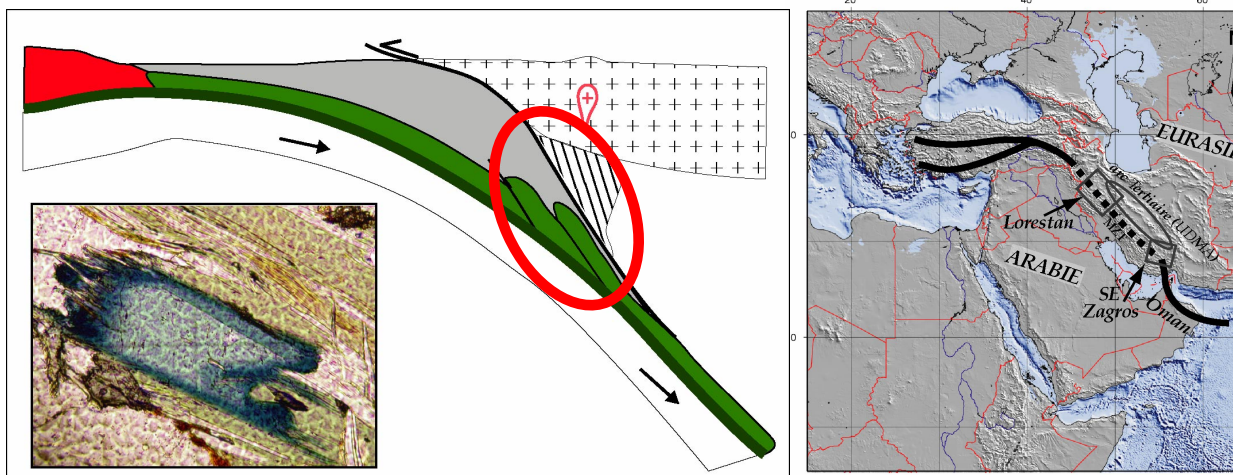


Couplage interplaque long-terme dans les zones de subduction : ce qu'enseignent les roches exhumées

P. Agard, Lab. Tectonique, UPMC (P6)



Exhum. transitoire de schistes bleus

Contraction de la Téthys vers 115 Ma

Obduction Péri-Arabe (c. 95 Ma)

Couplages interplaques, **rhéologie**

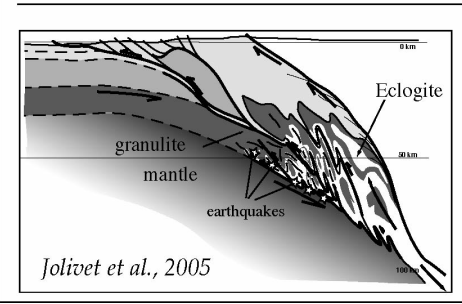
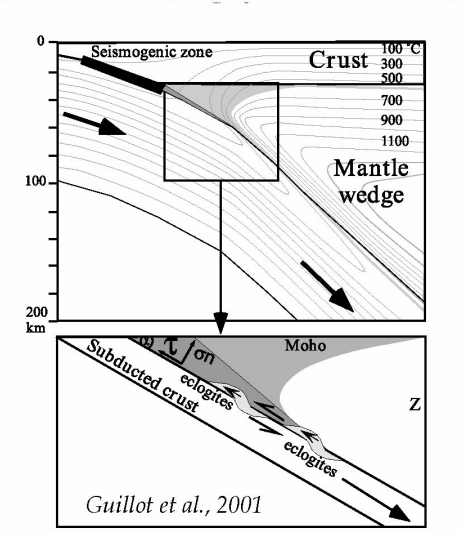
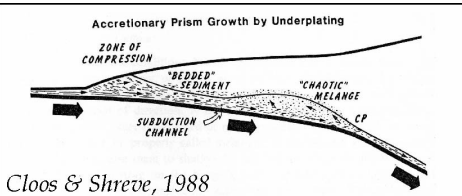
Exhum. croûte océanique

Thèses : J. Omrani, P. Yamato

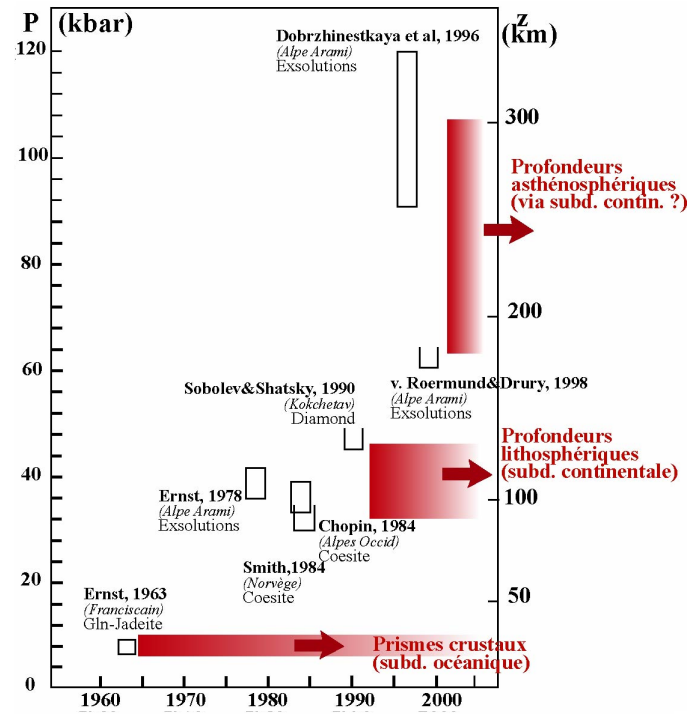
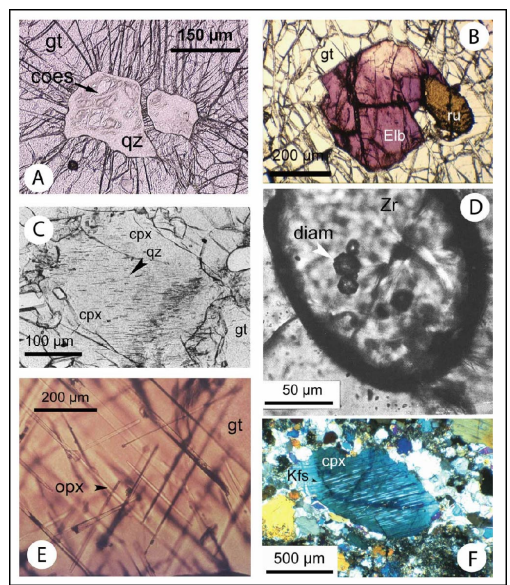
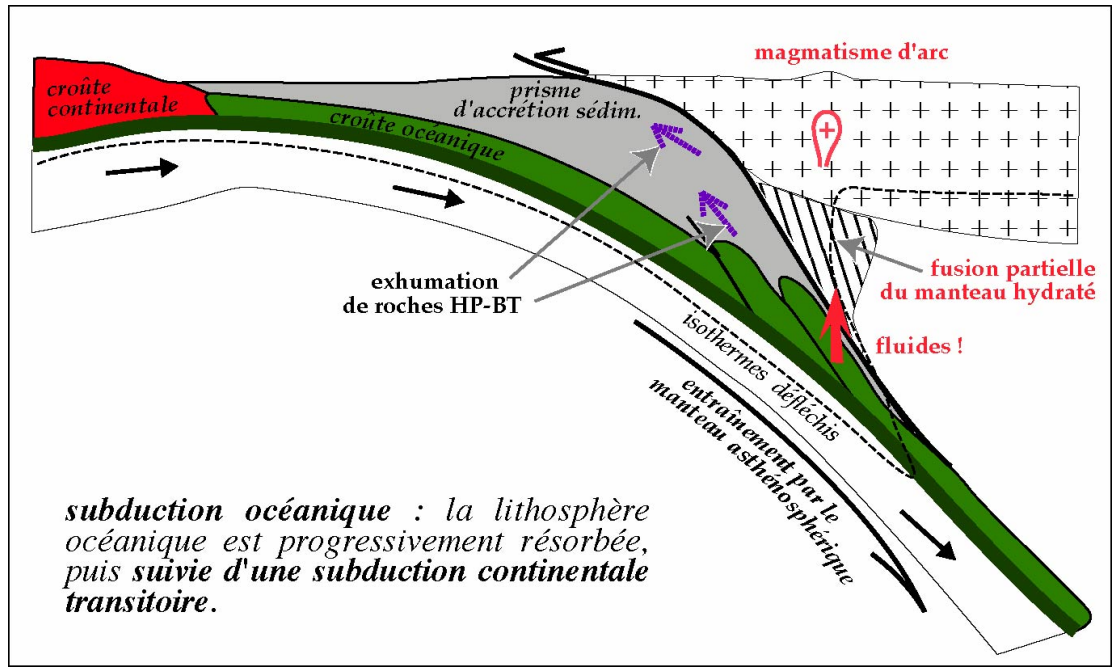
Collab. :

Paris 6 : L. Jolivet, E. Burov, B. Vryelinck

Autres : P. Monié, H. Whitechurch (O. Vidal, B. Goffé)

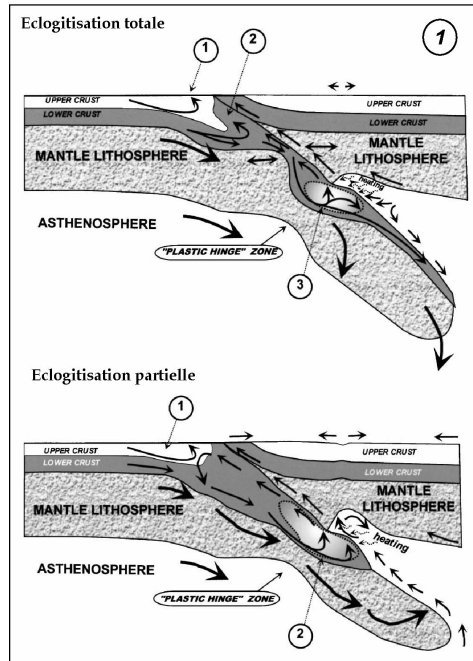


=> focalisation
récemment sur
mat. continental

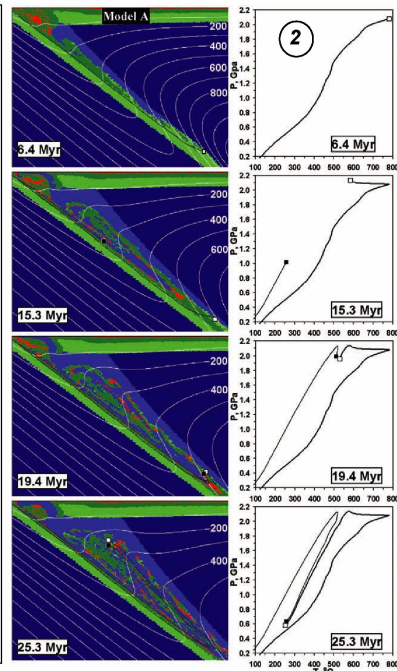


Que sait-on des couplages interplaques ?

Modélisation

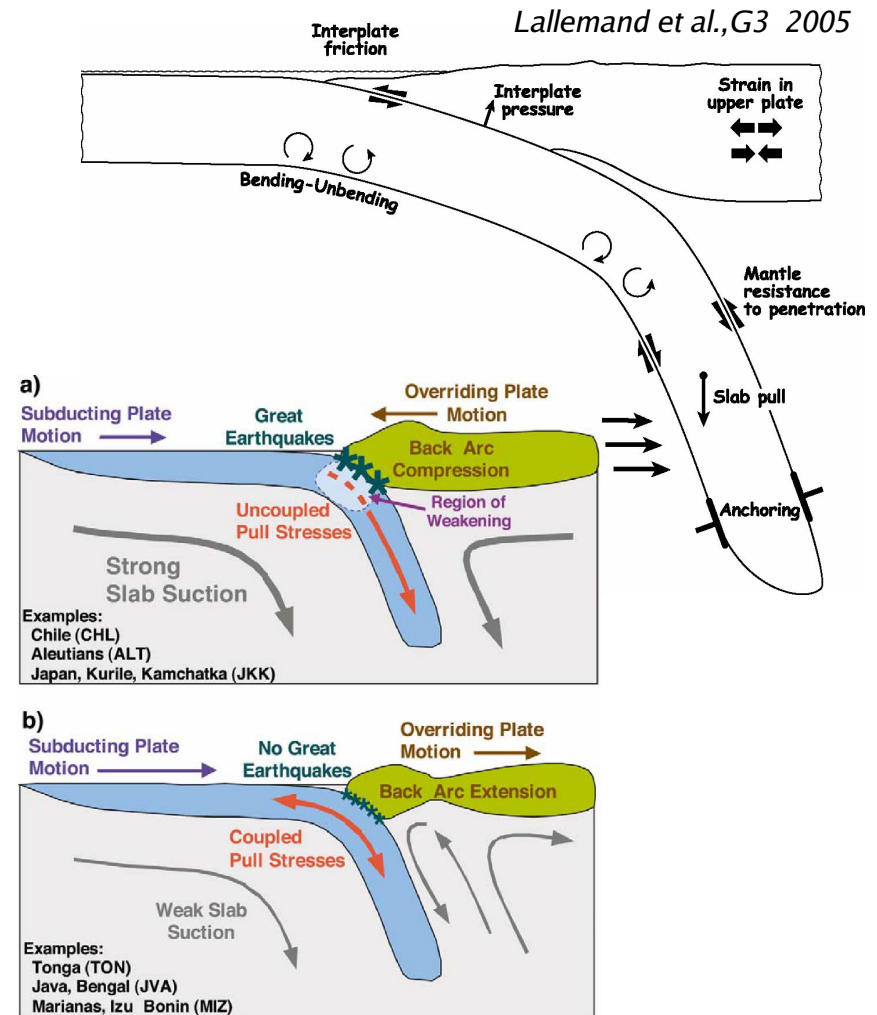


Burov et al., Tectonophysics 2001



Gerya et al., Tect. 2002

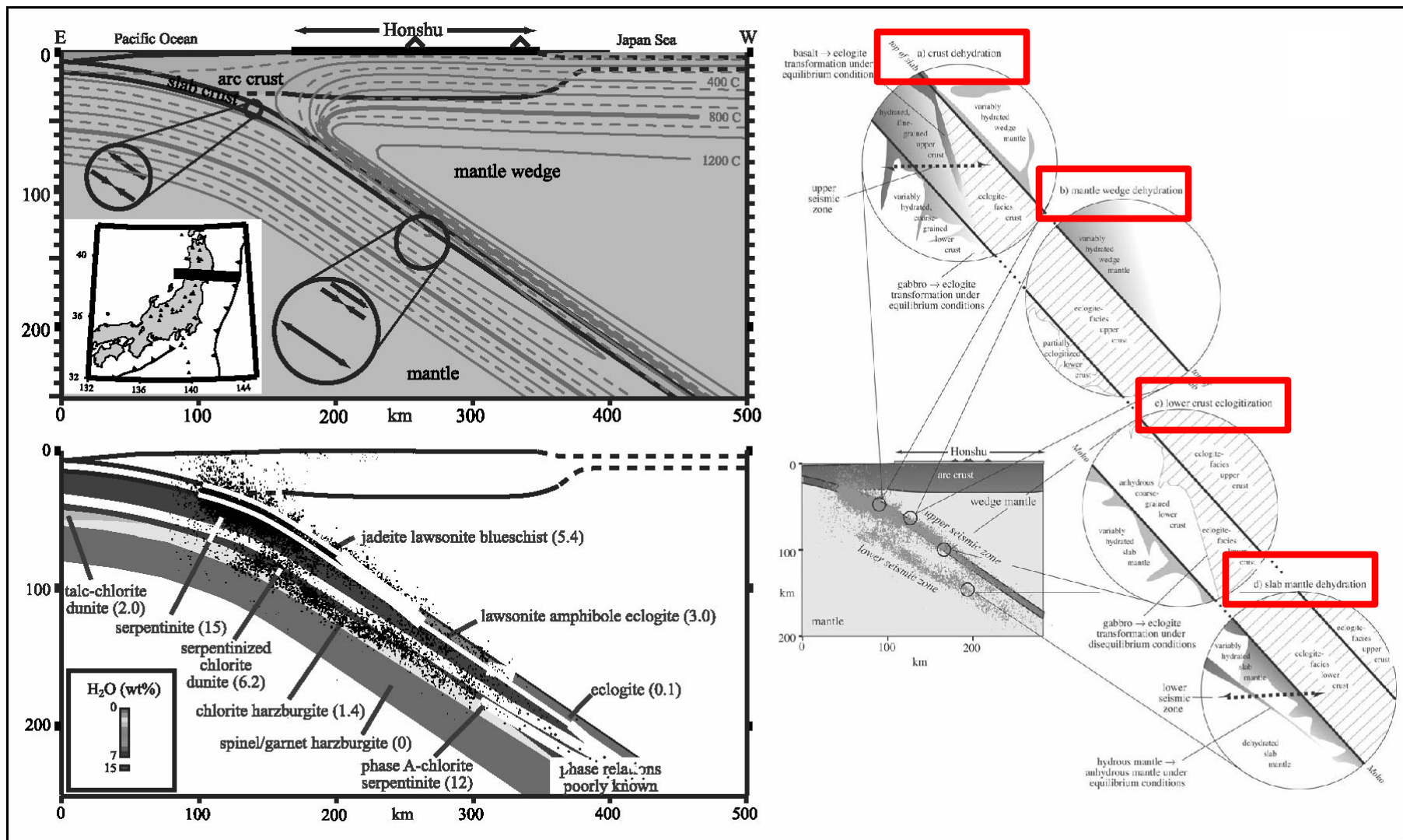
Géodynamique-Géophysique



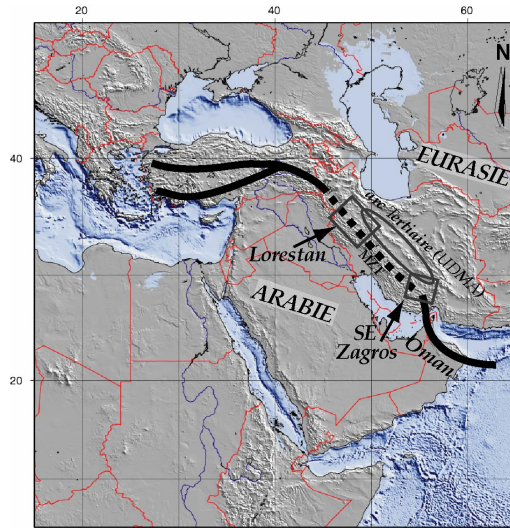
Conrad et al. EPSL, 2004

+ Pétrologie HP/UHP !!!...

Pétrologie, sismique et géodynamique ?...

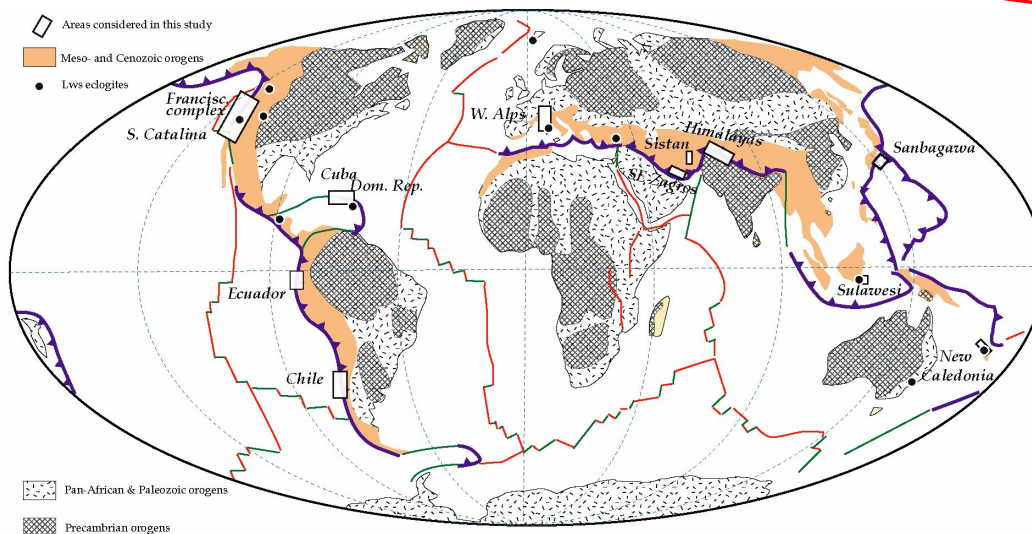


pas de schistes bleus ?...



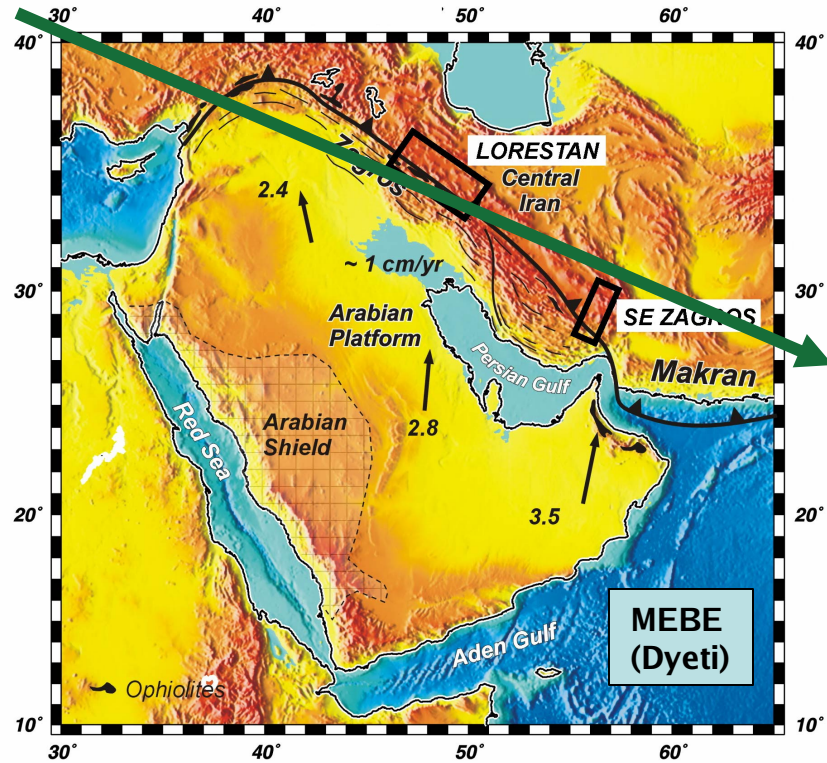
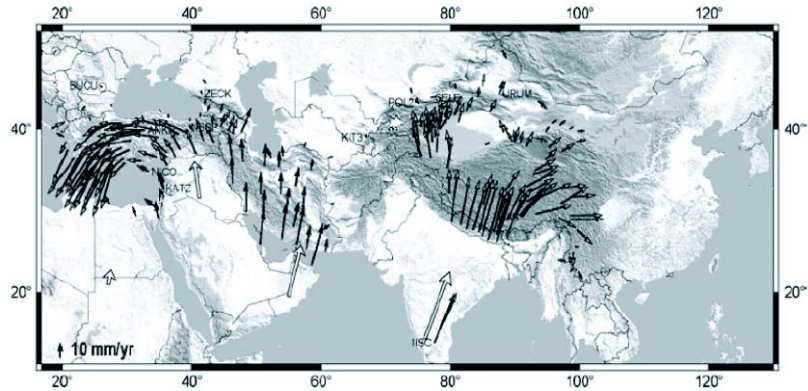
(La convergence Arabie / Eurasie...)
contexte géodynamique depuis 150 Ma

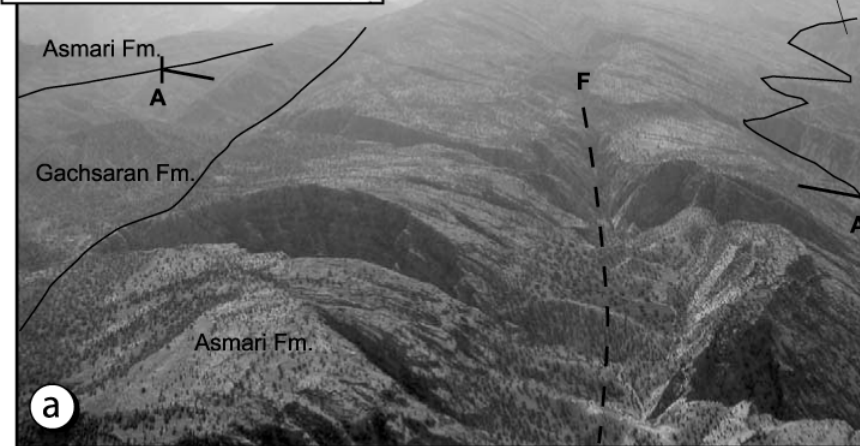
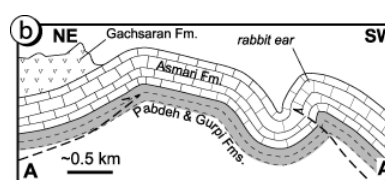
- 1. Exhumation des SB localisée... et transitoire !**
données & comparaison avec SB Omanais
- 2. Quel lien avec l'obduction ?**
convergence Téthys. & modèle d'obduction
- 3. Implications rhéologiques**
chenal de subduction & 'plate-slab coupling'



Convergence Arabie / Eurasie

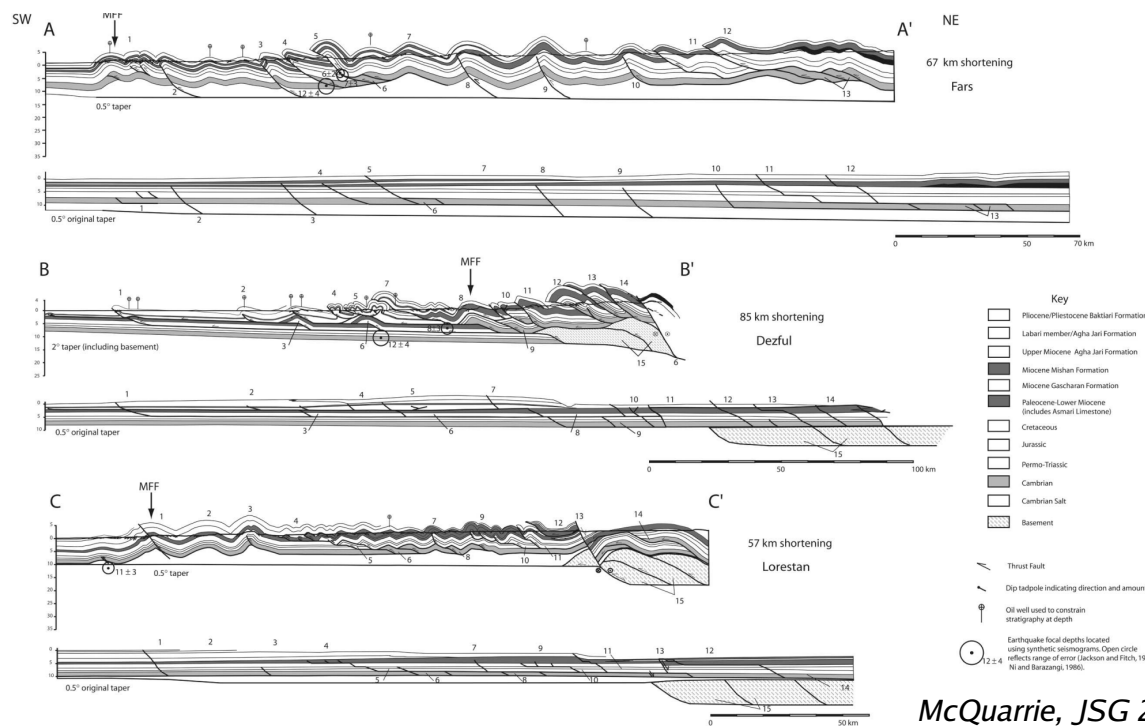
Vernant et al., GJI 2004





Sherkati et al., JSG 2005

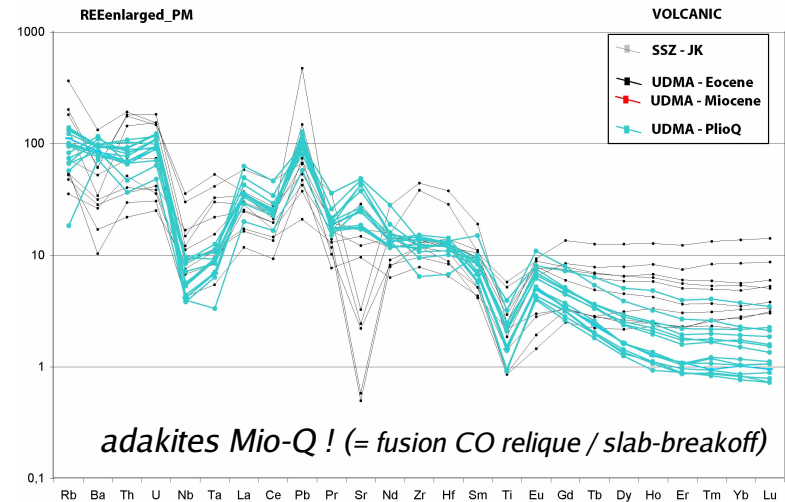
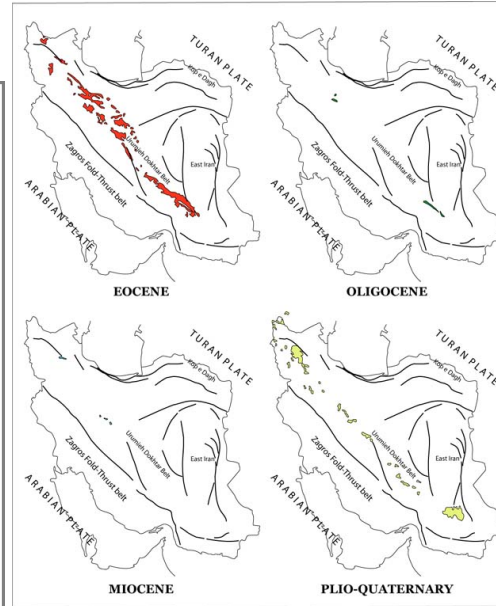
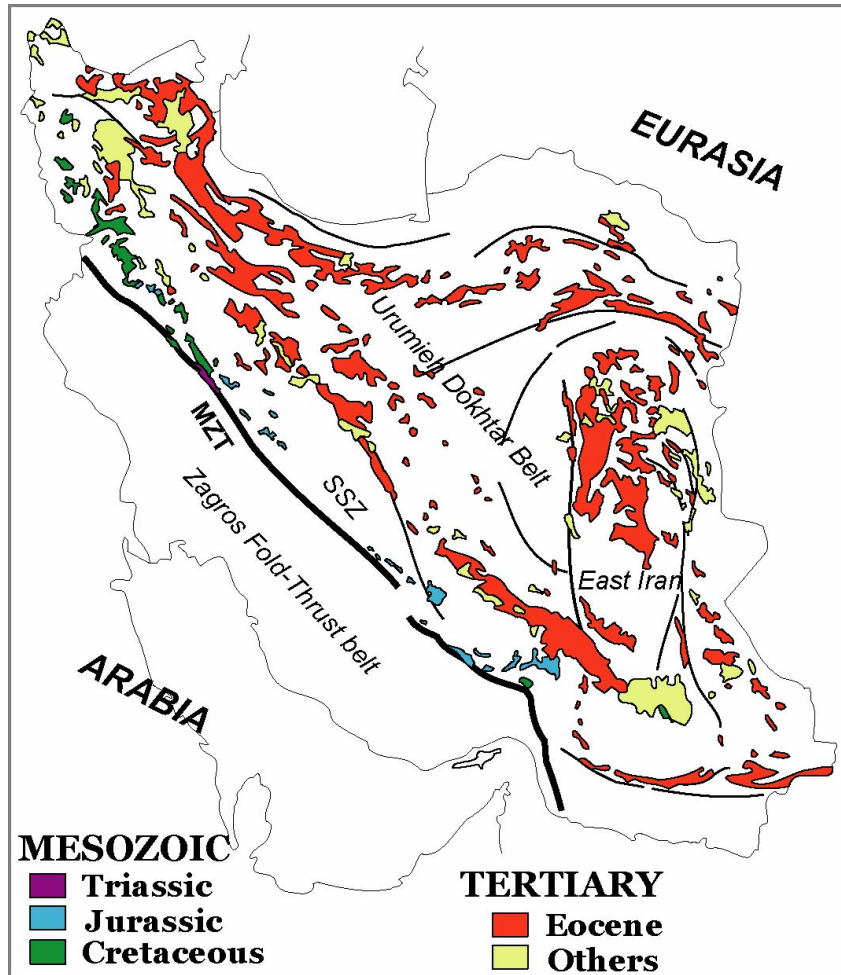
**le pestaculaire
Zagros...**



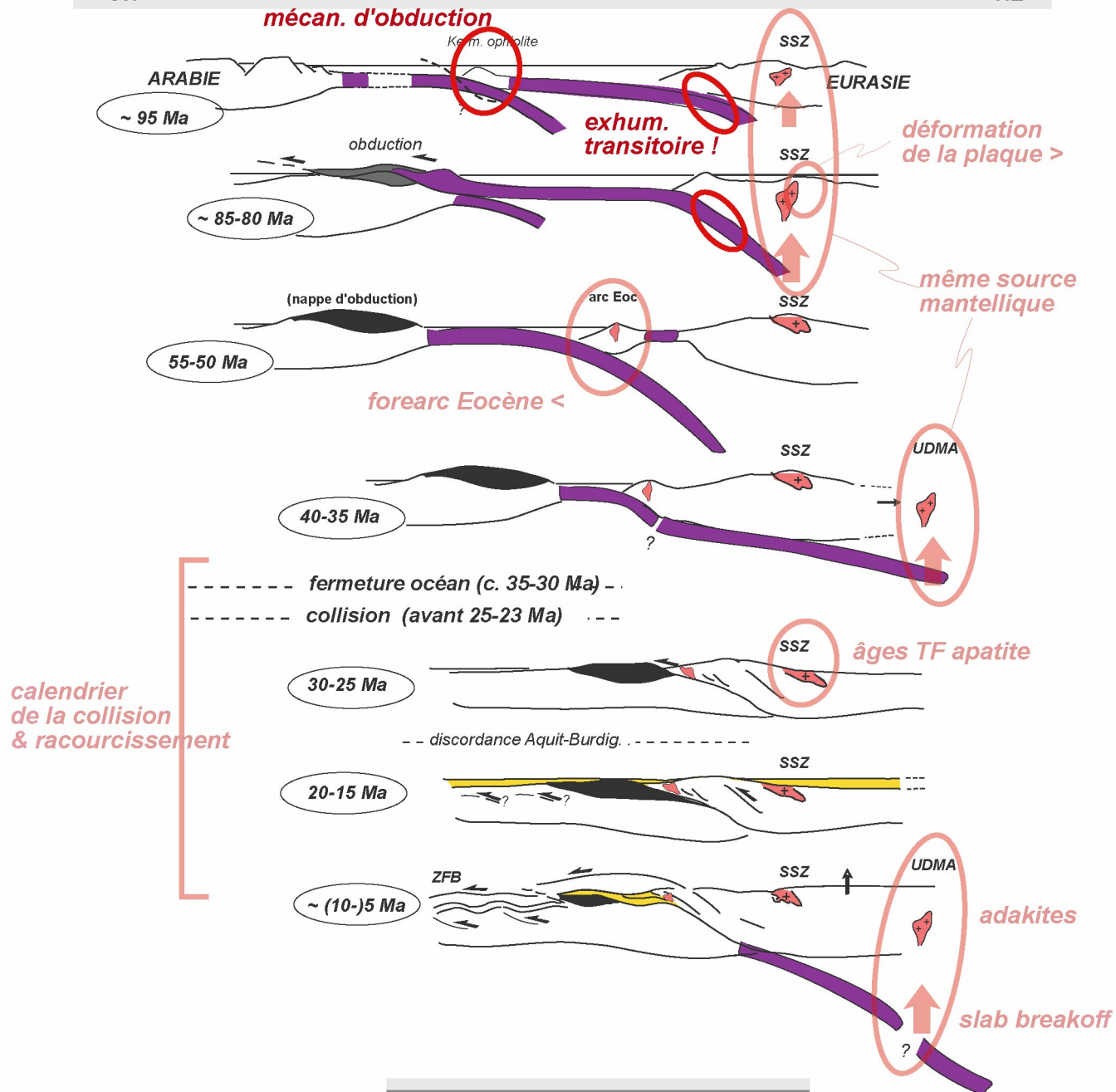
McQuarrie, JSG 2004

Magmatisme d'arc - et adakites

(avec Hubert Whitechurch)



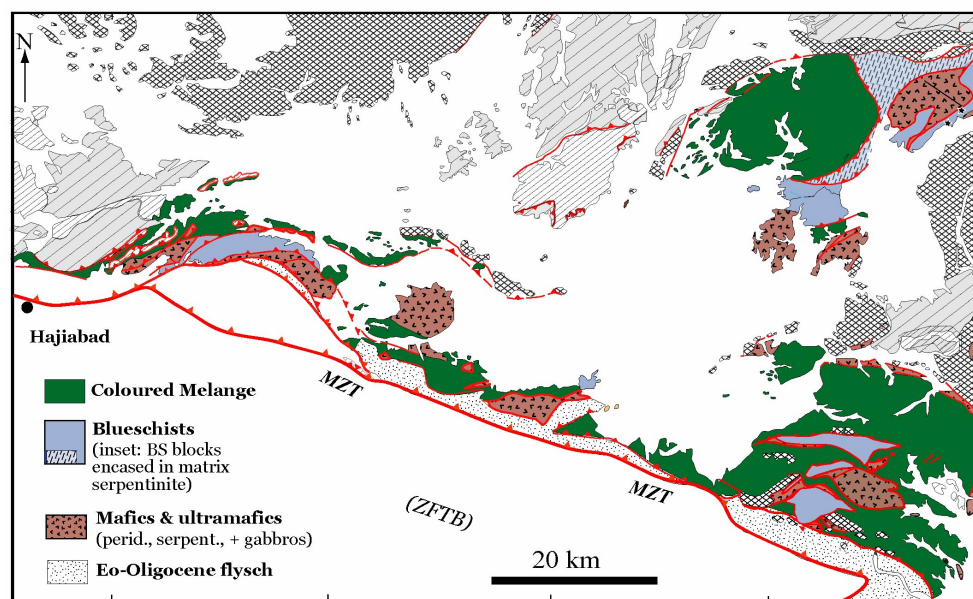
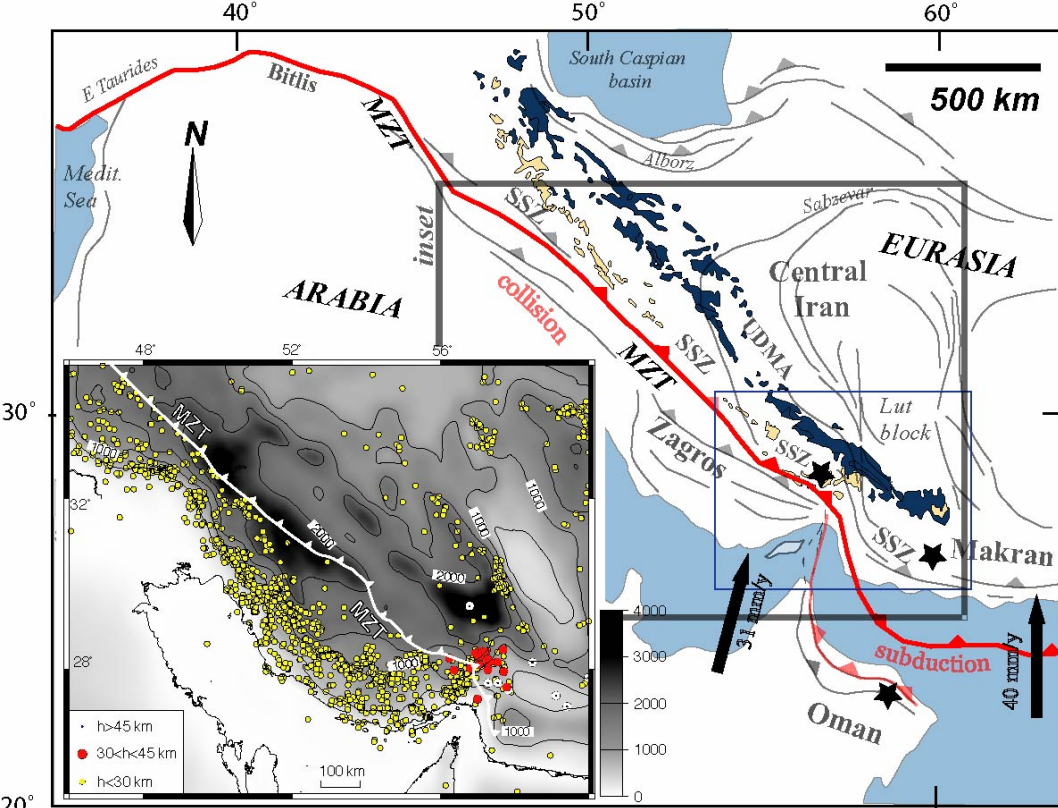
adakites Mio-Q ! (= fusion CO relique / slab-breakoff)

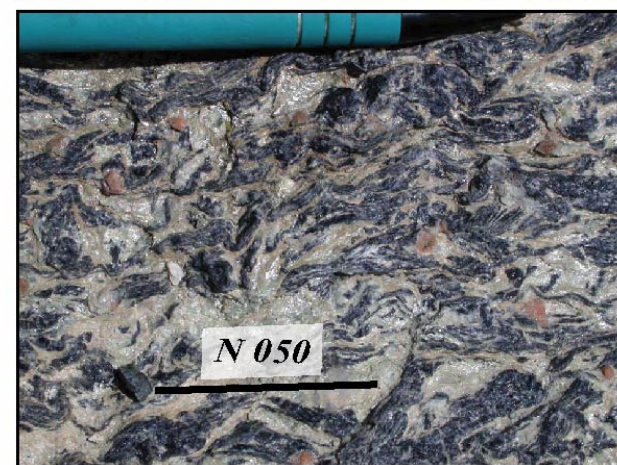
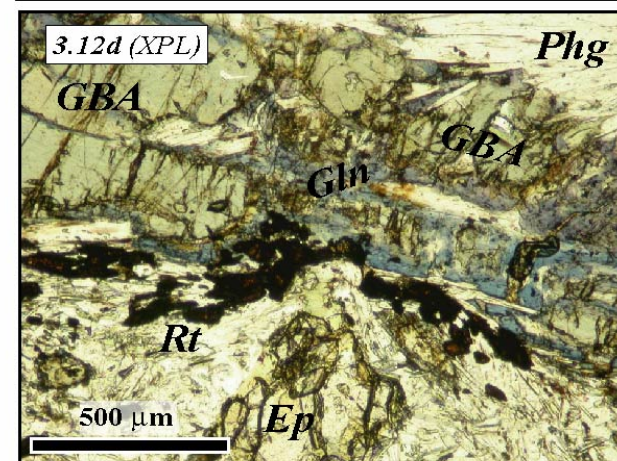
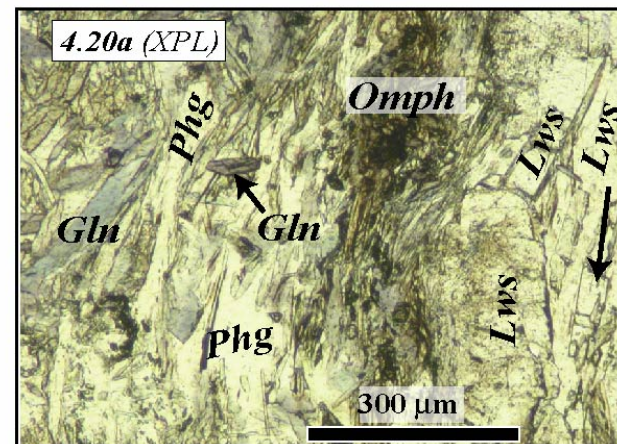
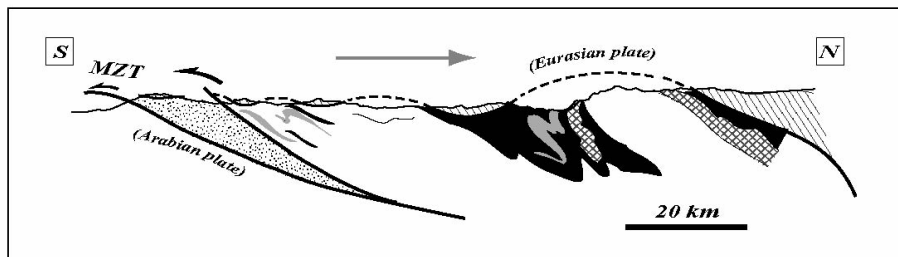
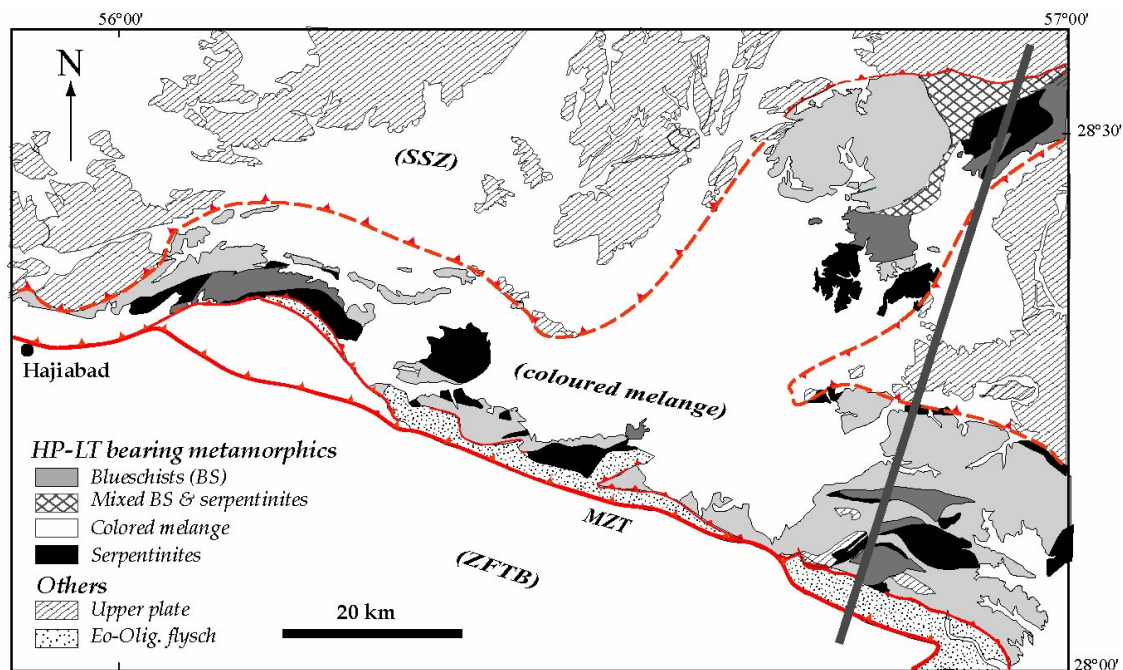


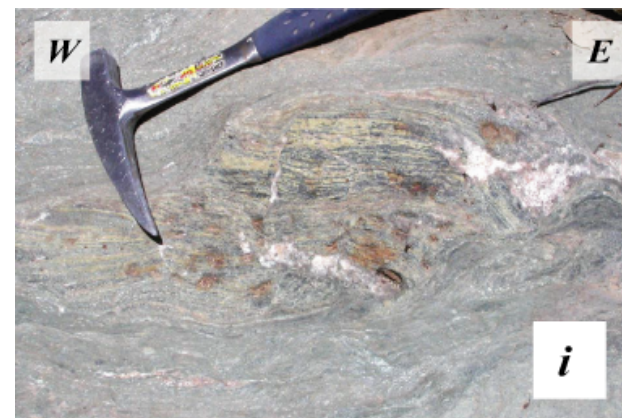
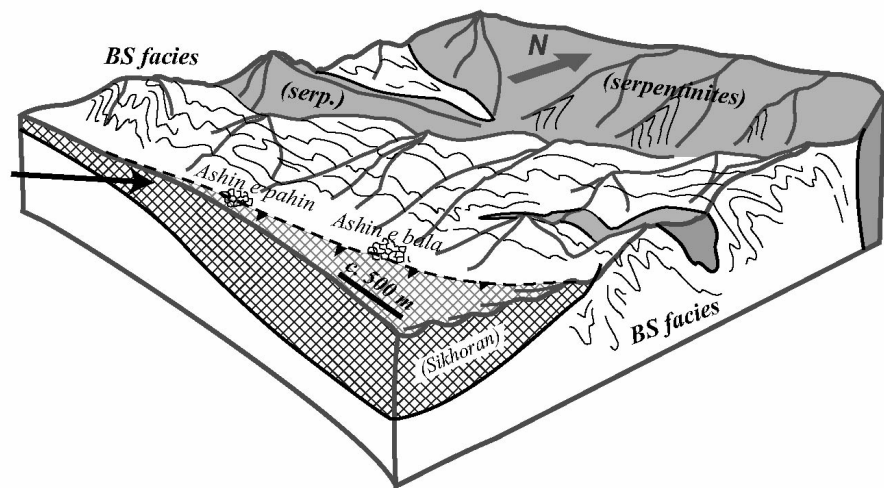
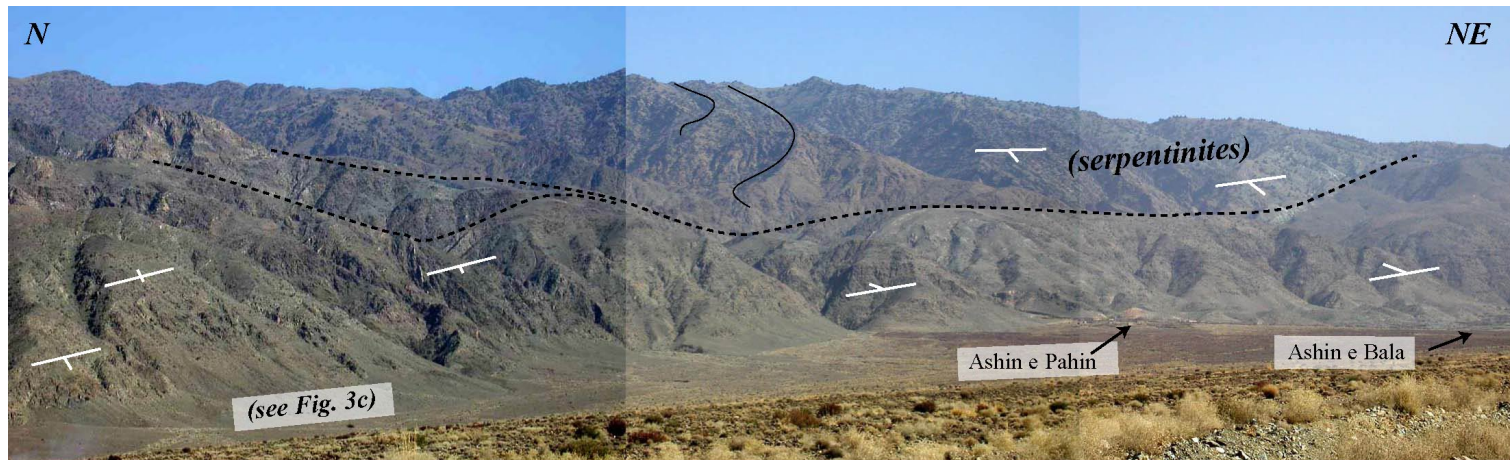
1. Exhumation des schistes bleus très localisée... et transitoire !

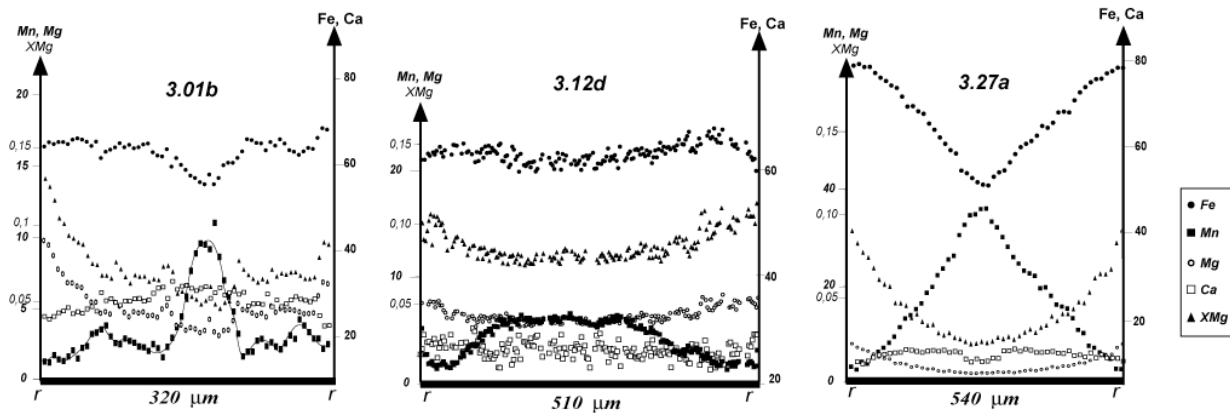
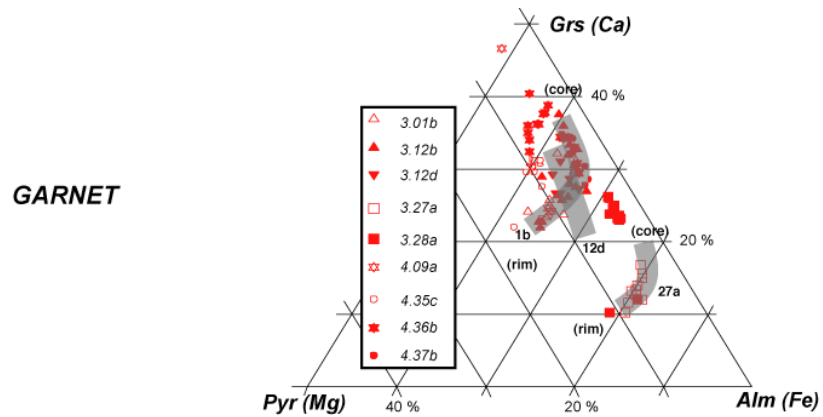
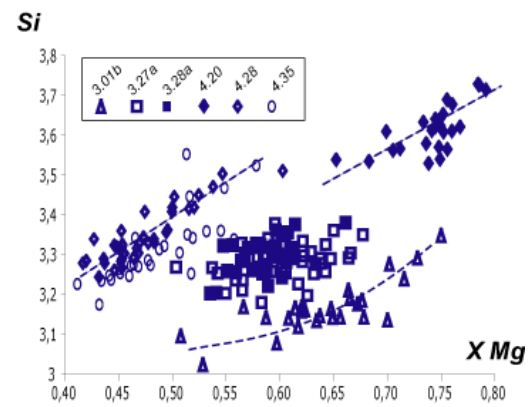
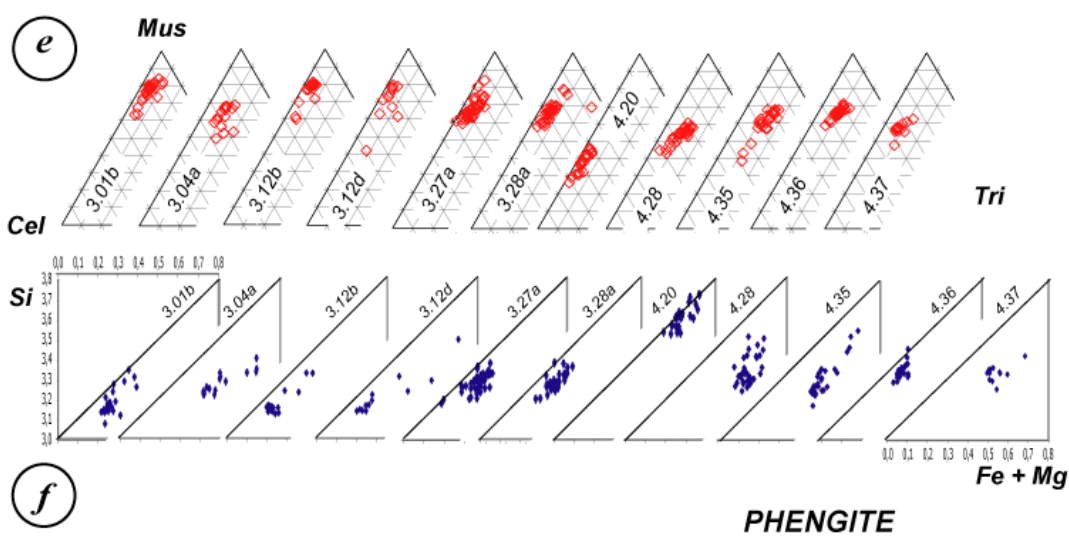


Agard, Monié et al., JGR, 2006

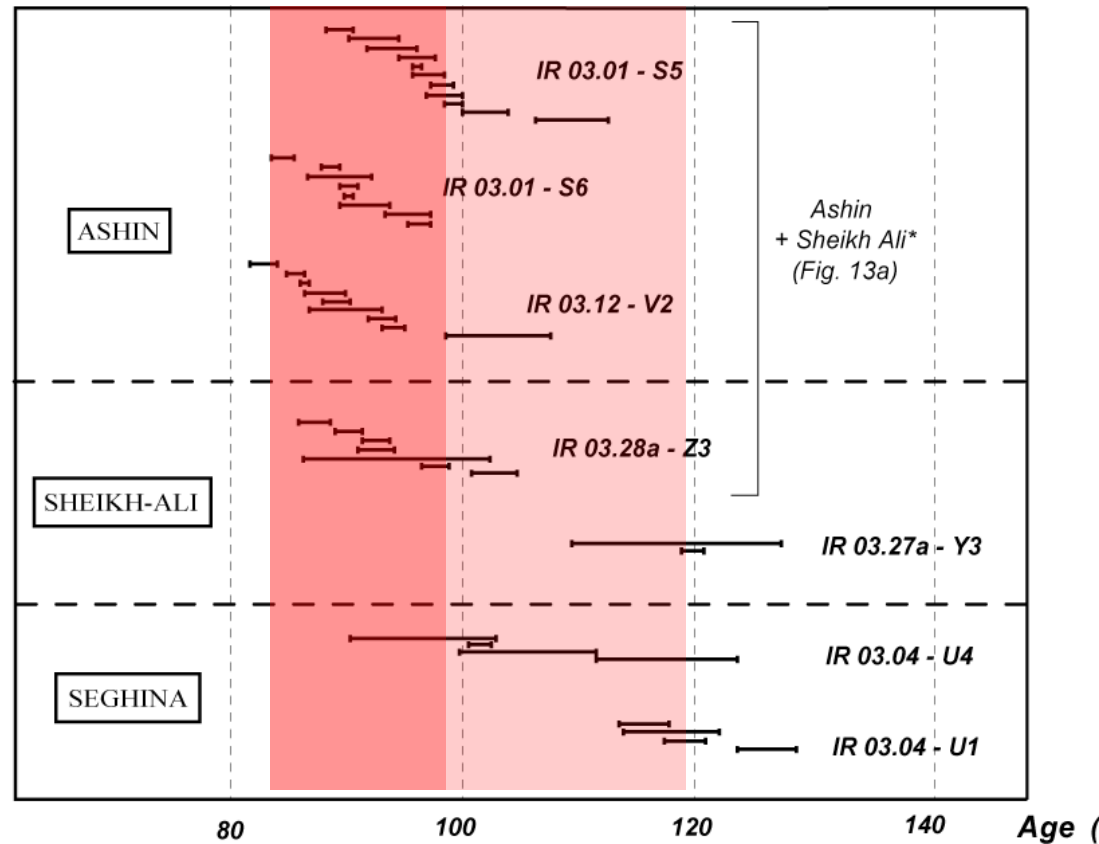
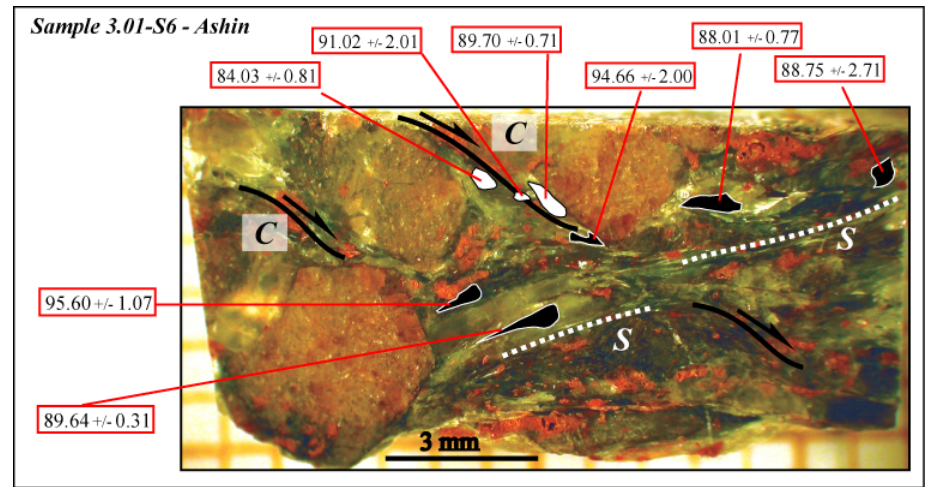
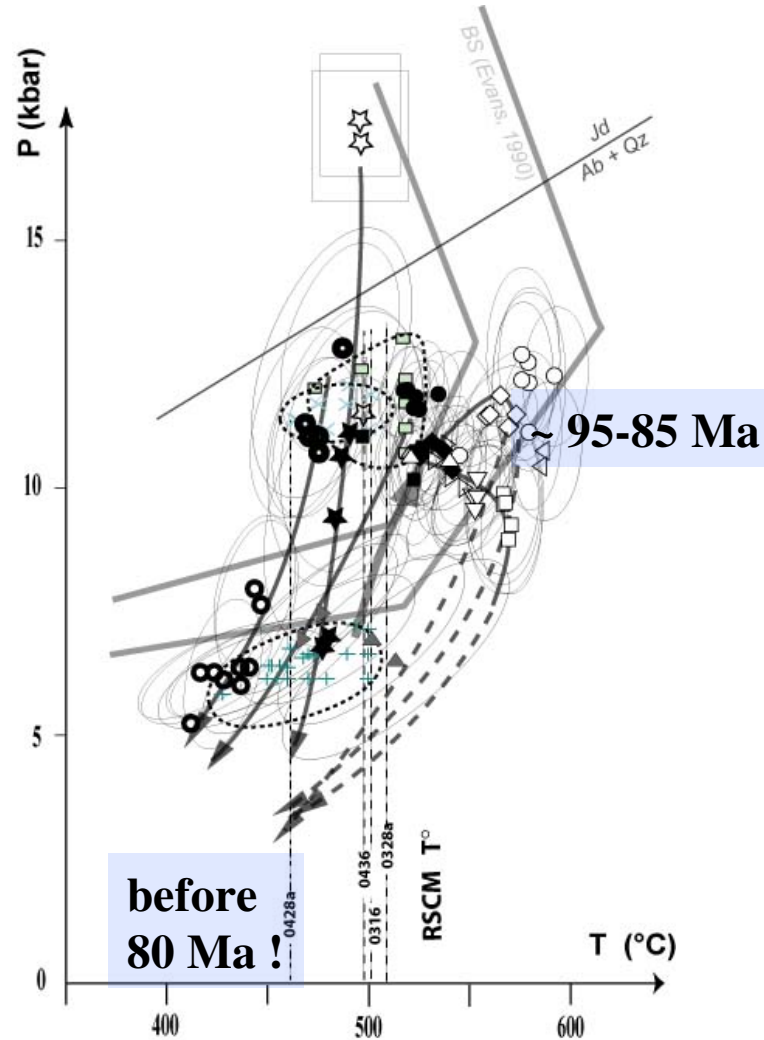






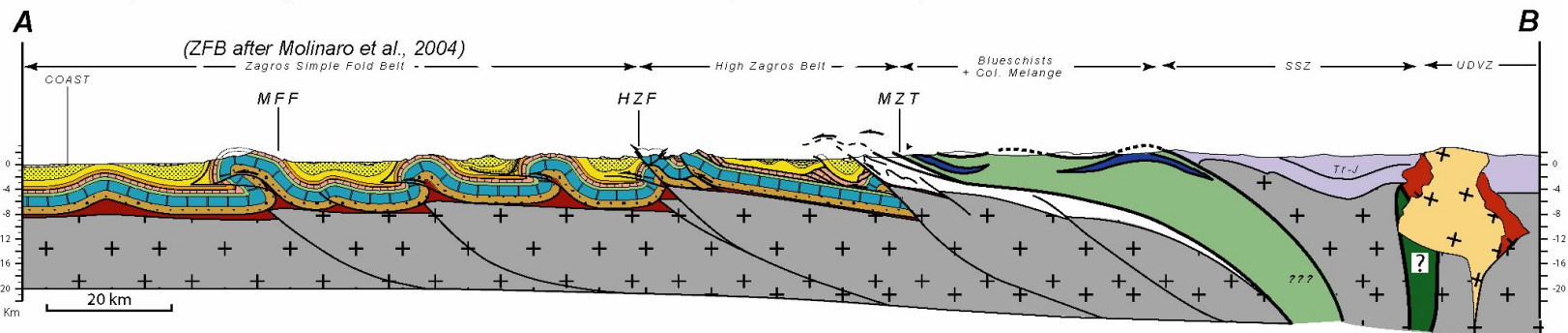
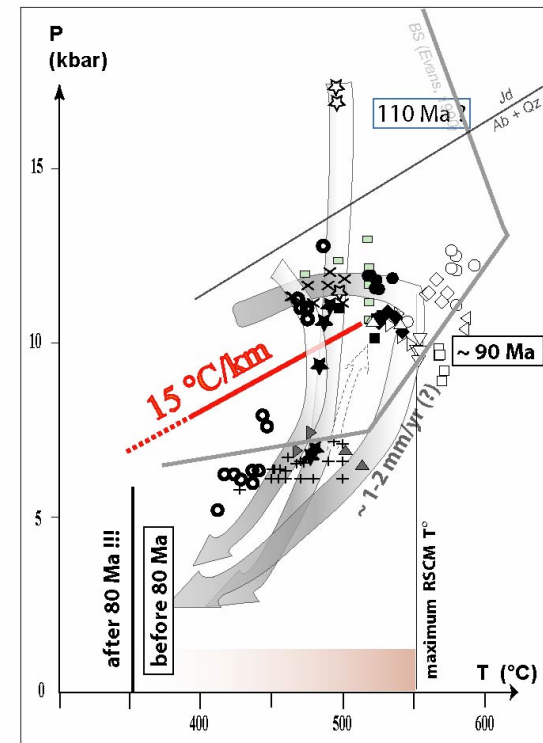
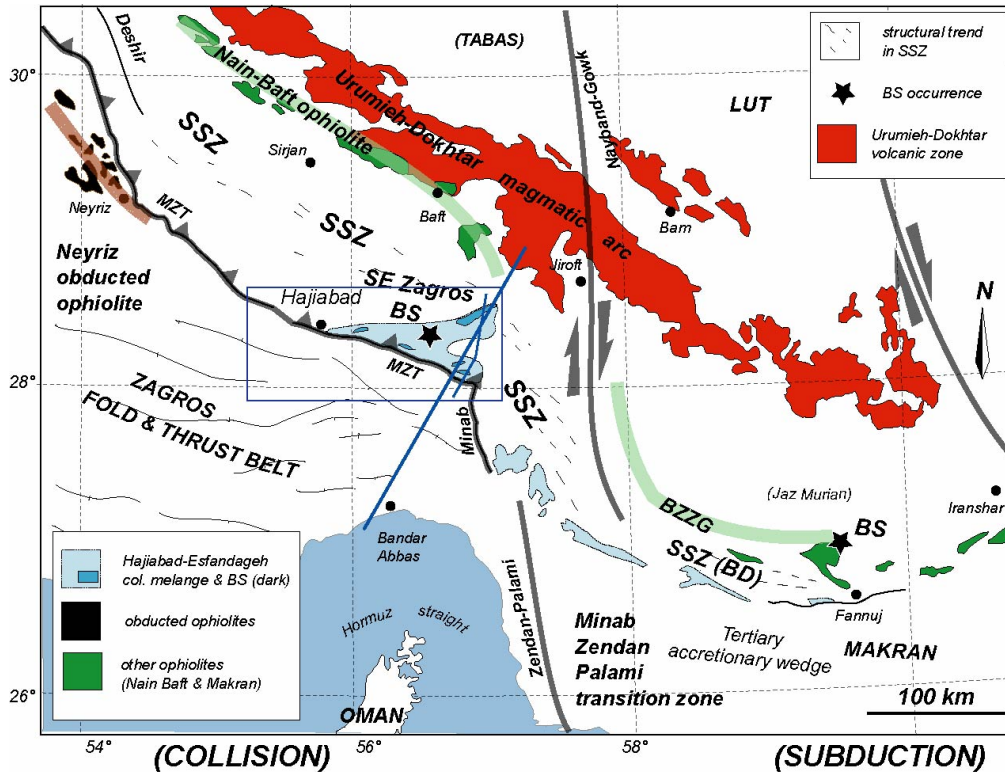


+ contraintes radiométriques :

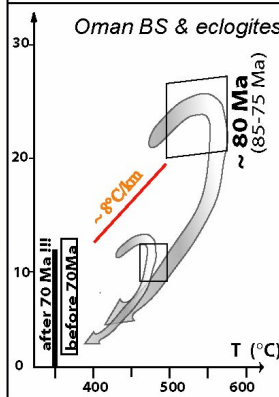
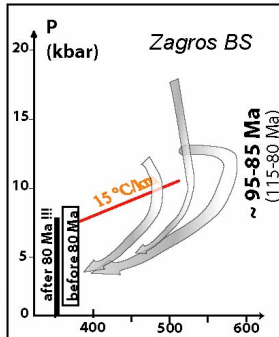
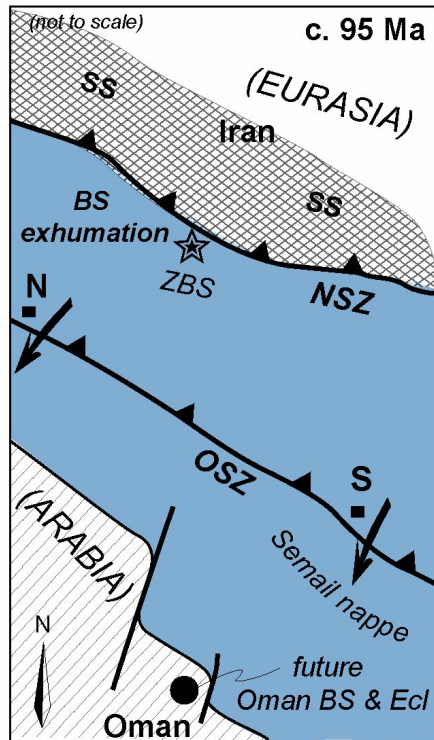
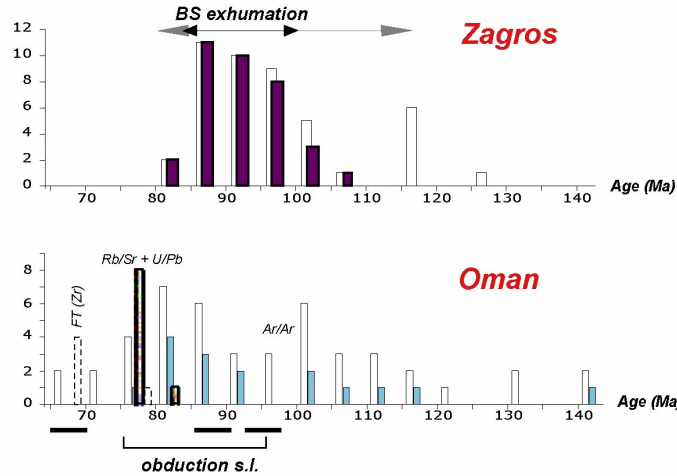


Bilan :

- exhumation très localisée
- transitoire : 100-85 Ma !... (subduction 150-30 Ma)
- forme et vitesse des chemins P-T...

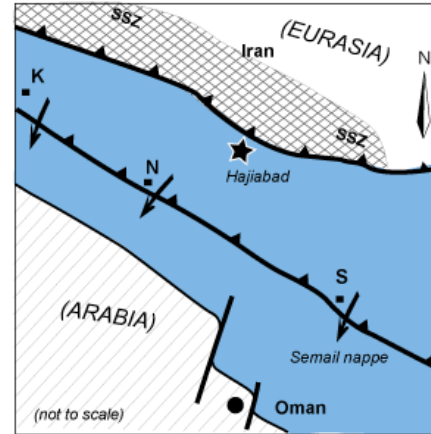


Quel lien avec les SB d'Oman ?...

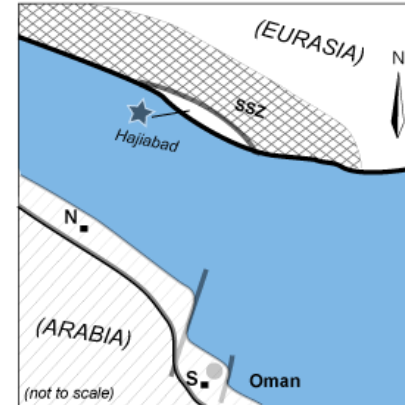


Hypothesis 1

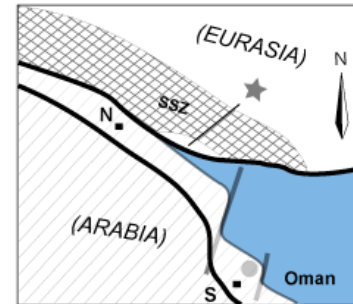
onset of obduction
(c. 95 Ma)



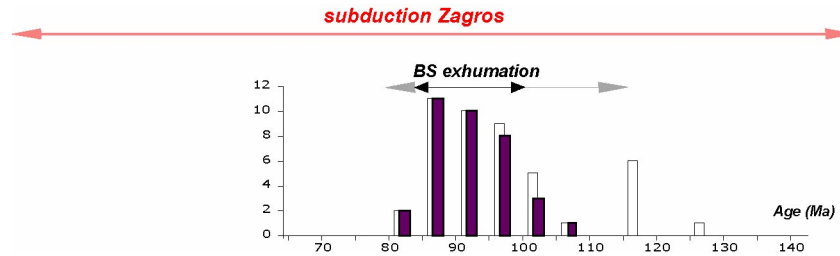
after obduction
(c. 70 Ma)



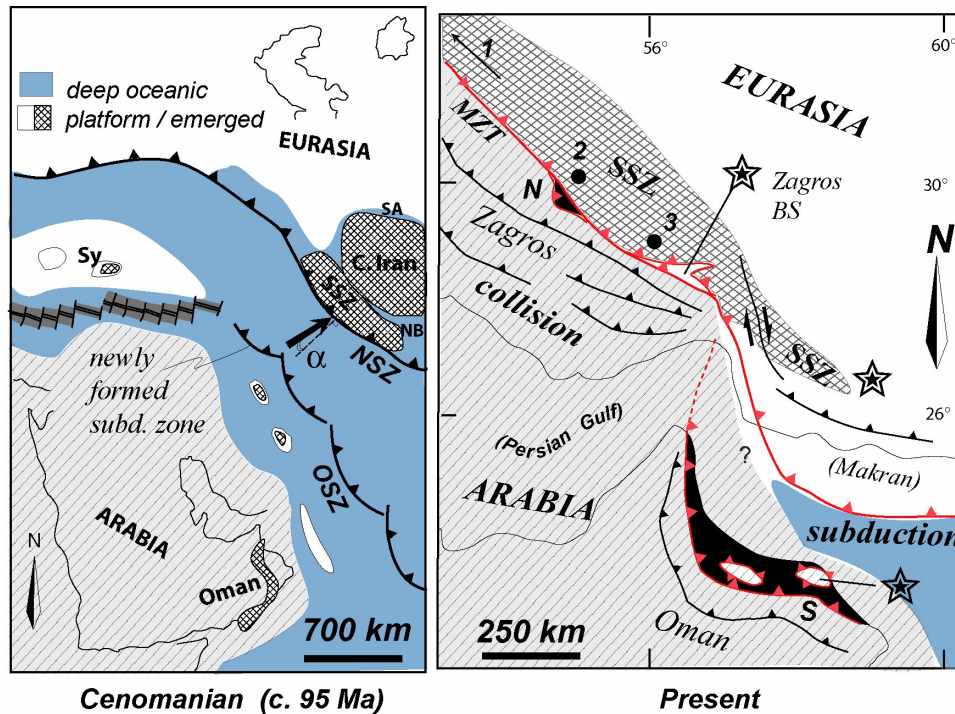
onset of collision
(c. 20 Ma)



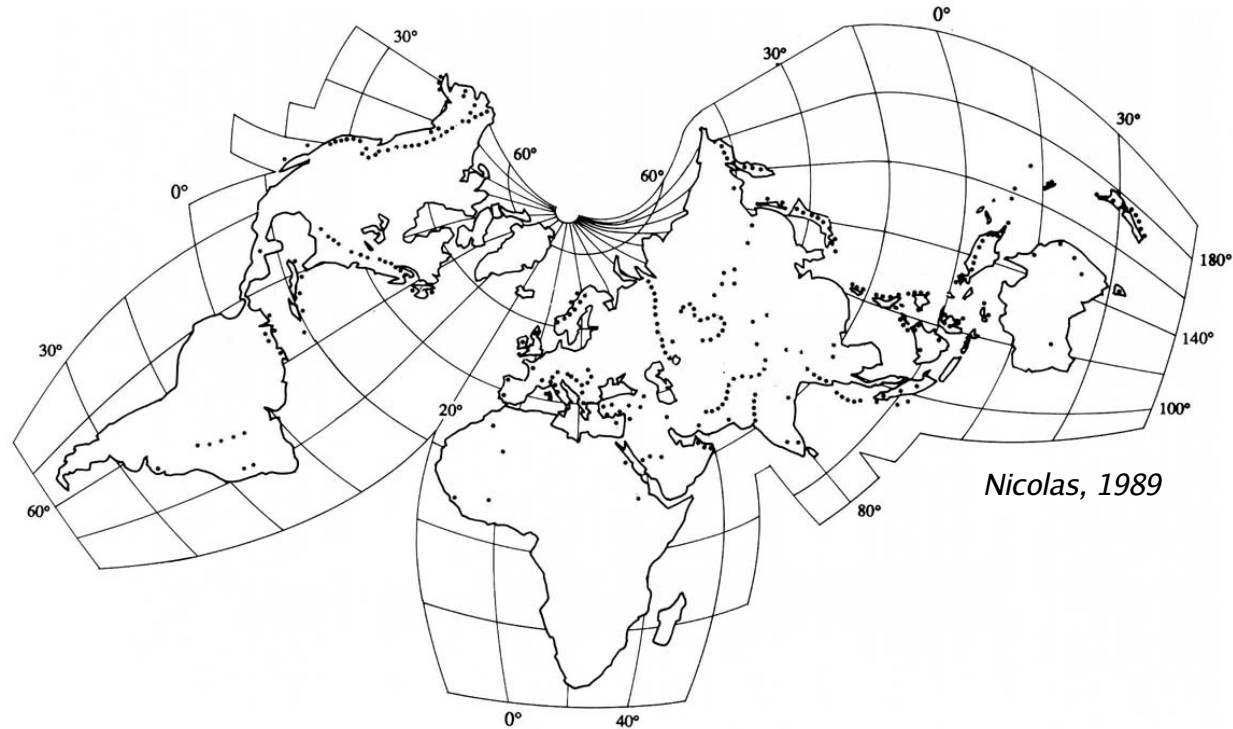
Bilan :



- exhumation très locale dans Zagros
- transitoire : 100-85 Ma... et syn-obduction (et SB différents de ceux de l'Oman)



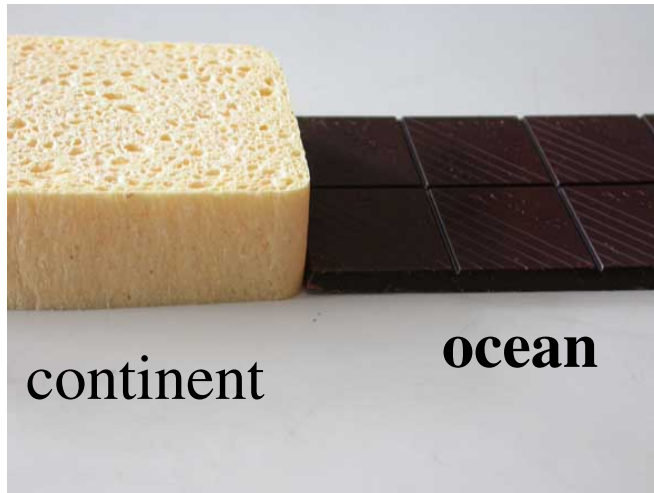
2. Quel lien avec l'obduction ?



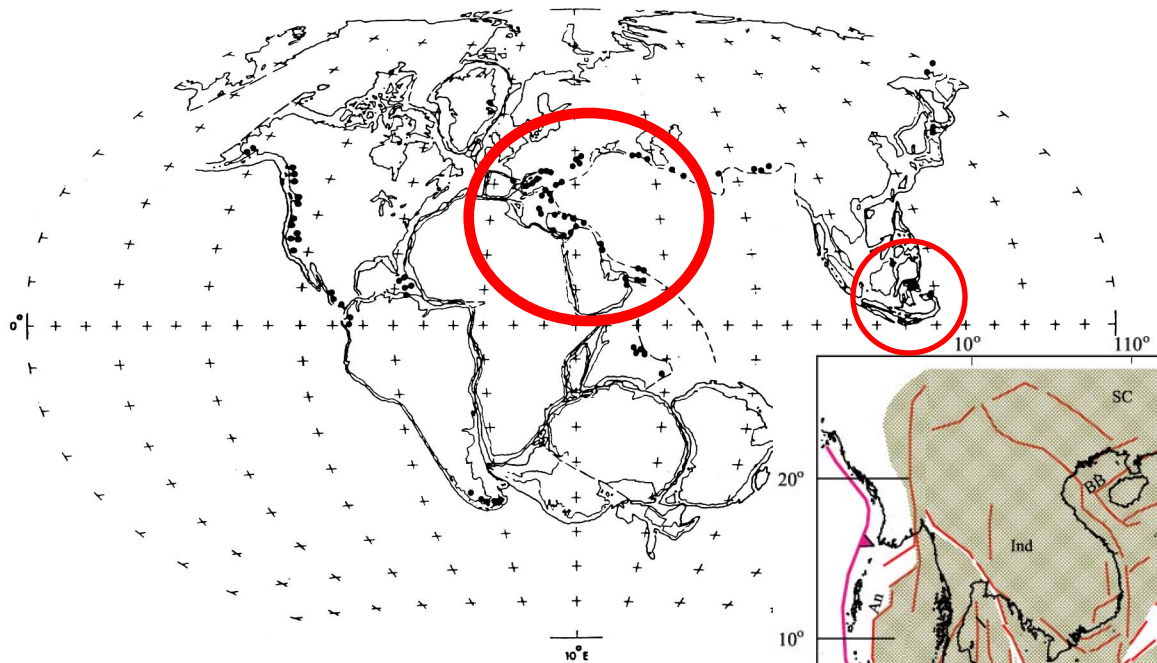
**ophiolites, subduction, schistes bleus,
vitesses des plaques, rhéologie & superplumes...**

Agard et al., EPSL (en rév.)

L'obduction: une énigme



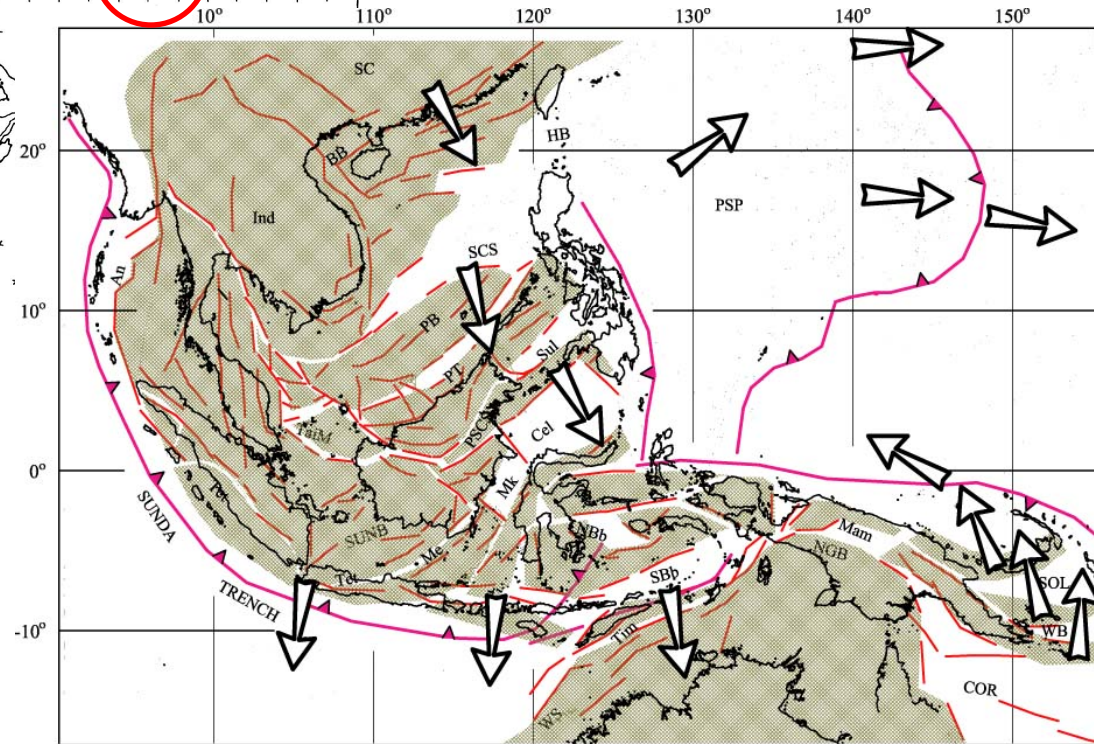
...wishful thinking ?
(... mais les ophiolites obductées existent !)



Ophiolites nombreuses...
(pas toutes intéressantes)

e.g., fermeture de bassins back-arc

- ~~Back-arc~~
- ~~sous-plaquées~~

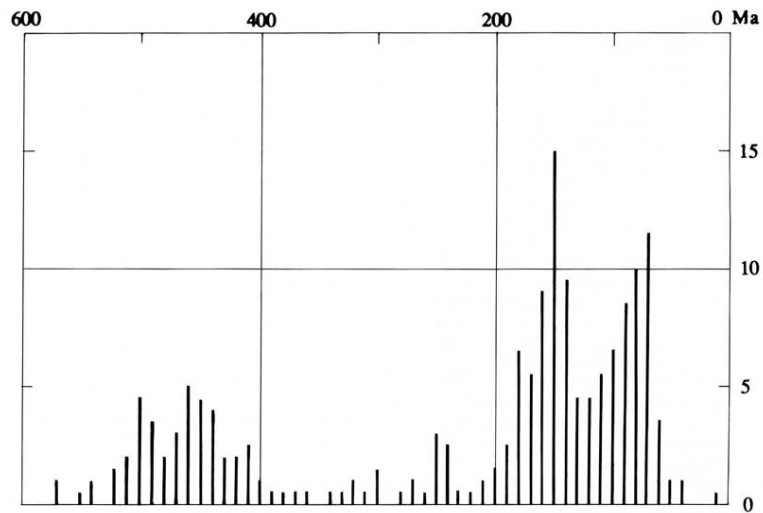


Pubellier et al., Tect. 2004

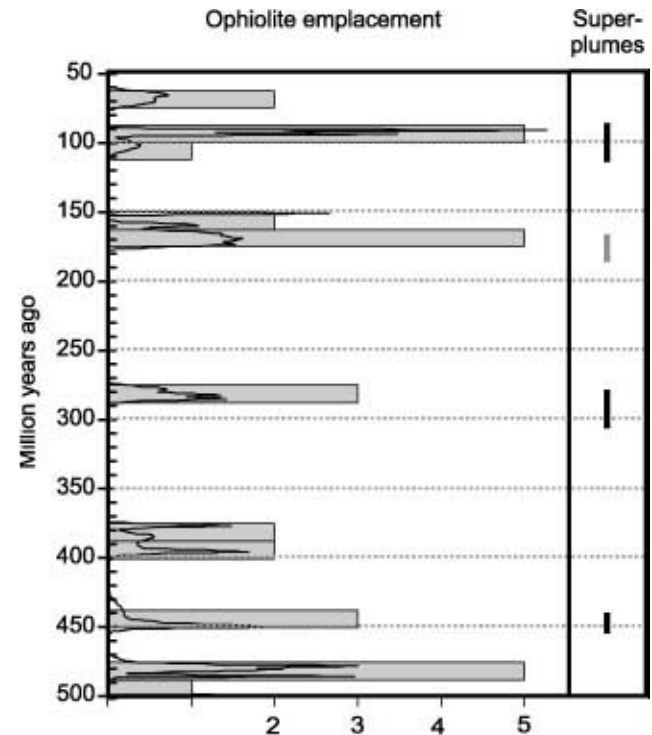
=> seulement les obductions de grande ampleur (> 1000 km) !

Rythmicité des obductions ?

⇒ pics
de mise en place
($< 1\%$ aujourd'hui)



Abbate et al., 1985, Ophioliti



Vaughan & Scarrow, 2003, EPSL

Indices & faits

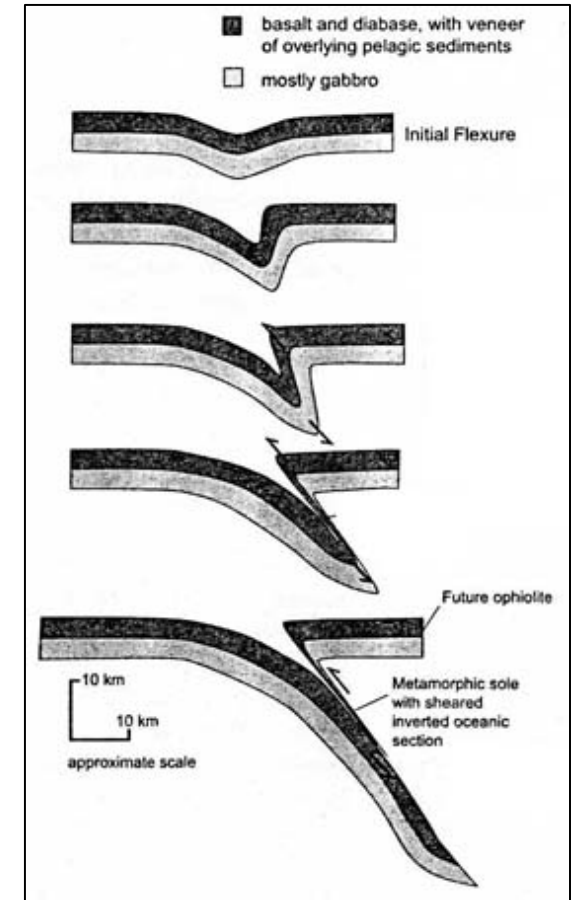
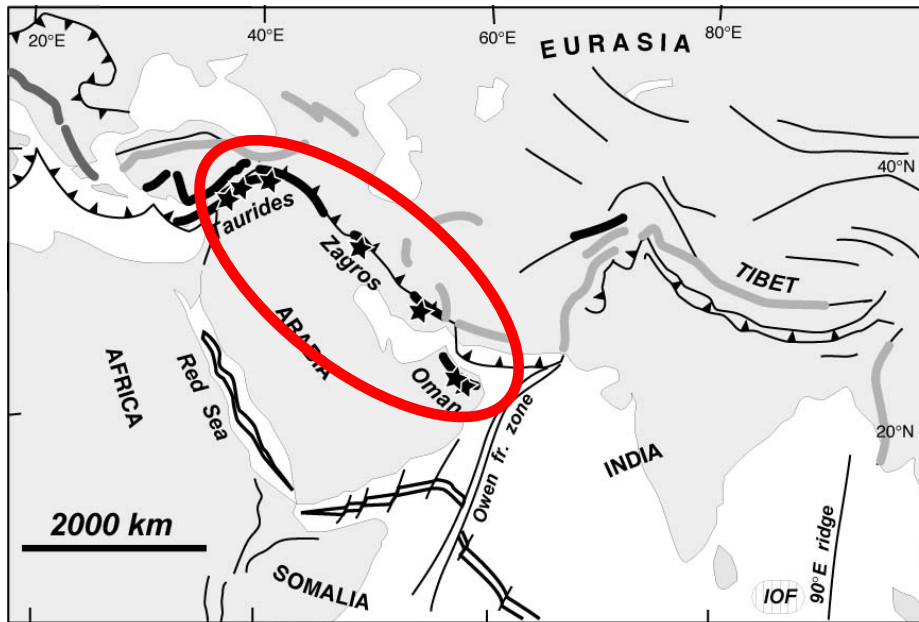
1. Semelles métam. : **synchronisme sur 1000s km**
2. **Accélération** des plaques / Néotéthys
3. **Exhumation** transitoire de SB dans le SE Zagros
4. Vitesses de convergence pour l'obduction **Jurassique** =

obduction
K >

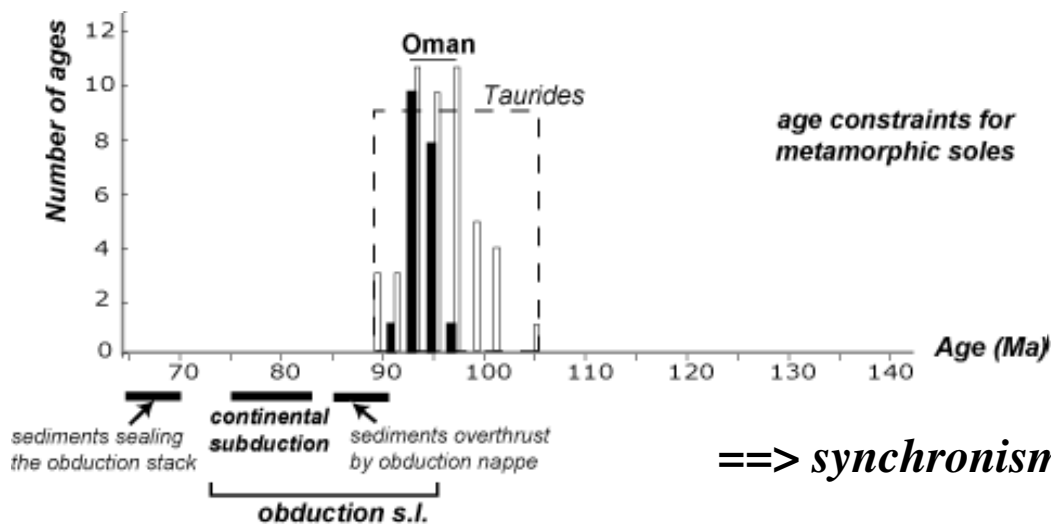
Un modèle

...les accélérations déclenchent les obductions?...

① *Semelles métamorphiques* (refroidissement < 5 Ma après charriage)

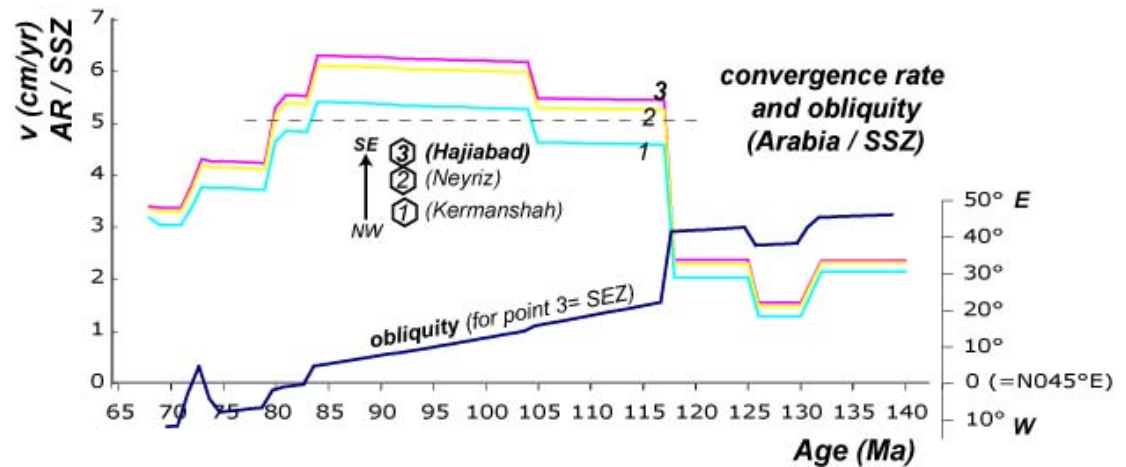
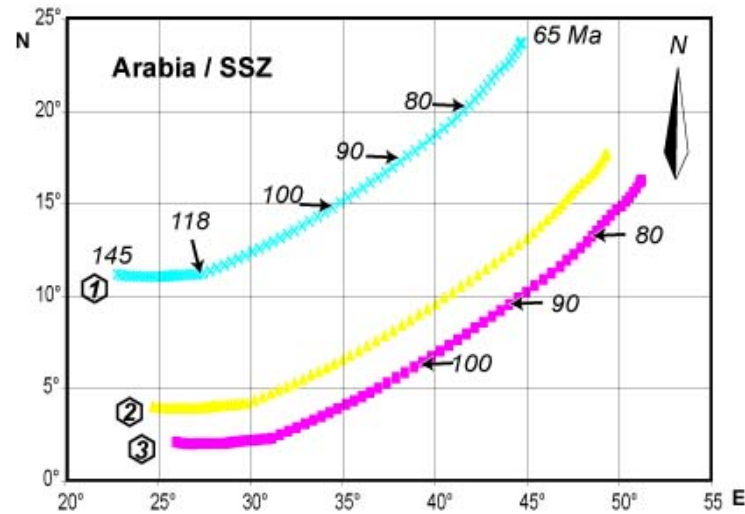
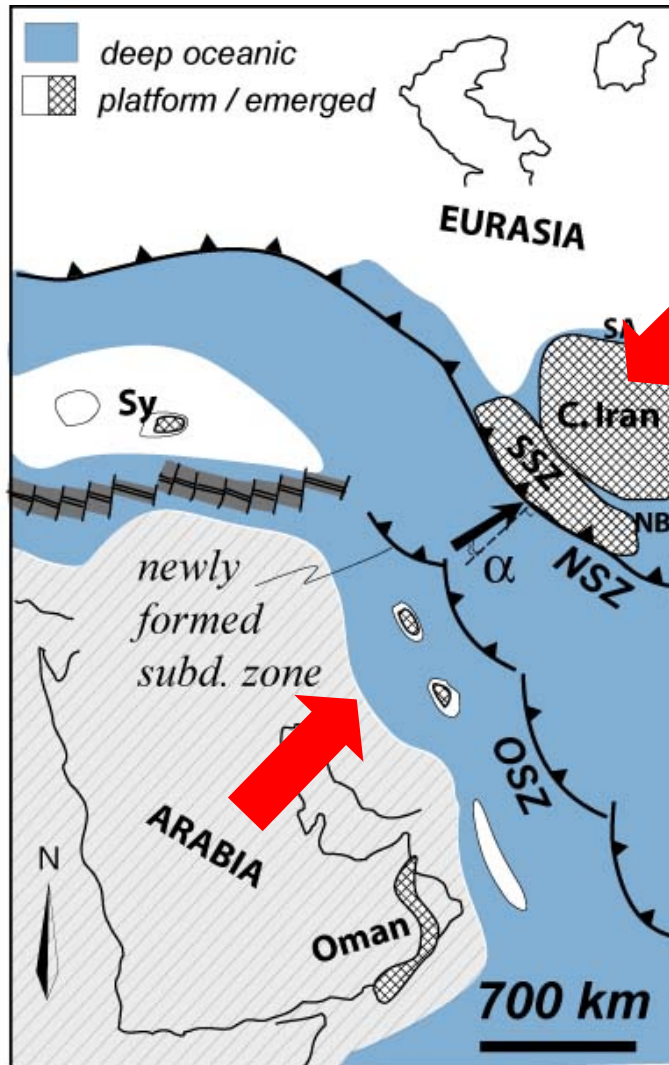


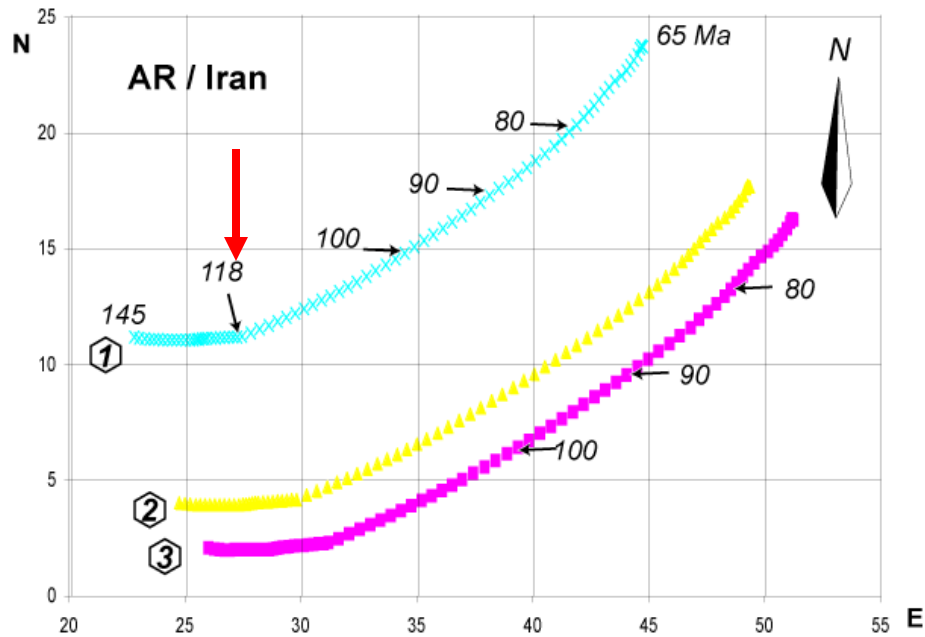
Wakabayashi & Dilek, 2003



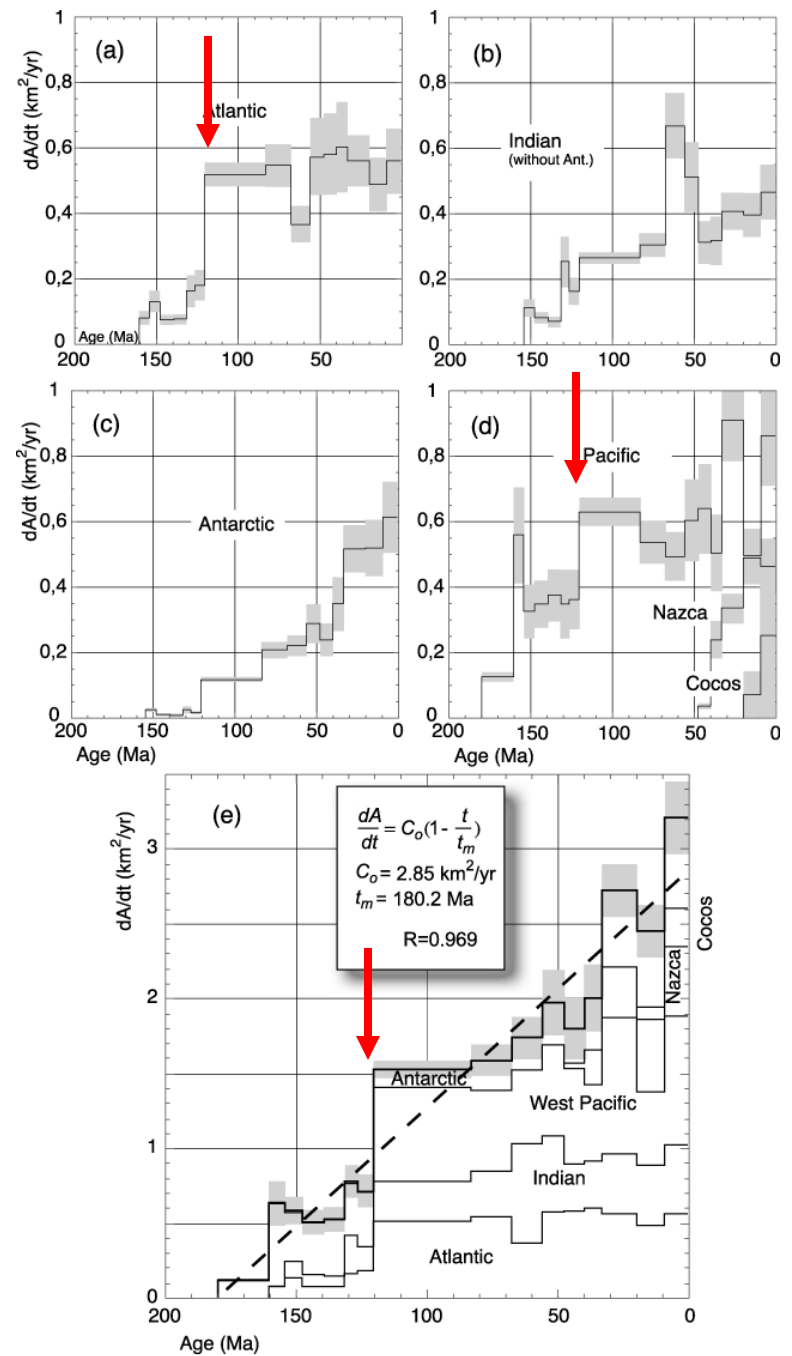
==> *synchronisme à 5-10 Ma près !*

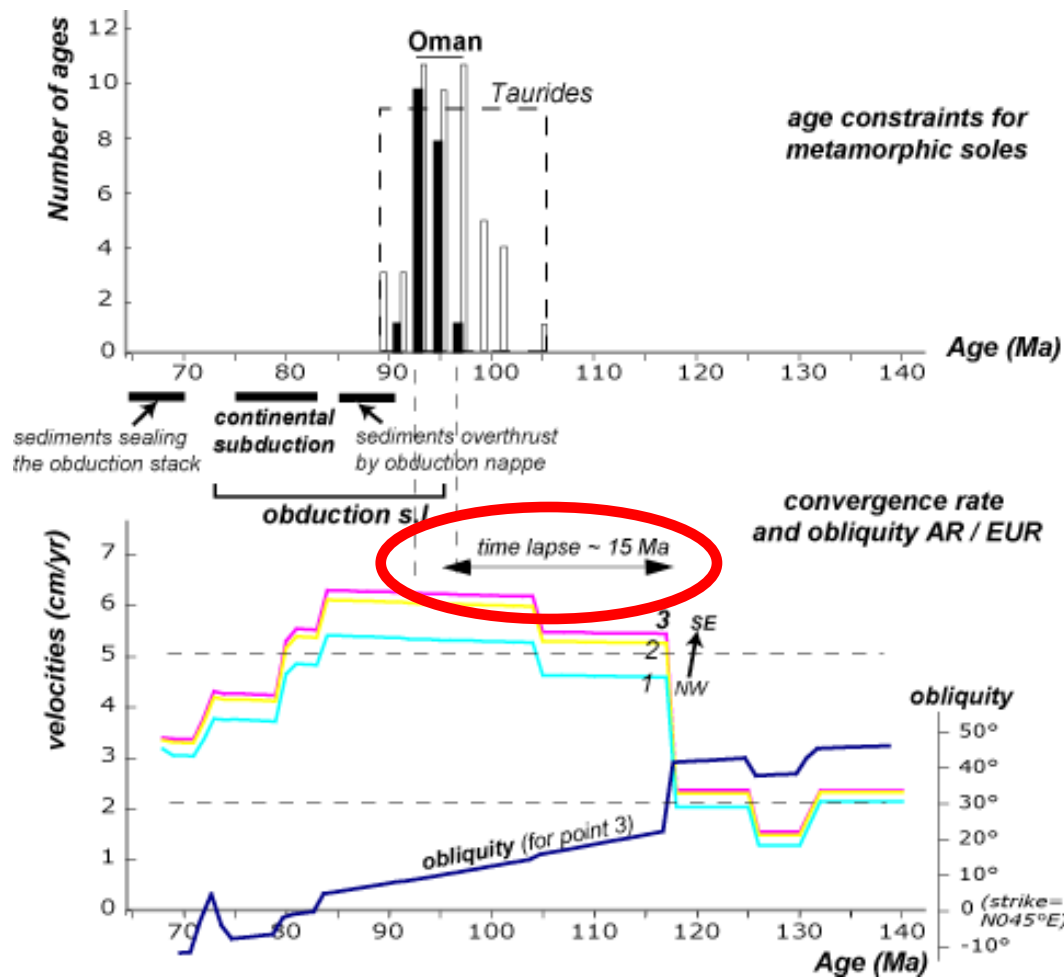
② Vitesses de convergence dans la Néotéthys

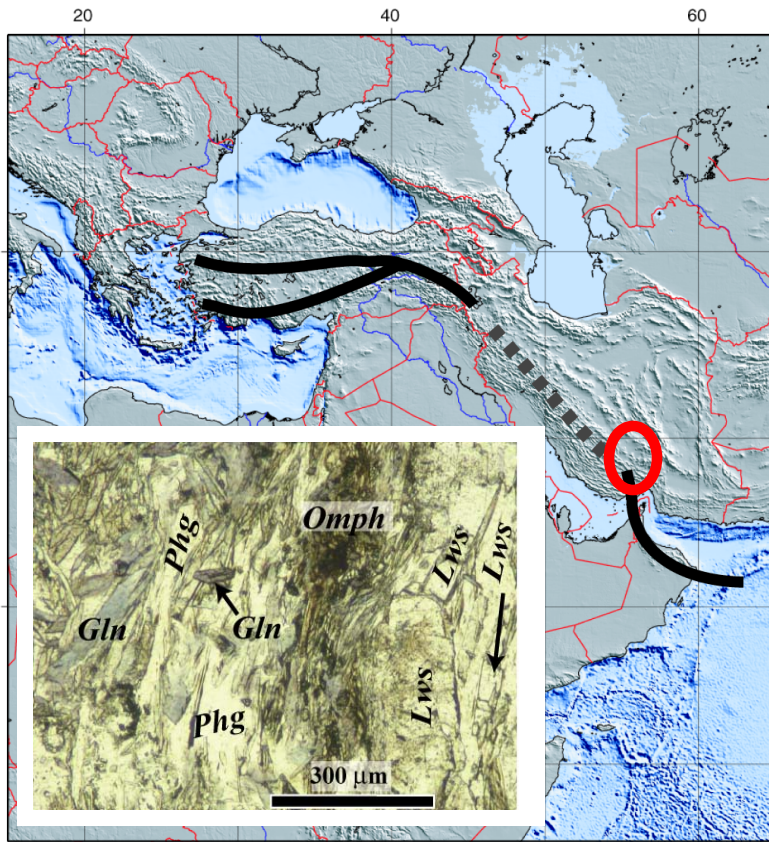




=> rétrécissement brutal de la Néotéthys !

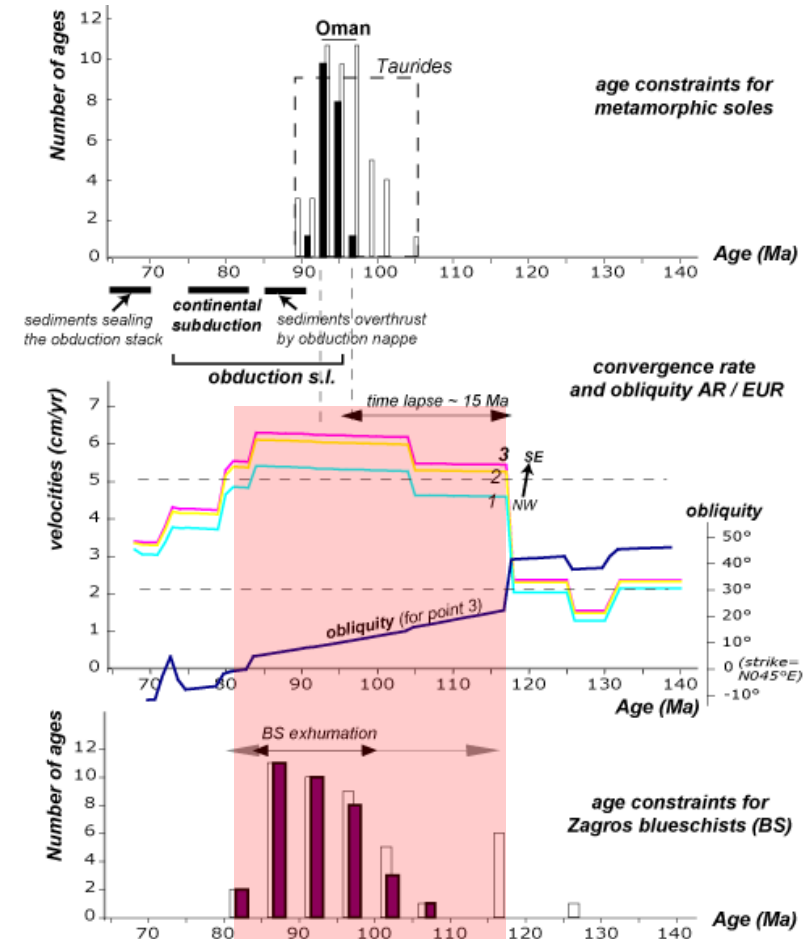


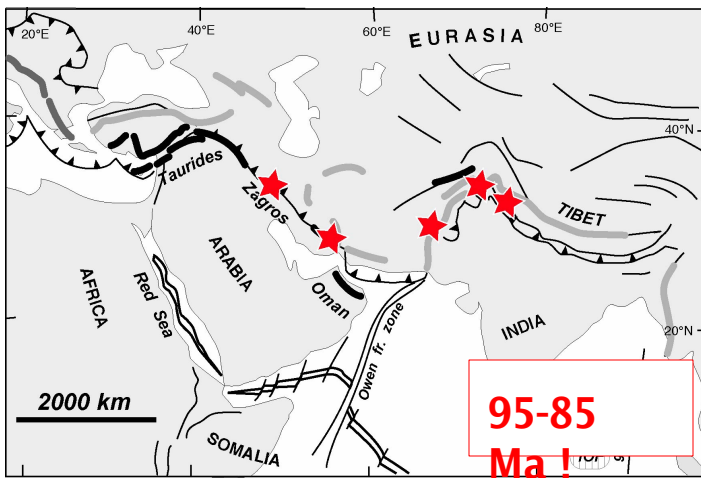




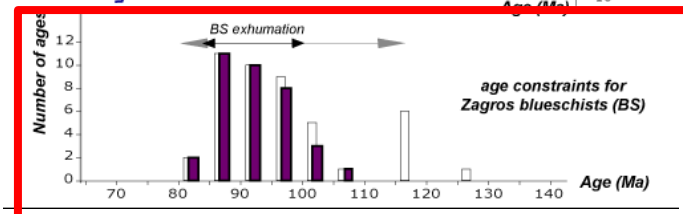
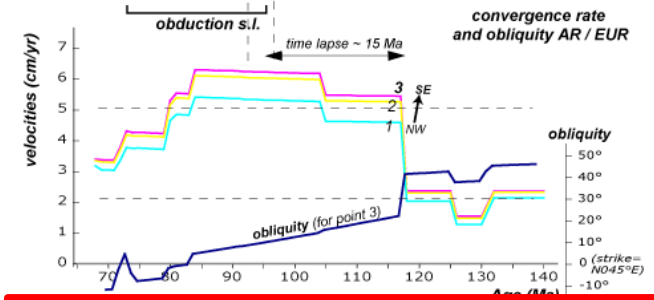
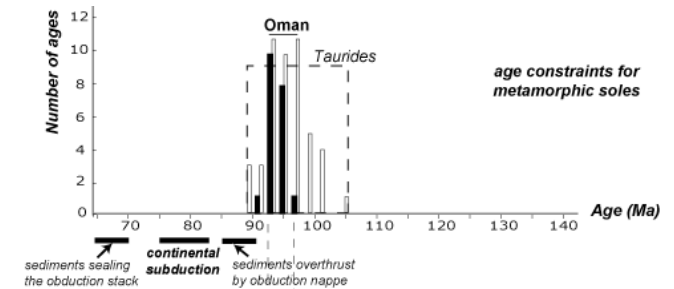
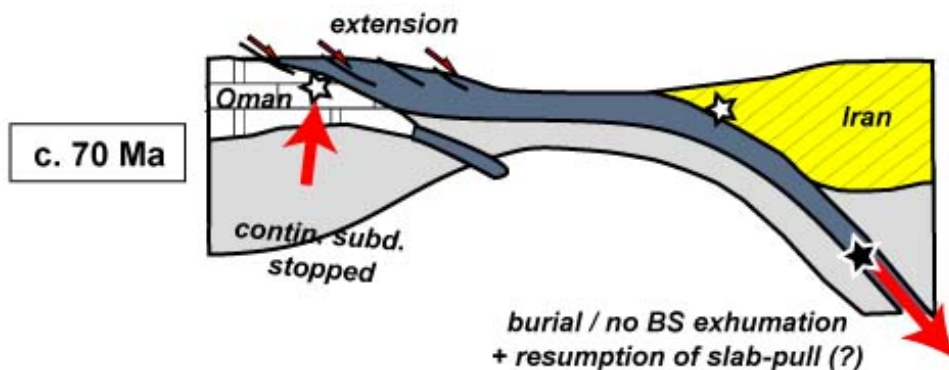
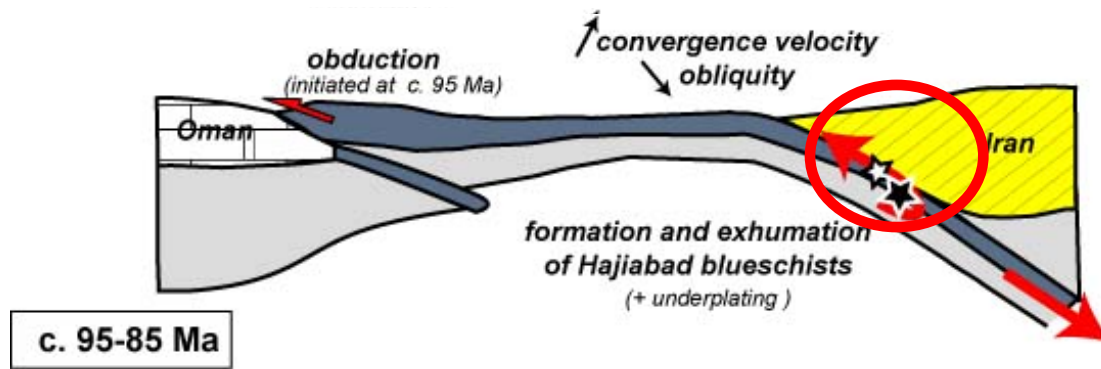
③ Ce qu'apportent les Schistes Bleus

==> subduction : ~150-35 Ma, peu de SB

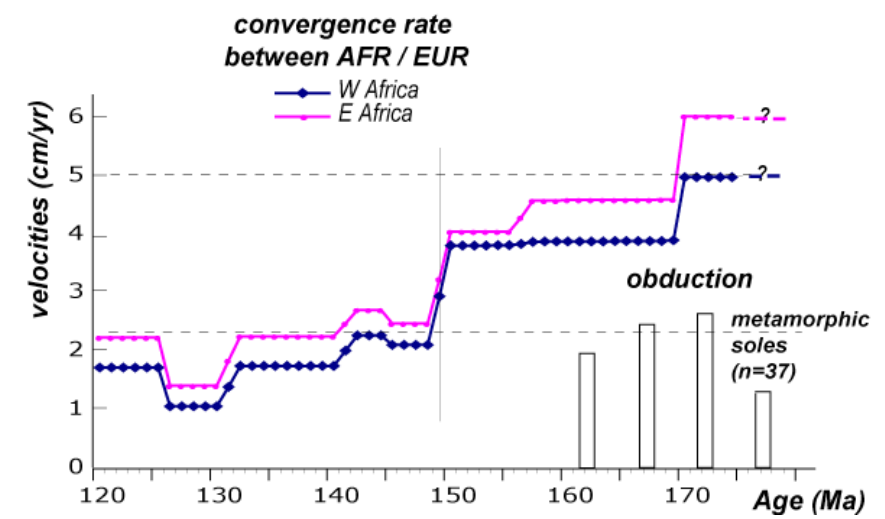
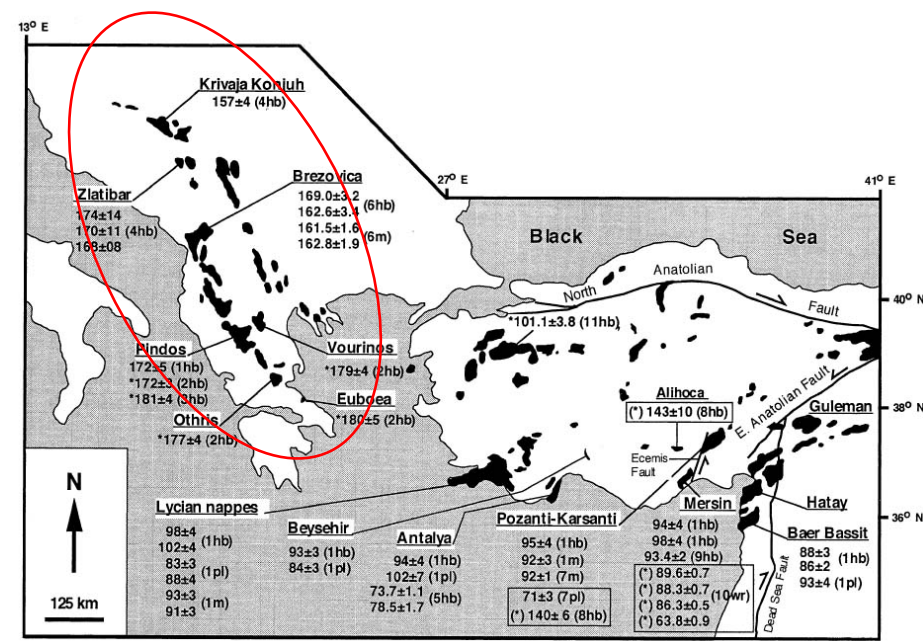
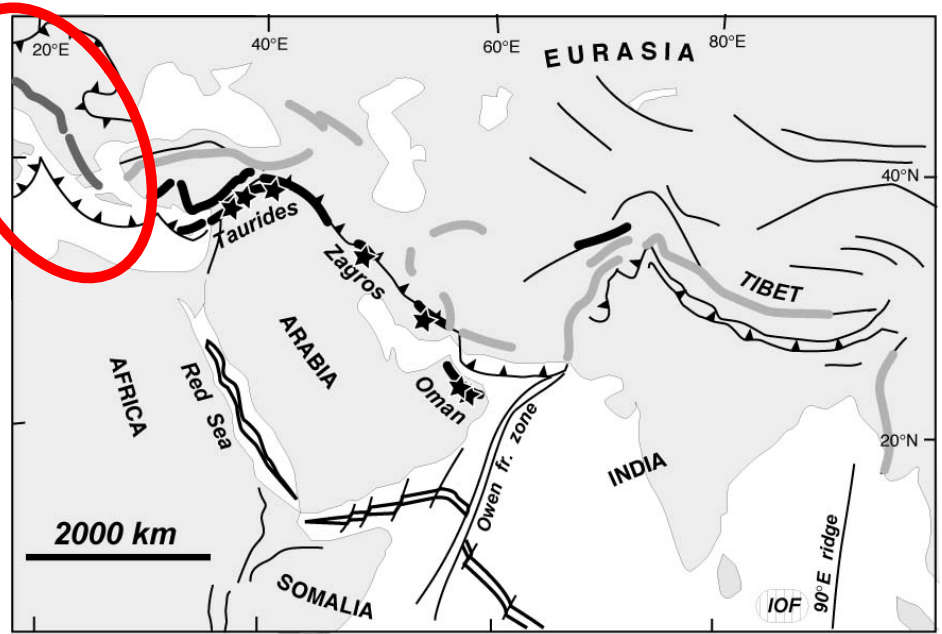




- => exhumation des SB = transitoire !
- => un phénomène de grande ampleur
- => modification du couplage plaque > et plaque <

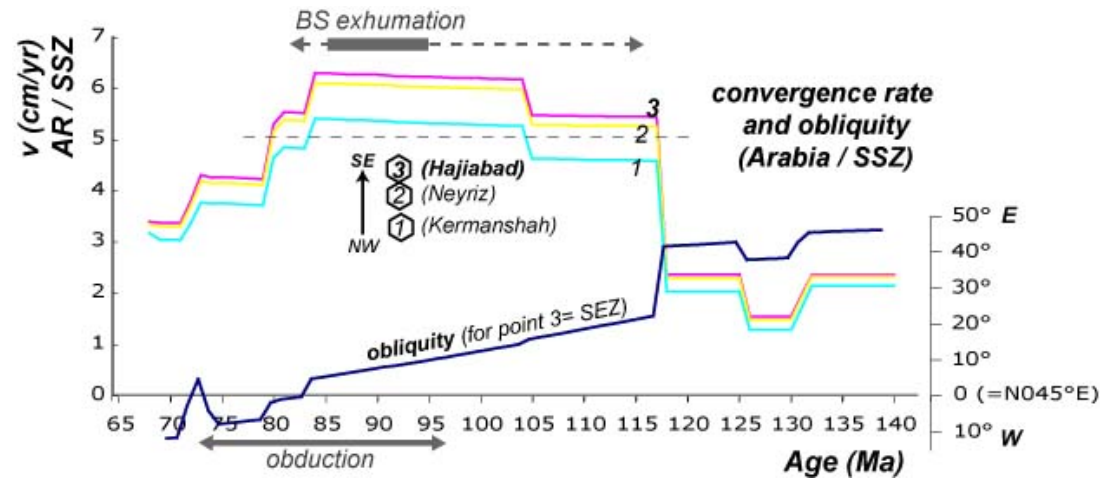


4 Vitesses de convergence : d'autres indices concordants

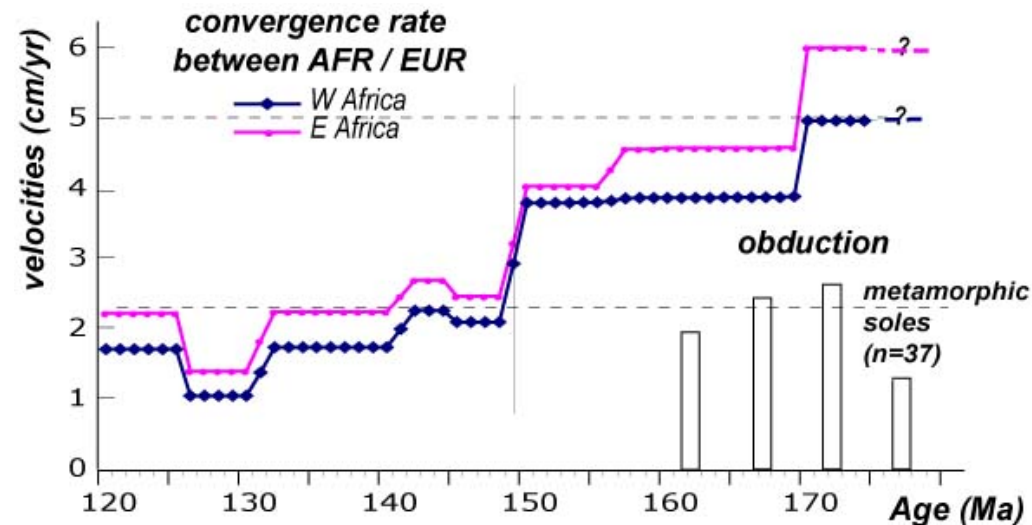


L'accélération des plaques... déclencheur de l'obduction ?

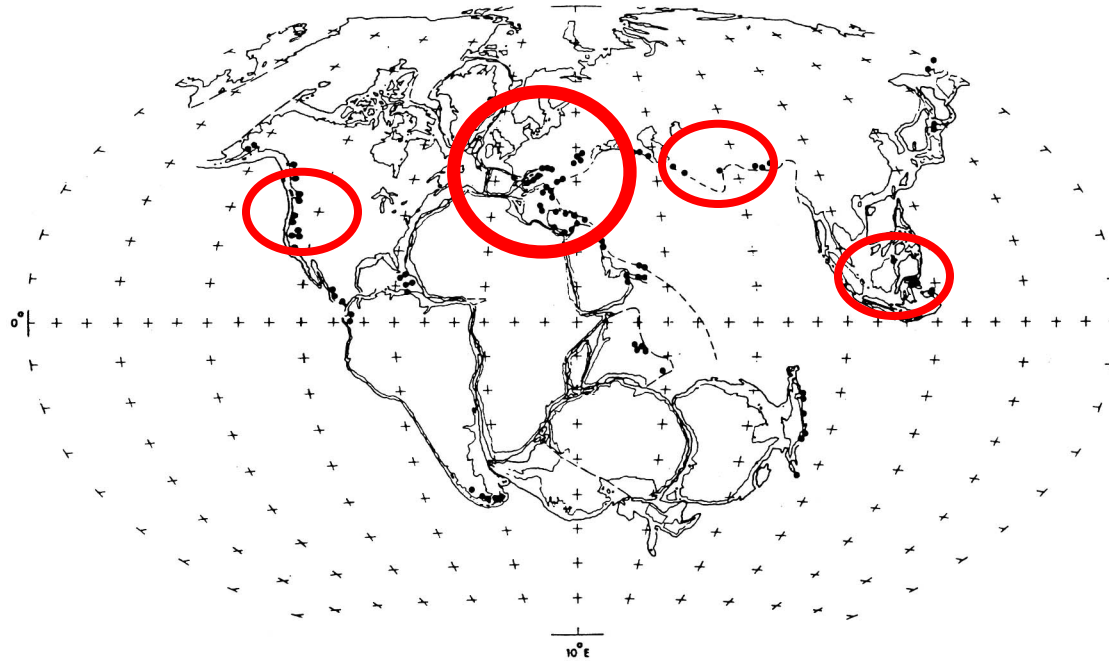
obduction
K >



obduction
J =



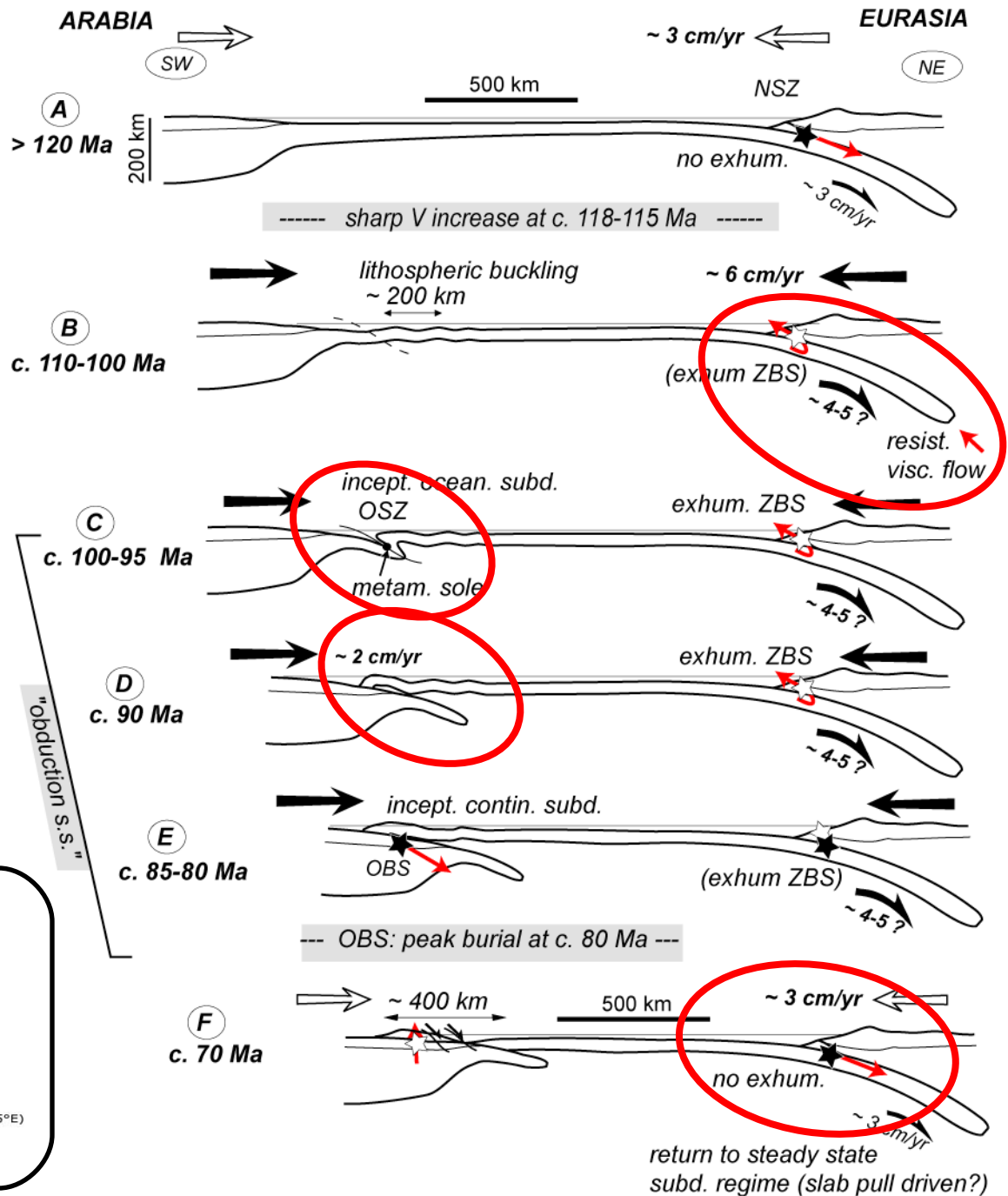
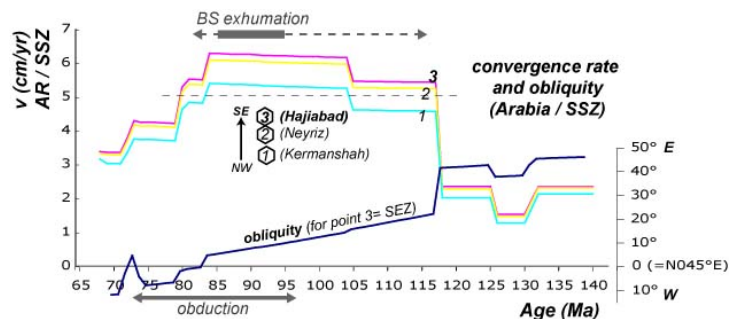
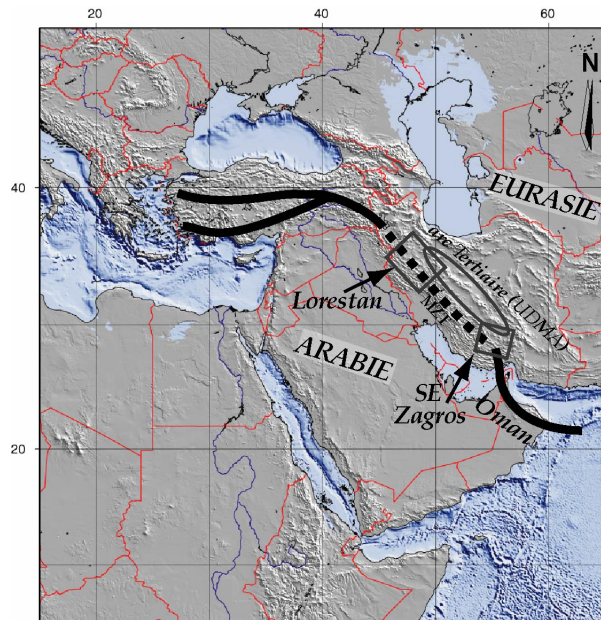
Et alors ?... wishful thinking ?

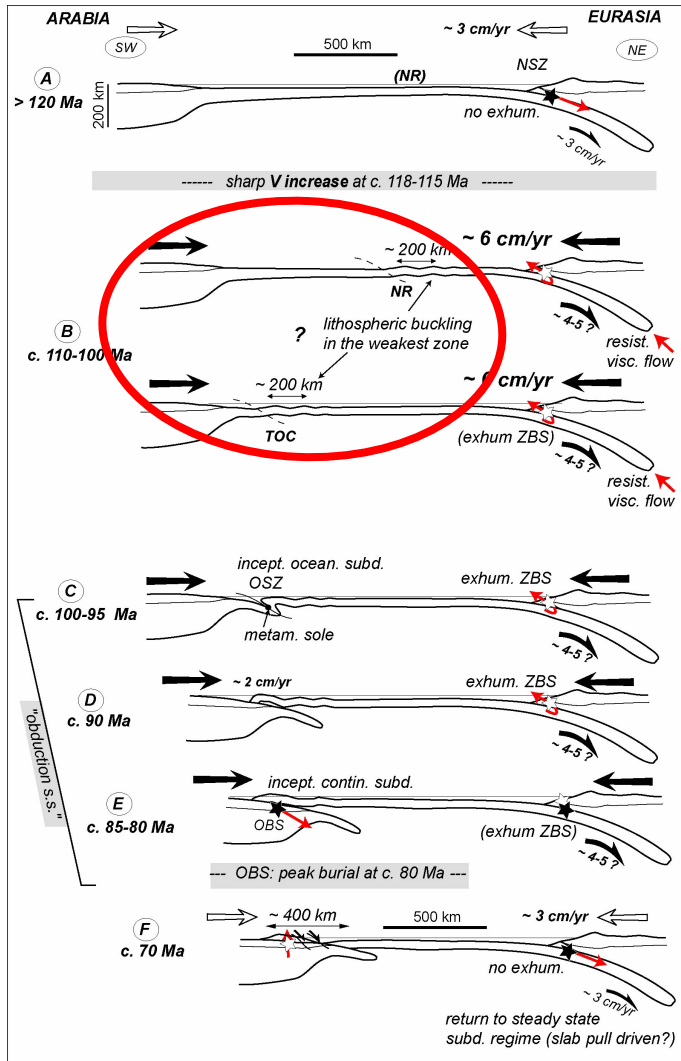


Tests complémentaires ? Oui mais...

- Himalaya: pas (peu) de semelles métamorphiques
- Franciscain, Coast ranges,... : 'terrane' très translatés
- obductions de petite taille (p ex., back-arcs)
- Paléozoïque: pas de données cinématiques

Transect Zagros - Oman



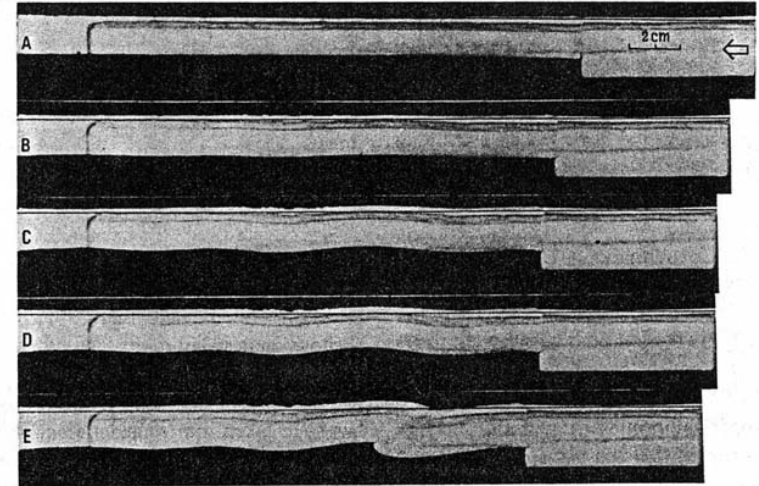


✓ Buckling de la lithosphère Indienne

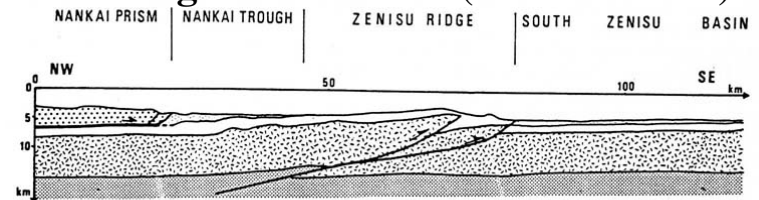
Bull & Scrutton, 1980, *Nature*
 Martinod & Davy, 1994, *JGR*
 Gerbault, 2000, *EPSL*

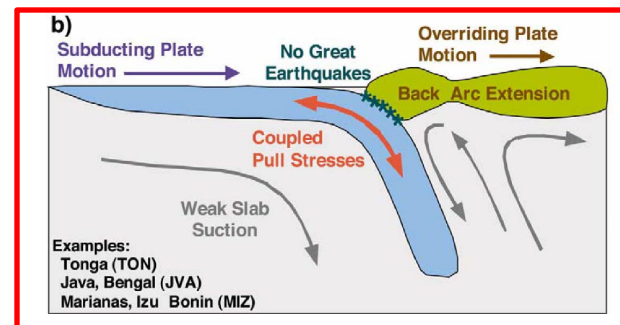
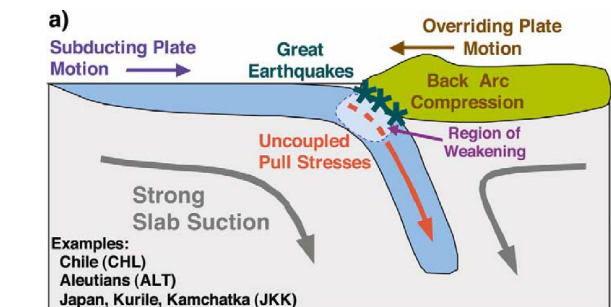
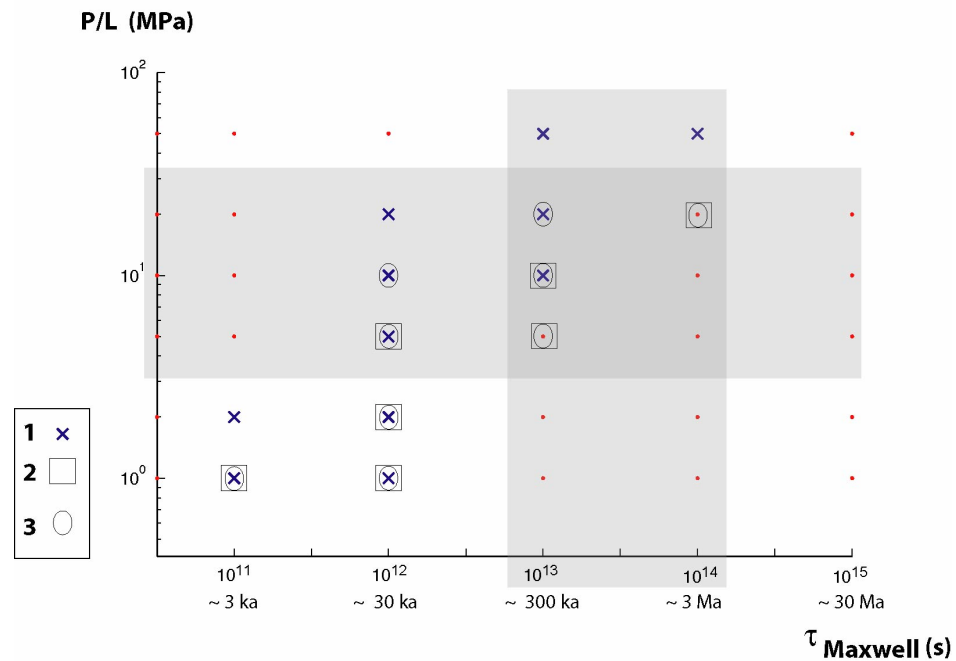
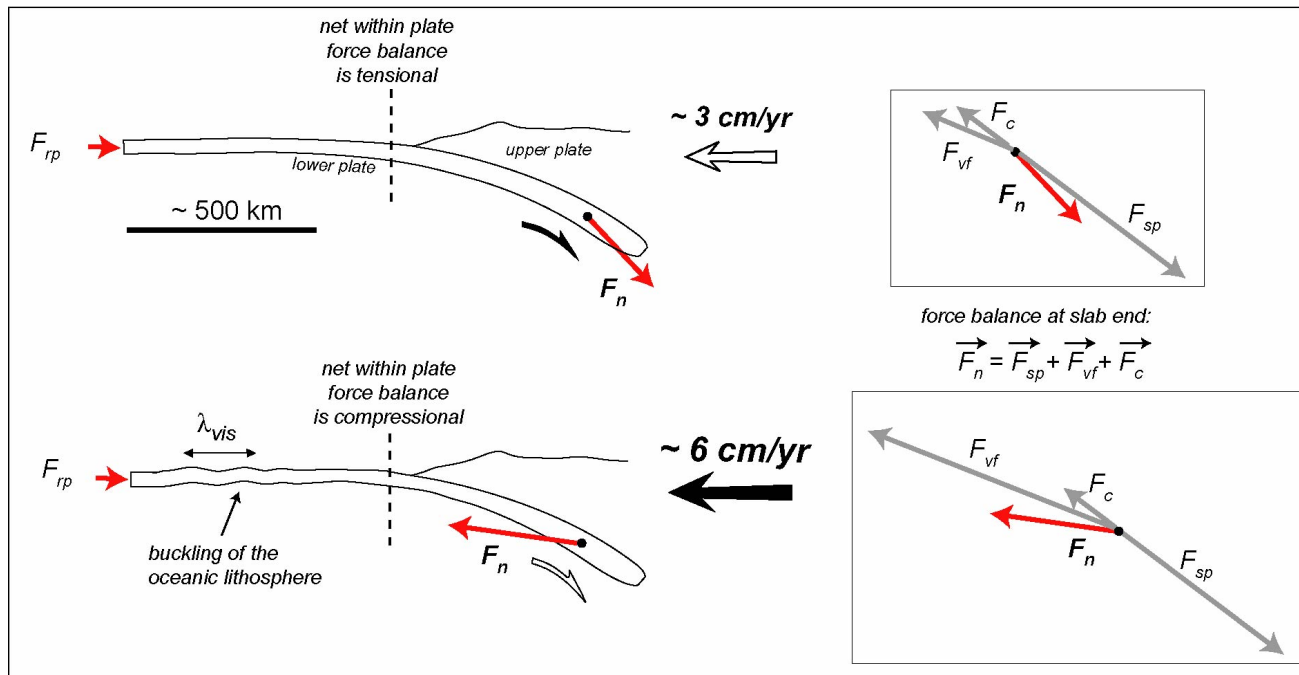
=> rupture
 après ~10 My

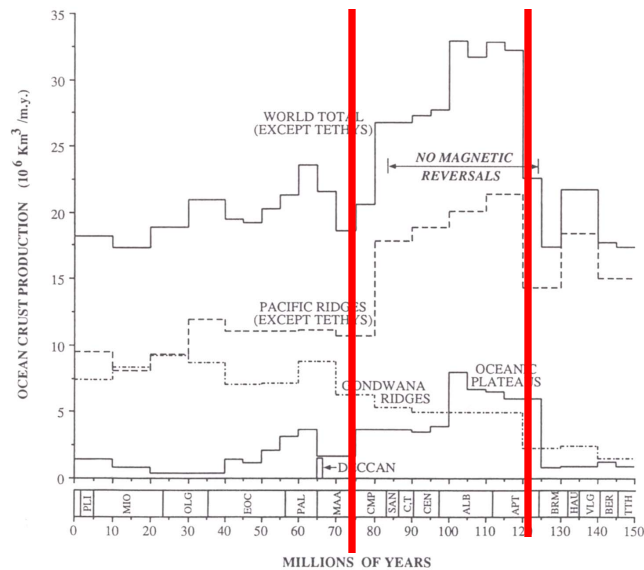
✓ Modélisation analogique Shemenda, 1992, *JGR*



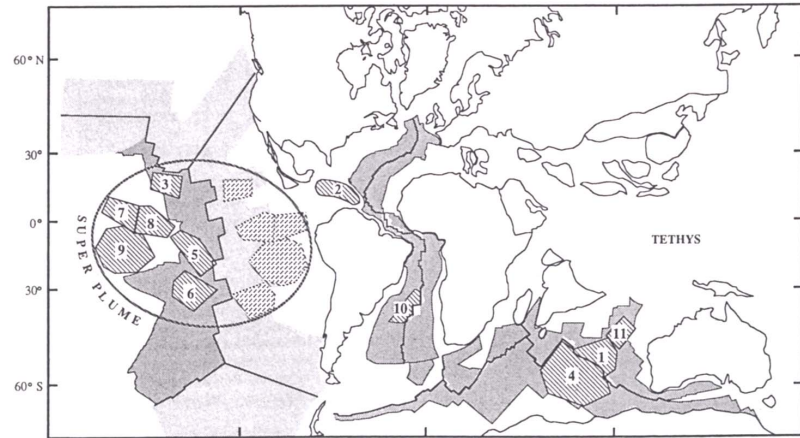
✓ Charriages intraocéan. (ride de Zenisu)



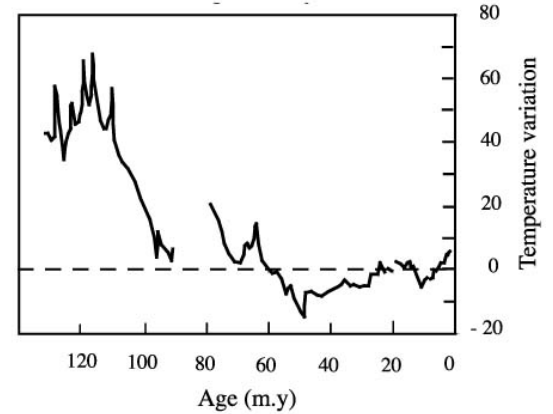
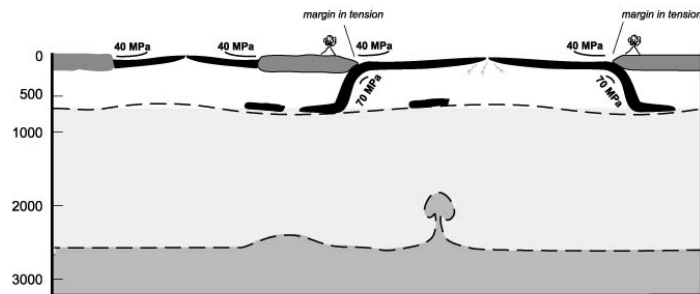




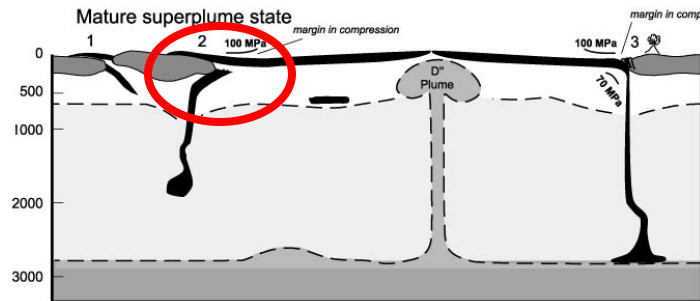
Larson, 1991, Geology



*accélérations des plaques
... et/ou superplumes ?...*



Machetel & Humler, 2003 EPSL

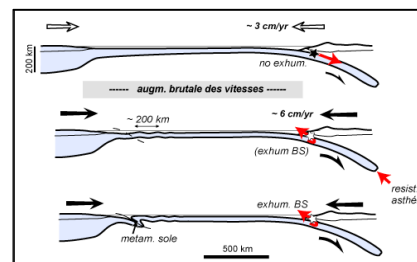
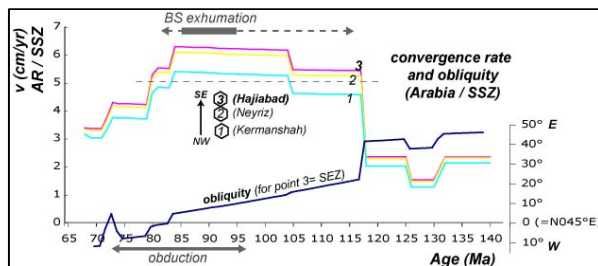


Vaughan & Scarrow, 2003, EPSL

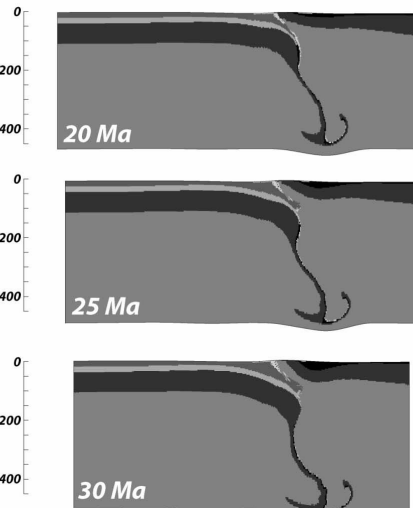
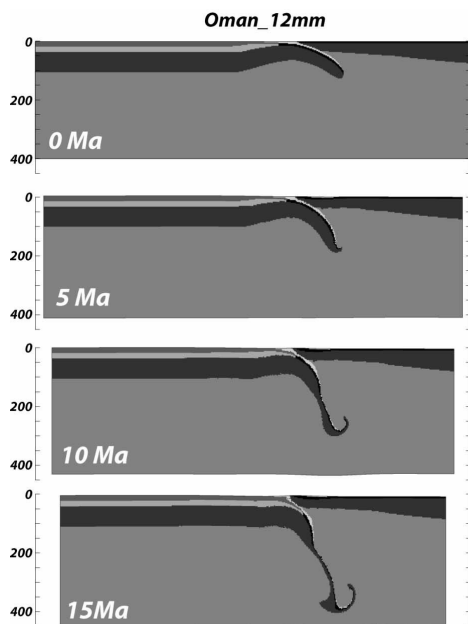
... 2 façons d'aborder la même chose ?

Ce qui ressort des 2 récentes obductions de grande ampleur :

- charriage synchrone sur milliers de km
- une accélération marquée précède l'obduction par ~10 Ma (ΔV à chaque fois)
- modification du couplage mécanique de la zone de subduction adjacente

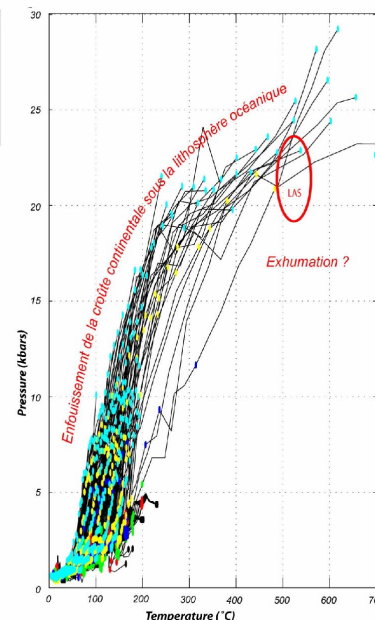


Perspectives

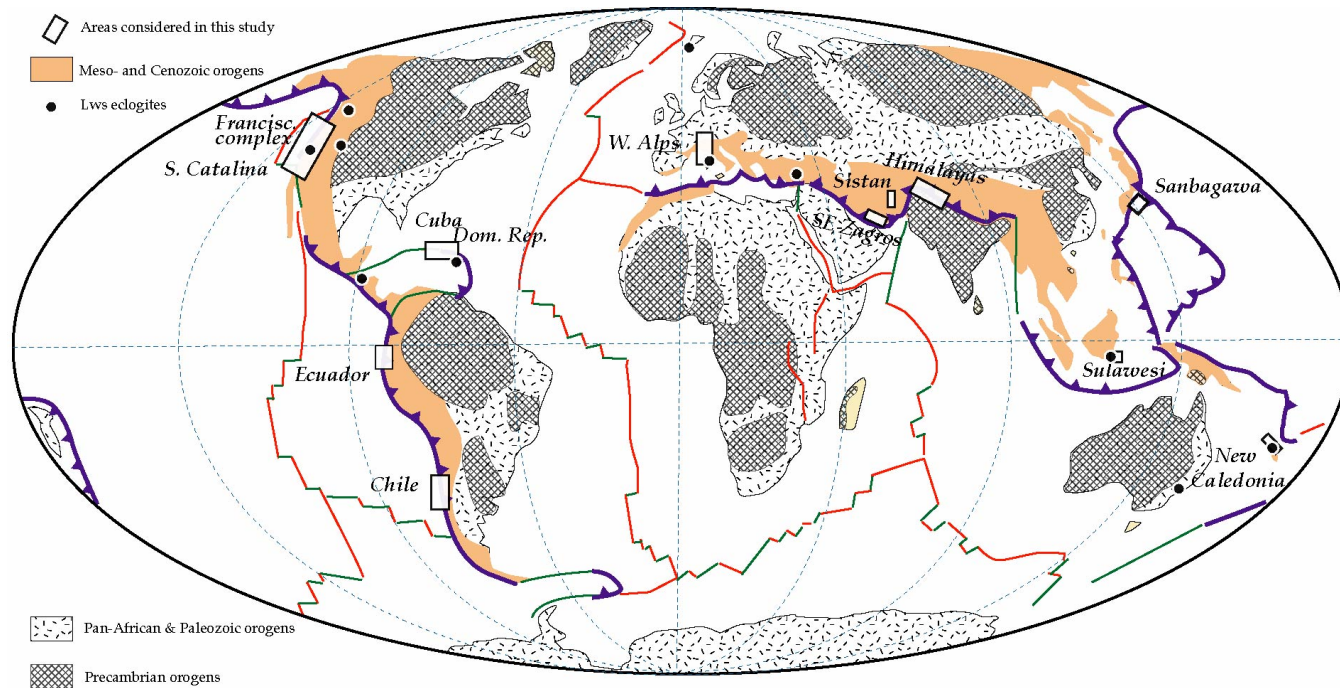


modélisation !...

Yamato et al., in progress...



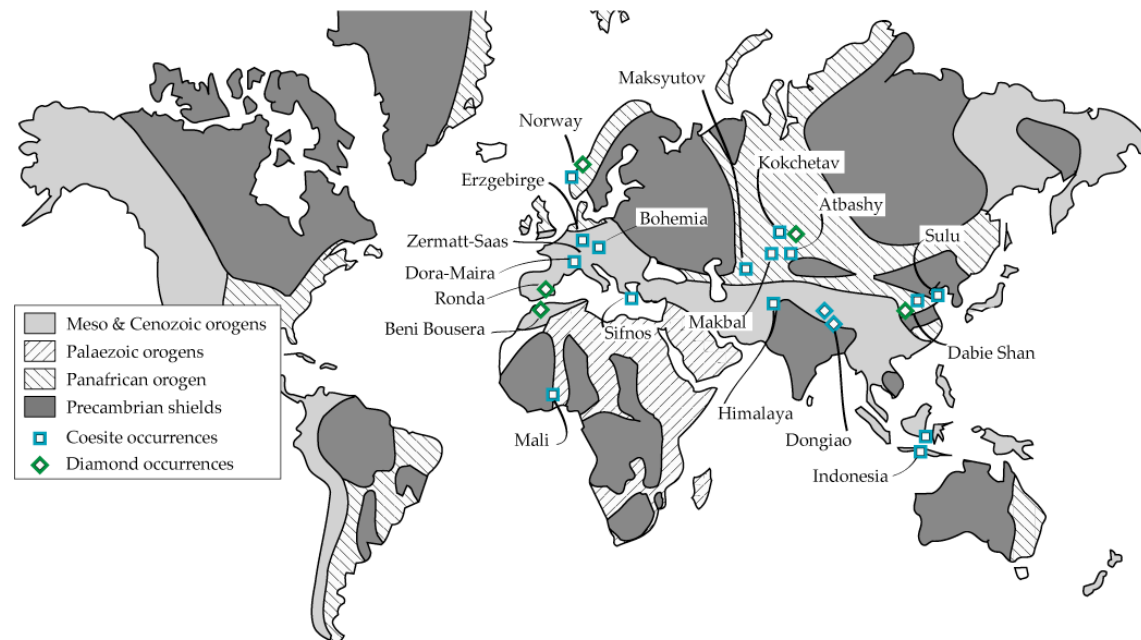
3. Implications rhéologiques



Agard et al., Am. J. Sci. (subm.)

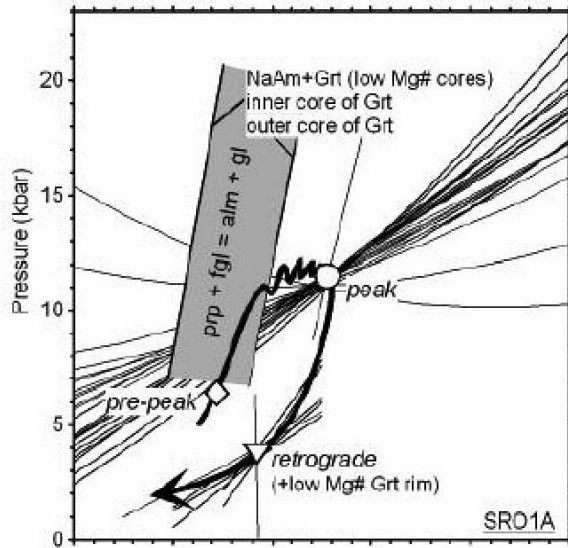
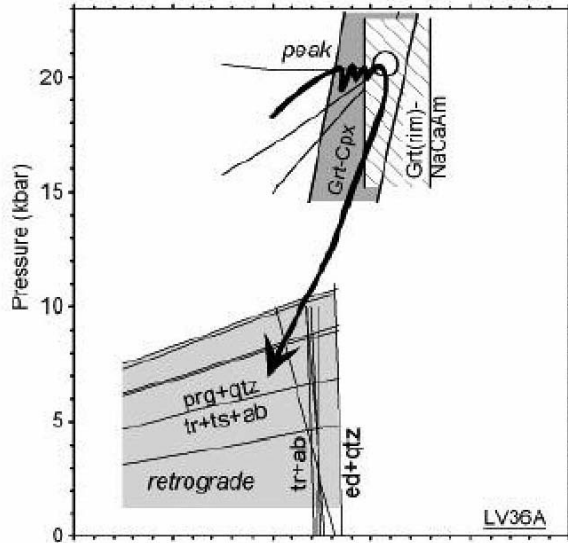
Couplages profonds et comportement de la **lithosphère océanique** dans les zones de subduction 'worldwide'...

- Exhumation du matériel continental très étudiée, rapide (cm/a), bien comprise
- Les terrains de UHP-HP sont pour l'essentiel continentaux, ramenés lors de la subduction continentale transitoire



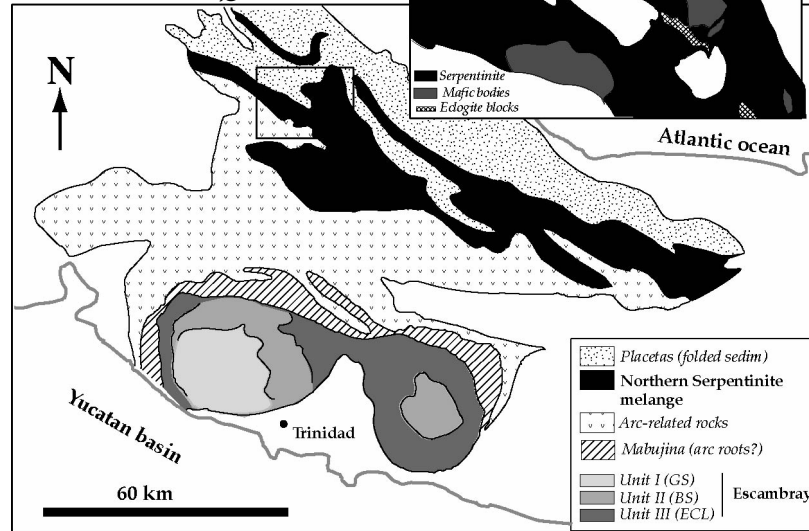
**idée/objectifs : les unités océaniques exhumées rarement
peuvent nous renseigner sur la mécanique de la subduction**

Le cas de Cuba :



Garcia-Casco et al., 2006

Schneider et al., JMG 2004



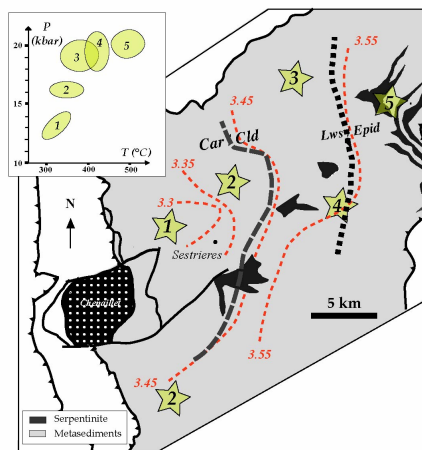
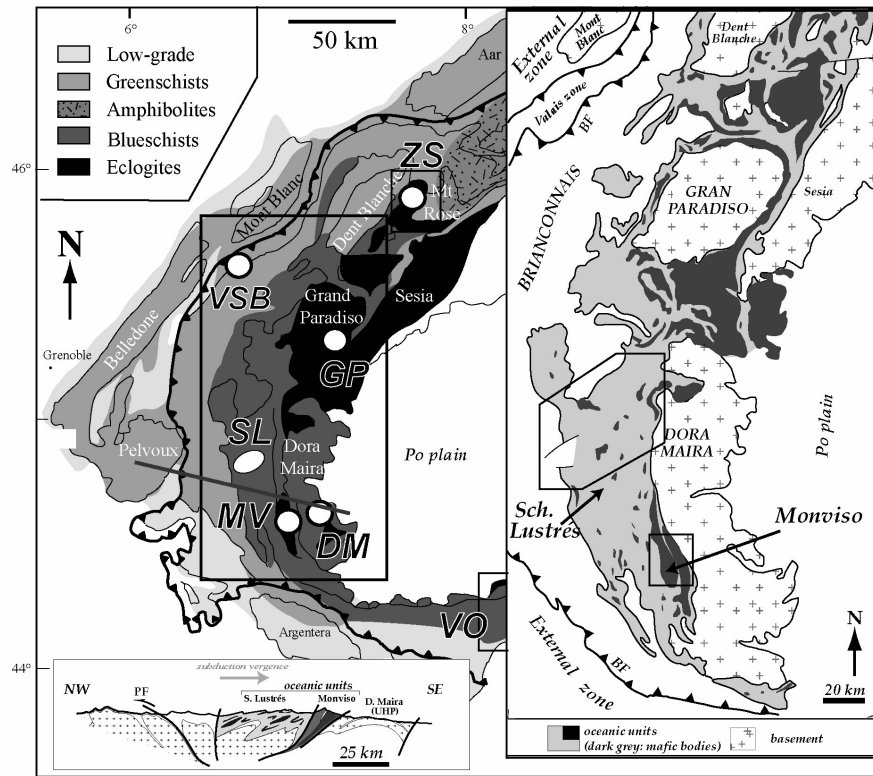
=> il existe d'autres indices de subductions 'instables' !

=> compilation mondiale !

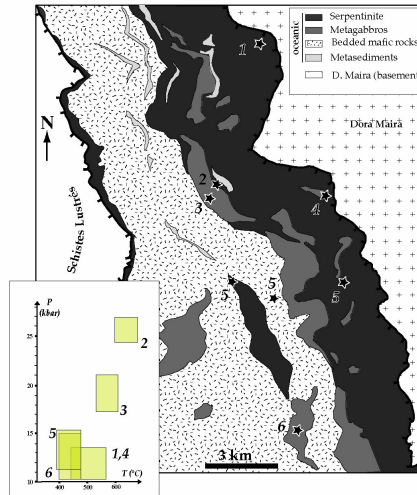
**Alpes, Franciscain, Antilles, Himalaya,
Nlle Calédonie, Zagros, Sanbagawa
(+ Sistan, Equateur, Chili, Sulawesi)**

- Durées (subduction, exhumation, relation/collision...),
- Grad. P/T, profondeur max.
- Vexhumation,
- Vconv., âges des plaques et pendage,
- Nature du matériel, relation avec serpentinites, volumes exhumés...

Le cas des Alpes Occidentales. :

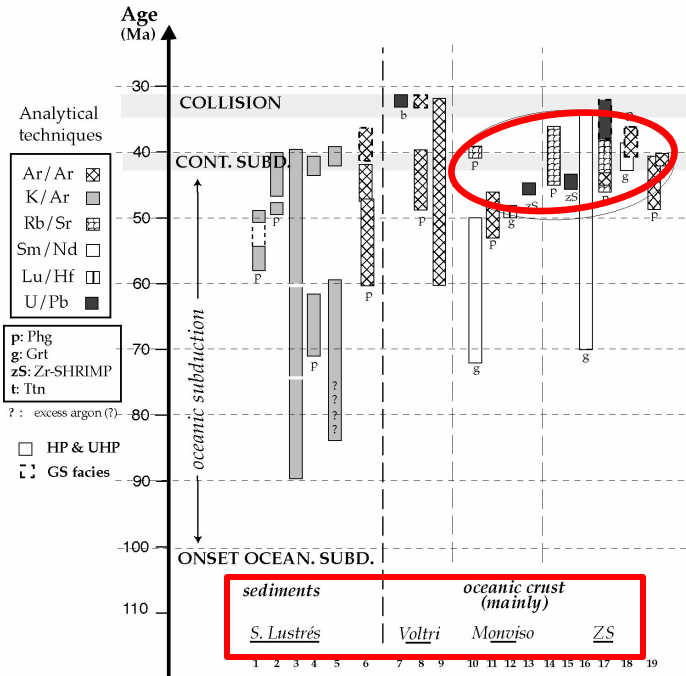
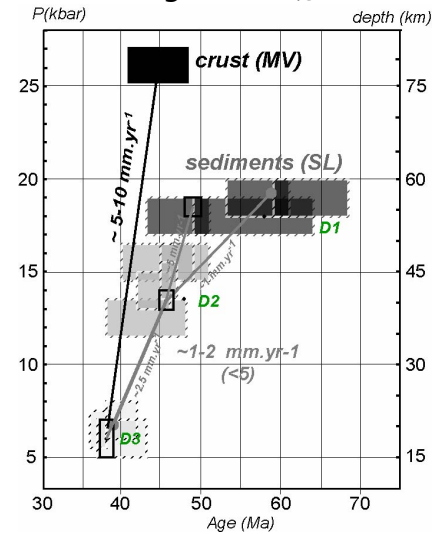


Agard et al., BSGF 2001



Schwartz et al., GA 2000

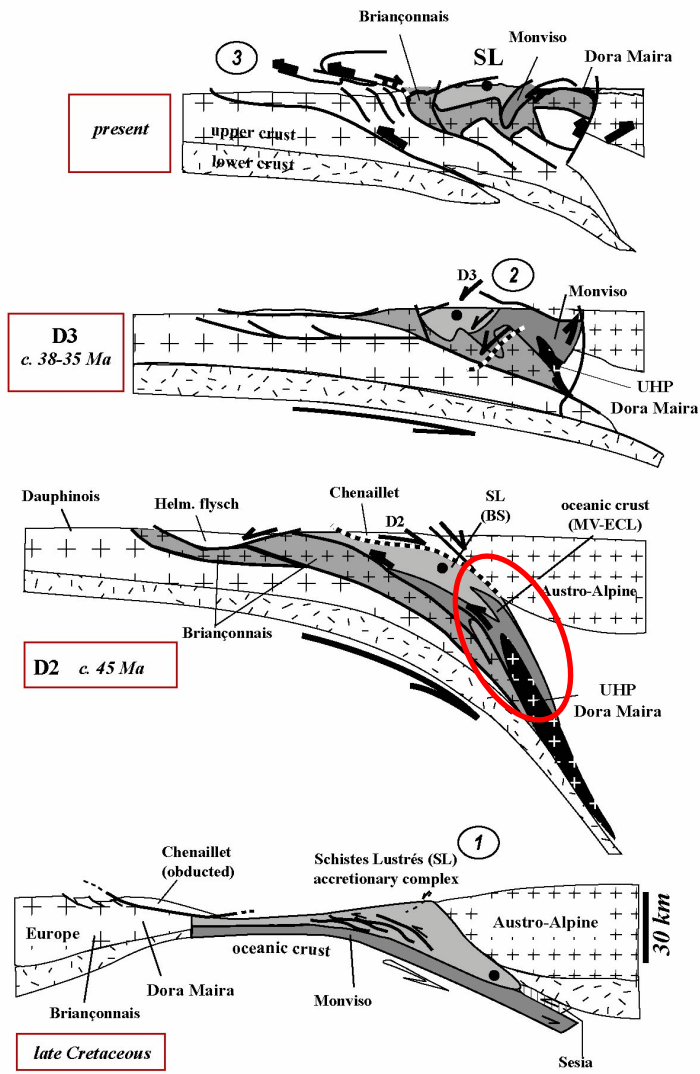
Agard et al., JMG 2002

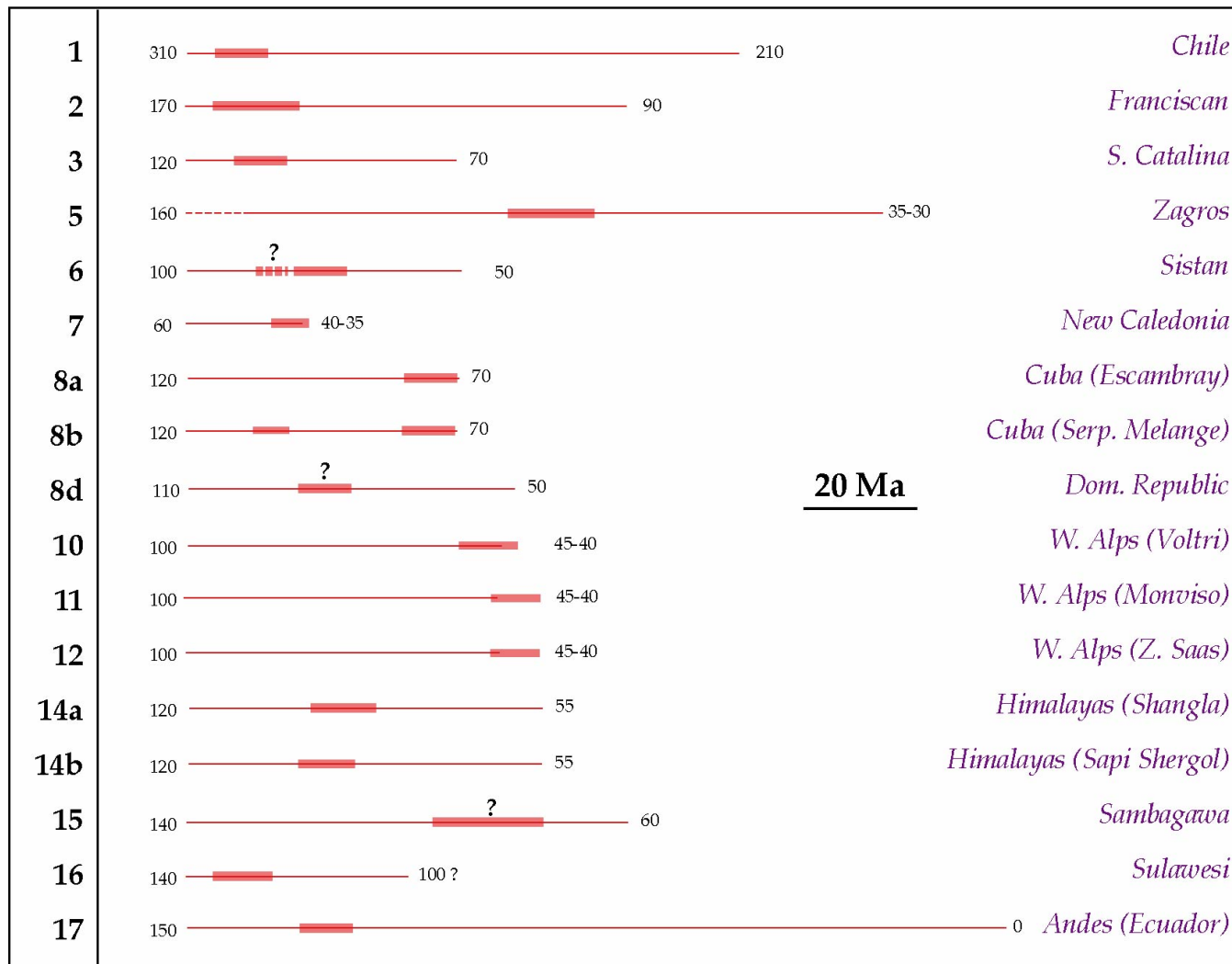


=> contraste croûte / sédim.

=> exh. tardive / Viso et ZS (subd. cont.)

Reconstitution géodynamique :



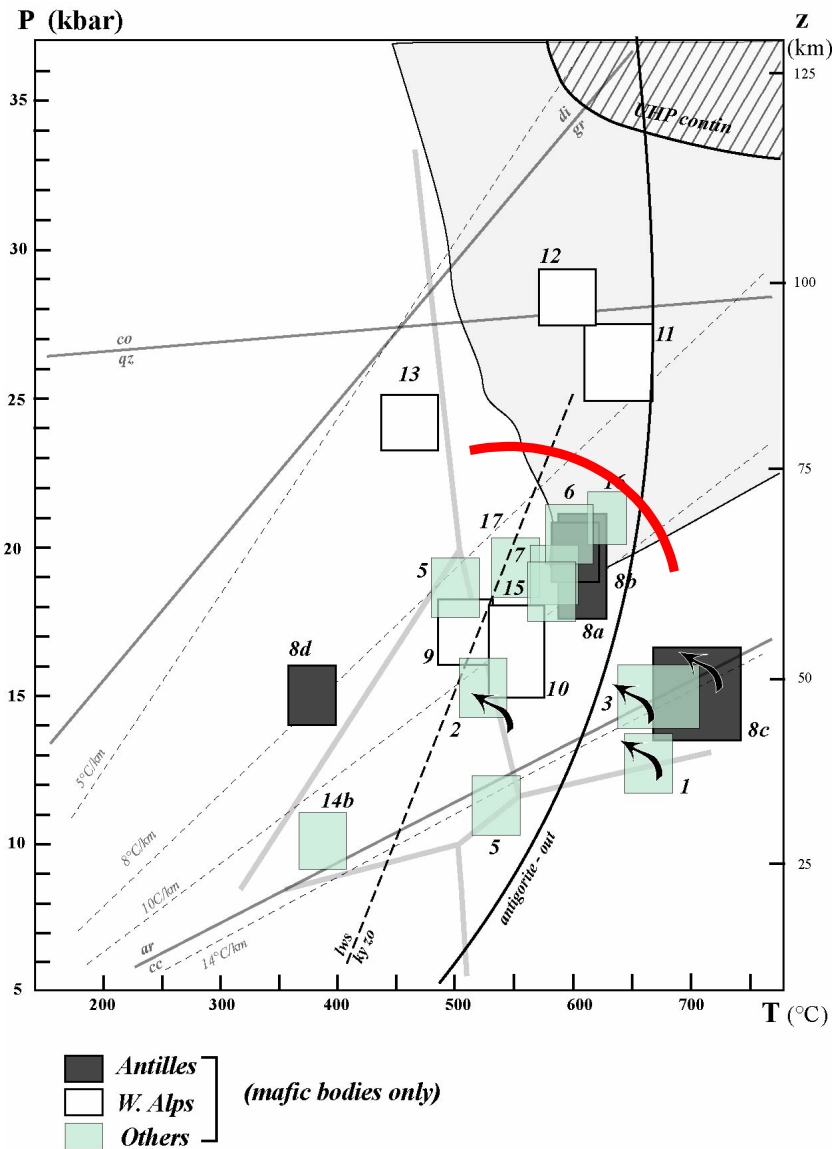
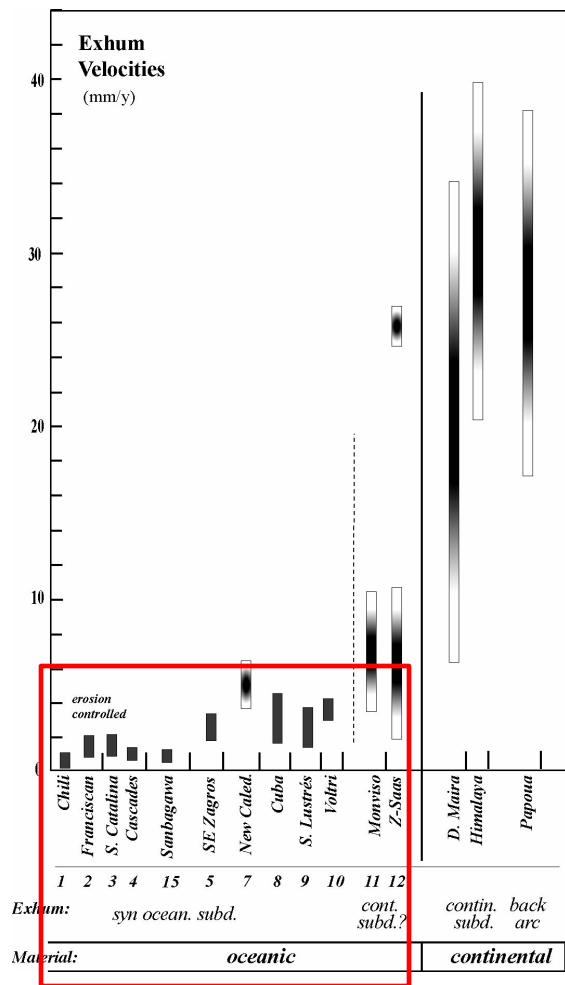


Exhumation de la croûte océanique = transitoire !

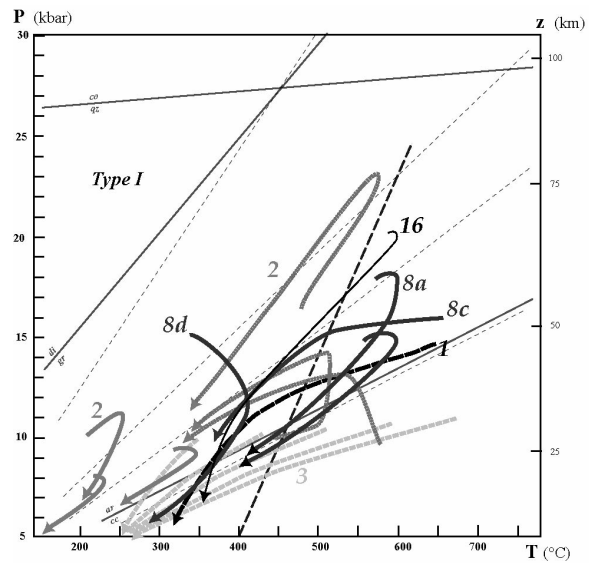
précoce: Franciscain, Chili, ...

pendant: SE Zagros, Himalaya (?), N Cuba ?

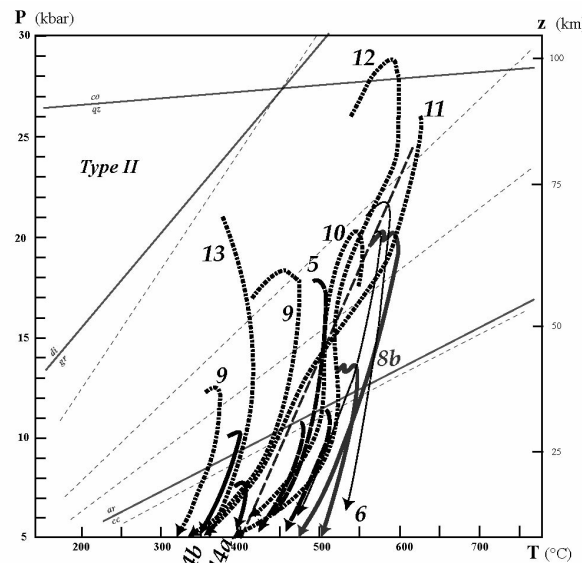
tardive: Alpes Occ., Nlle Caled.



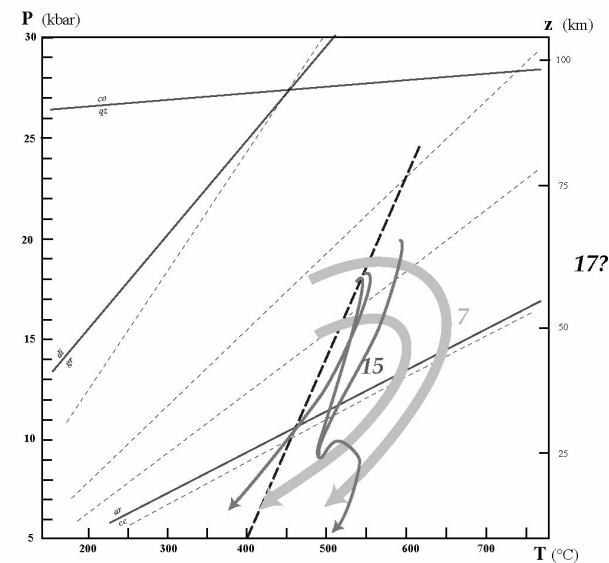
=> Exhum discontinue
=> V_{exhum} faibles (1-5 mm/a)
=> P max (W. Alps = max!)



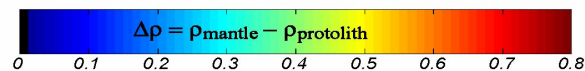
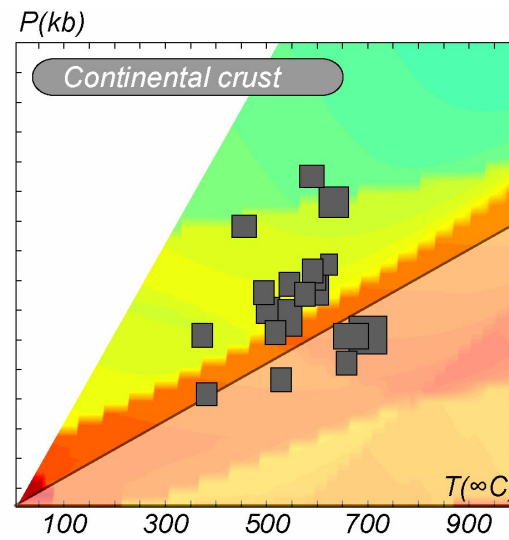
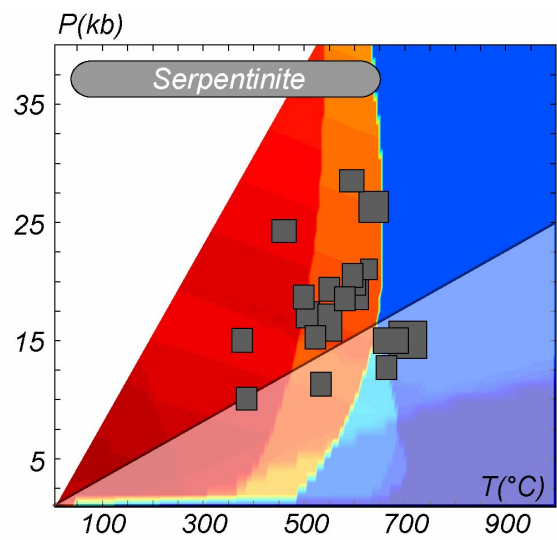
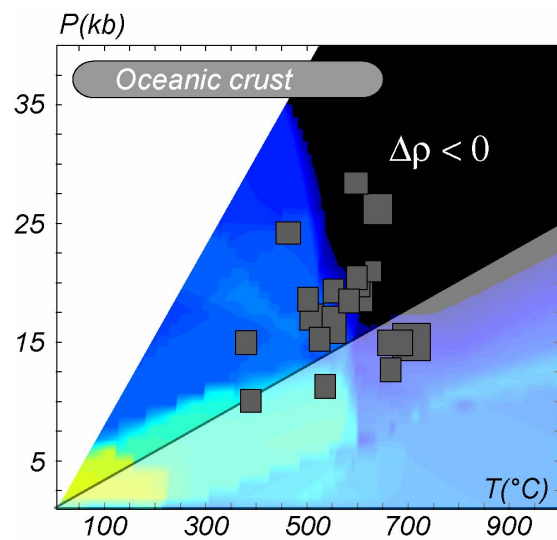
*Chile (1), Franciscan (2), S. Catalina (3)
S. & E. Cuba (8a,c), Dom. Rep. (8d), Sulawesi (16)*



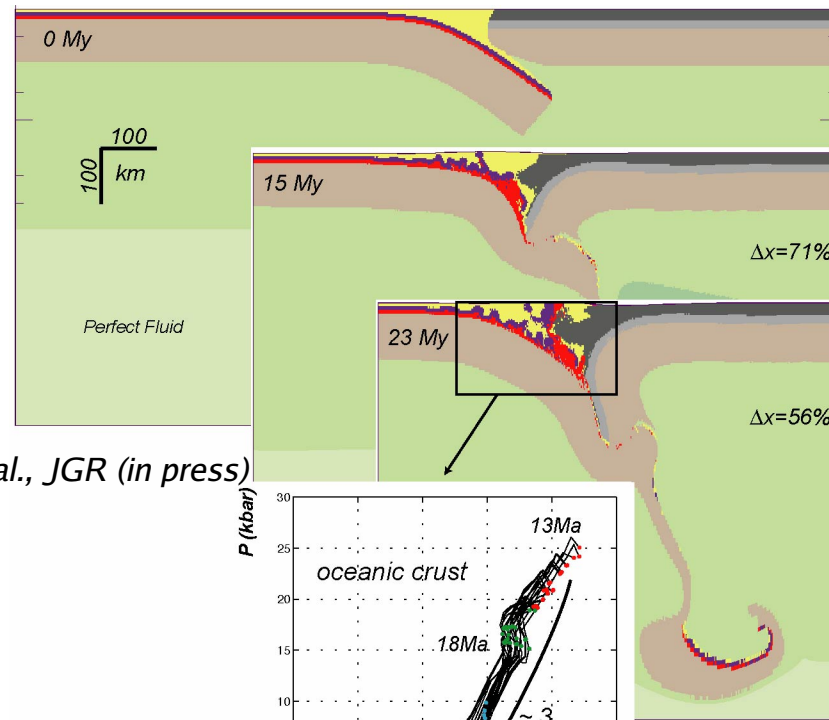
*SE Zagros (5), Sistan (6), N. Cuba (8b)
W. Alps (9 to 13), Himalayas (14a,b),*



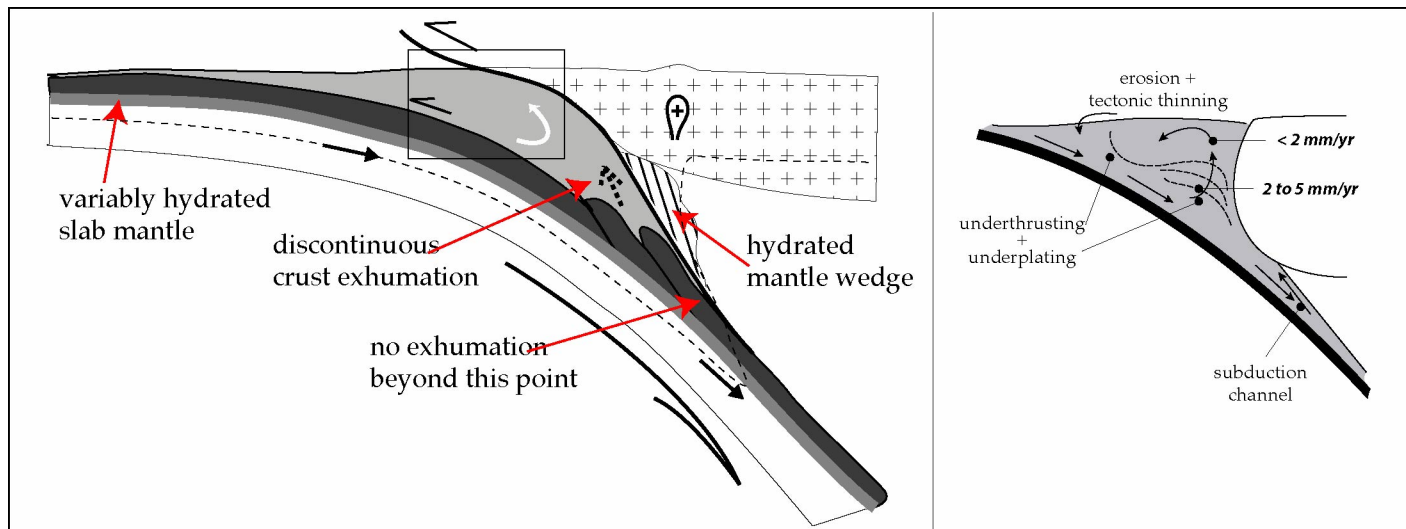
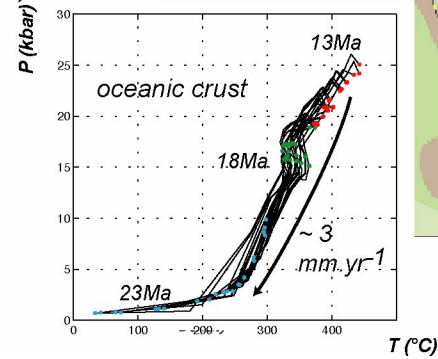
New Caledonia (7), Sanbagawa (15)

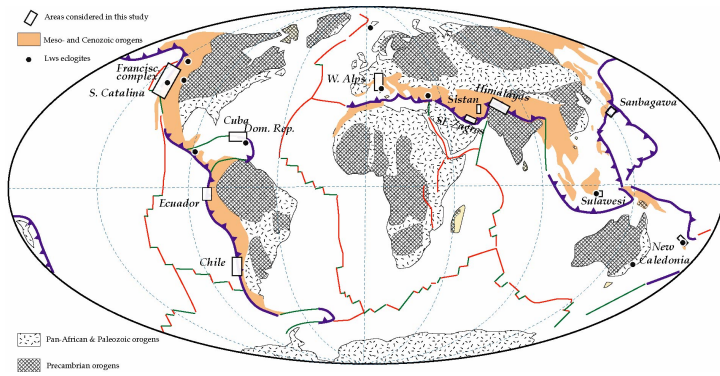


Oceanic crust

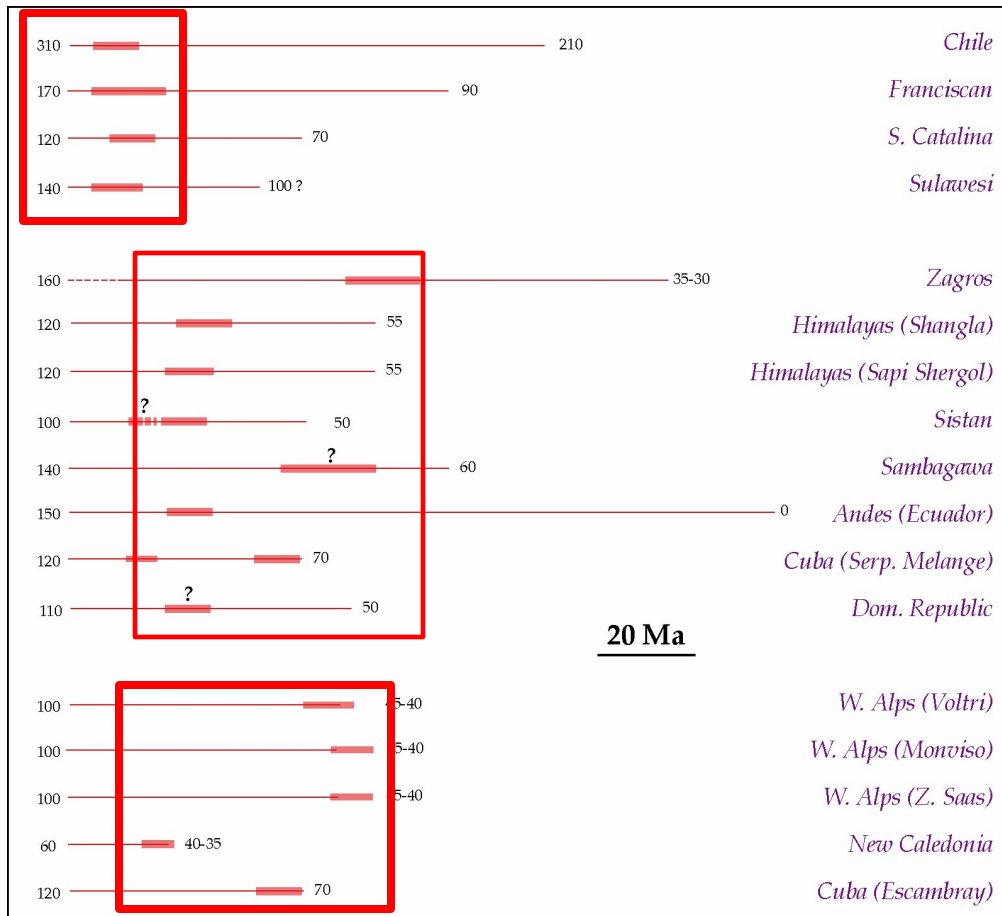


Yamato et al., JGR (in press)



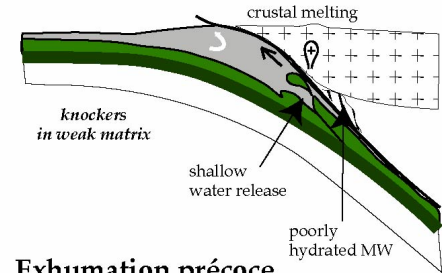


=> exhumation discontinue !!!

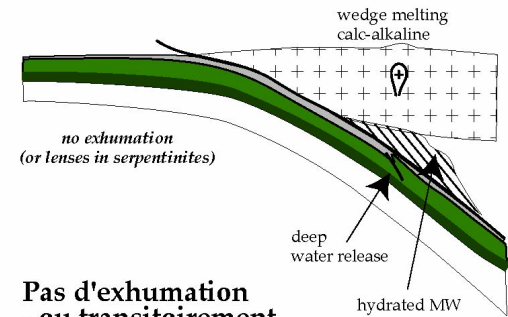


20 Ma

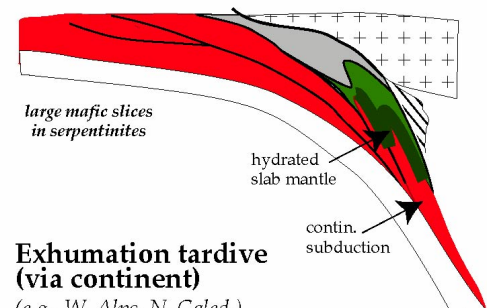
Agard al., AJS (subm)



Exhumation précoce de croûte océan.
(e.g., Franciscan, Chile)



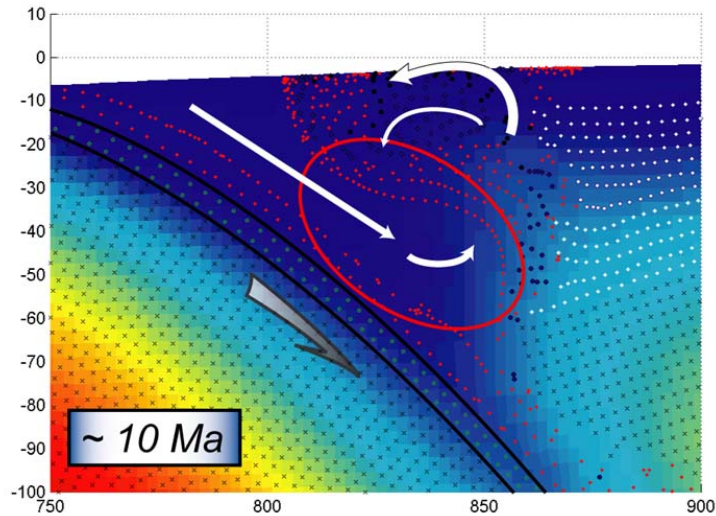
Pas d'exhumation - ou transitoirement
(e.g., Himalayas, Iran)



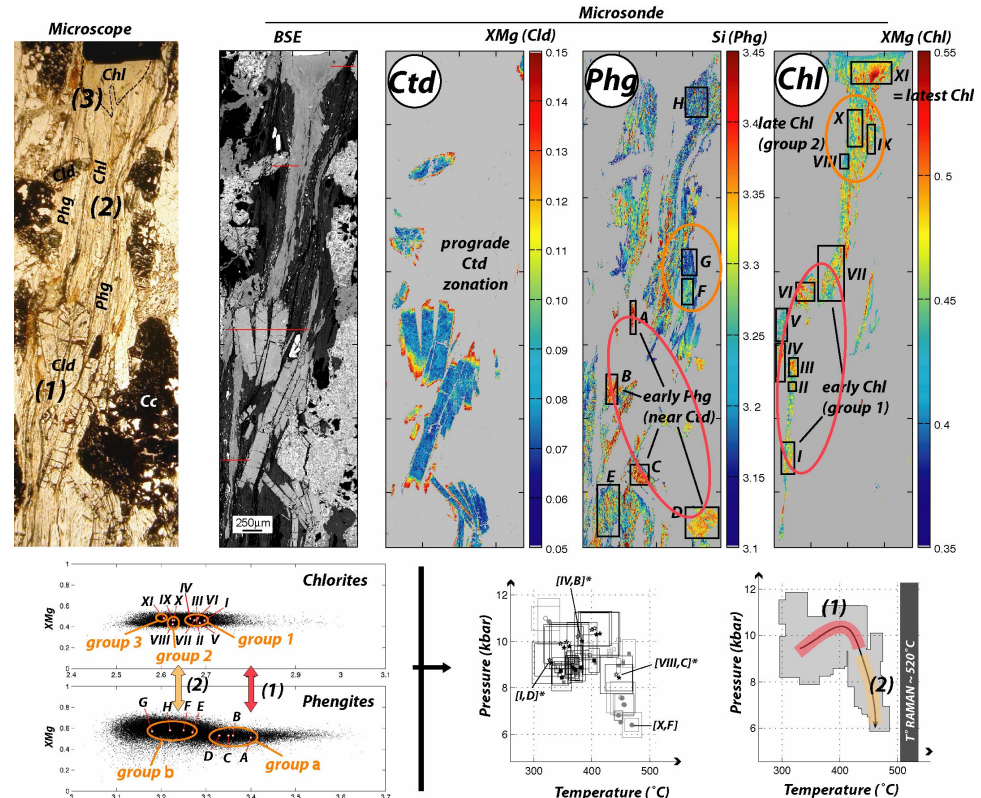
Exhumation tardive (via continent)
(e.g., W. Alps, N. Caled.)

Quelques pistes :

modélisation T-mécanique



couplages P-T-t-déformation-fluides (3F)



Yamato et al., JMG (en rév.)

... et discussions avec les géodynamiciens/géophysiciens !!!