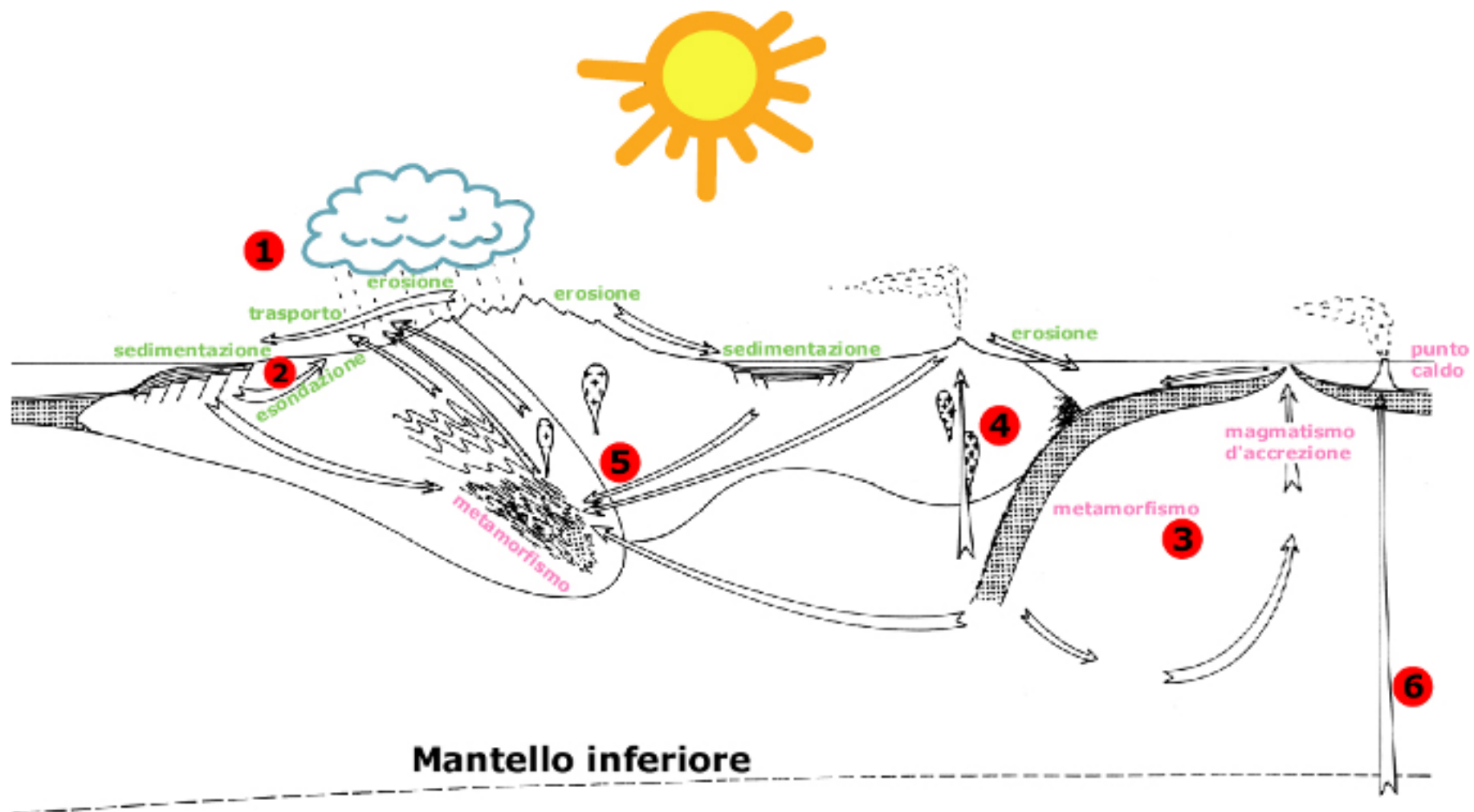






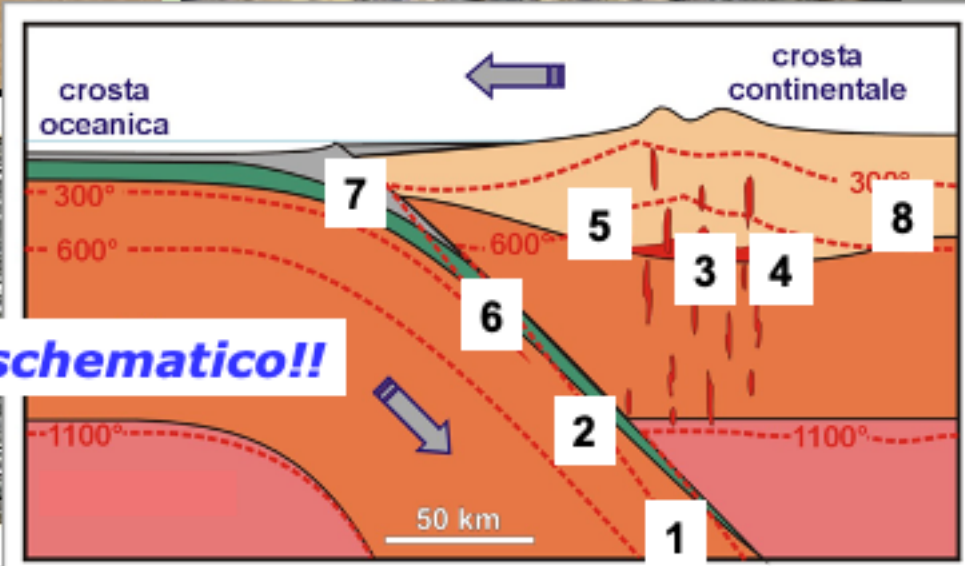
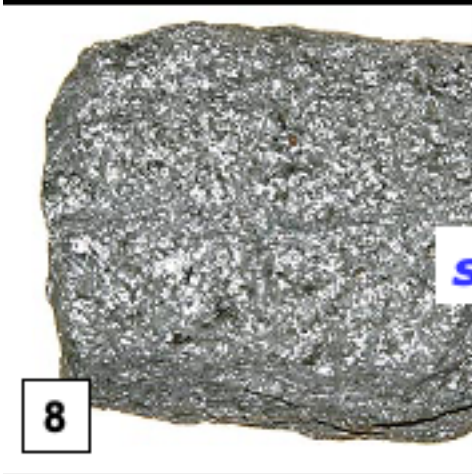
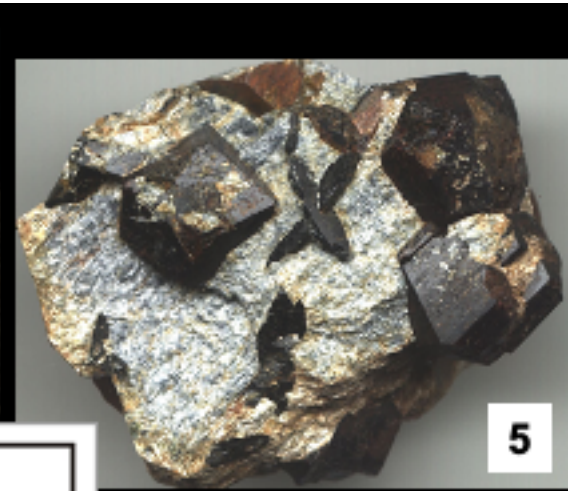
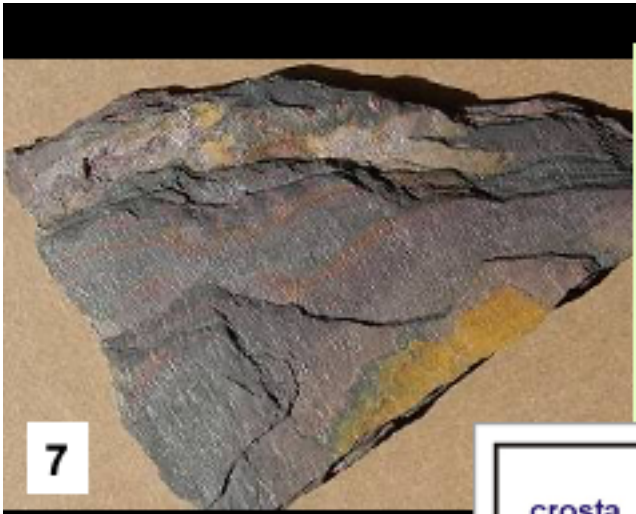
Le frecce gialle indicano come ci possa essere trasferimento di materia tra un ciclo e l'altro: ad esempio i sedimenti possono entrare nel ciclo interno se trascinati nelle zone di subduzione.



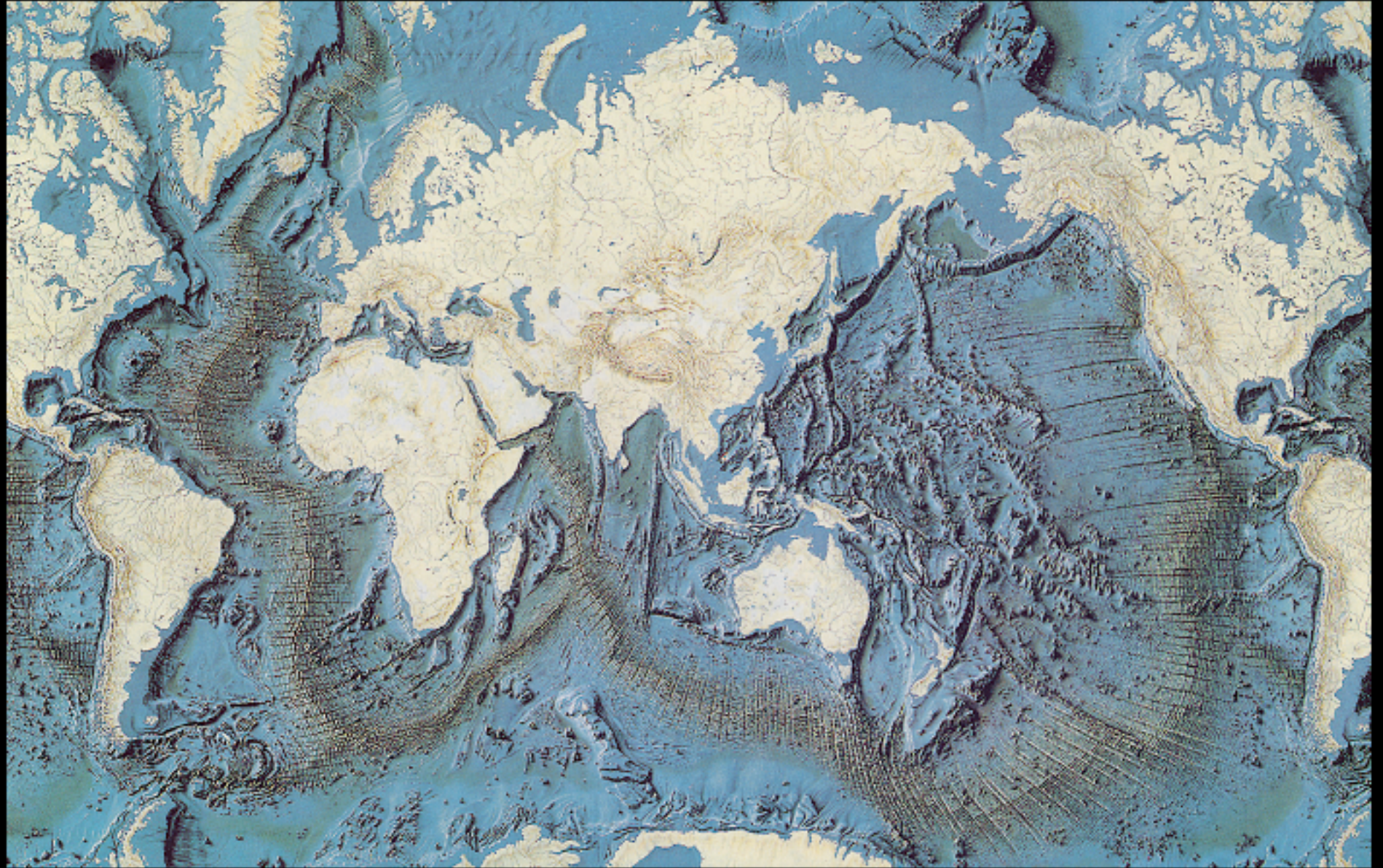


Le rocce e il loro coinvolgimento nei due cicli interno ed esterno



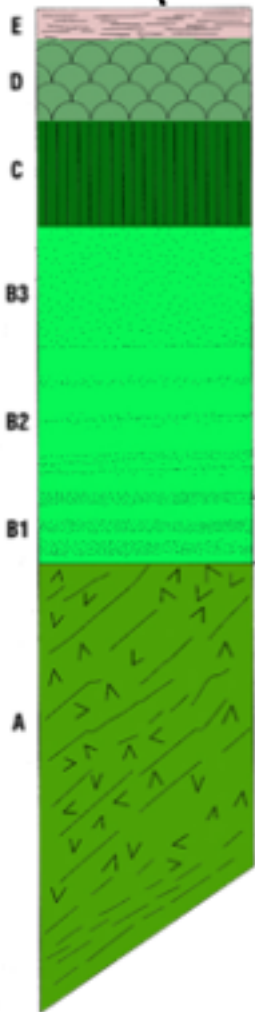




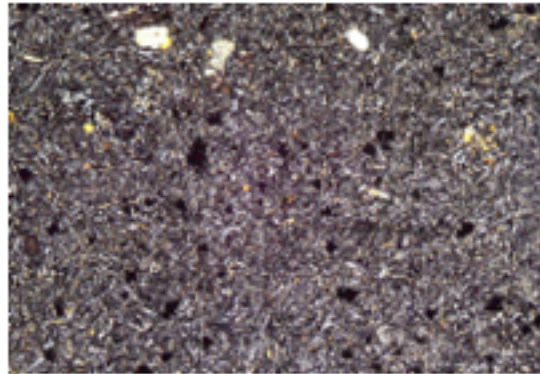




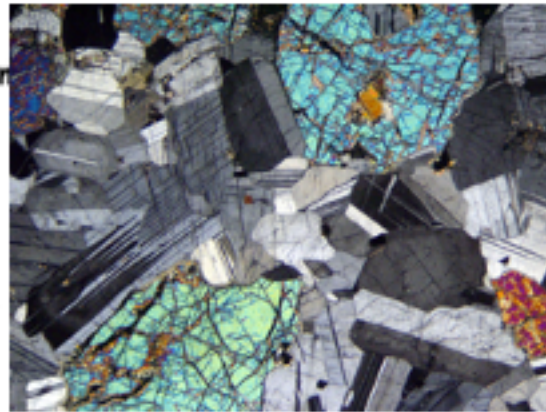
sedimenti



D) Basalti a cuscini



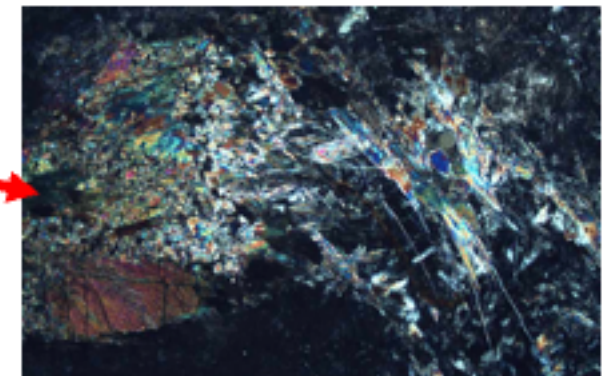
C) Complesso filoniar



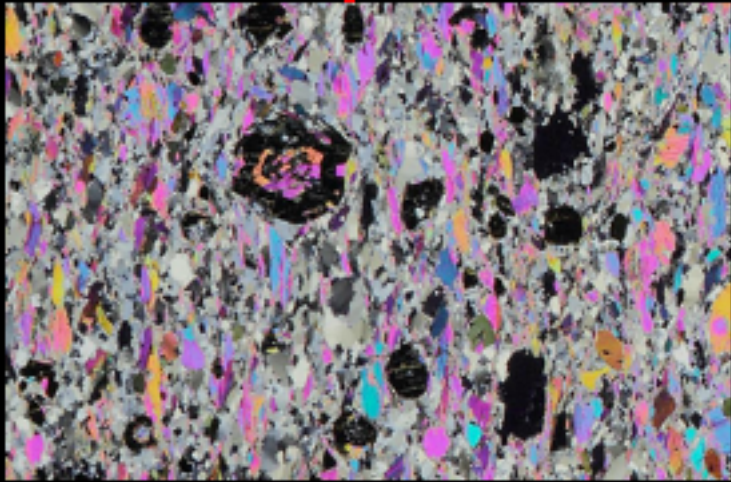
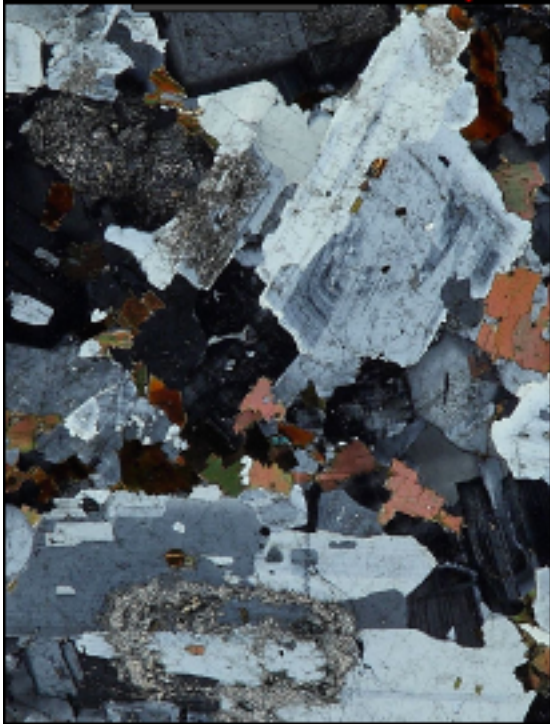
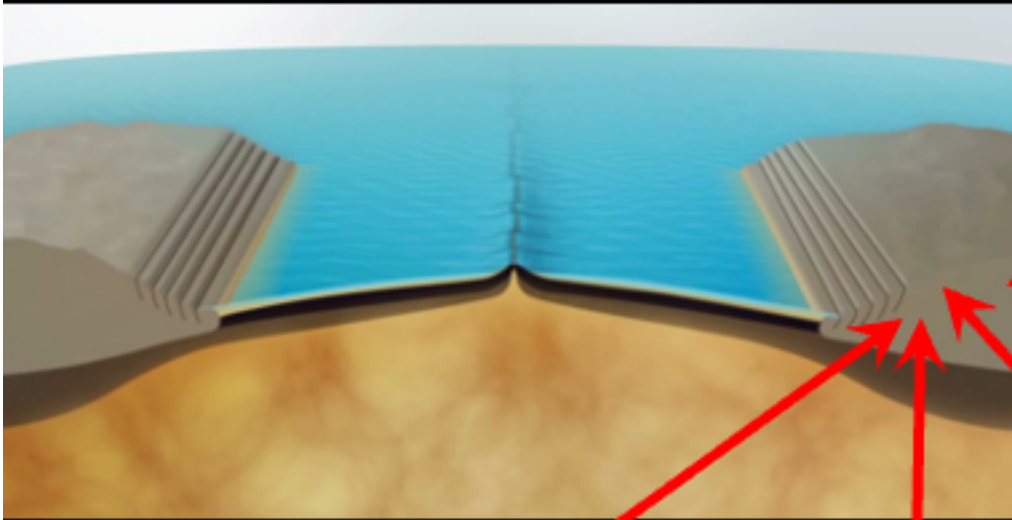
B) Gabbri cumulitici



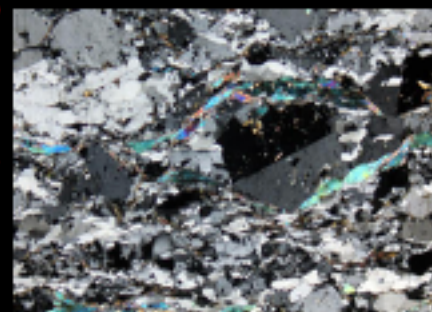
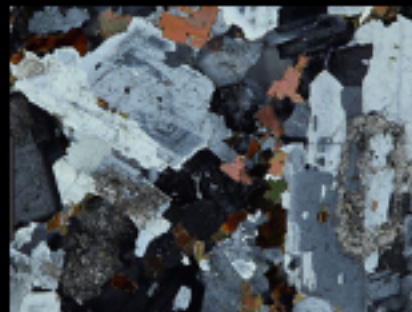
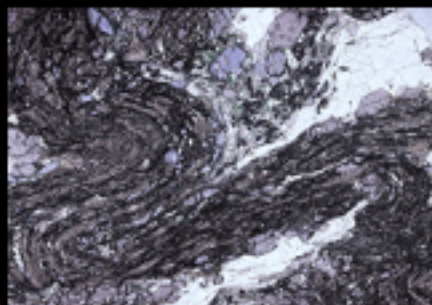
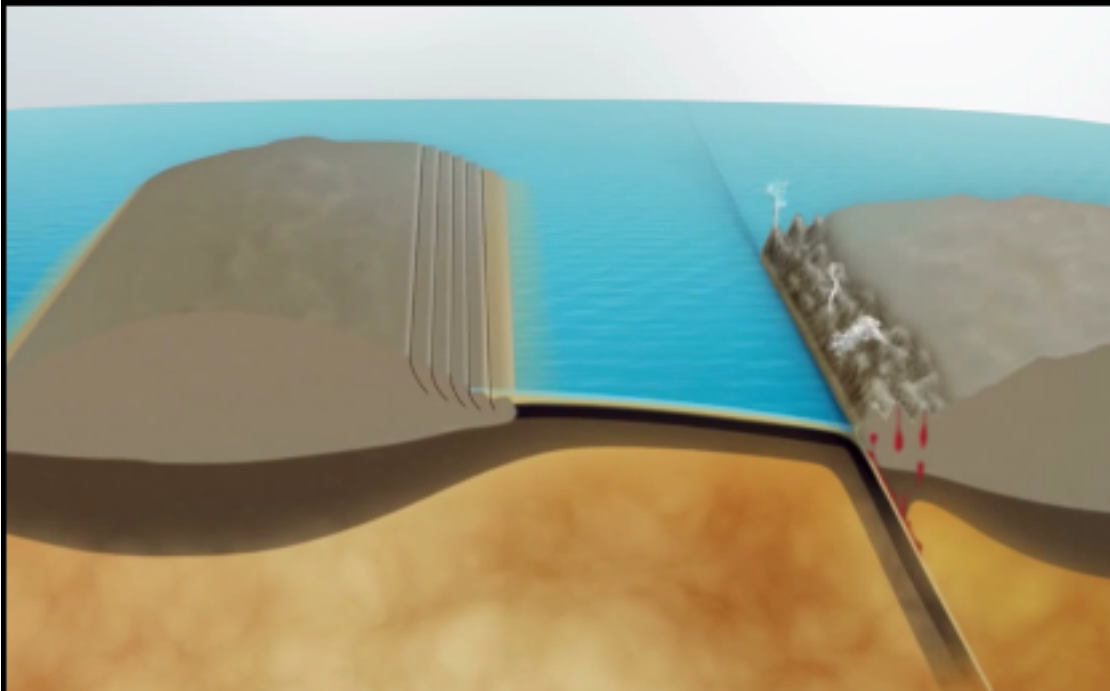
A) Peridotiti tettonitiche









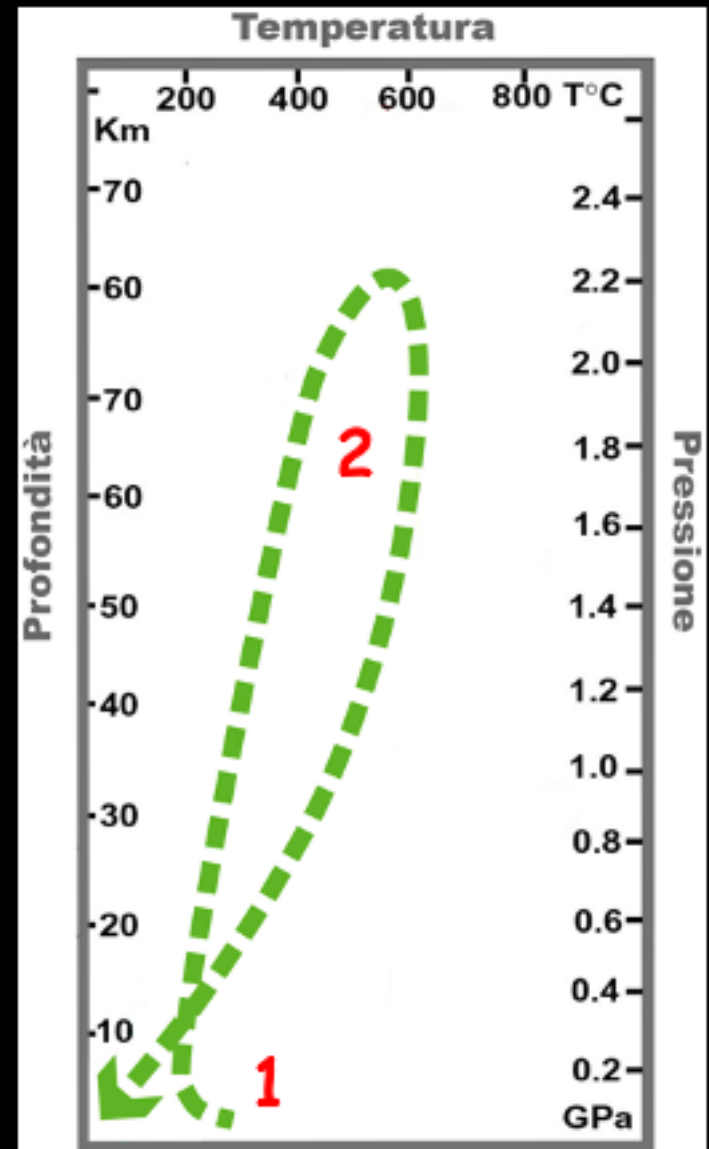


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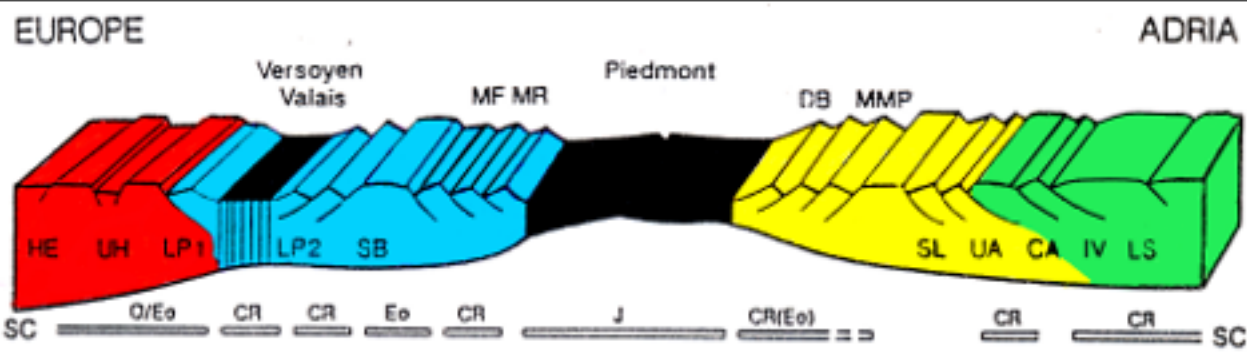
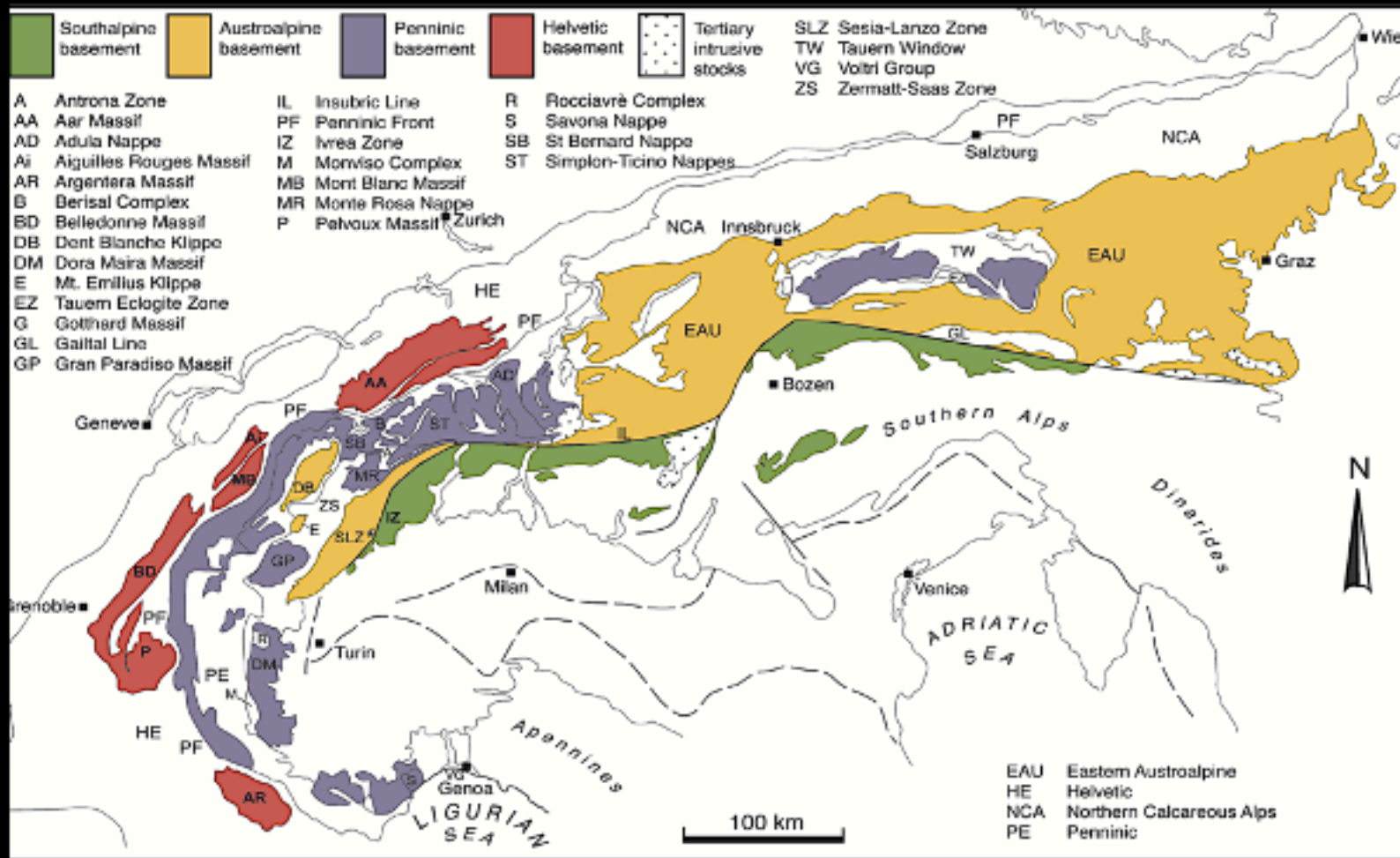
2

1

2



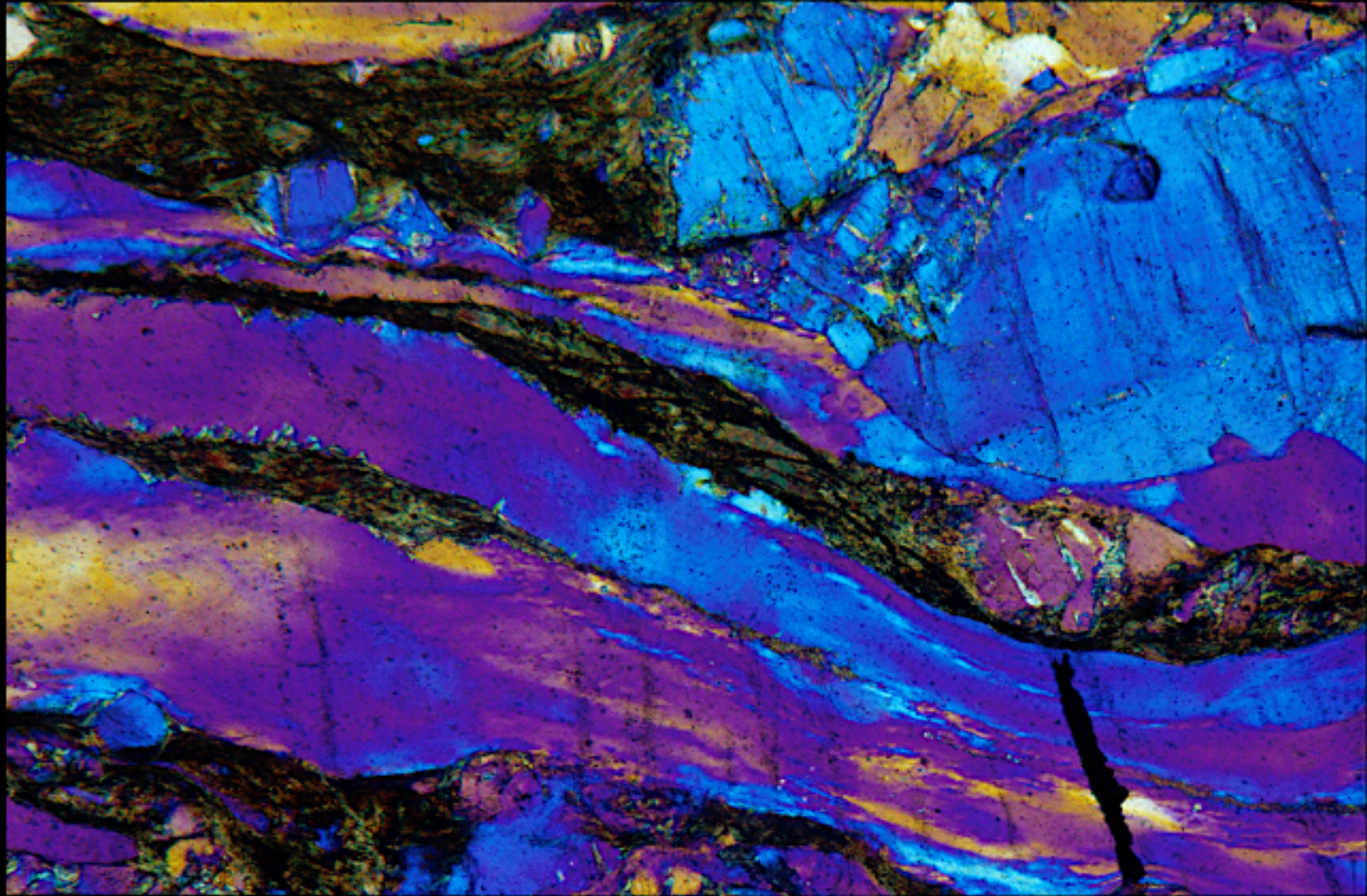




Terra "A. Desio"

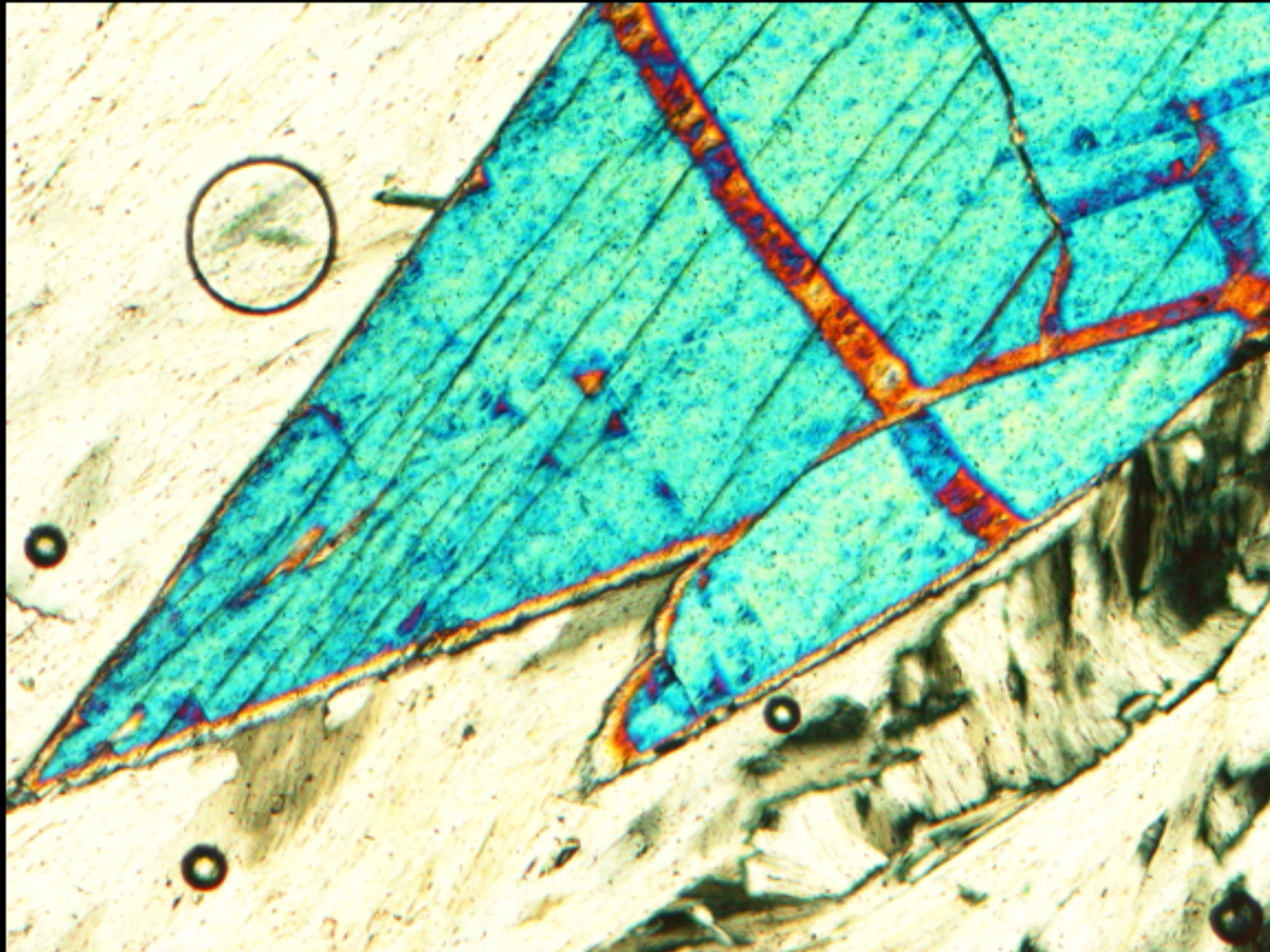


Qualche storia...





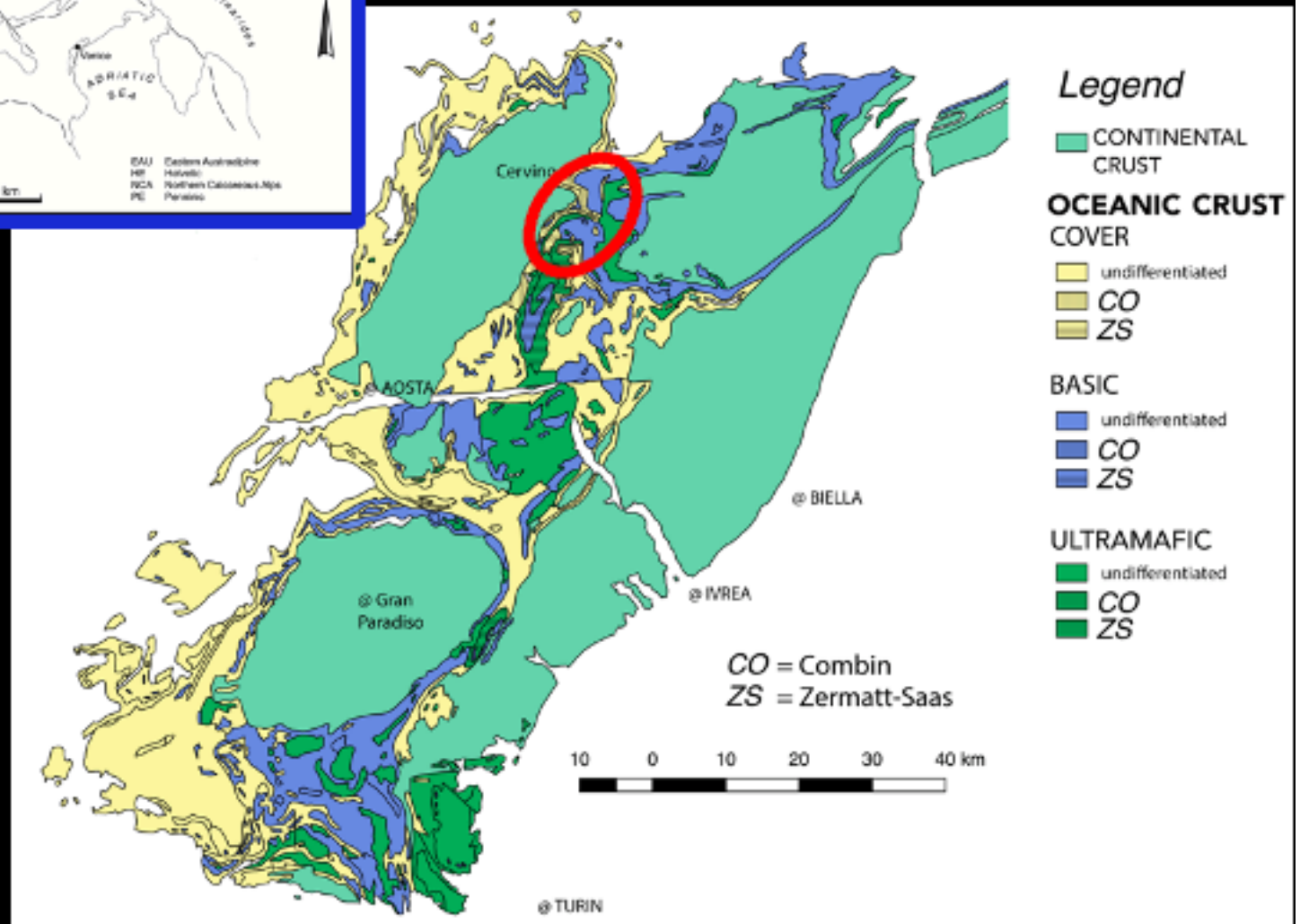
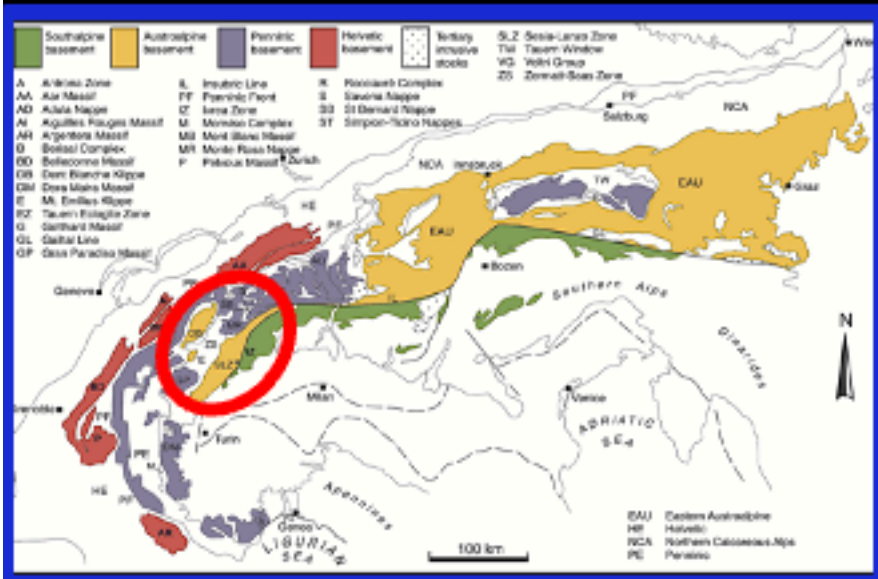
*Le ofioliti metamorfiche delle Alpi Occidentali e  
il margine continentale di Adria....*



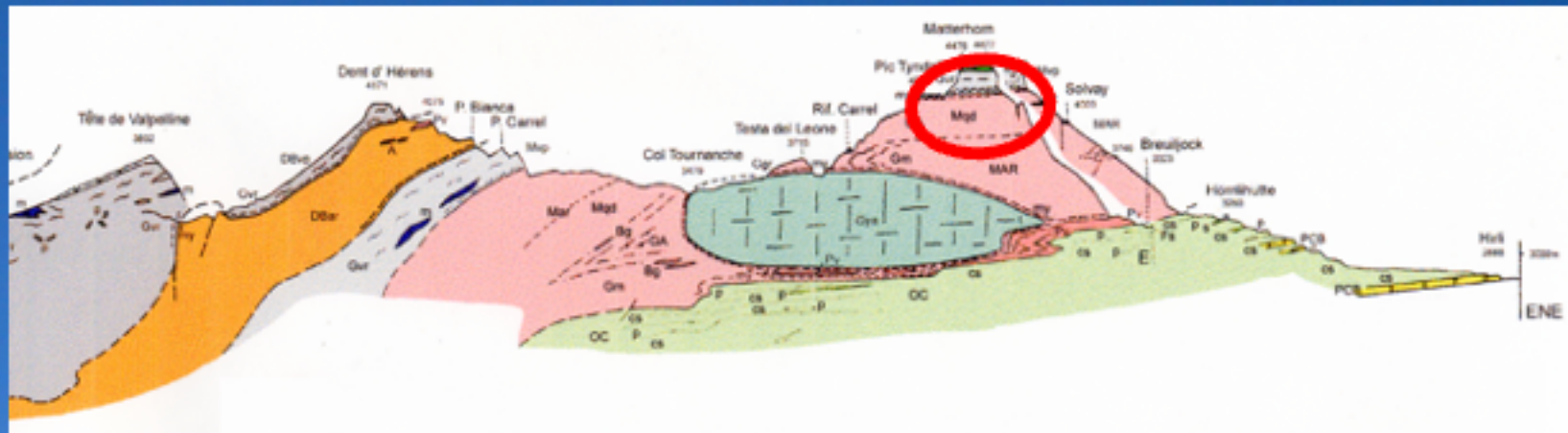














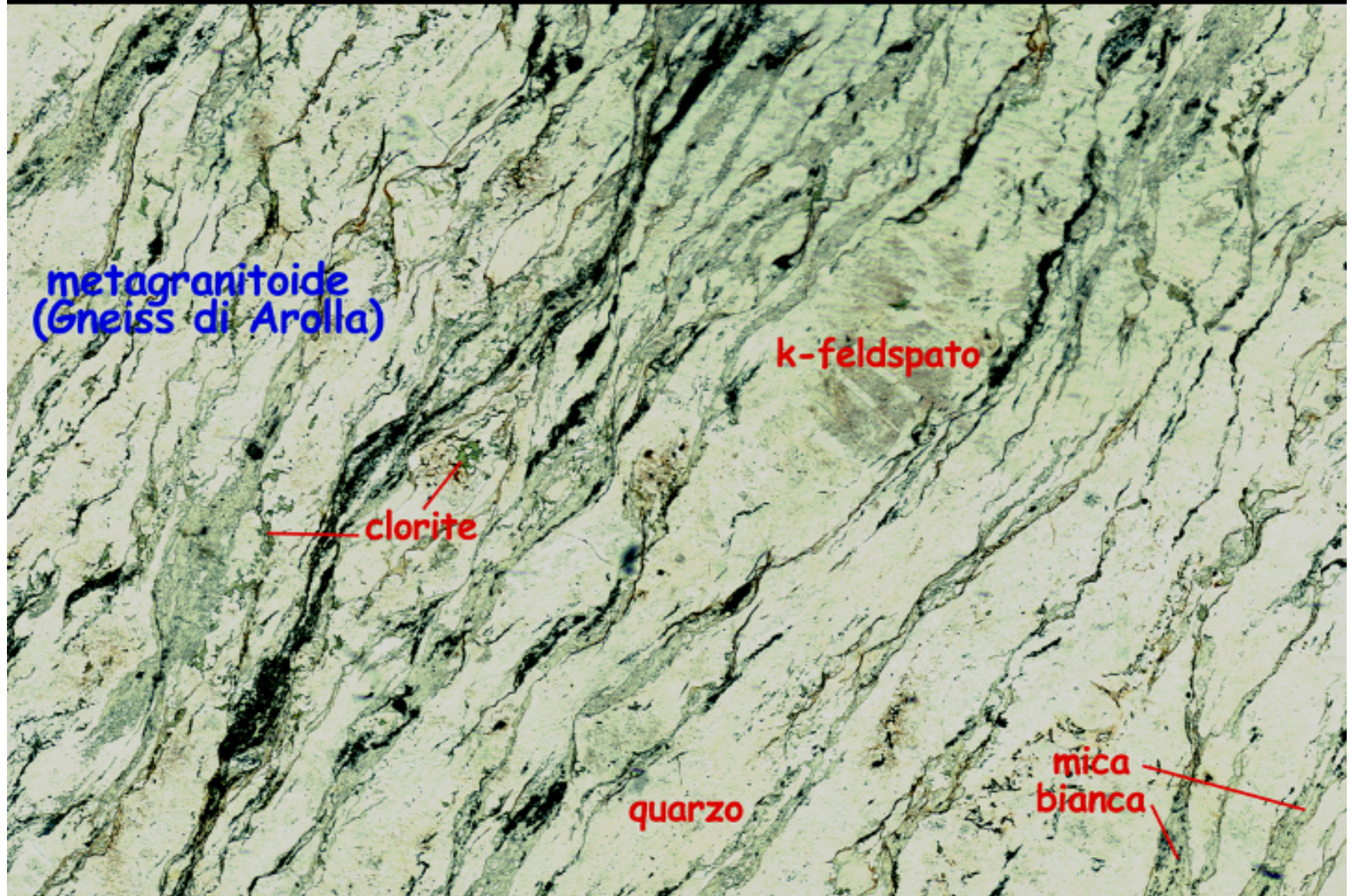
metagranitoide  
(Gneiss di Arolla)

k-feldspato

clorite

quarzo

mica  
bianca





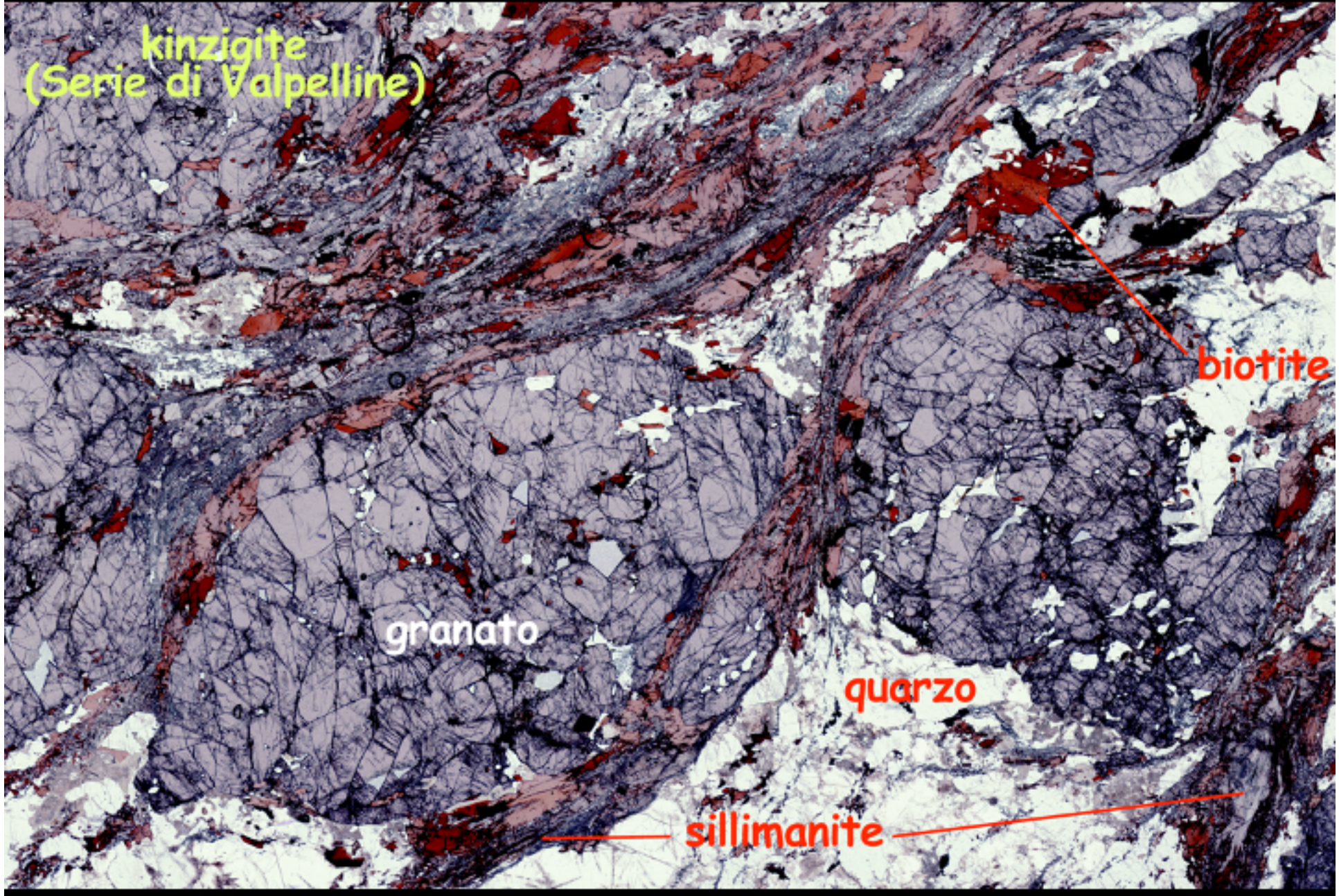
kinzigite  
(Serie di Valpelline)

biotite

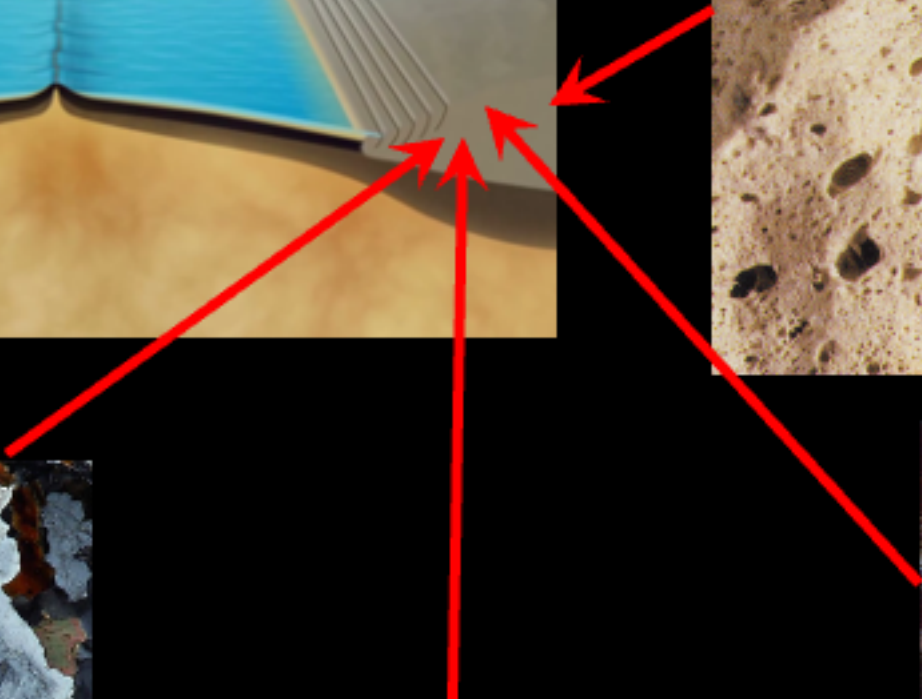
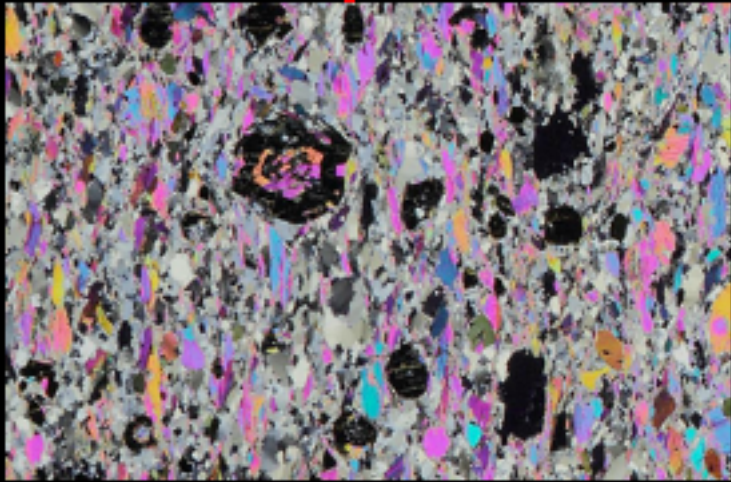
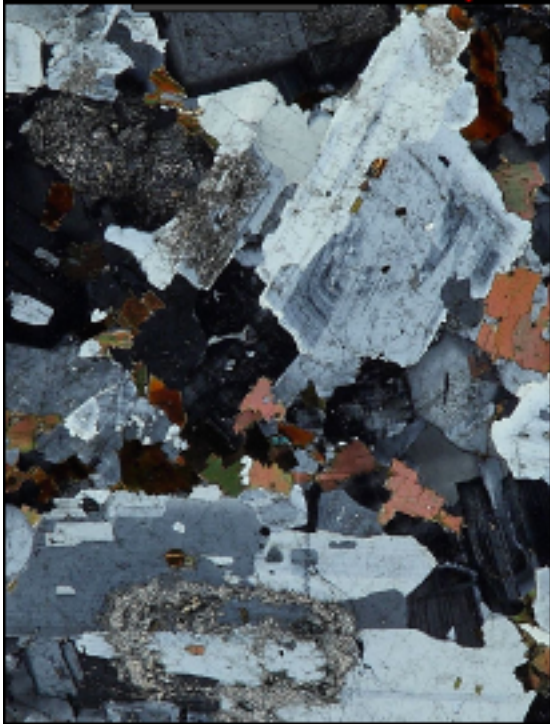
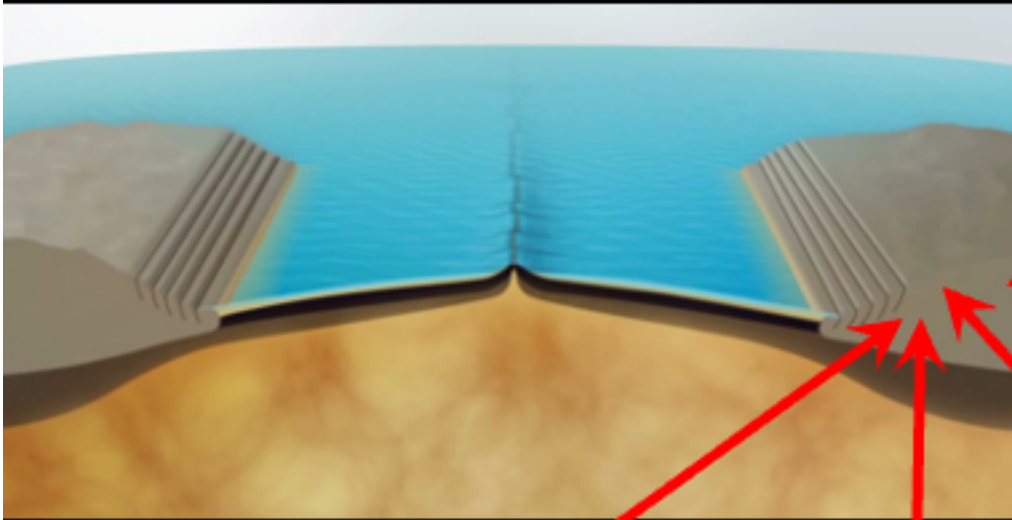
granato

quarzo

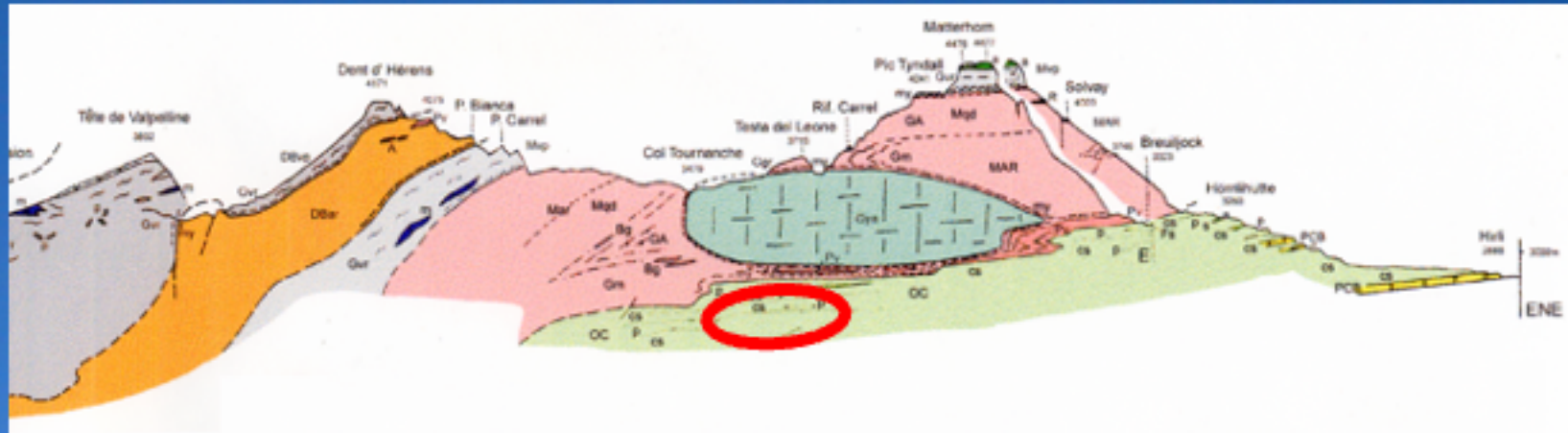
sillimanite







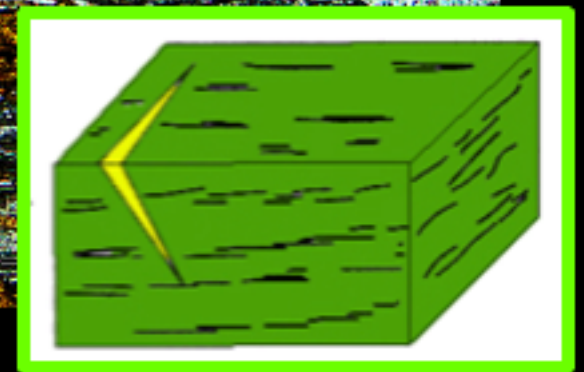
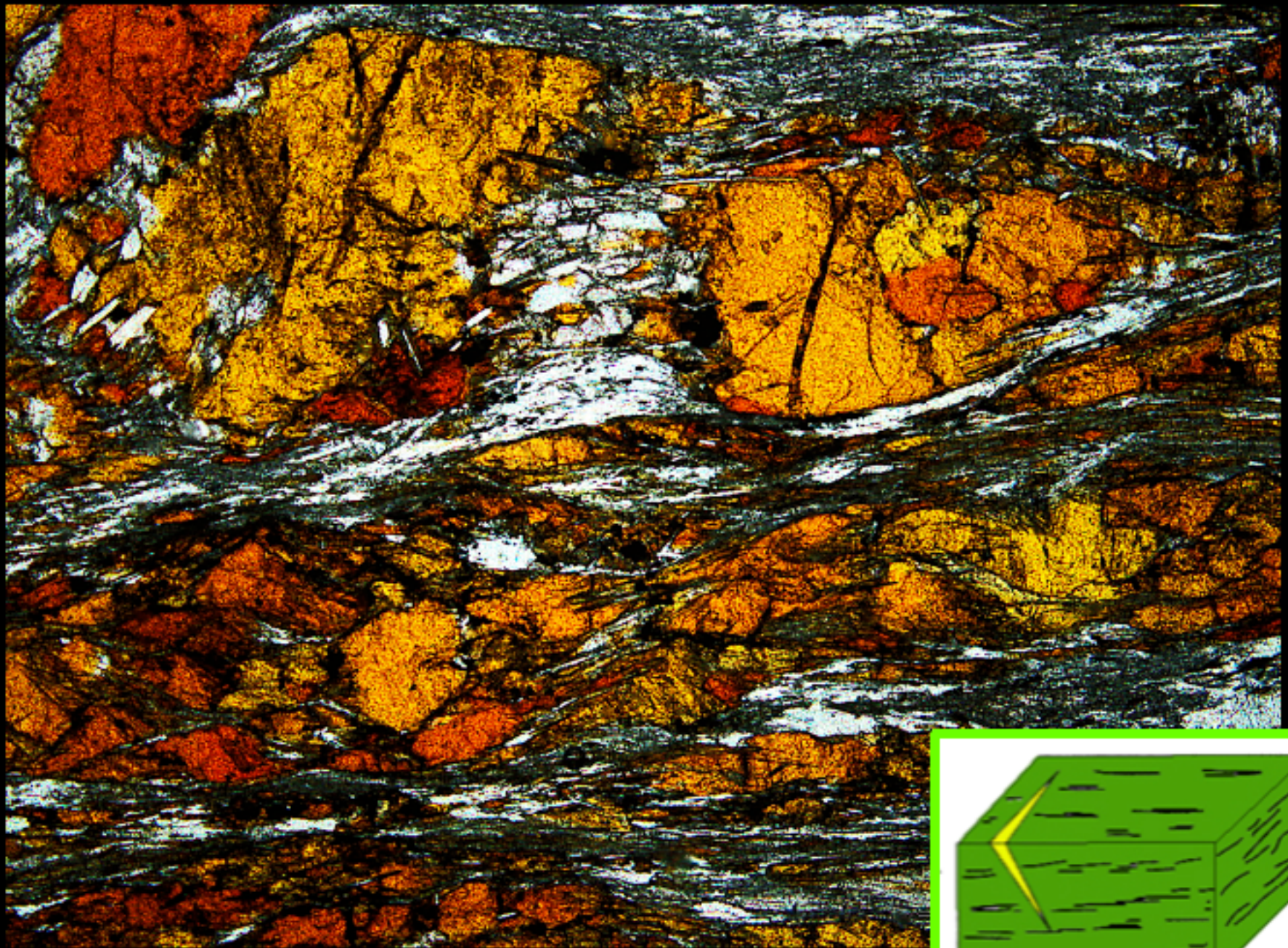




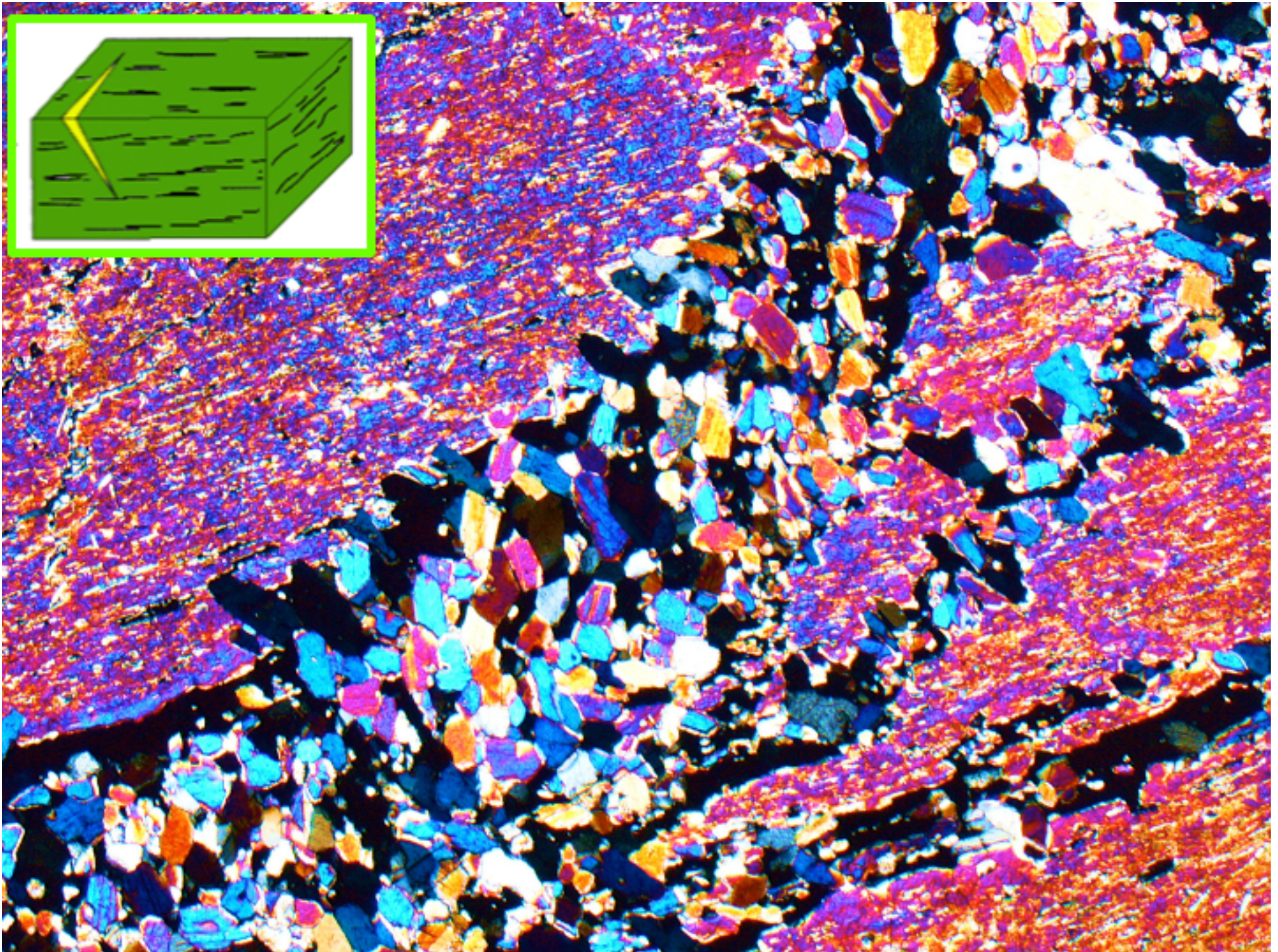




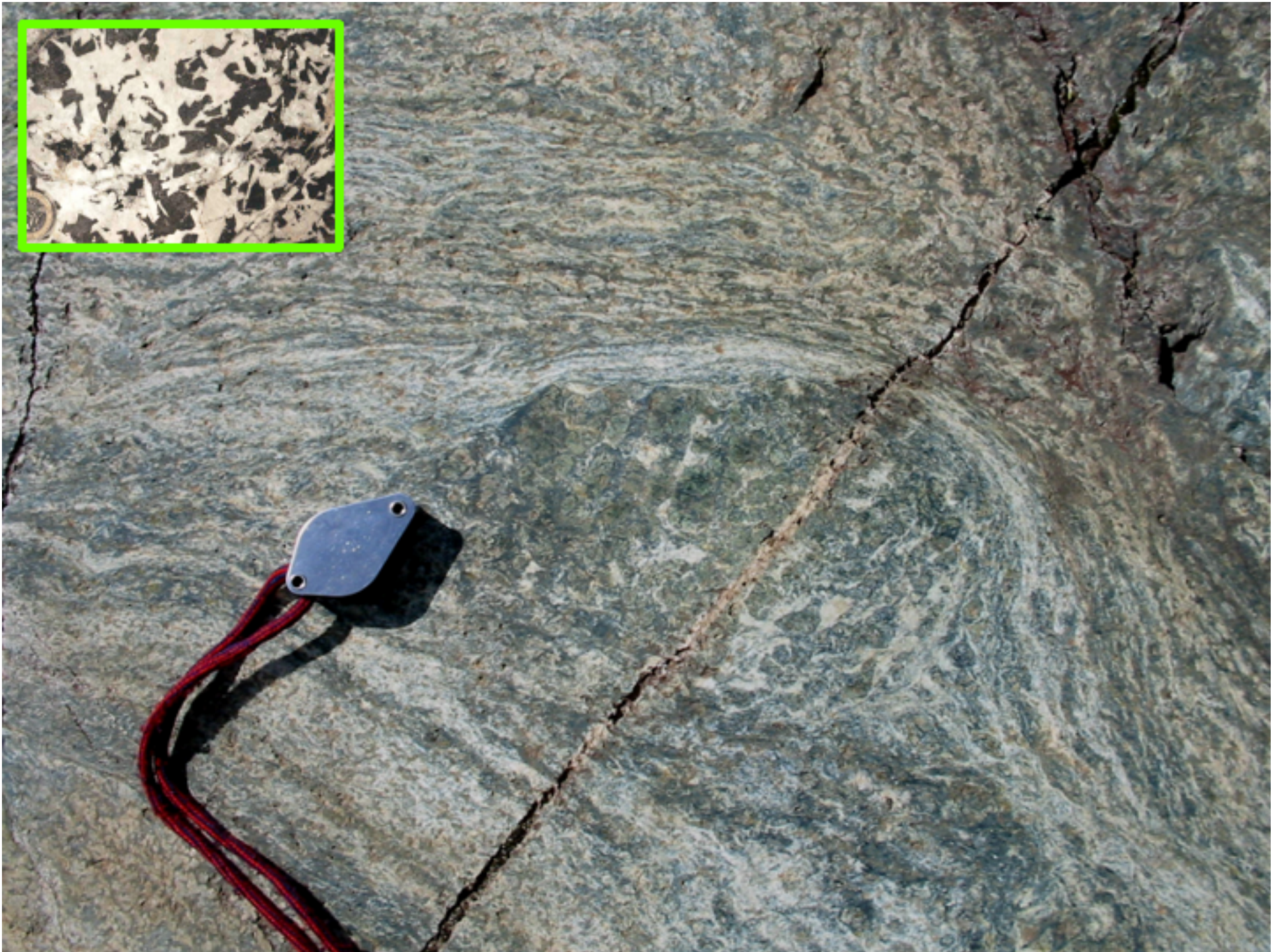




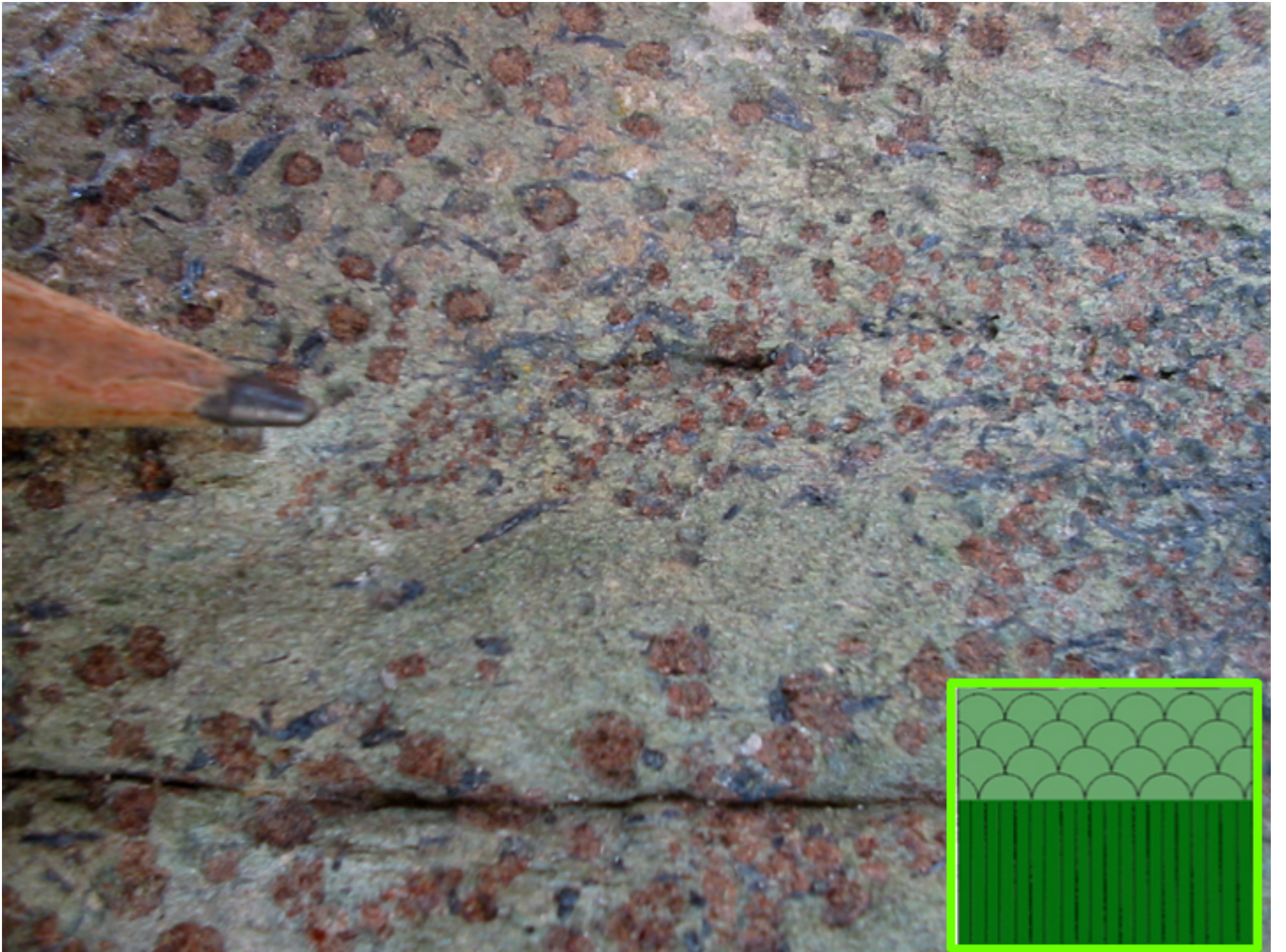




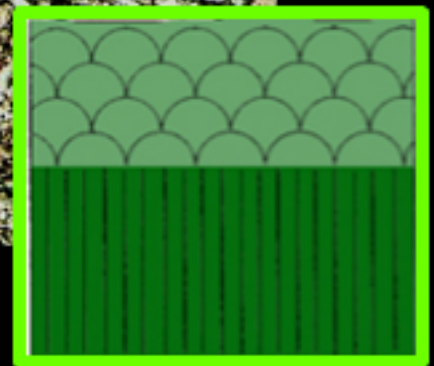
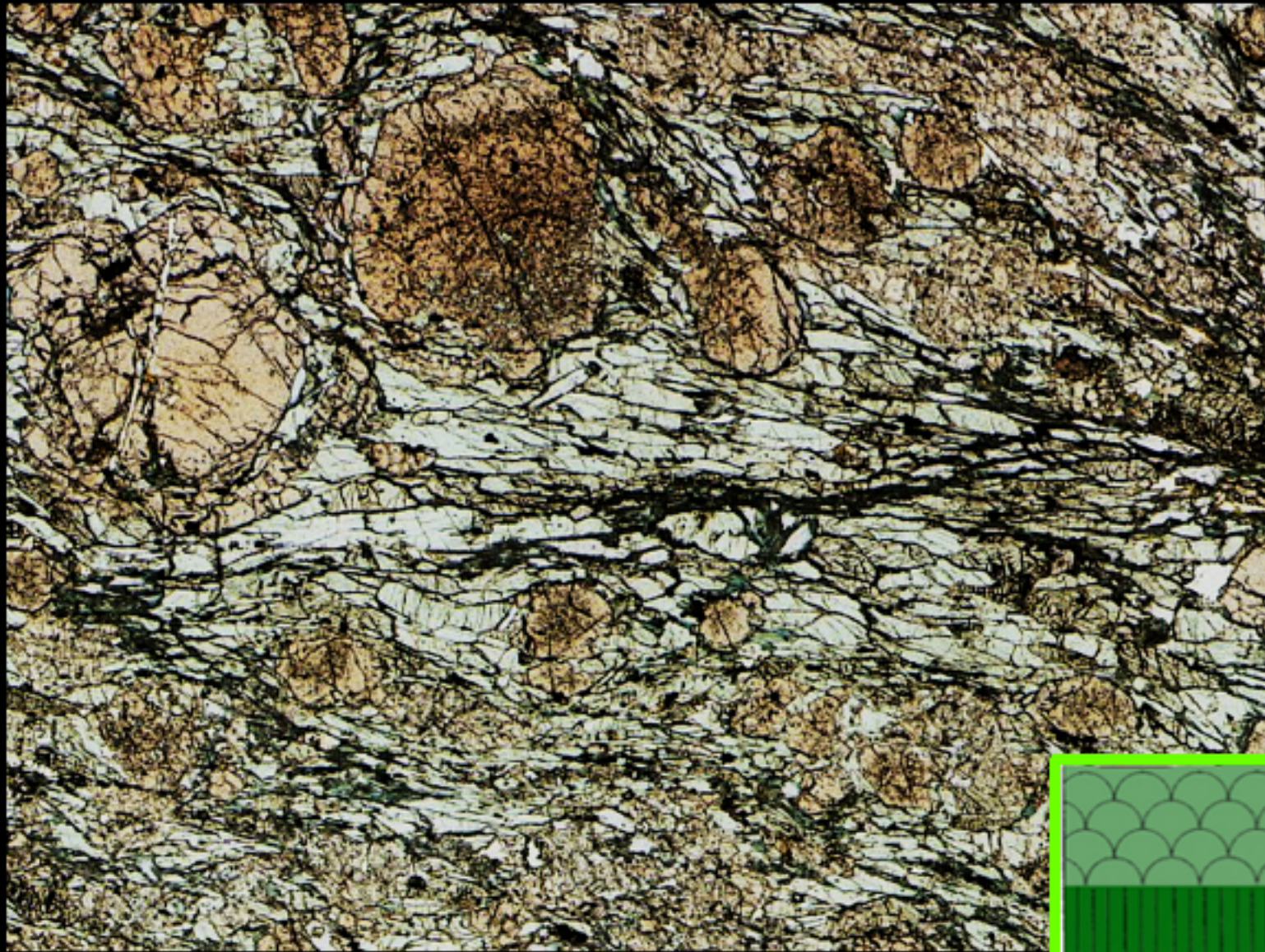




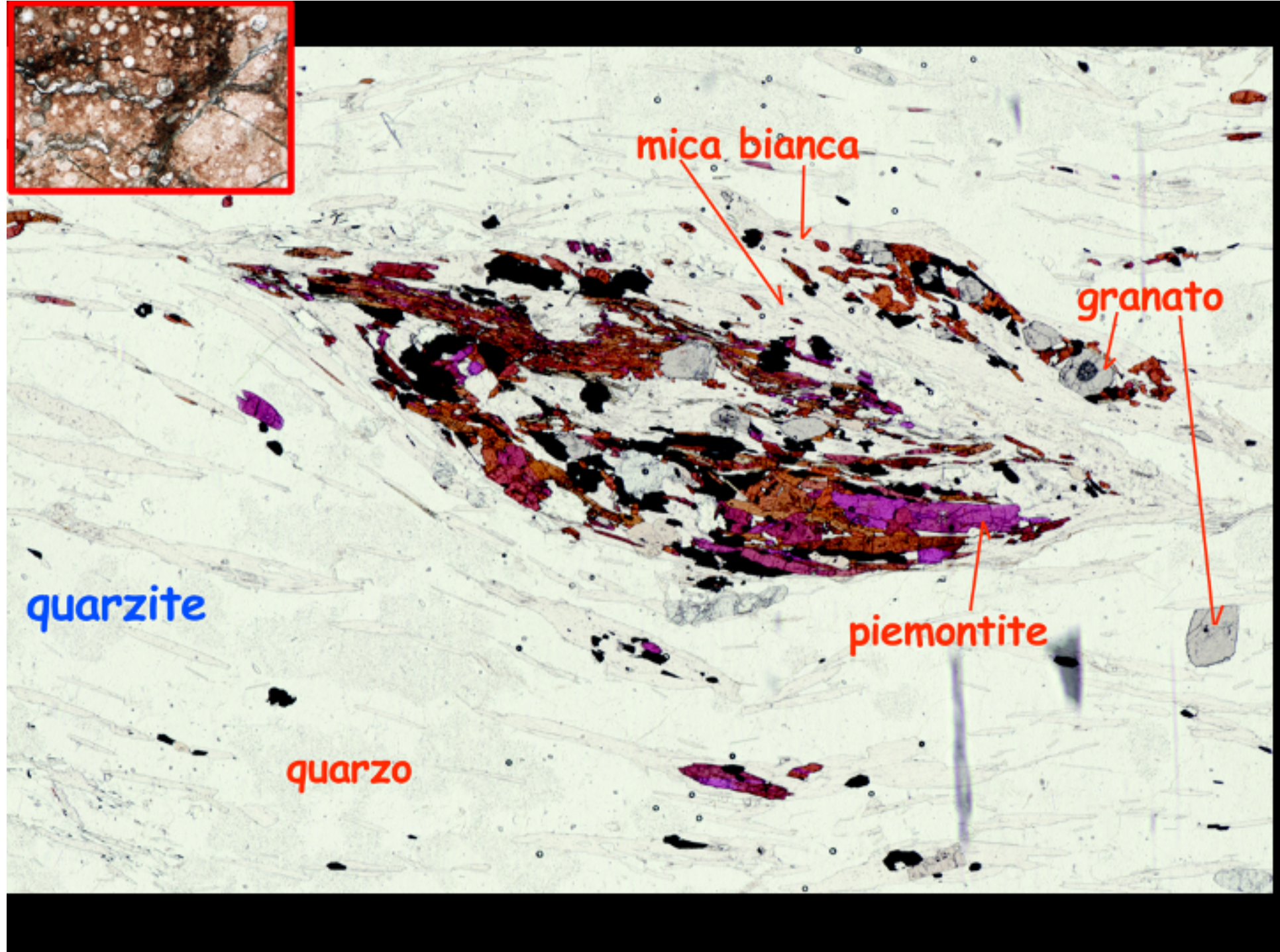
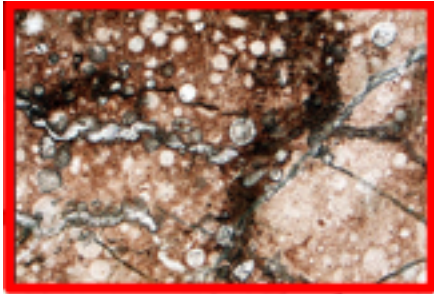












mica bianca

granato

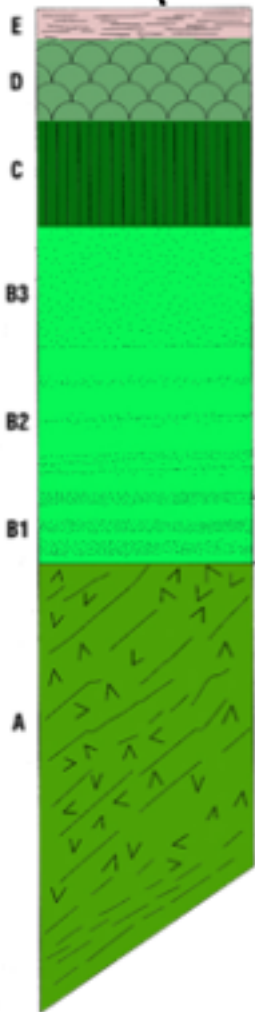
piemontite

quarzite

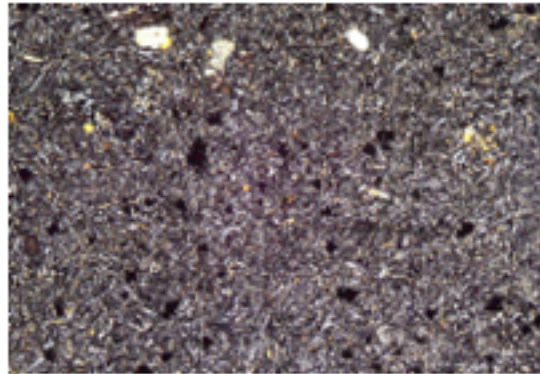
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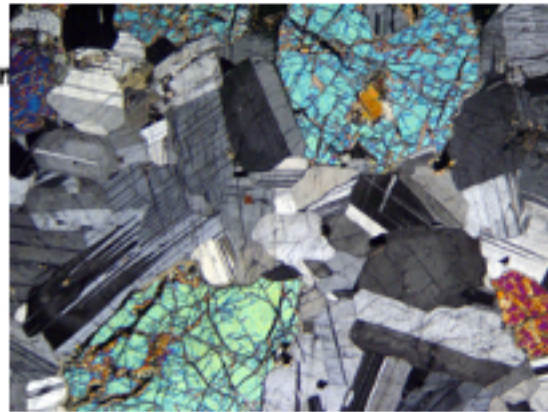
sedimenti



D) Basalti a cuscini



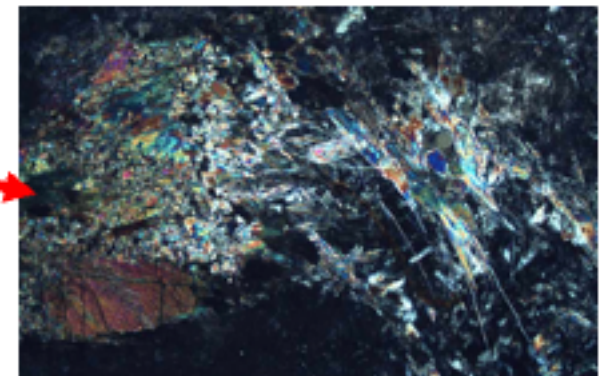
C) Complesso filoniar



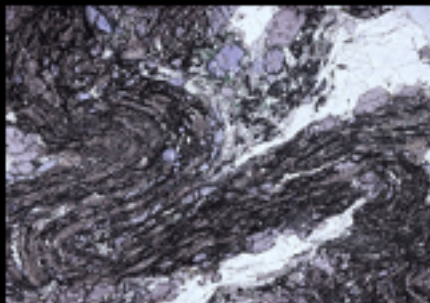
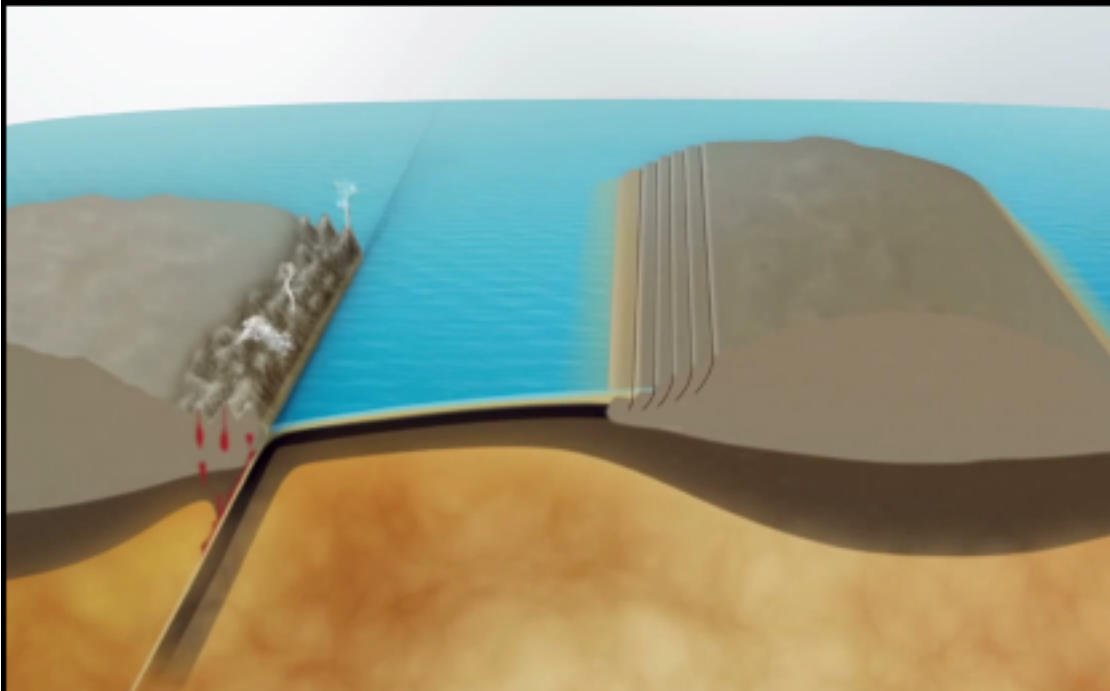
B) Gabbri cumulitici



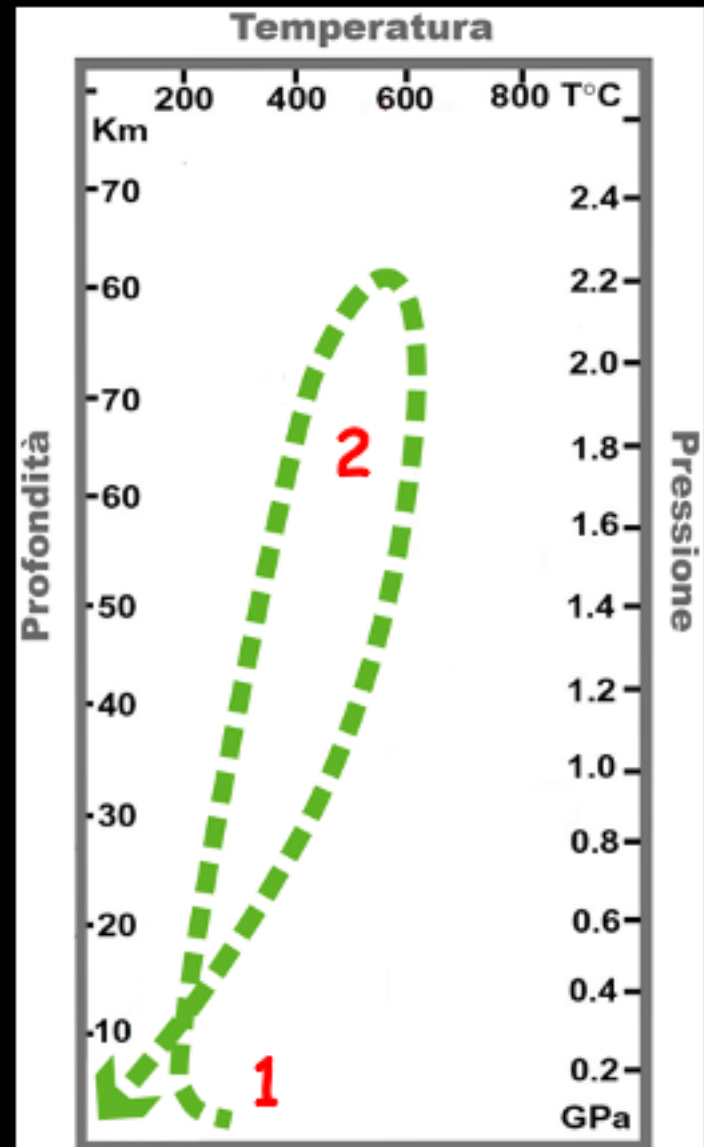
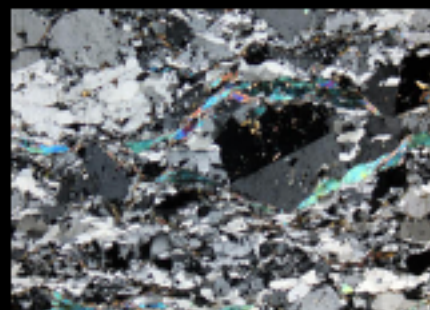
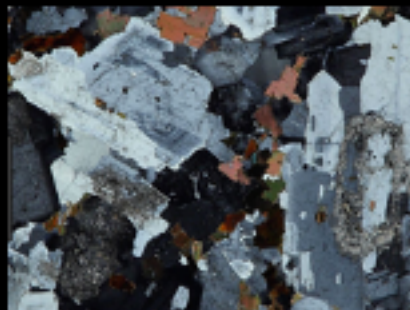
A) Peridotiti tettonitiche



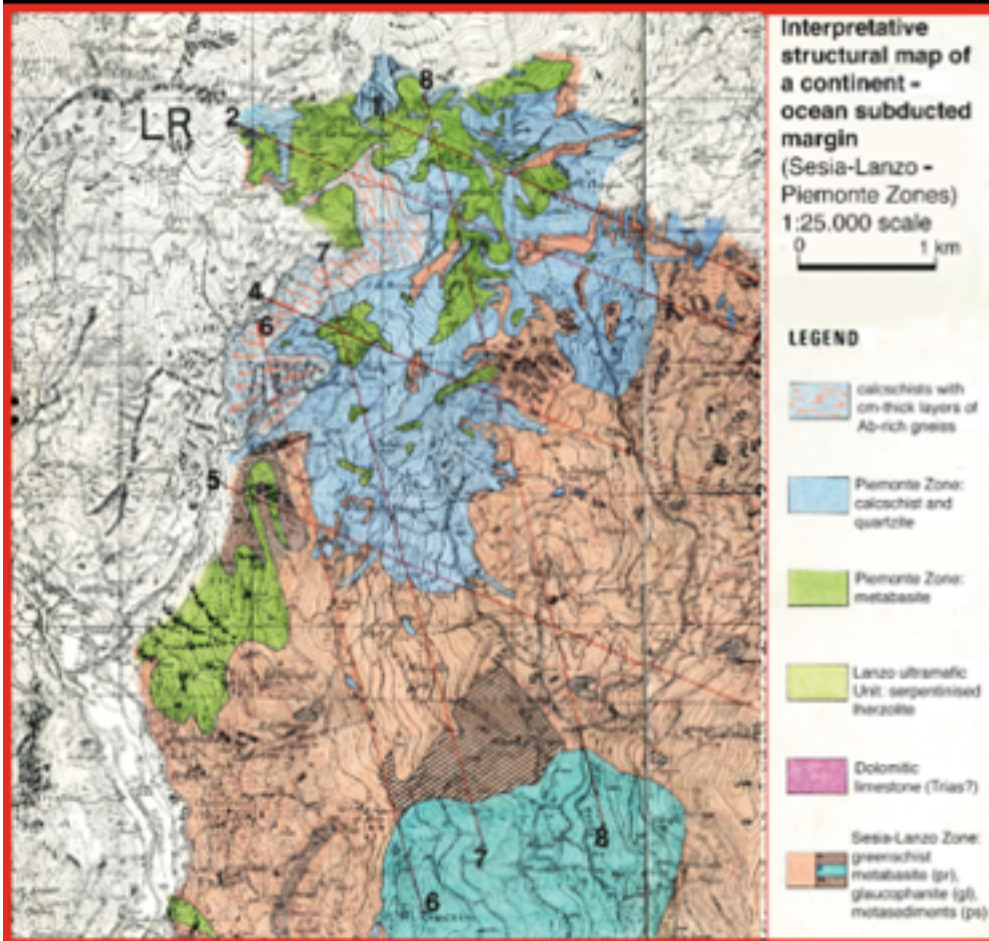




1 2

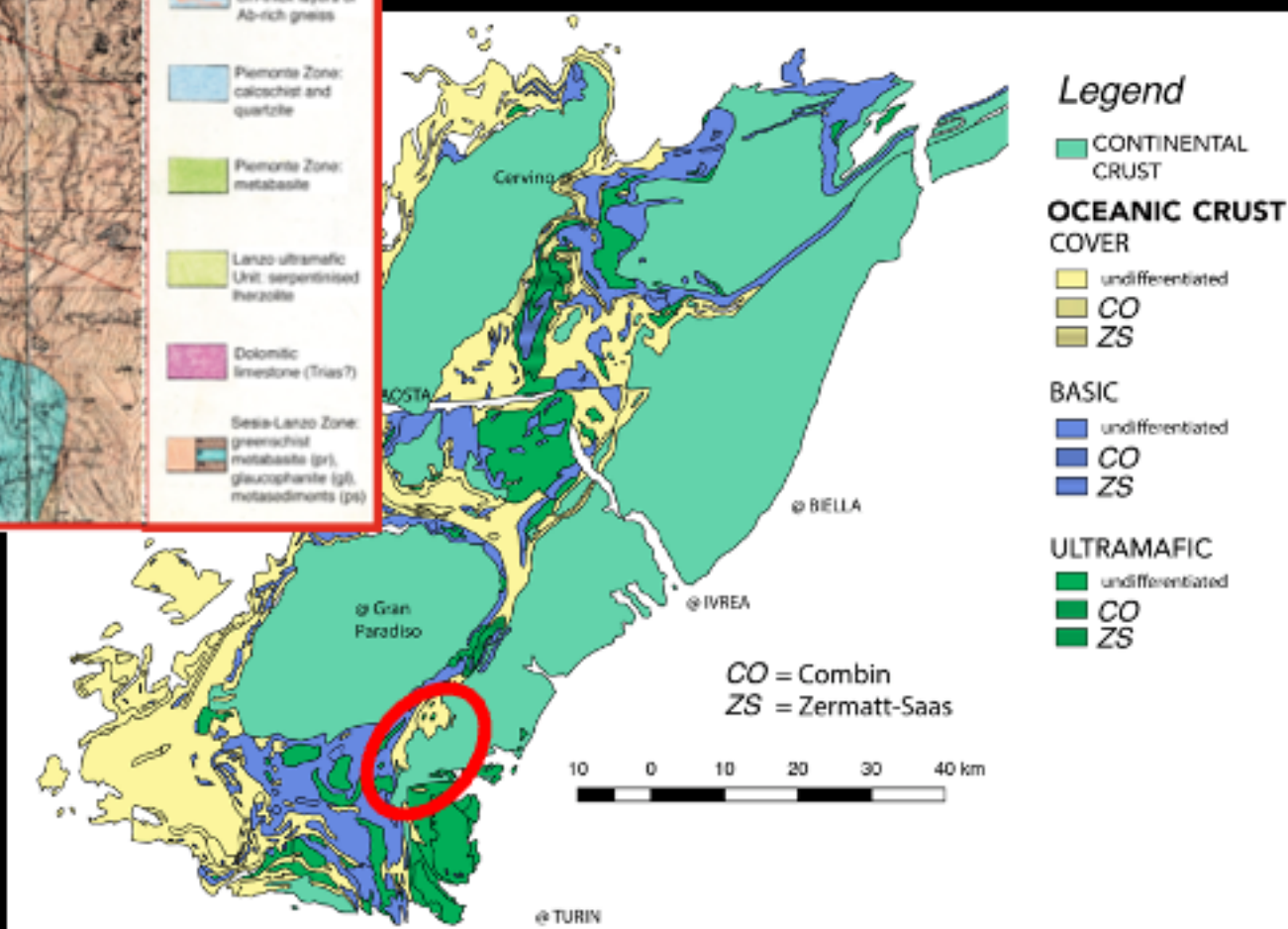






## Zona Piemontese (Oceano):

metasedimenti carbonatici & terrigeni, quarziti, metabasiti, metagabbri, eclogiti, serpentiniti, oficalciti, rodingiti.



## Zona Sesia Lanzo

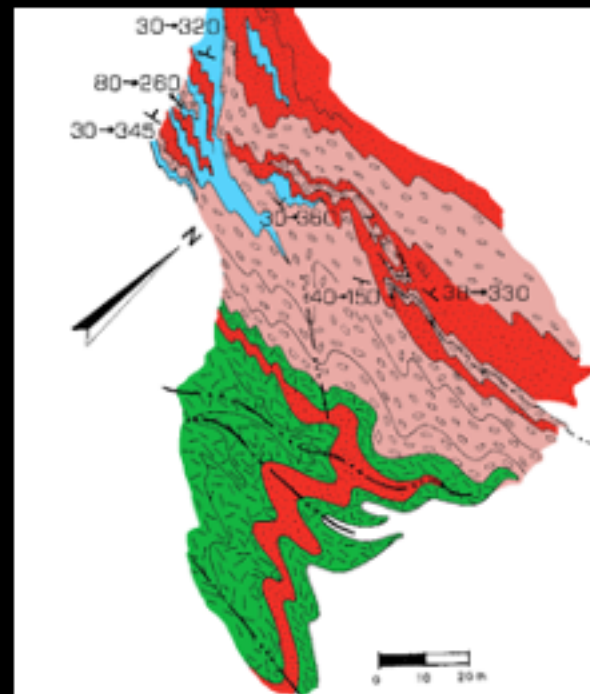
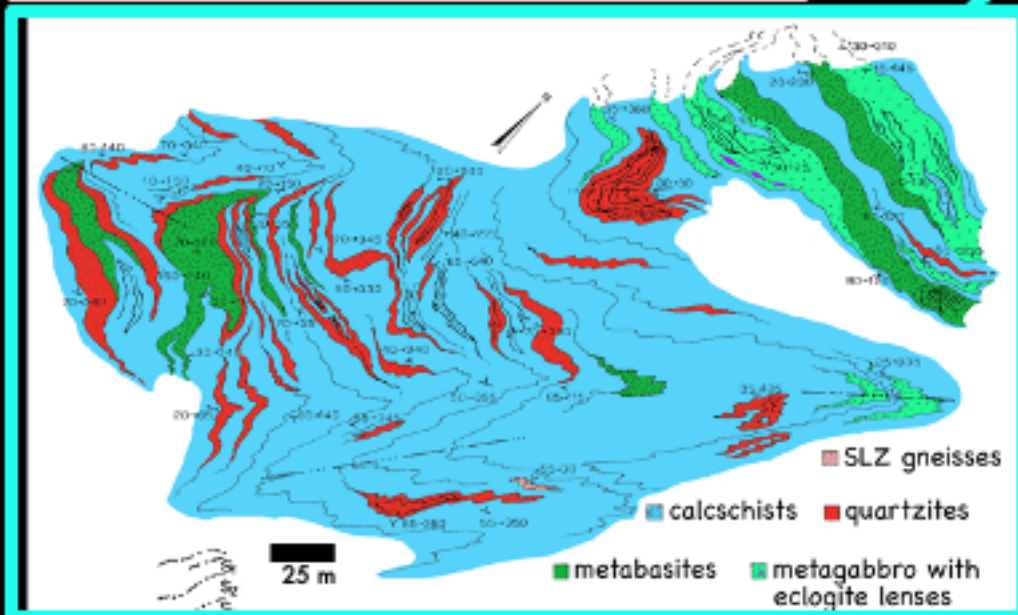
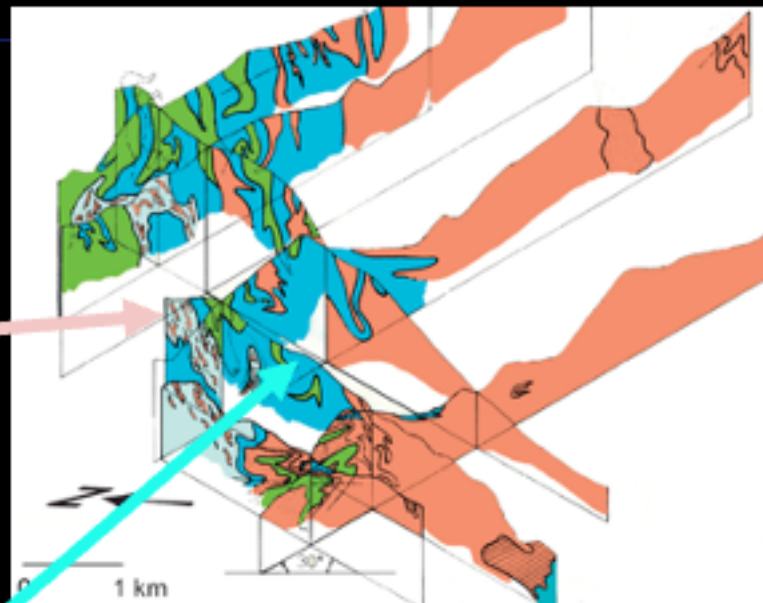
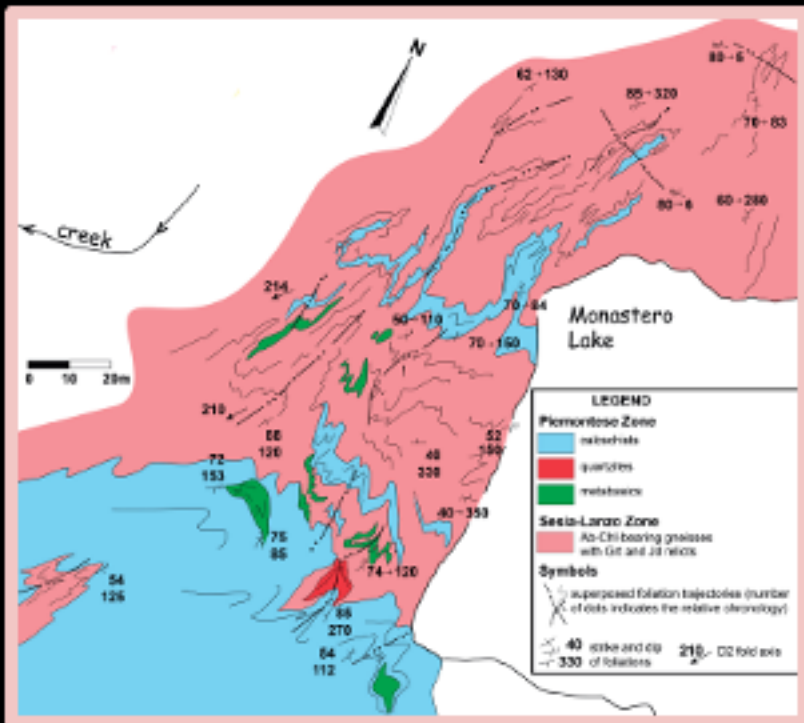
(Adria):

metagranitoidi, metapeliti, metagabbri









Gosso et al. (2015)

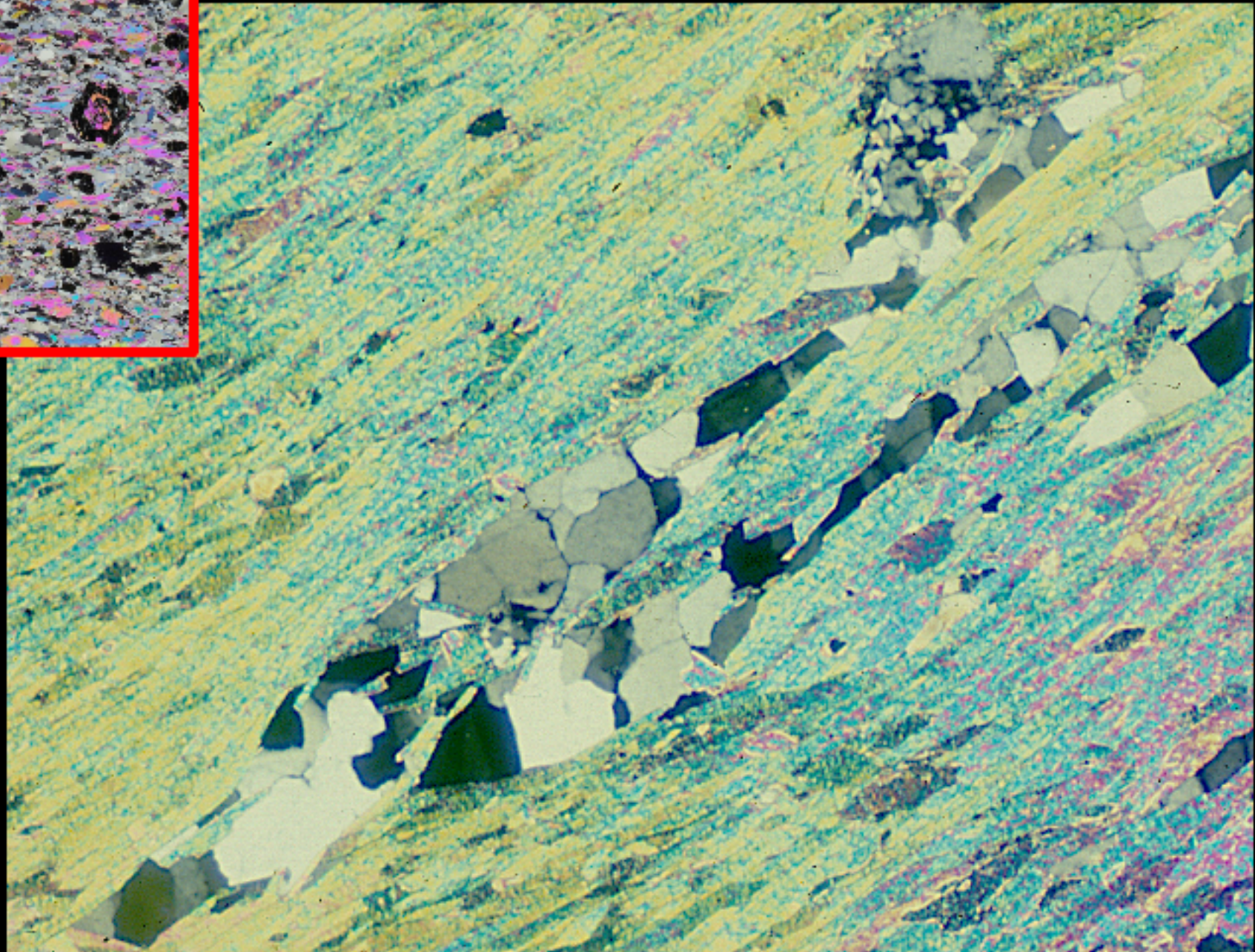
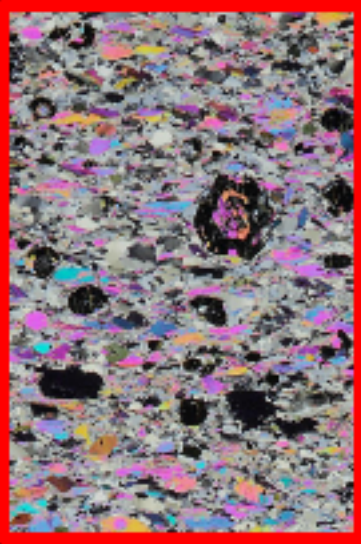




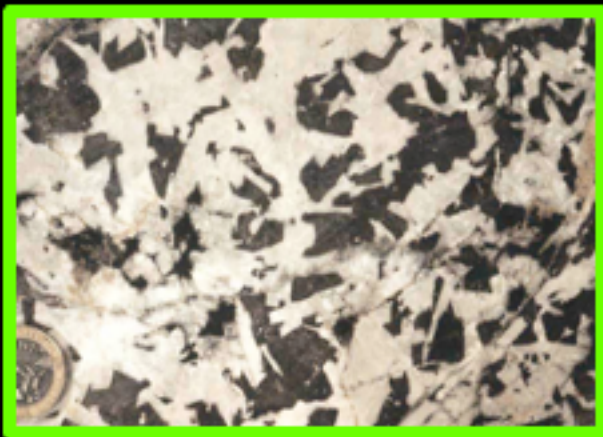
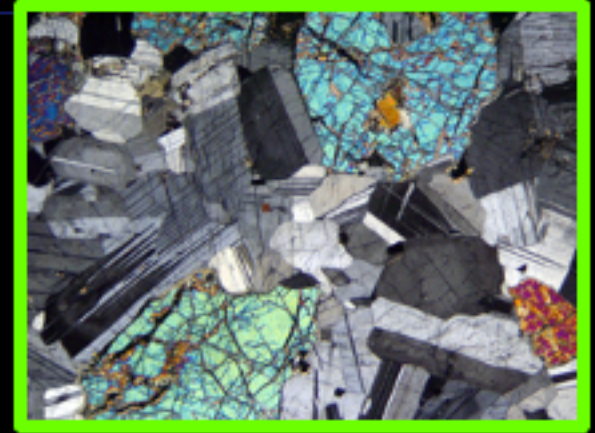








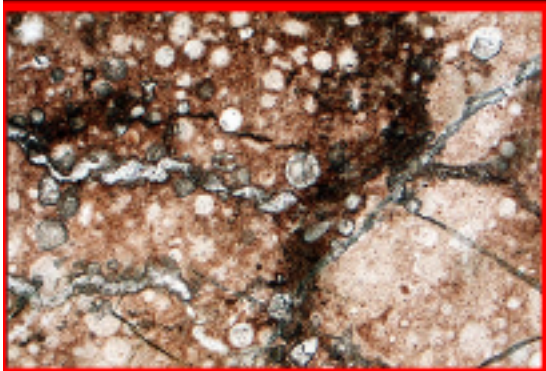




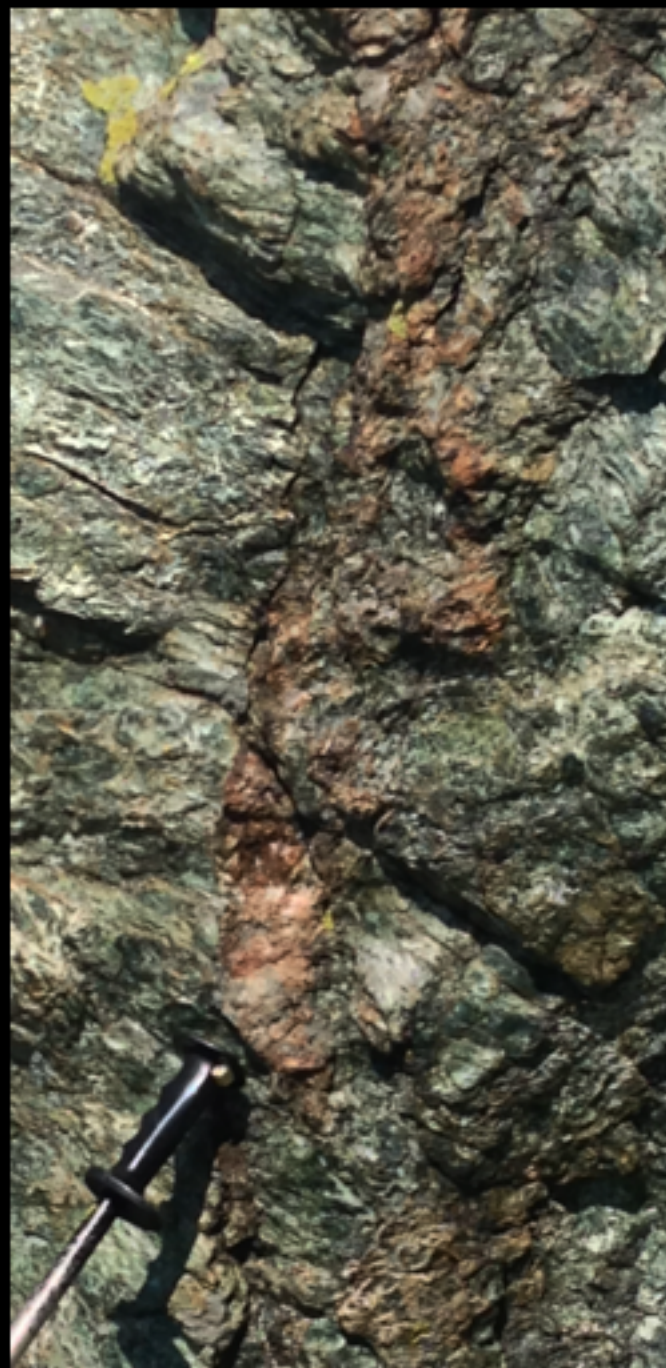
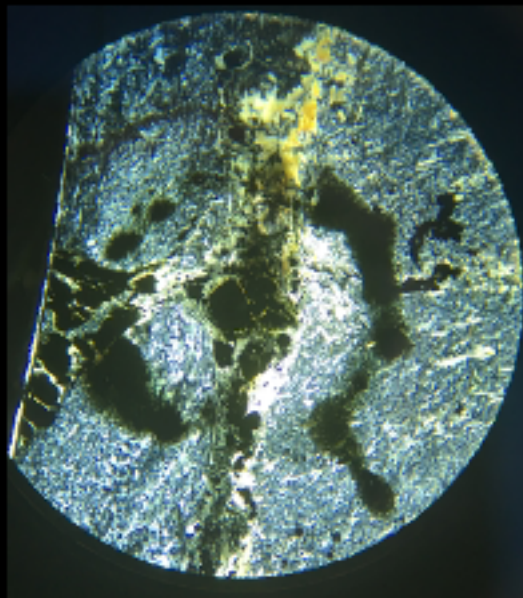
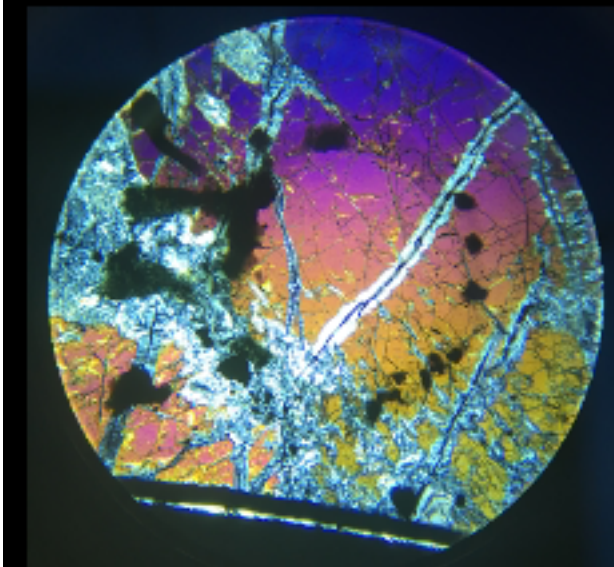
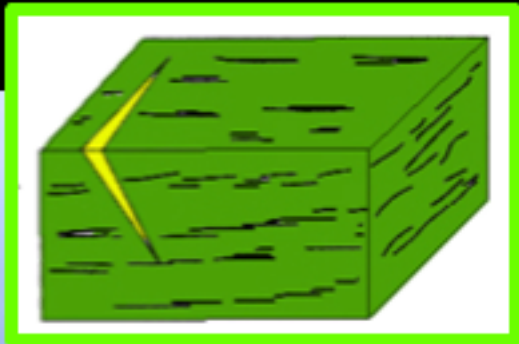




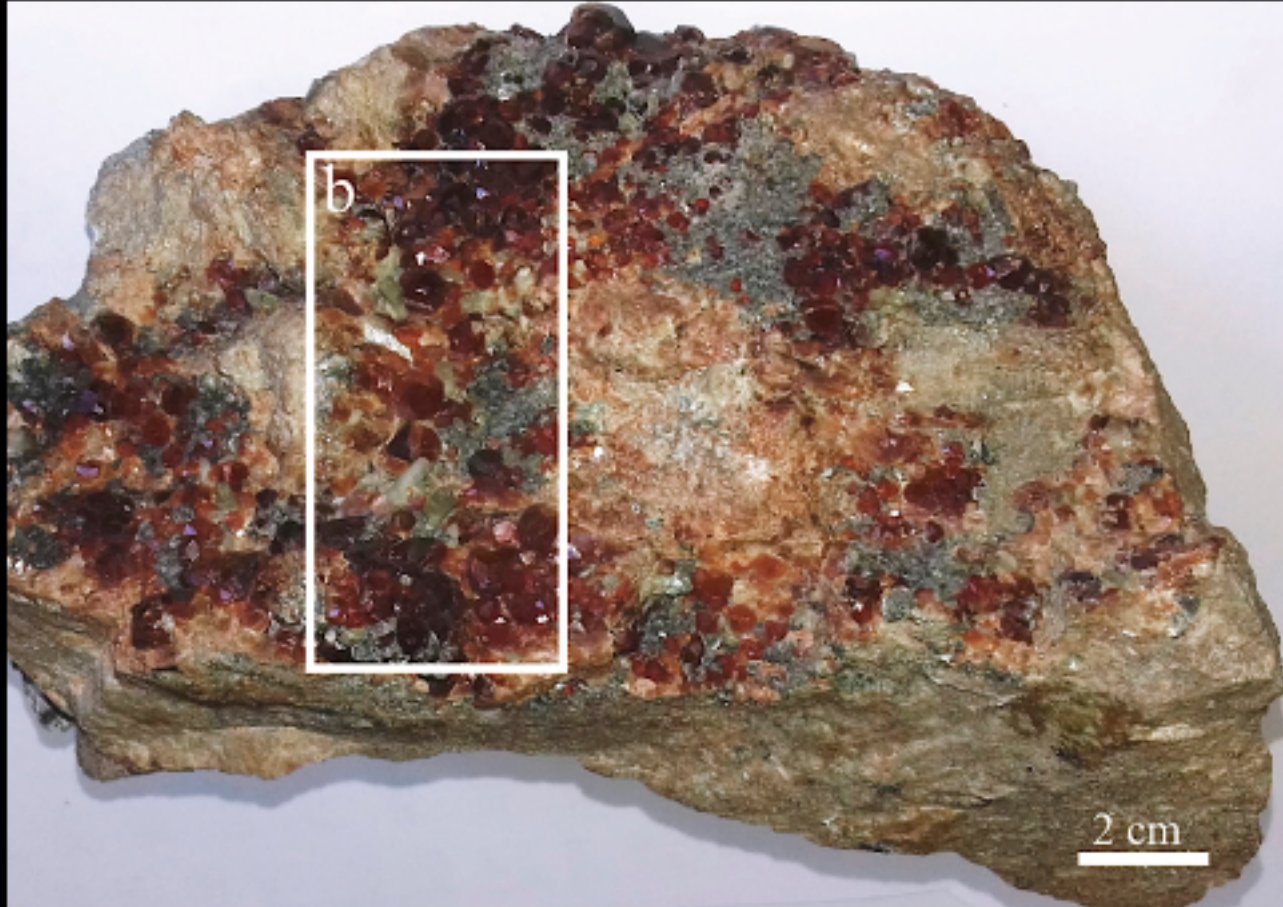




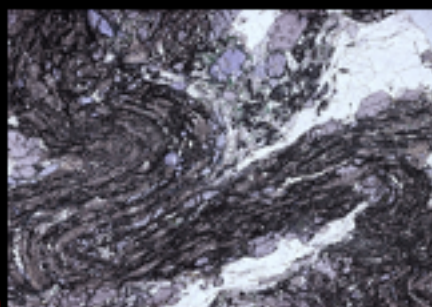
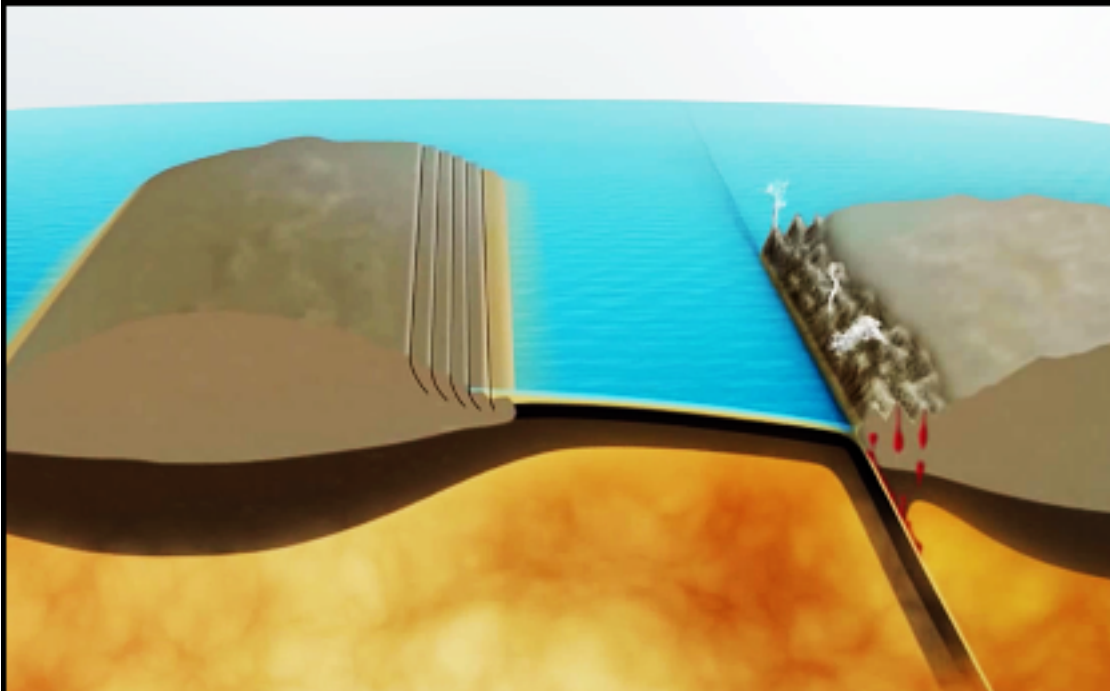




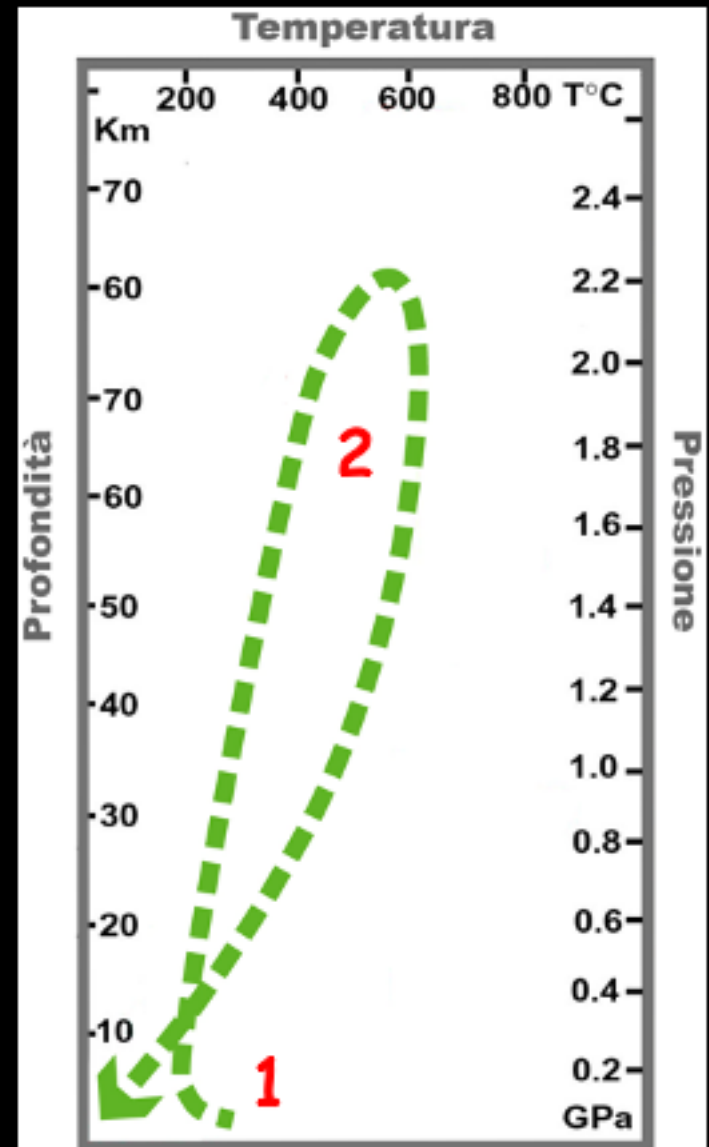
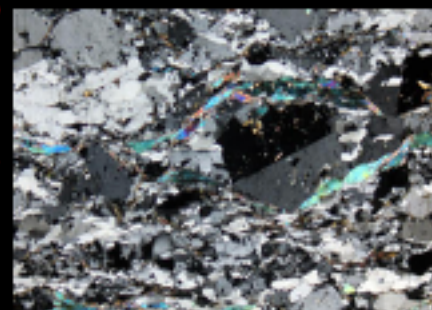
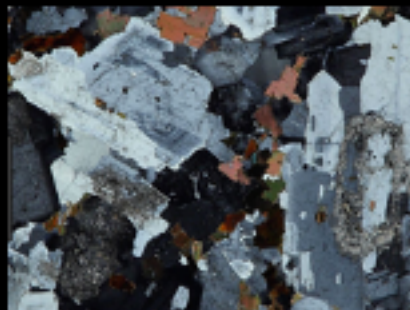






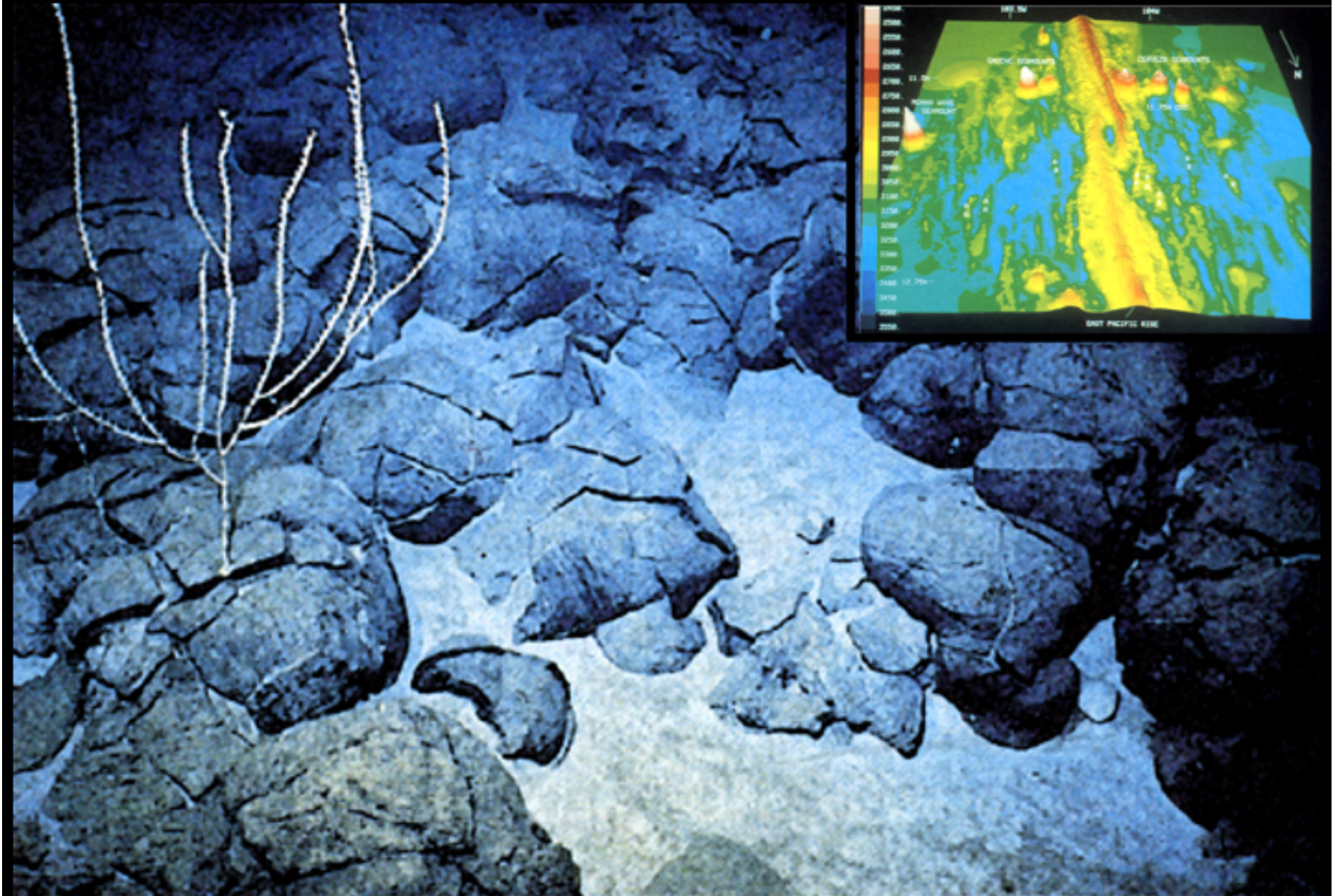


1 2

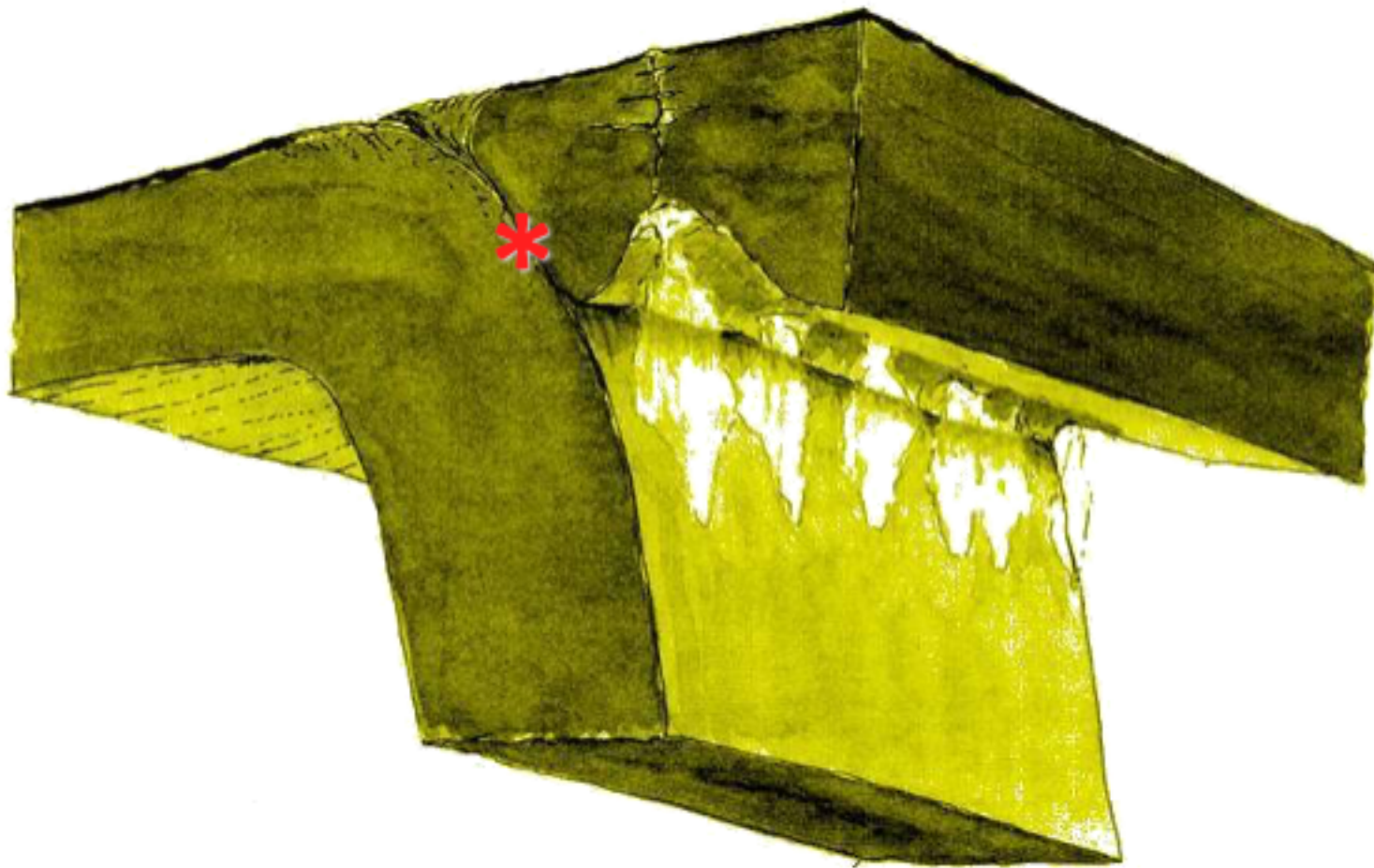




*pillow lavas (lave a cuscino) in una zona di frattura della dorsale Atlantica*



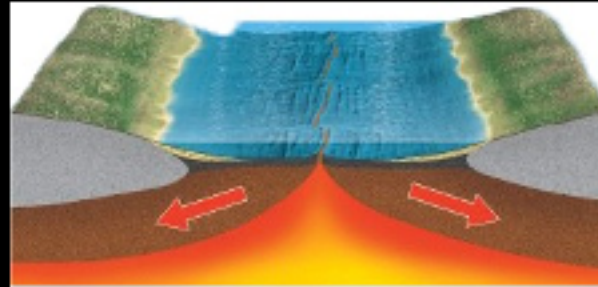




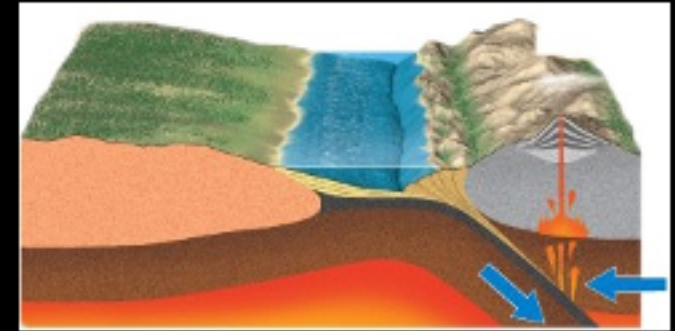
**Metamorfismo di subduzione: durante la subduzione Alpina sono state raggiunte profondità maggiori di 70 km**



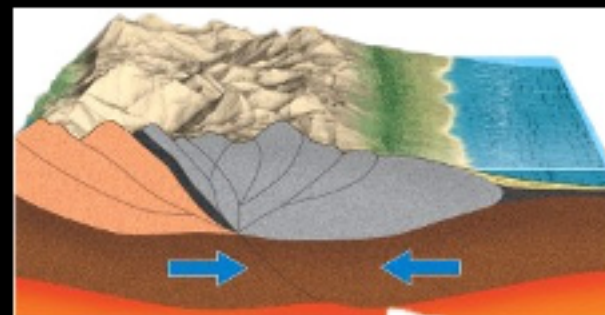
**Formazione della crosta oceanica ( da ~ 170 Ma)**



**Subduzione di crosta oceanica e continentale (110-40 Ma)**



**Collisione continentale (35 Ma)**

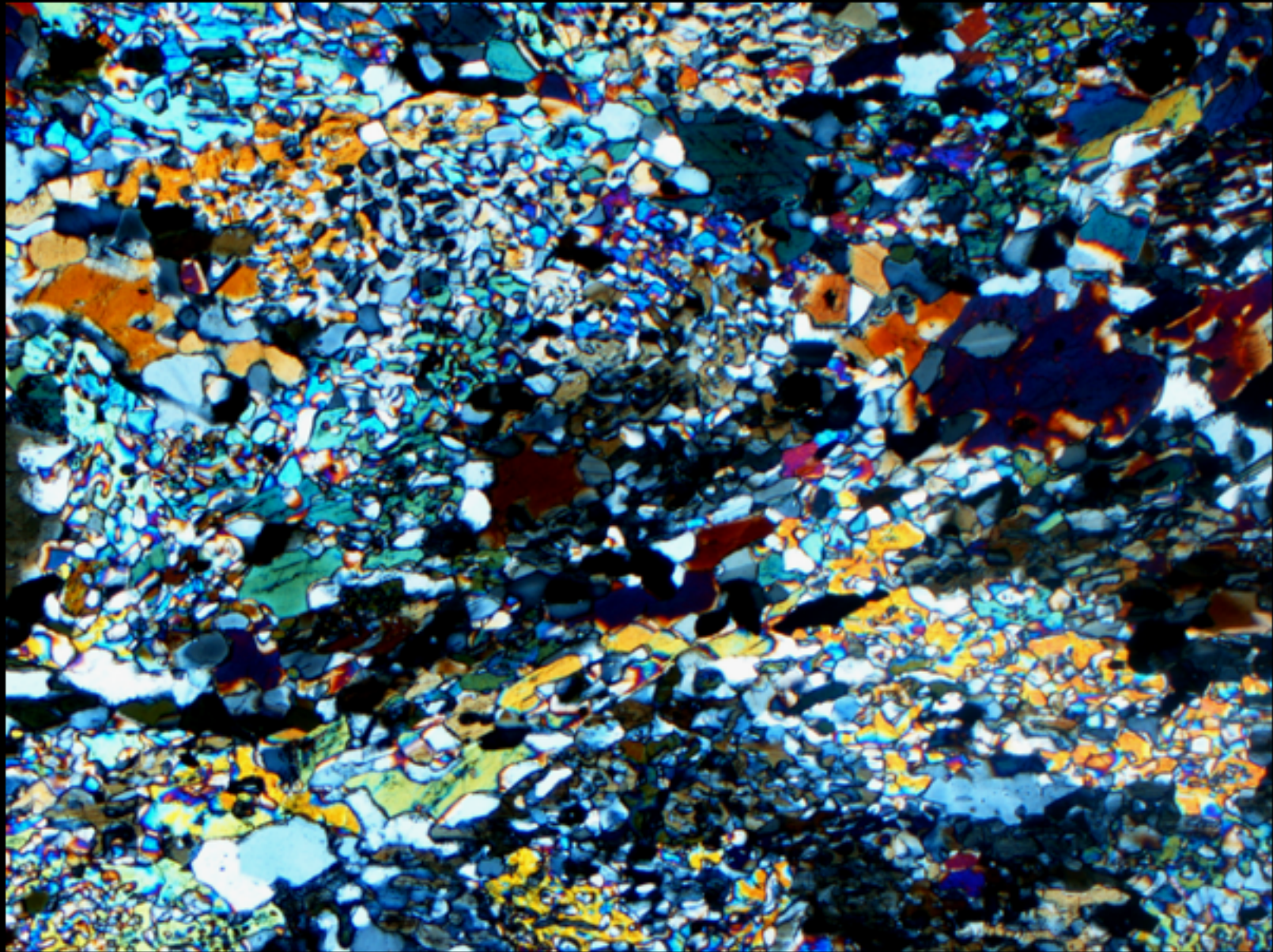


**Esumazione ed esposizione nella zona assiale della catena**





L'Argentera...







# INTERNATIONAL STRATIGRAPHIC CHART

Comité de la Carte Géologique du Monde  
Commission on the Geological Map of the World

International Union of Geological Sciences

Compiled by Jürgen Retzer, Chairman of the International Commission of Stratigraphy (ICS) with the collaboration of all ICS Subcommissions, A. FAIRBRIDGE (Stratigraphic Scale) and G. G. COPE (ICS-CHRS) (dated by an international working group with J. FAIRBRIDGE, M. B. STUBBS, I. C. BIRCHALL, D. BIRCHALL, J. COOPER, R. PETERSON, J. HARRIS and A. FALICKI, 2004) (2004)



International Commission on Stratigraphy

EDONTHÈME ÉON	ÉRAIÈRE ÈRA	SISTÈME PÉRIODE	SÈRIE ÈPOQUE	STAGE ÂGE	ÂGE en Ma	STAGE NOTATION	SÈRIE NOTATION	SISTÈME NOTATION
PHANÉROZOÏQUE PH	CÉNOZOÏQUE CZ	Quaternaire	HOLOCÈNE	Changhsingien	0	Q	Q	Q
				Würtembergien	0	Q	Q	
			PLÉISTOCÈNE	Caldéens	0.012	Q	Q	
				Gébiens	0.012	Q	Q	
		NEOGENÈNE	PLIOCÈNE	Pléistocène	2.58	N	N	
				Éocène	5.3	N	N	
			MIOCÈNE	Miocène	5.3	N	N	
				Pliocène	2.58	N	N	
				Sarmatien	0.2	N	N	
				Langhien	0.012	N	N	
		PALÉOGENÈNE	ÉOLOCÈNE	Chattien	24.5	E	E	
				Burgundien	24.5	E	E	
			ÉOCÈNE	Paléocène	33.9	E	E	
				Yprésien	33.9	E	E	
	Sarmatien			0.2	E	E		
	Lutétien			0.012	E	E		
	MÉSOZOÏQUE MZ	CRÉTACEUX	UPPÉRIÈRE	Maastrichtien	65.5	K	K	
				Campânien	65.5	K	K	
			INFÉRIÈRE	Santonien	85.8	K	K	
				Cenomanien	95.0	K	K	
				Turonien	95.0	K	K	
				Cenomanien	95.0	K	K	
		JURASSIQUE	UPPÉRIÈRE	Albien	100.0	J	J	
				Aptien	100.0	J	J	
			INFÉRIÈRE	Santonien	135.0	J	J	
				Hauteriviens	155.0	J	J	
		TRIASSIQUE	UPPÉRIÈRE	Tithonien	199.0	T	T	
				Keokoukien	199.0	T	T	
INFÉRIÈRE			Norian	201.0	T	T		
			Carfouien	201.0	T	T		

EDONTHÈME ÉON	ÉRAIÈRE ÈRA	SISTÈME PÉRIODE	SÈRIE ÈPOQUE	STAGE ÂGE	ÂGE en Ma	STAGE NOTATION	SÈRIE NOTATION	SISTÈME NOTATION
PHANÉROZOÏQUE PH	CÉNOZOÏQUE CZ	QUATERNAIRE	HOLOCÈNE	Changhsingien	0	Q	Q	Q
				Würtembergien	0	Q	Q	
			PLÉISTOCÈNE	Caldéens	0.012	Q	Q	
				Gébiens	0.012	Q	Q	
		NEOGENÈNE	PLIOCÈNE	Pléistocène	2.58	N	N	
				Éocène	5.3	N	N	
			MIOCÈNE	Miocène	5.3	N	N	
				Pliocène	2.58	N	N	
				Sarmatien	0.2	N	N	
				Langhien	0.012	N	N	
		PALÉOGENÈNE	ÉOLOCÈNE	Chattien	24.5	E	E	
				Burgundien	24.5	E	E	
			ÉOCÈNE	Paléocène	33.9	E	E	
				Yprésien	33.9	E	E	
	Sarmatien			0.2	E	E		
	Lutétien			0.012	E	E		
	MÉSOZOÏQUE MZ	CRÉTACEUX	UPPÉRIÈRE	Maastrichtien	65.5	K	K	
				Campânien	65.5	K	K	
			INFÉRIÈRE	Santonien	85.8	K	K	
				Cenomanien	95.0	K	K	
				Turonien	95.0	K	K	
				Cenomanien	95.0	K	K	
		JURASSIQUE	UPPÉRIÈRE	Albien	100.0	J	J	
				Aptien	100.0	J	J	
			INFÉRIÈRE	Santonien	135.0	J	J	
				Hauteriviens	155.0	J	J	
		TRIASSIQUE	UPPÉRIÈRE	Tithonien	199.0	T	T	
				Keokoukien	199.0	T	T	
INFÉRIÈRE			Norian	201.0	T	T		
			Carfouien	201.0	T	T		

EDONTHÈME ÉON	ÉRAIÈRE ÈRA	SISTÈME PÉRIODE	SÈRIE ÈPOQUE	STAGE ÂGE	ÂGE en Ma	STAGE NOTATION	SÈRIE NOTATION	SISTÈME NOTATION
PHANÉROZOÏQUE PH	CÉNOZOÏQUE CZ	QUATERNAIRE	HOLOCÈNE	Changhsingien	0	Q	Q	Q
				Würtembergien	0	Q	Q	
			PLÉISTOCÈNE	Caldéens	0.012	Q	Q	
				Gébiens	0.012	Q	Q	
		NEOGENÈNE	PLIOCÈNE	Pléistocène	2.58	N	N	
				Éocène	5.3	N	N	
			MIOCÈNE	Miocène	5.3	N	N	
				Pliocène	2.58	N	N	
				Sarmatien	0.2	N	N	
				Langhien	0.012	N	N	
		PALÉOGENÈNE	ÉOLOCÈNE	Chattien	24.5	E	E	
				Burgundien	24.5	E	E	
			ÉOCÈNE	Paléocène	33.9	E	E	
				Yprésien	33.9	E	E	
	Sarmatien			0.2	E	E		
	Lutétien			0.012	E	E		
	MÉSOZOÏQUE MZ	CRÉTACEUX	UPPÉRIÈRE	Maastrichtien	65.5	K	K	
				Campânien	65.5	K	K	
			INFÉRIÈRE	Santonien	85.8	K	K	
				Cenomanien	95.0	K	K	
				Turonien	95.0	K	K	
				Cenomanien	95.0	K	K	
		JURASSIQUE	UPPÉRIÈRE	Albien	100.0	J	J	
				Aptien	100.0	J	J	
			INFÉRIÈRE	Santonien	135.0	J	J	
				Hauteriviens	155.0	J	J	
		TRIASSIQUE	UPPÉRIÈRE	Tithonien	199.0	T	T	
				Keokoukien	199.0	T	T	
INFÉRIÈRE			Norian	201.0	T	T		
			Carfouien	201.0	T	T		

Gondwana

Rodinia

Pangea

Ur

Catena Varisica

Alpi

...to give a clear picture of the present state of the international chronostratigraphic and geochronological scales, including only units recommended for international use. A geographical distribution is made between formal, conventional and informal units.

The 1986 Guidelines of ICS (COOPER et al., 1986) and their recent revision (JURMANSKI et al., 1996) regulate the definition of the international chronostratigraphic/geochronological units. The Revised Guidelines were voted by the full commission of ICS as a mandatory document. Both versions of the guidelines stipulate that the global chronostratigraphic units are not defined by unit-stratigraphy, but their lower boundary only, following the principle introduced with the definition of the base of the Devonian in 1972 (SILVERBERG, 1972). This is the only way to arrive at a global chronostratigraphic scale made of strictly contiguous units.

Phanerozoic global chronostratigraphic boundaries are formally defined by a Global Standard Stratigraphic Section and Point (GSSSP - COOPER et al., 1986), whereas Precambrian chronostratigraphic boundaries are formally defined in terms of absolute ages. Global Standard Stratigraphic Age (GSSSA - JURMANSKI et al., 1996). In order to become mandatory, a boundary definition as to be accepted by GSSP requires an executive vote, first by the working group responsible for the choice of the GSSP, then by the concerned Subcommittee of ICS and finally by the Full Commission of ICS. With its ratification through IUGS, the GSSP or GSSSA becomes mandatory.

FORMAL ENITS (in bold characters) are all the those which have their lower boundary defined by a GSSP or GSSSA voted by ICS in accordance with the Guidelines and ratified by IUGS. Proposed GSSPs (in bold italic) are pending ratification. INFORMAL ENITS (normal characters) formal Subcommissions are formally defined in terms of absolute ages. Global Standard Stratigraphic Age (GSSSA - JURMANSKI et al., 1996). In order to become mandatory, a boundary definition as to be accepted by GSSP requires an executive vote, first by the working group responsible for the choice of the GSSP, then by the concerned Subcommittee of ICS and finally by the Full Commission of ICS. With its ratification through IUGS, the GSSP or GSSSA becomes mandatory.

The subdivisions used in the present Global Chart, are based on the proposals made by the concerned Subcommissions. Simplified subdivisions have, however been adopted for the Carboniferous and the Ordovician, in order to maintain the necessary homogeneity of presentation. The complex variants were included in the detailed explanatory notes. Also some traditional names which are becoming obsolete have been retained (Lias, Dogger, Malm in the Jurassic and Tertiary in the Cretaceous) (the latter already abandoned in the first edition of this chart). "Tertiary" can be used as an informal name like Precambrian.

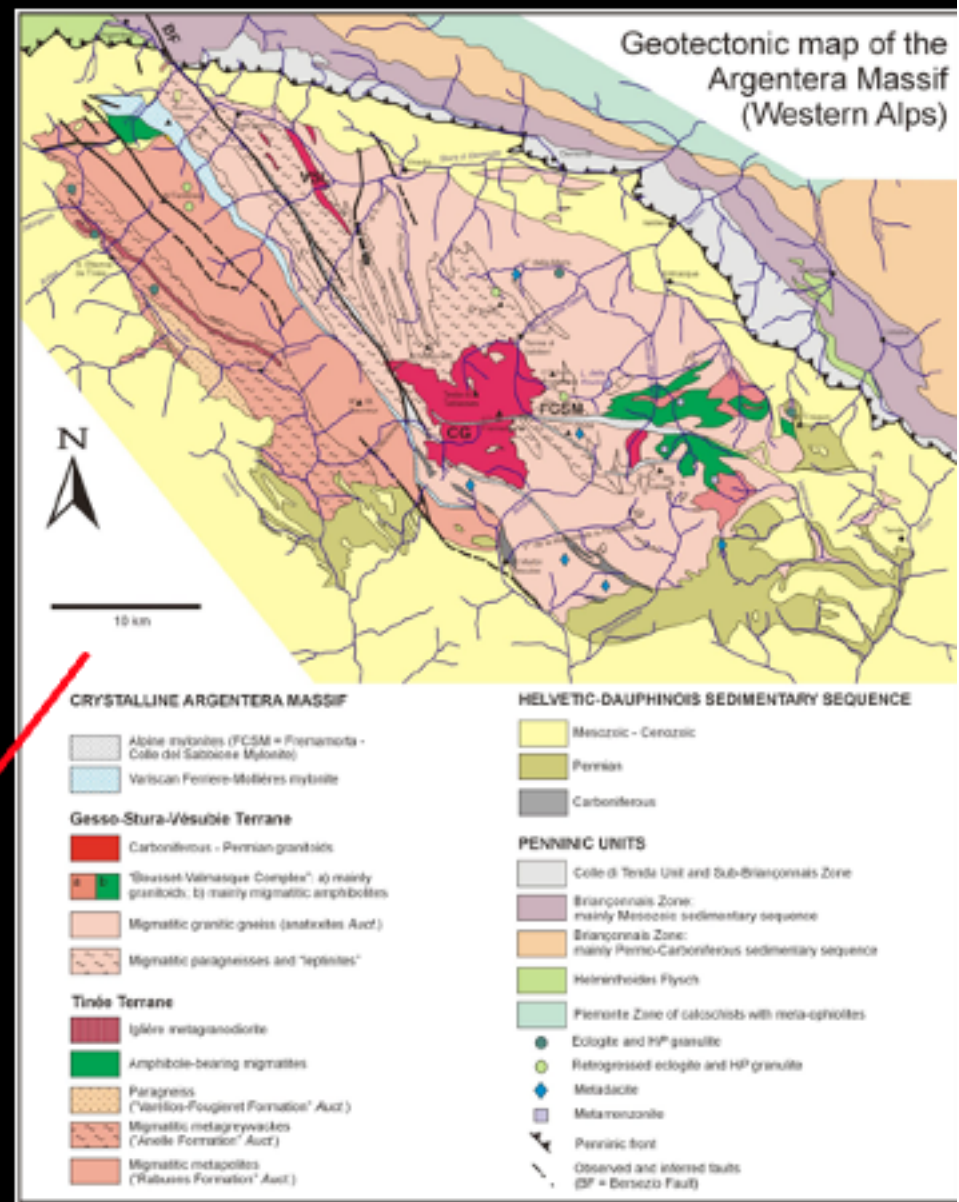
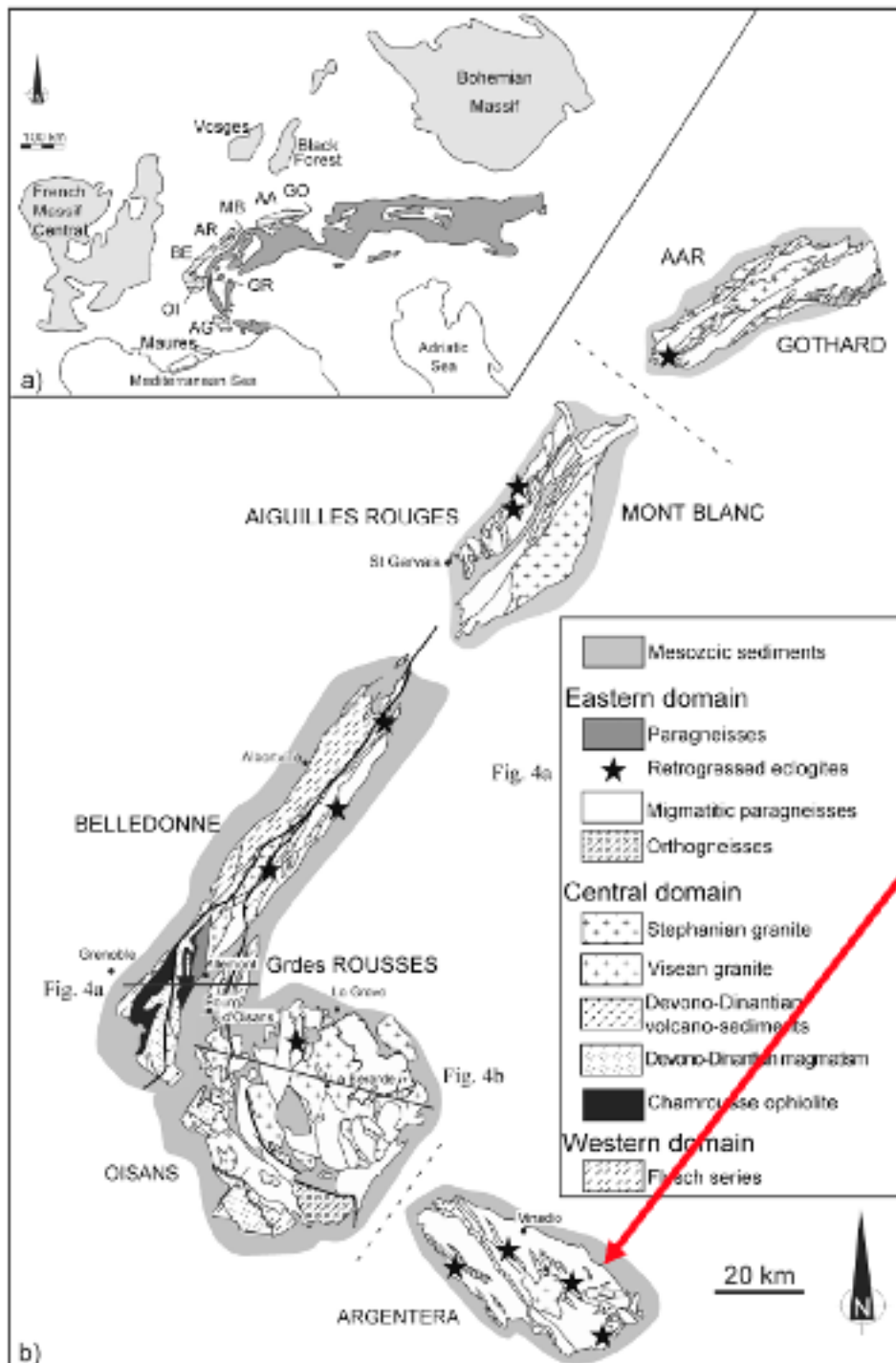
Nominal ages of the Phanerozoic chronostratigraphic boundaries were provided by Subcommission International for Stratigraphy (1975) by Gradstein & Ogg, or other sources, and are subject to revision.

The International Commission on Stratigraphy (ICS) is a body in Geology and the sciences of the individual units are established by the IUGS, taking as a basis the Geological Atlas of the World. This chart is updated periodically during its general assemblies convened within the International Geological Congress and open ratification of GSSPs by IUGS.











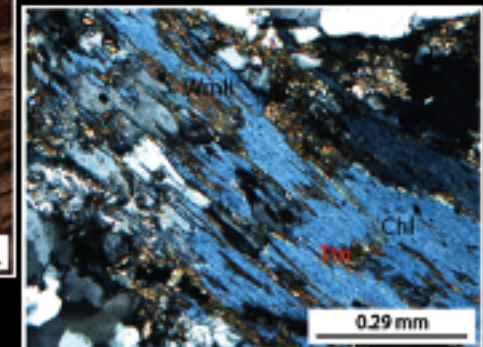
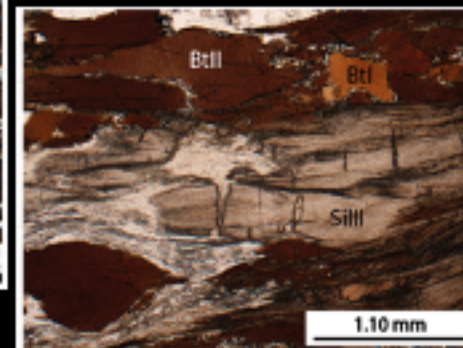
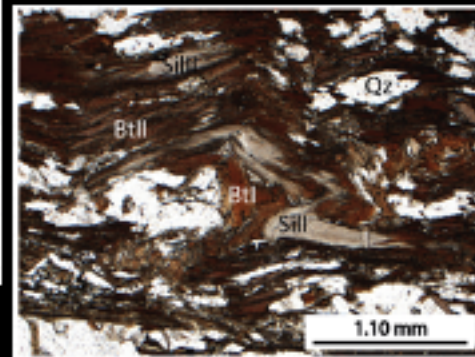
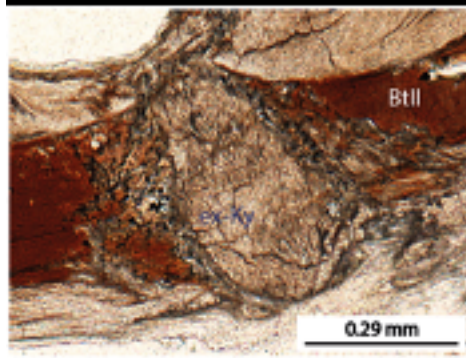




## Migmatiti a Bt: Paragneiss e Ortogneiss migmatitici



Metatessiti a biotite: paragneiss e ortogneiss migmatitici (Lago delle Portette)





## Boudin inclusi nelle migmatiti



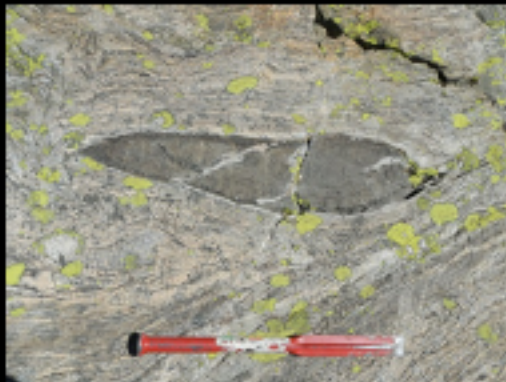
Marmi a silicati



Peridotiti serpentizzate



Talcoscisti a relitti di Amp, Phl, Spl



Anfiboliti



Gneiss ad Amp a grana fine



Eclogiti riequilibrare



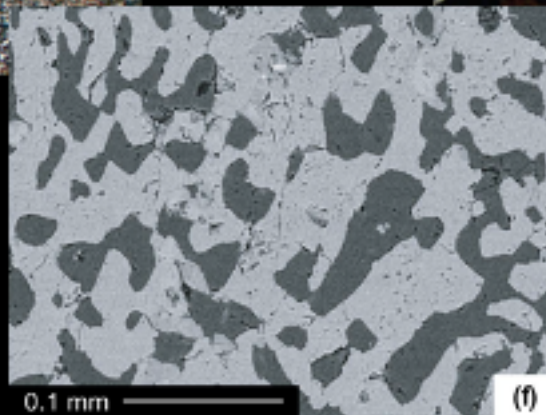
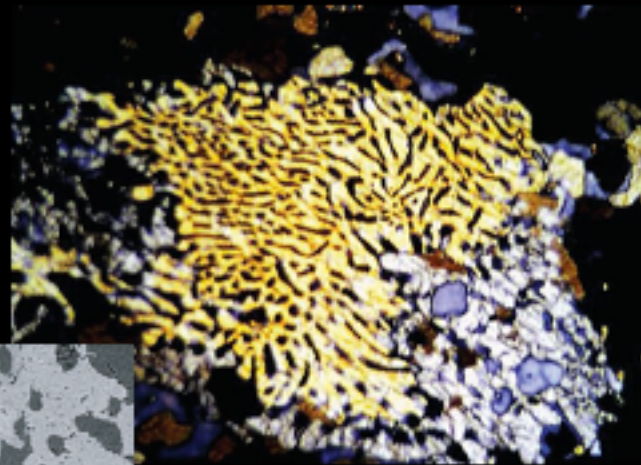
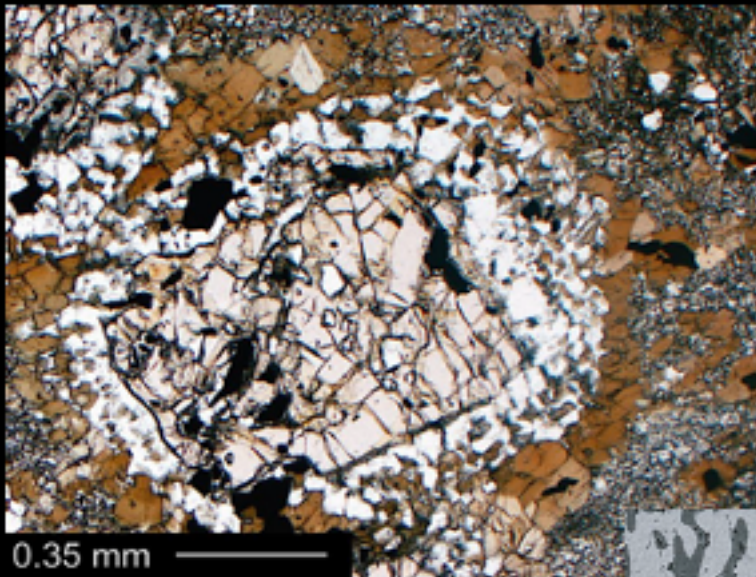
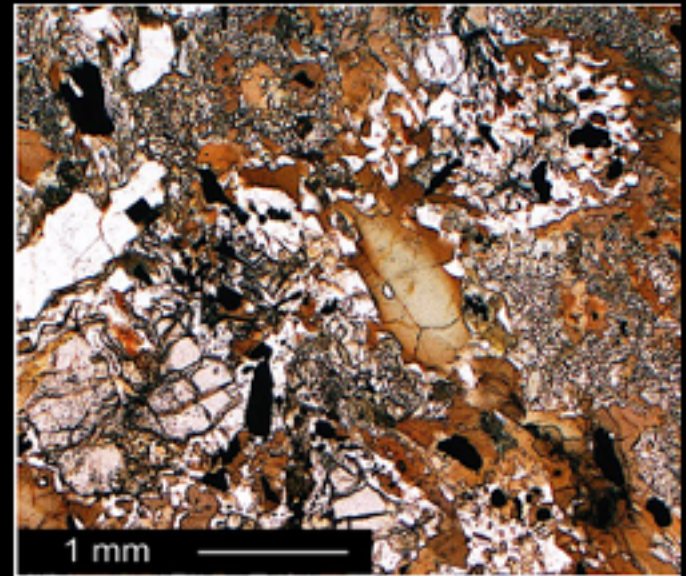
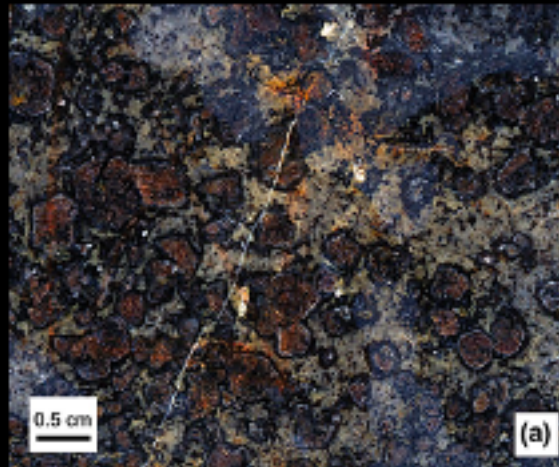
Biotititi



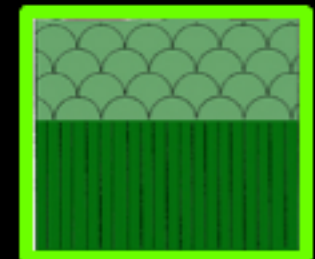
Rocce a silicati di calcio

**Boudin = banche dati  
geologiche!!!**





**Eclogiti riequilibrata**



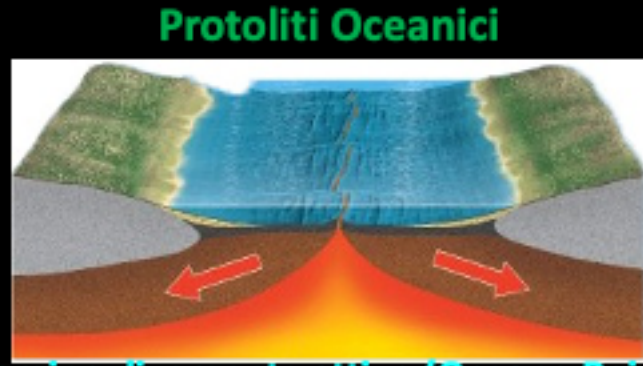




dettaglio della struttura al margine intrusivo del Granito Centrale dell'Argentera alla Testa di Tablasses W; unita' tettonica Elvetico-delfinese-**provenzale** al margine esterno delle Alpi



Rifting e  
apertura della  
Tetide Alpina

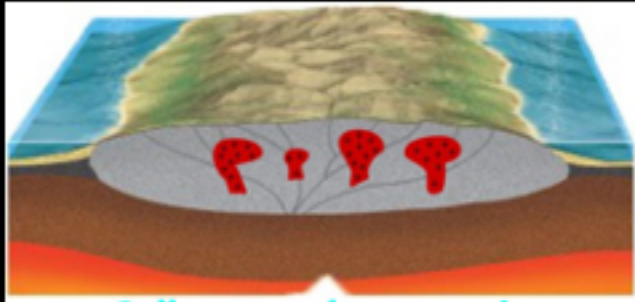


Margine divergente attivo (Oceano Reico?)

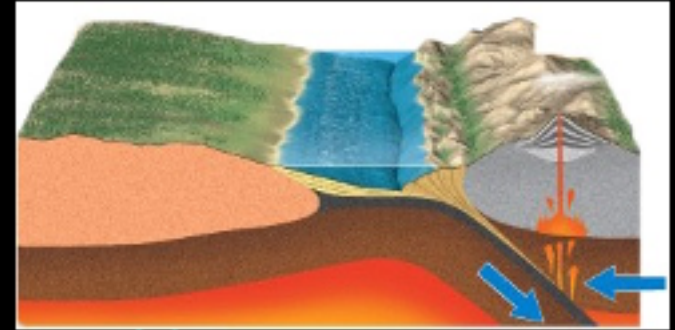
graniti 290 Ma

eclogiti

# Ciclo Varisico



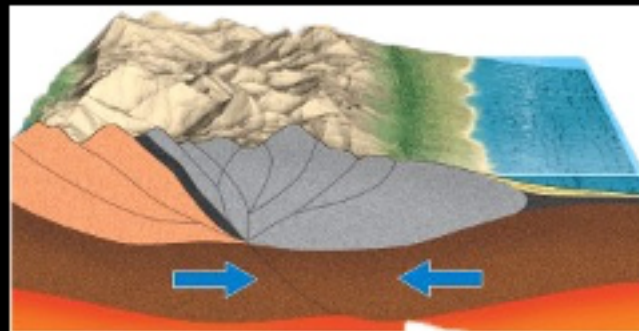
Collasso tarso-orogenico



Subduzione 380-340 Ma ca.

migmatiti

PANGEA



Collisione continentale matura



310 Ma







*Le bellissime rocce delle Alpi ci rivelano che il continente Europeo contiene i segni di apertura e chiusura di oceani antichi, ma....*





*se ci affacciamo verso sud dalle cime delle Alpi  
Maritime... la nostra vista si apre su un nuovo  
"oceano"*