Serpentinites: role and extent

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Exhumation of subducted oceanic lithosphere

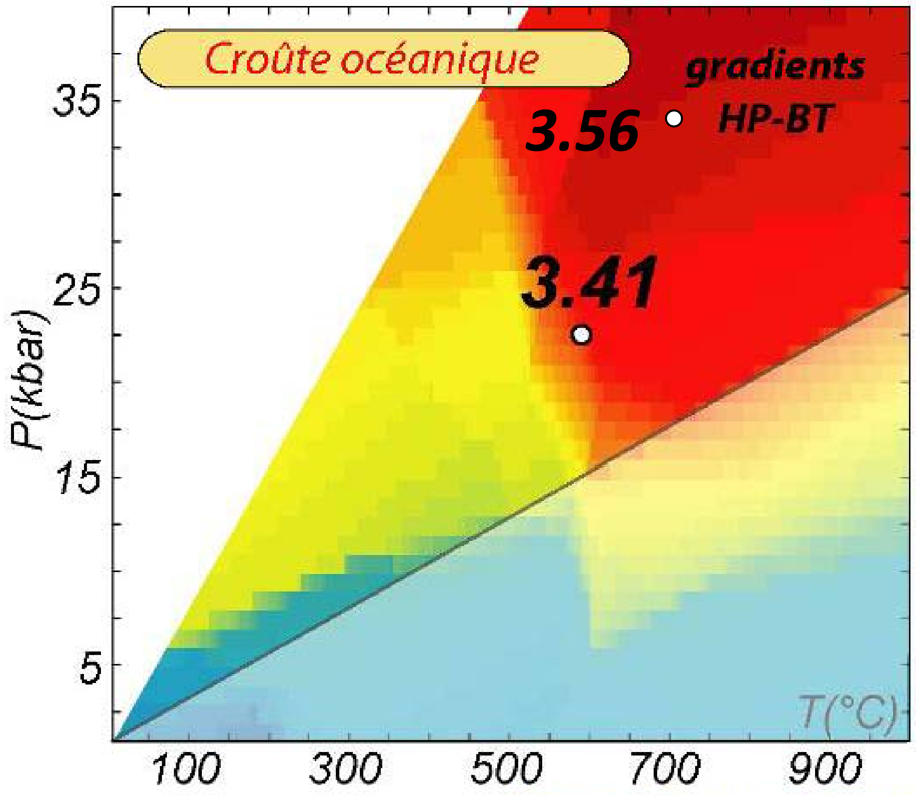
asks

two difficulties...

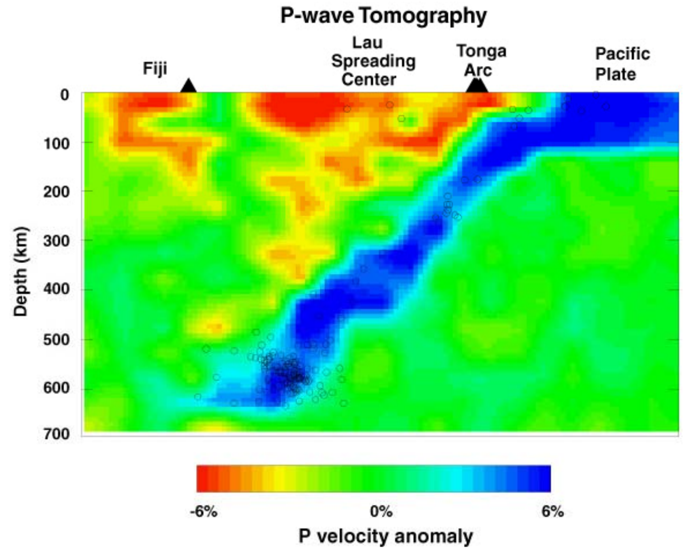
density

viscosity

The density oceanic case



Yamato et al., 2007



Karato et al., 2000

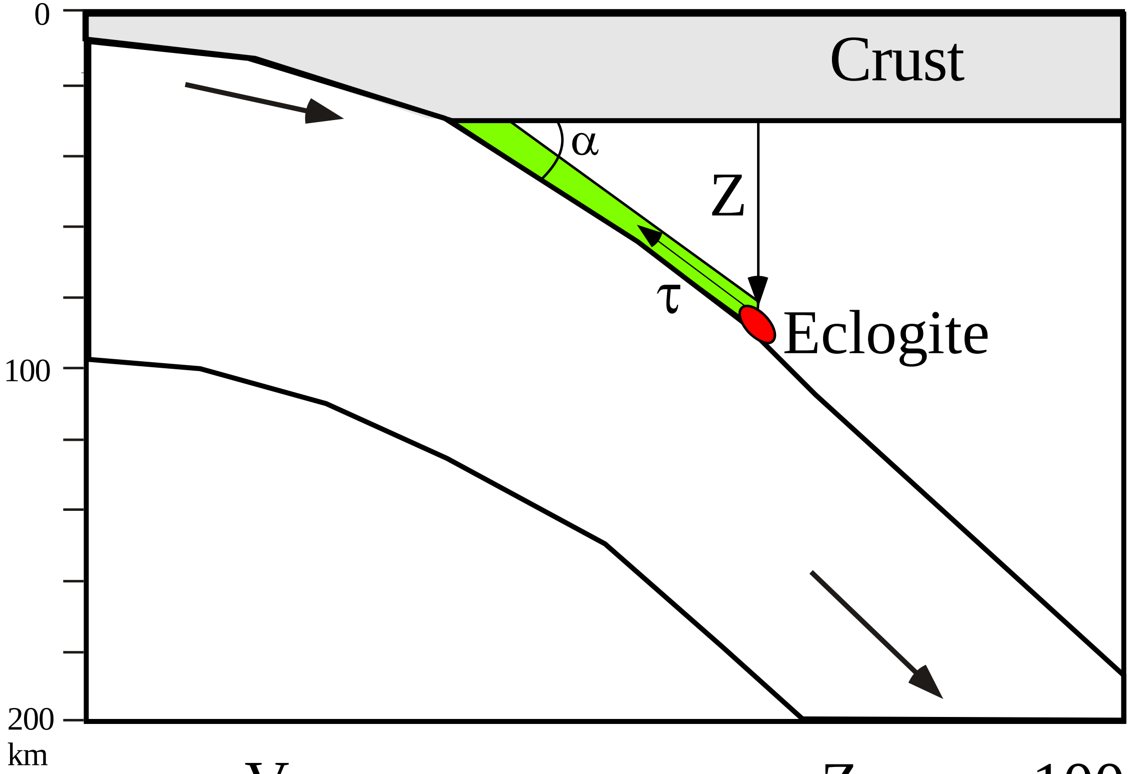
Upper mantle density

3.37 (Griffin et al., 1998)

d oceanic crust > d mantle

=> Negative buoyancy

The viscosity problem …



Guillot et al., 2001

$$\mathring{\varepsilon} = \frac{V}{Z\sin\alpha} = 5.10^{-13}s^{-1}$$

$$\boxed{\mu = \frac{\tau}{2\mathring{\varepsilon}} = 10^{19}\ \text{Pa.s}}$$

Zmax = 100 km

Vmax = 1 cm/yr

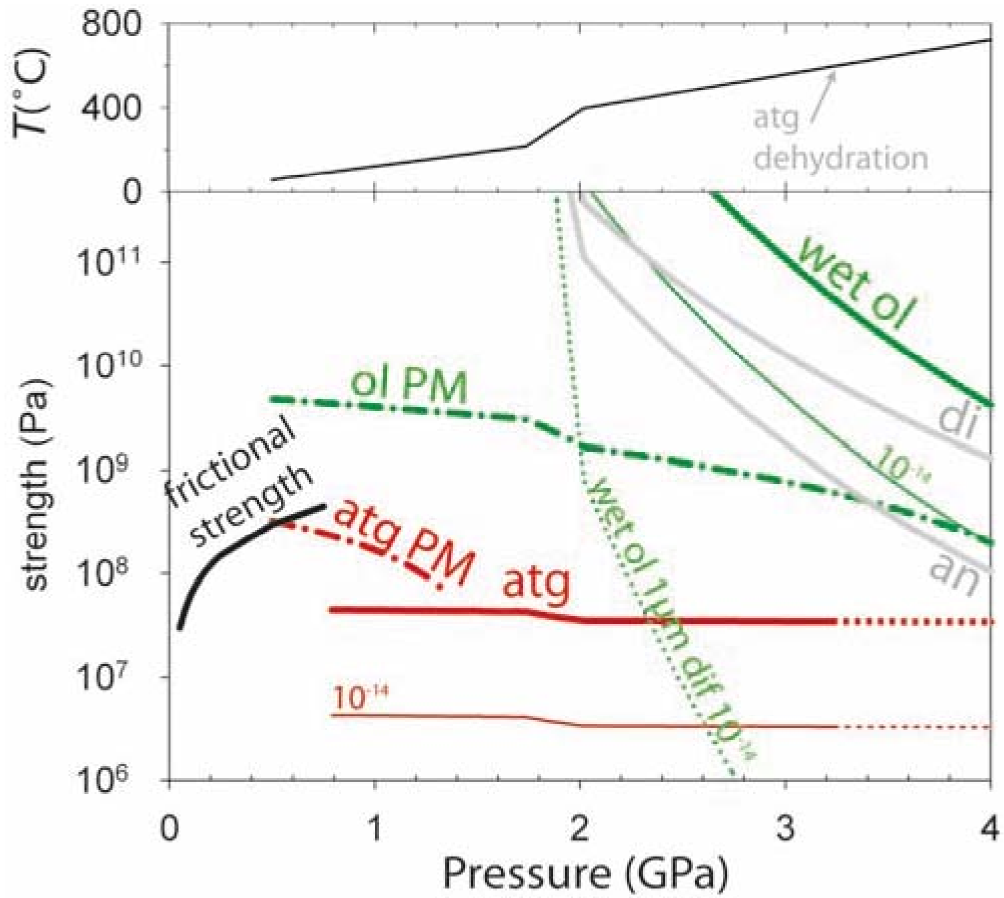
τ : 10 MPa

Dry Mantle : $10^{22\text{-}24}$ Pa.s

(Jelly Sandwich: Burov and Watts, 2006)

The viscosity and the density of the subduction channel should be low !!

Serpentinites : a good candidate to facilitate exhumation of HP to UHP rocks

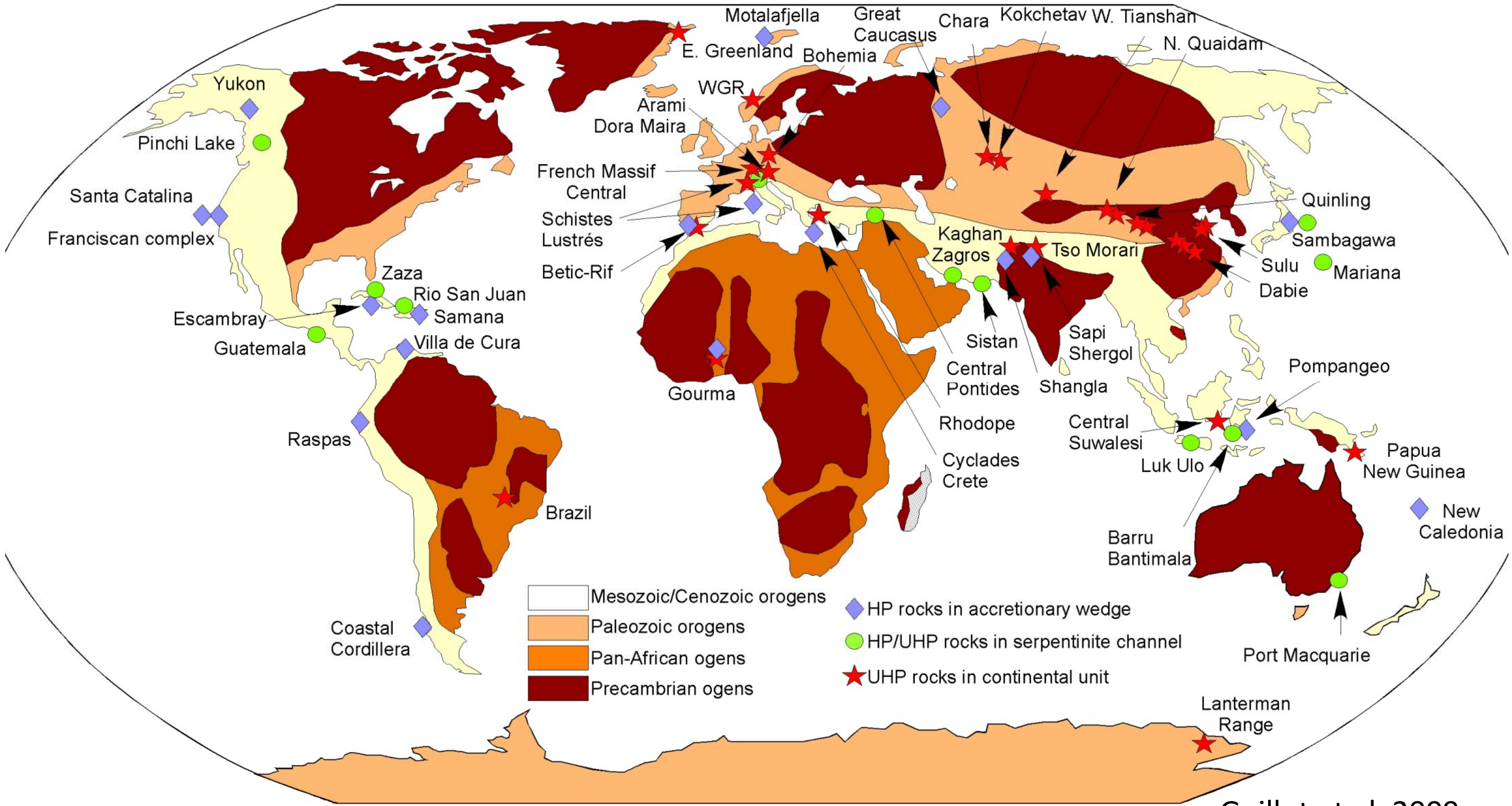


Low strengh of antigorite for a creep law at
10^{-10} s^{-1} (300 thick layer) and $10^{-14}s^{-1}$ (10 km thick layer)

Hilairet et al., Science, 2007

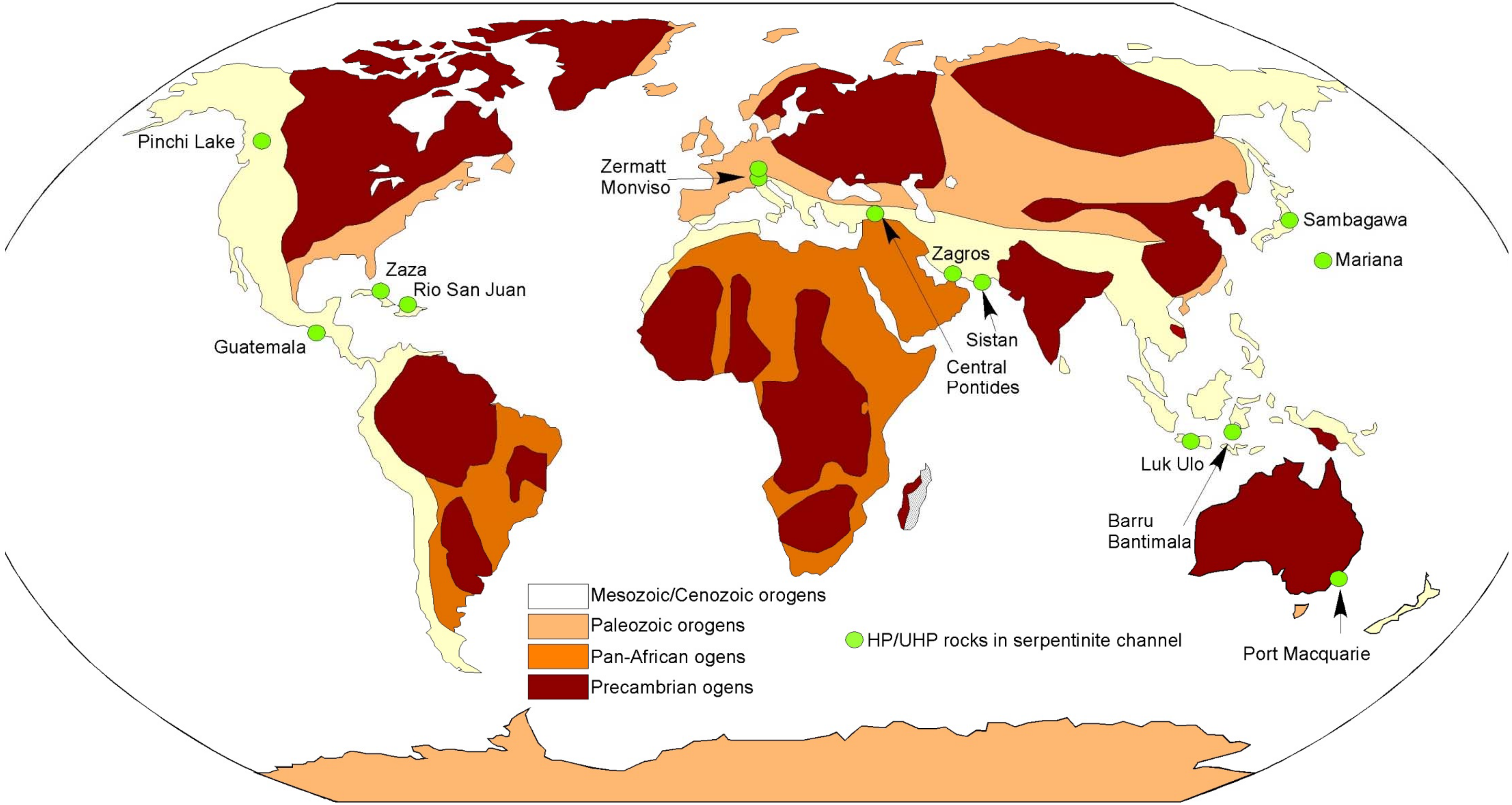
Effective viscosity :10^{18} to 4.10^{-19} Pas

61 occurrences of Phanerozoic HP to UHP units

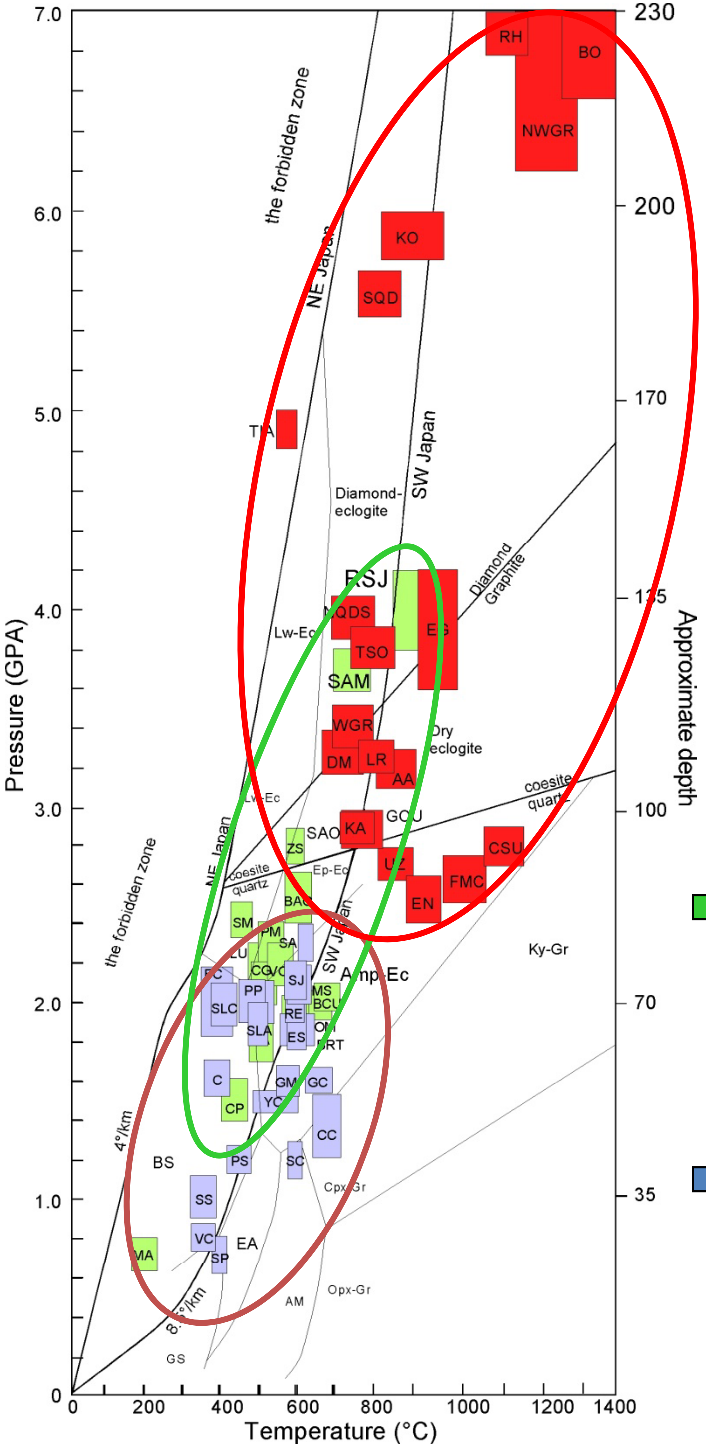


Guillot et al. 2009

14 occurrences of HP-UHP rocks in serpentinite channel



Almost 25% of HP to UHP are exhumed within a serpentinite subduction channel



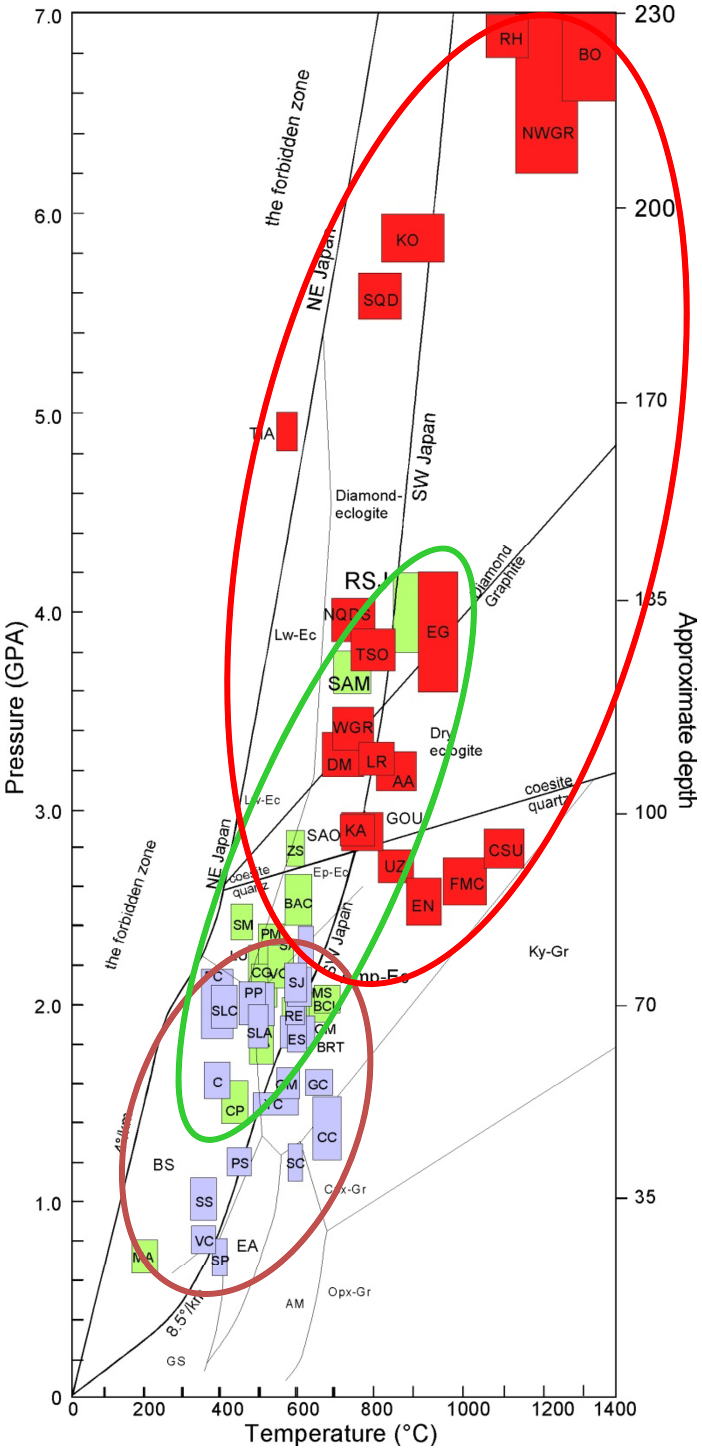
Pressure-Temperature conditions

Continental Subduction

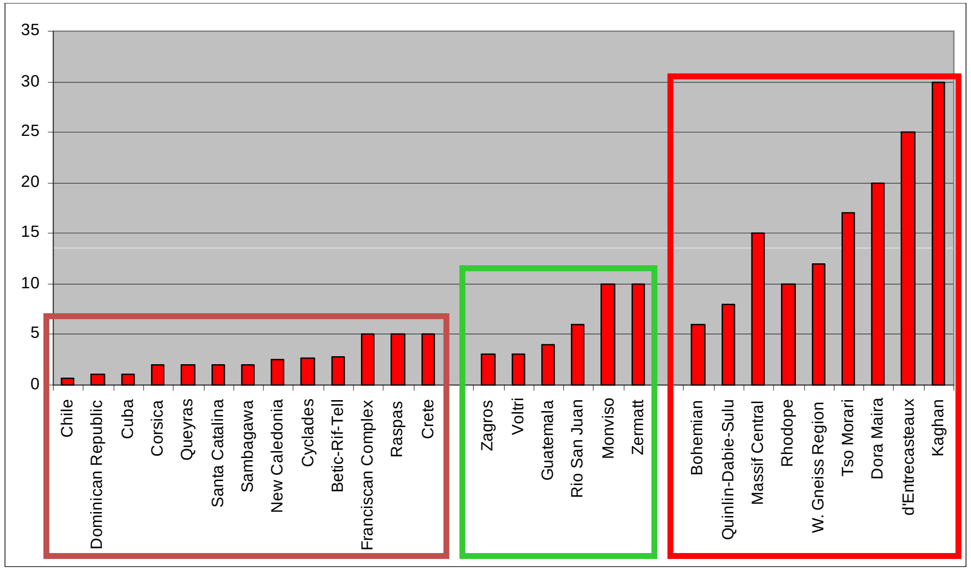
Serpentinite channel

Accretionary wedge

Guillot et al. 2009



Exhumation velocities cm/yr



Accretionary wedge

Serpentinite channel

Continental subduction

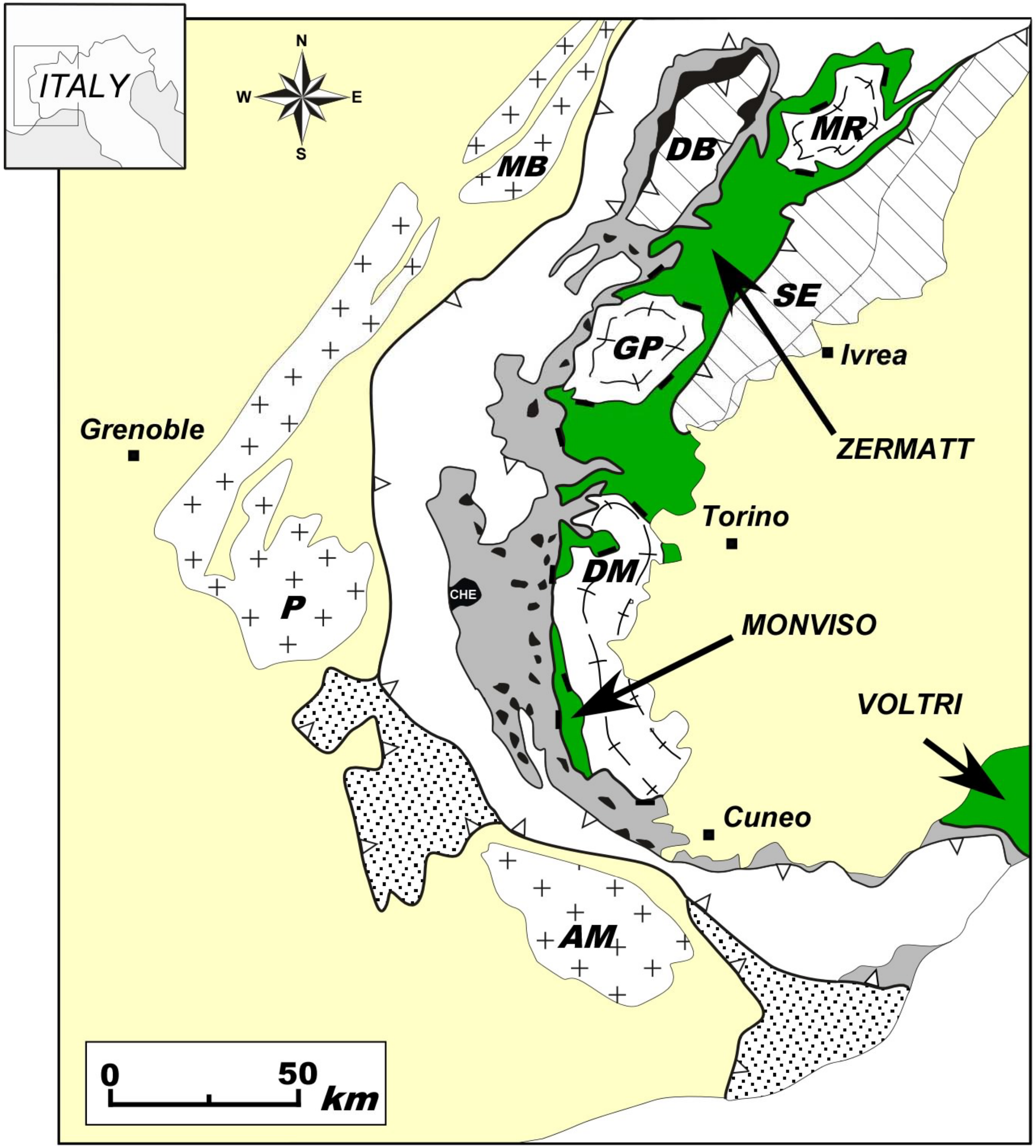
low V_{exhum} (1-5 mm/yr)

int V_{exhu} (0.5-1 cm/yr)

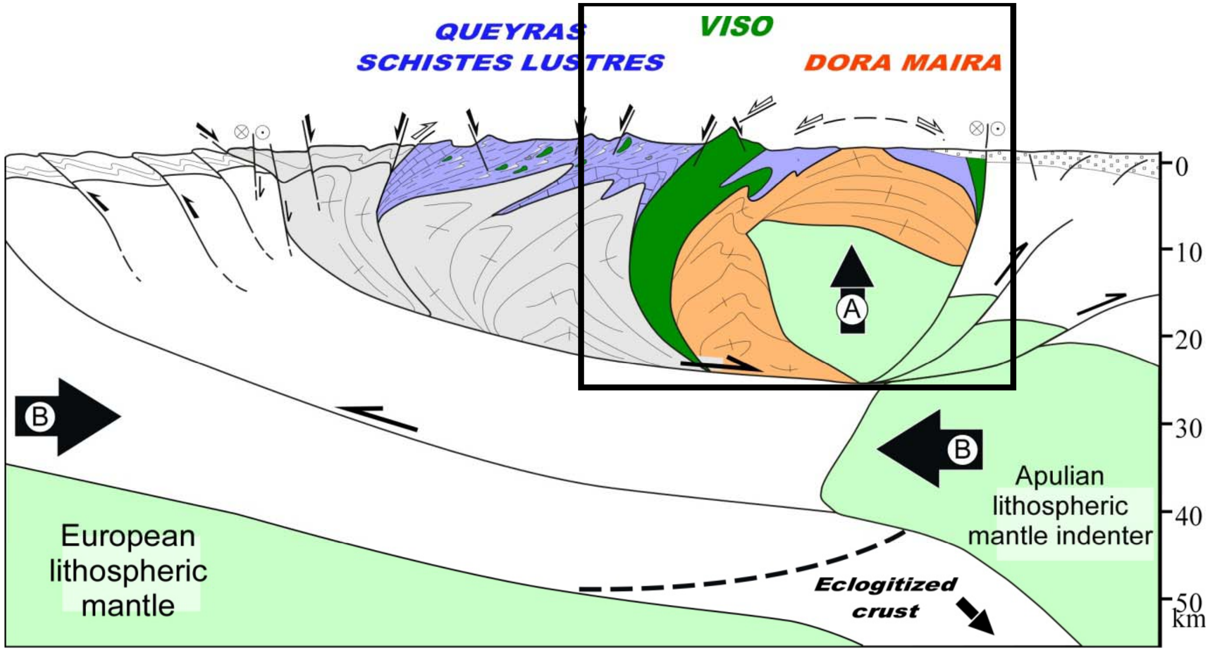
high V_{exhum} (0.7-3 cm/yr)

Guillot et al. 2009

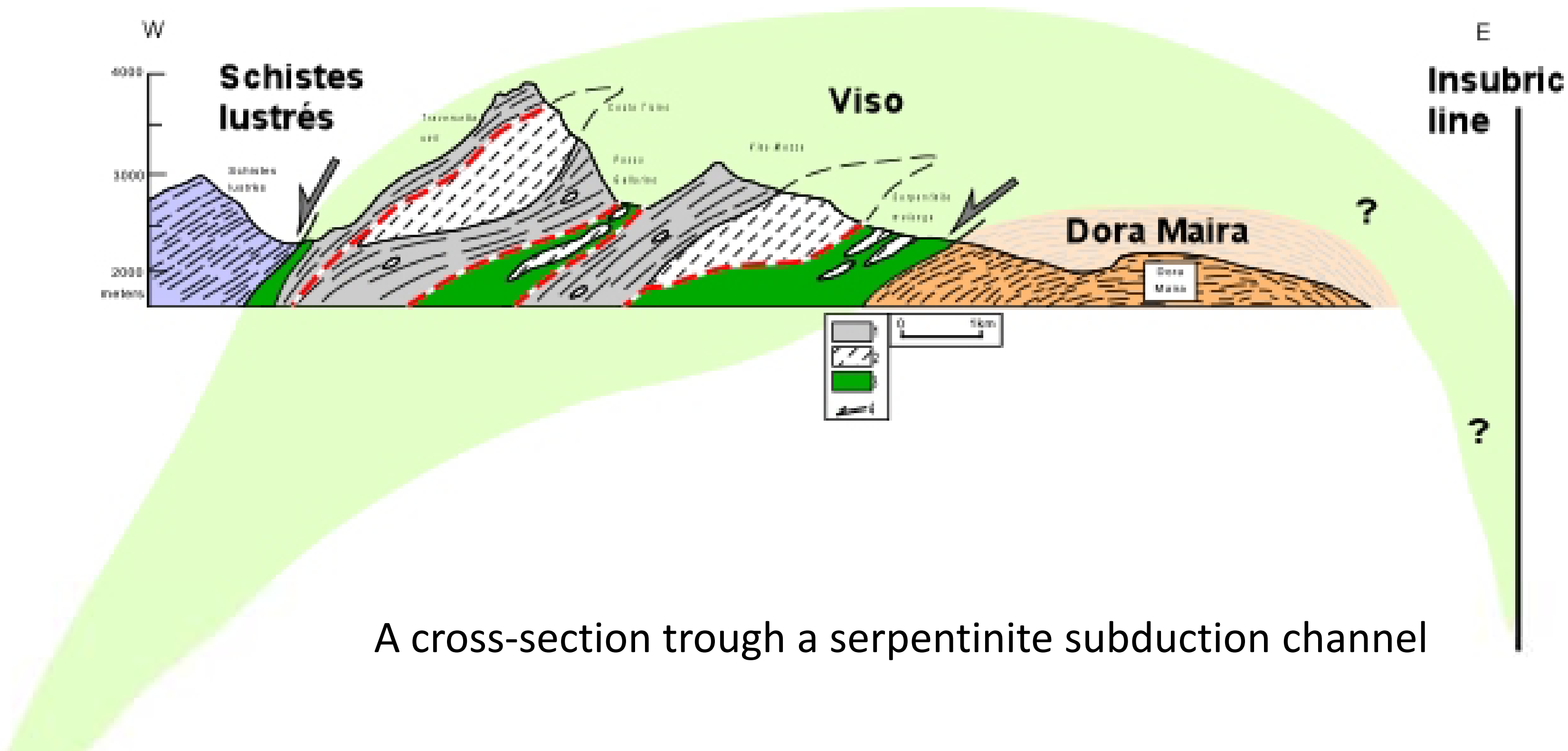

Let’s go in the field
to see the rocks !!



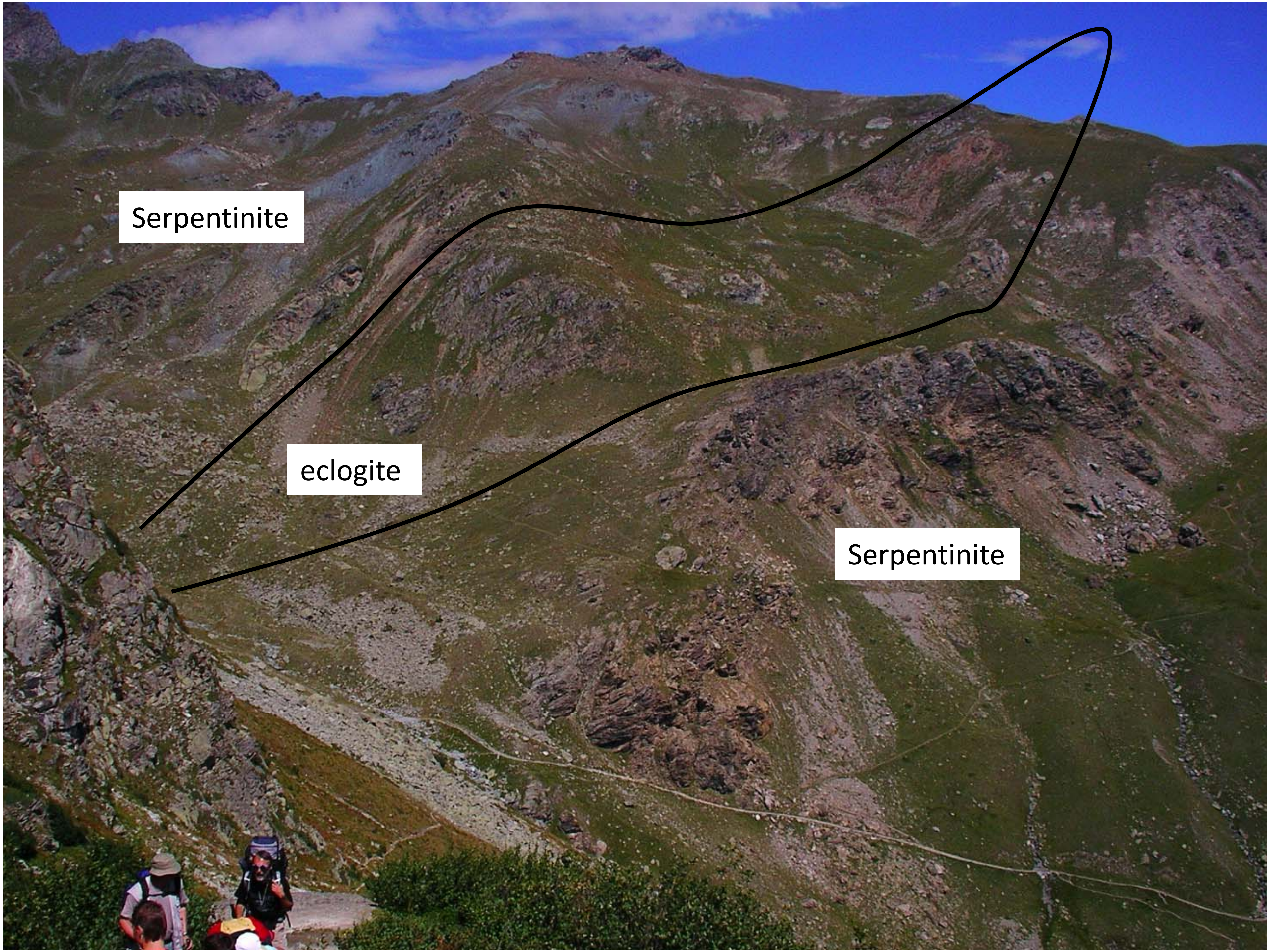
Schwartz et al., 2007

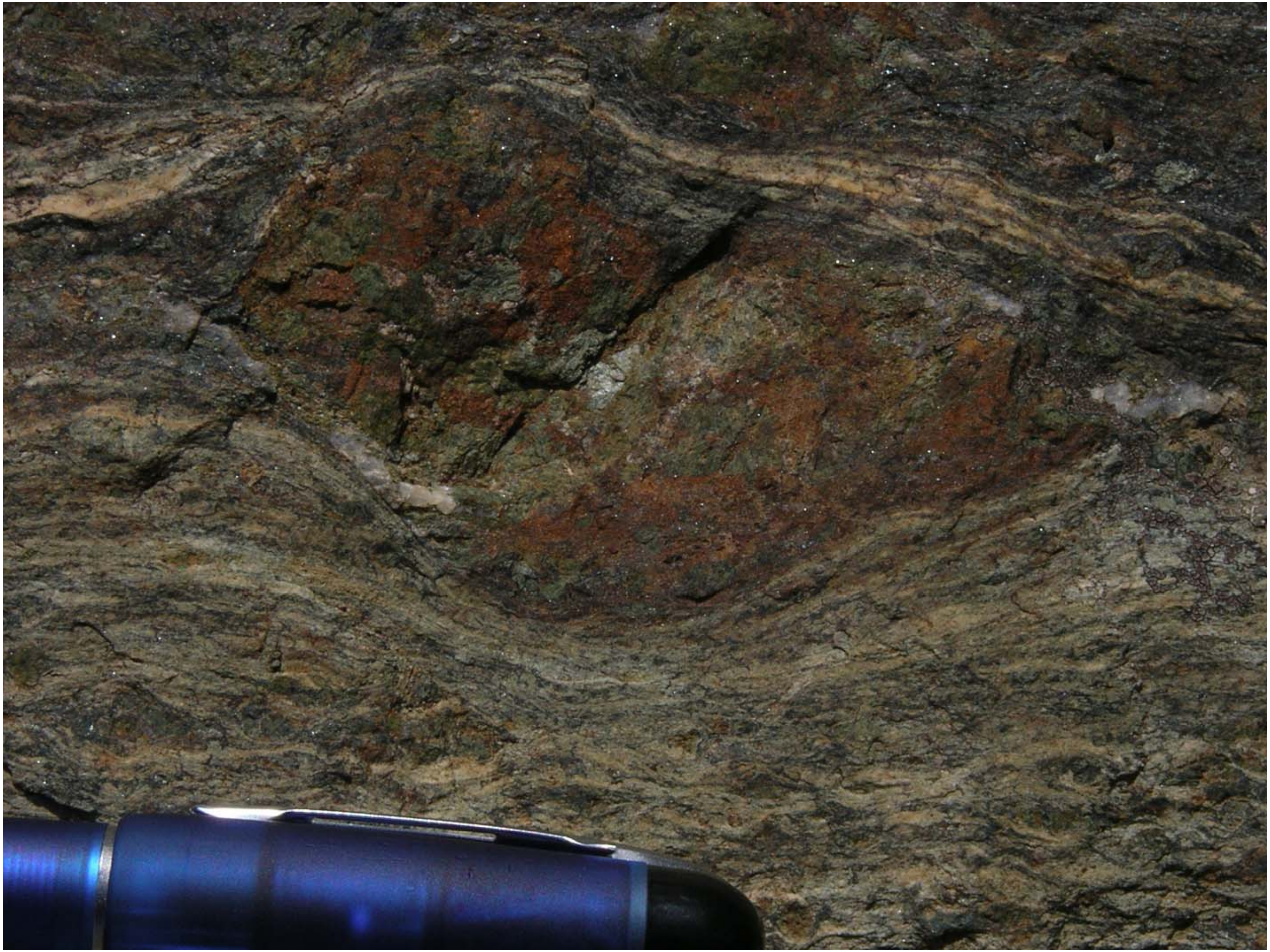


Schwartz et al., 2000
Guillot et al., 2004
Lardeaux et al., 2007



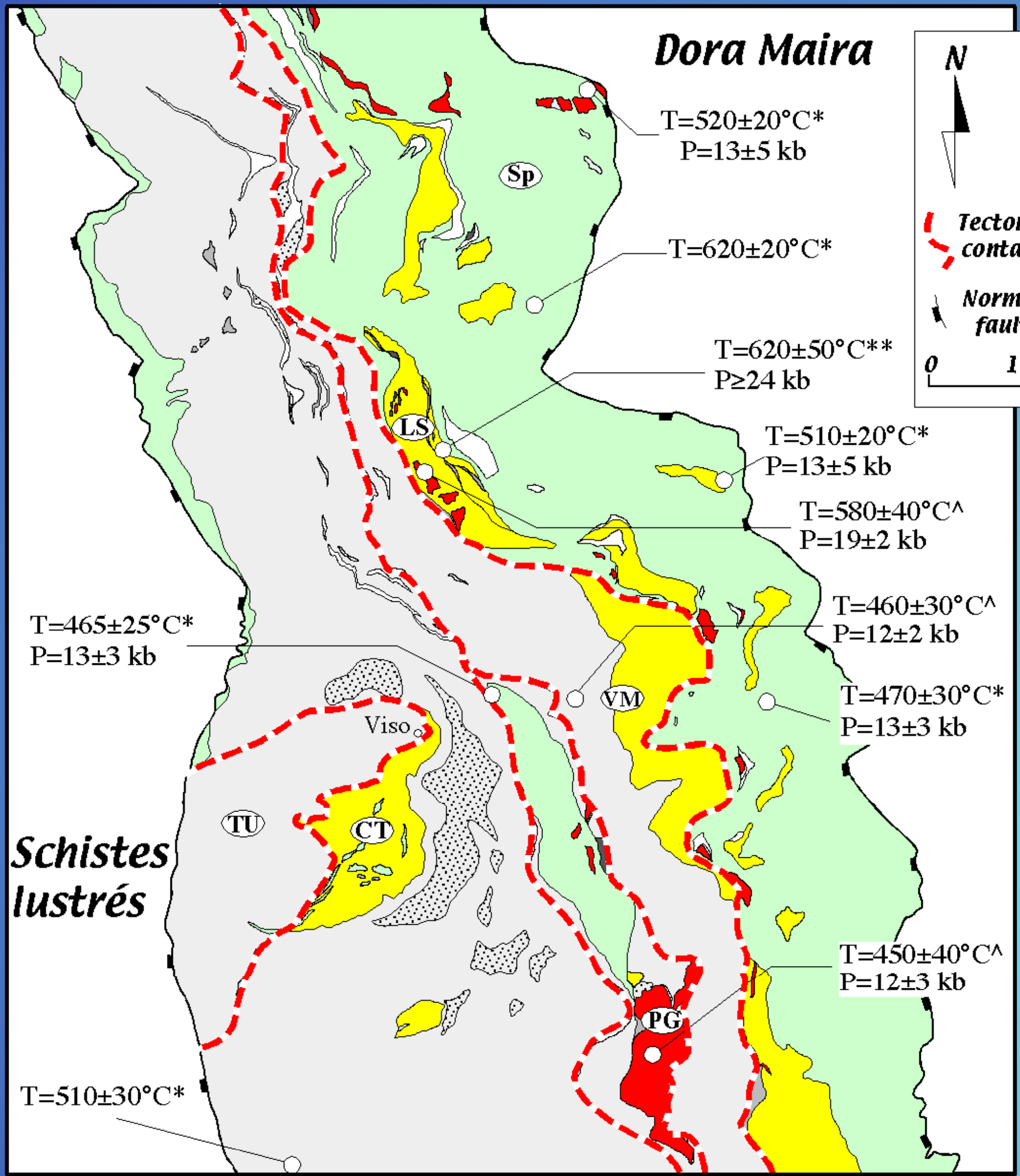
A cross-section trough a serpentinite subduction channel


Serpentinite
eclogite
Serpentinite

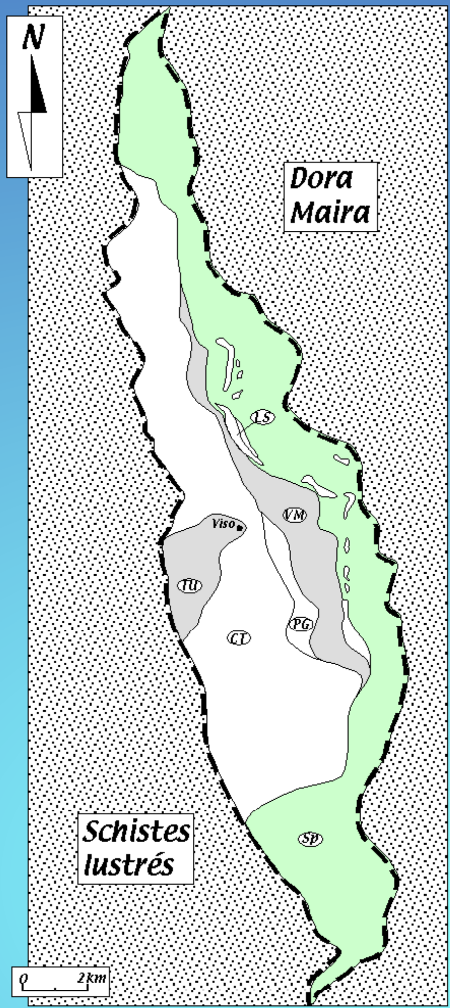



IMPEGA
DRY WIPE MARKER

LA PARTIE CENTRALE DU MONVISO



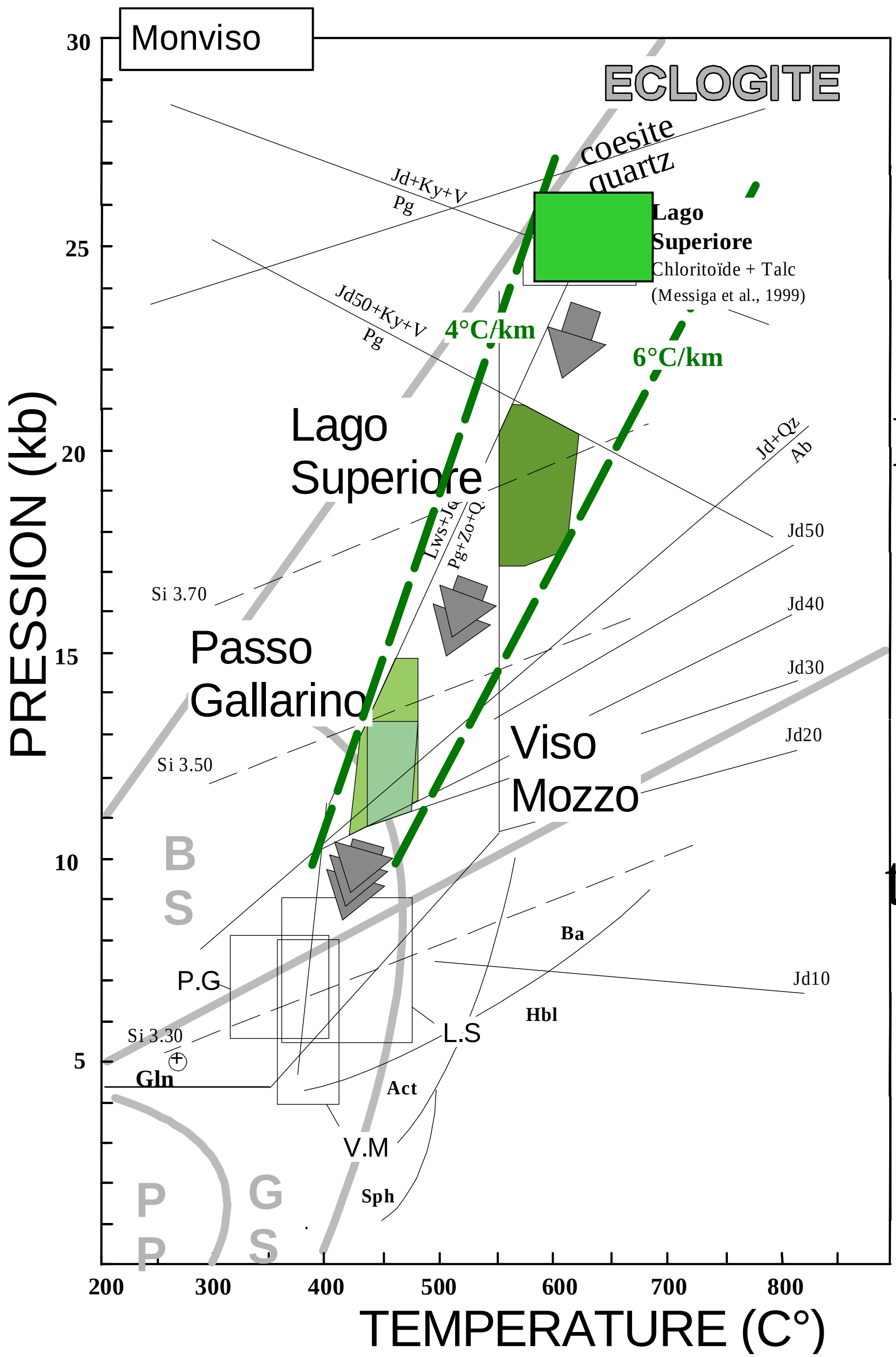
(*) Blake *et al.*, 1995
(**) Messiga *et al.*, 1999
(^) Schwartz *et al.*, 2000



PG	Passo Gallarino
	2.63km²
VM	Viso Mozzo
	10.63km²
CT	Costa Ticino
	46.35km²
TU	Traversetta unit
	4.81km²
Sp	Serpentinite melange
	54.49km² including
LS	Lago Superiore
	1.10km²

Le volume des différentes unités est inférieur à 50km³

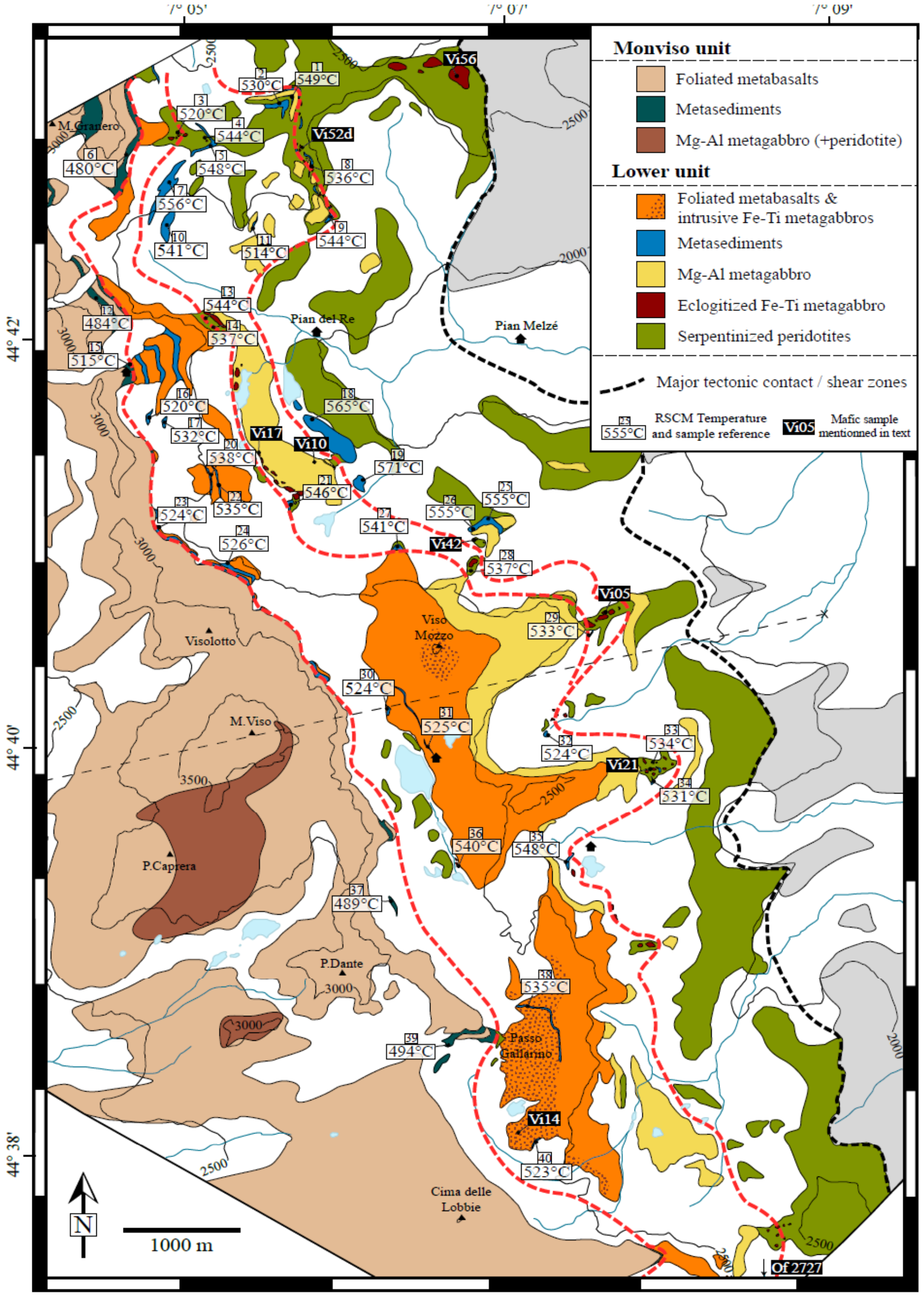
Schwartz et al., 2001

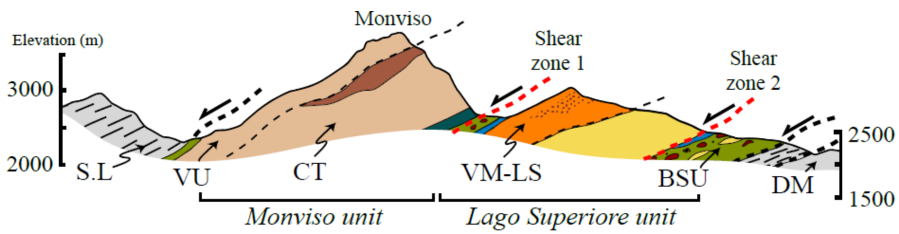


Each eclogitic block records different P-T conditions but aligned along the same geotherm =>

typical of a tectonic mélange in the subduction channel

Schwartz et al., 2000,2001



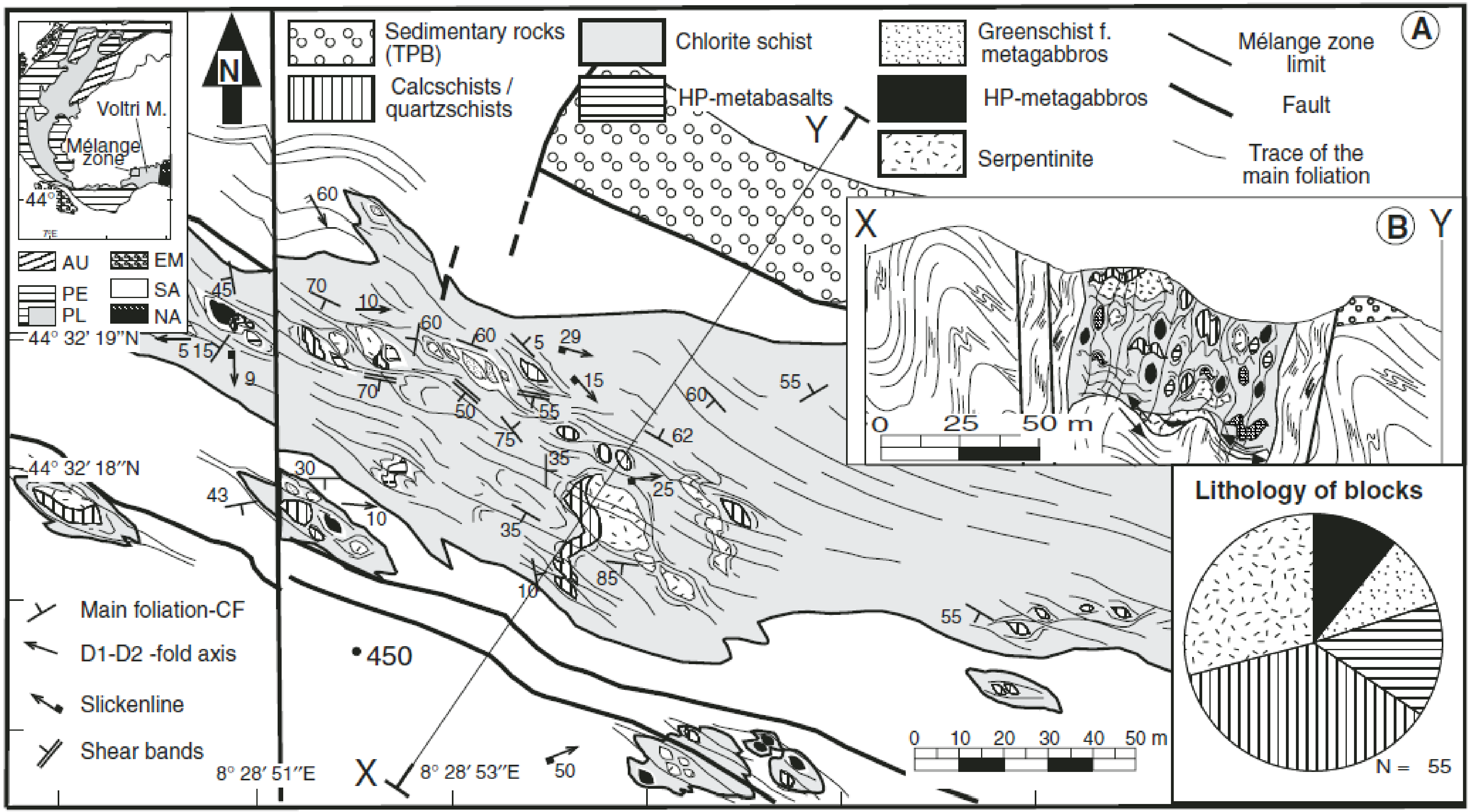


Angisboust & Agard, in prep, JMG

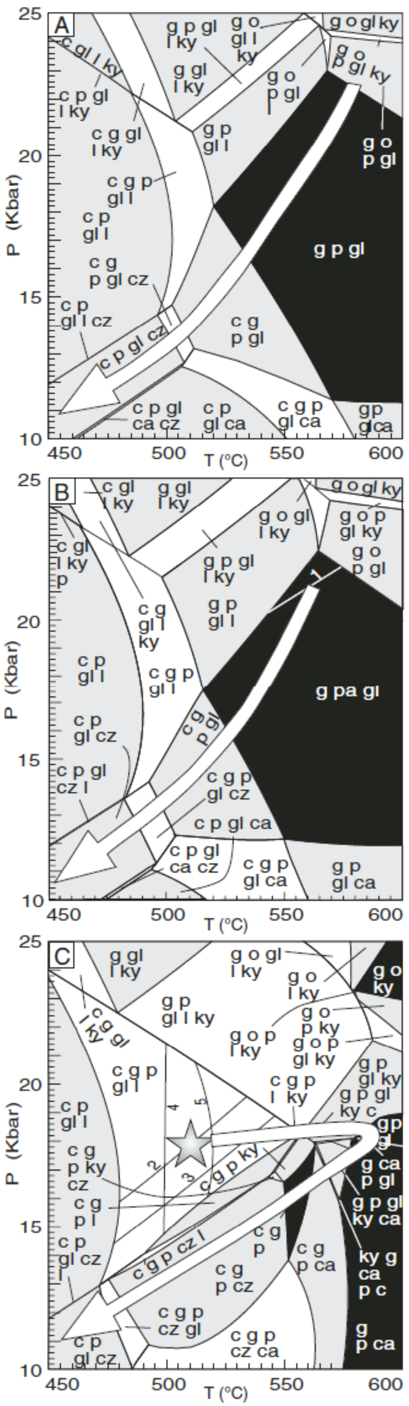
The Monviso Massif

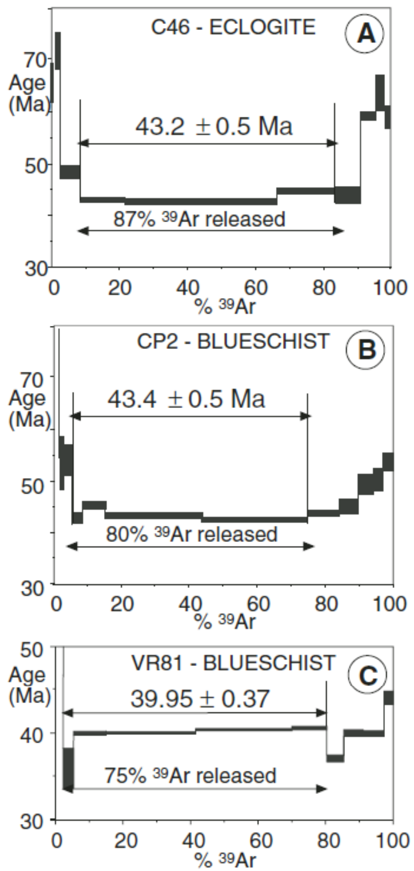
Two units, thickness of about 2km each

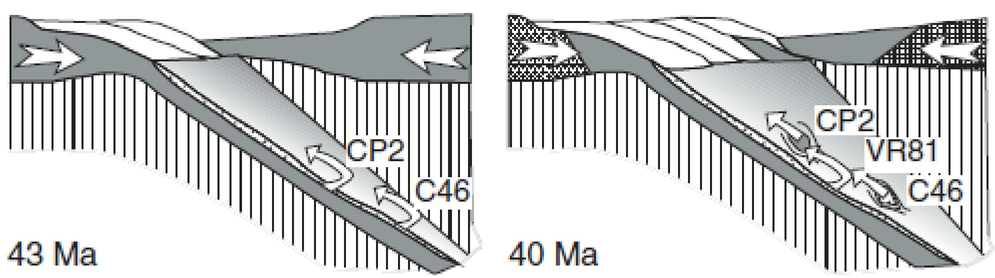
Similar to Zermatt unit
(e.g. Angiboust & Agard, 2010)



Frederico et al., 2007, Geology







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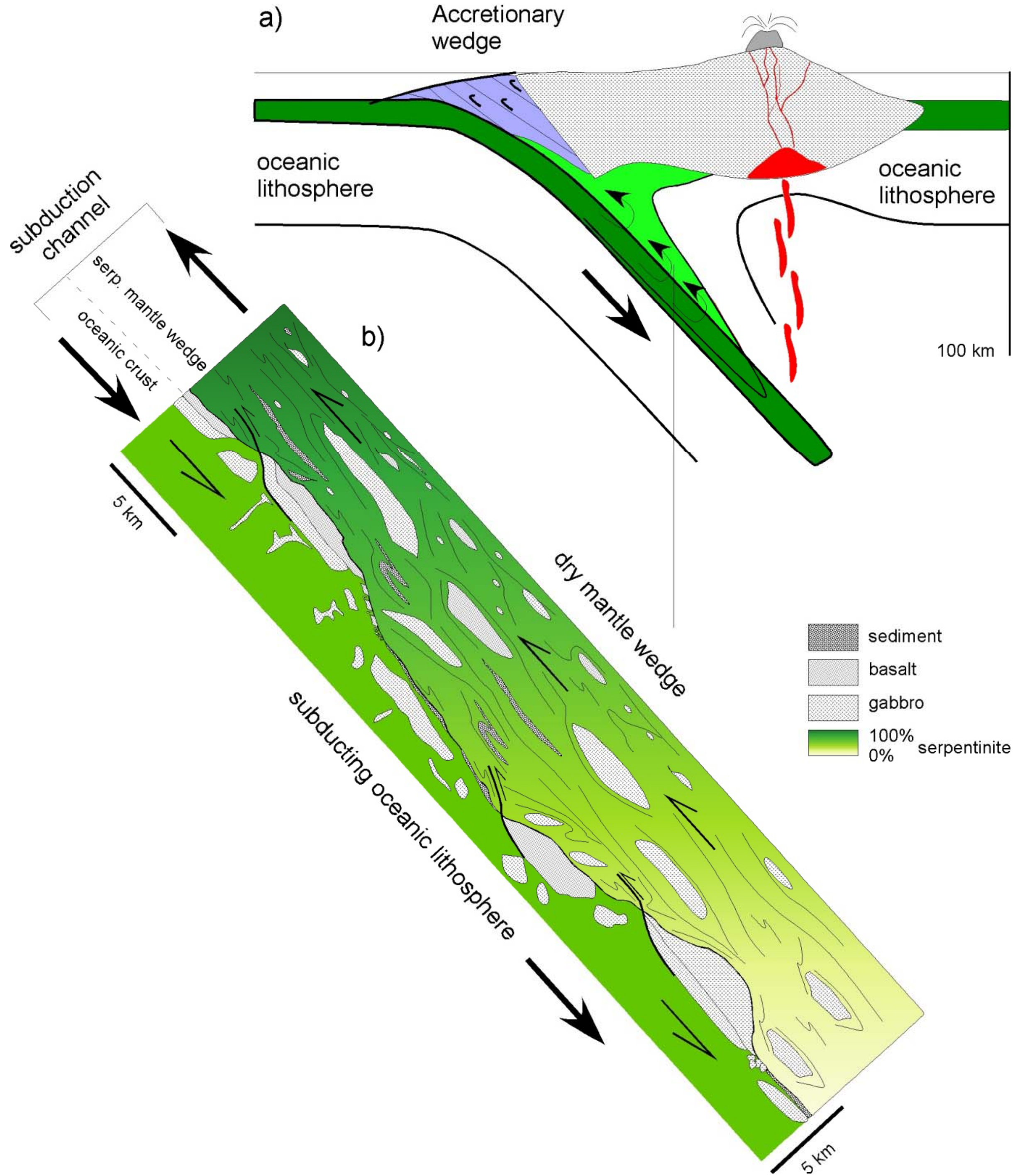
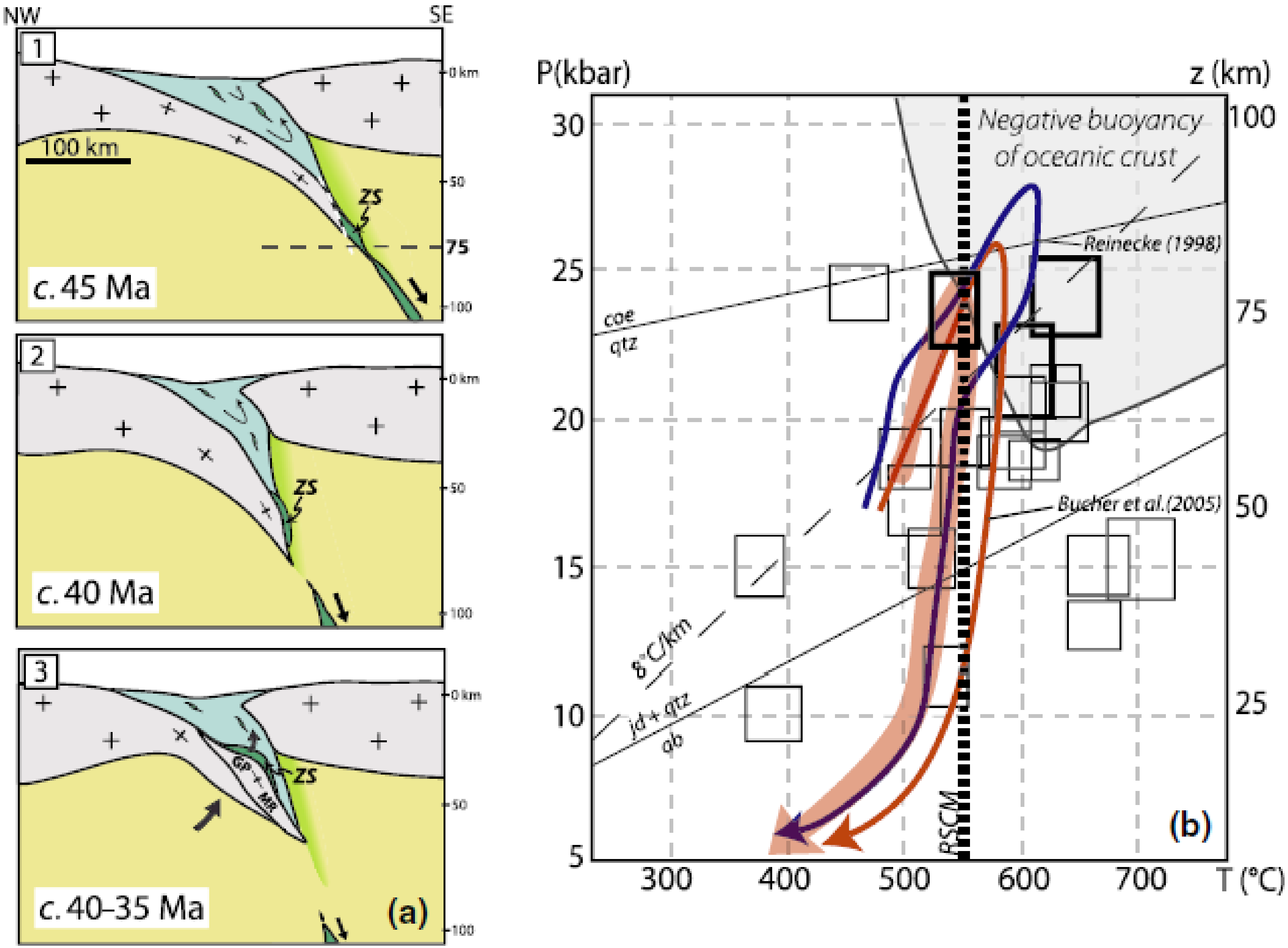
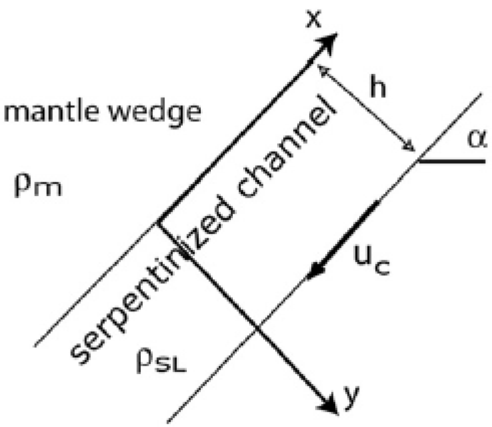


Guillot et al., 2009



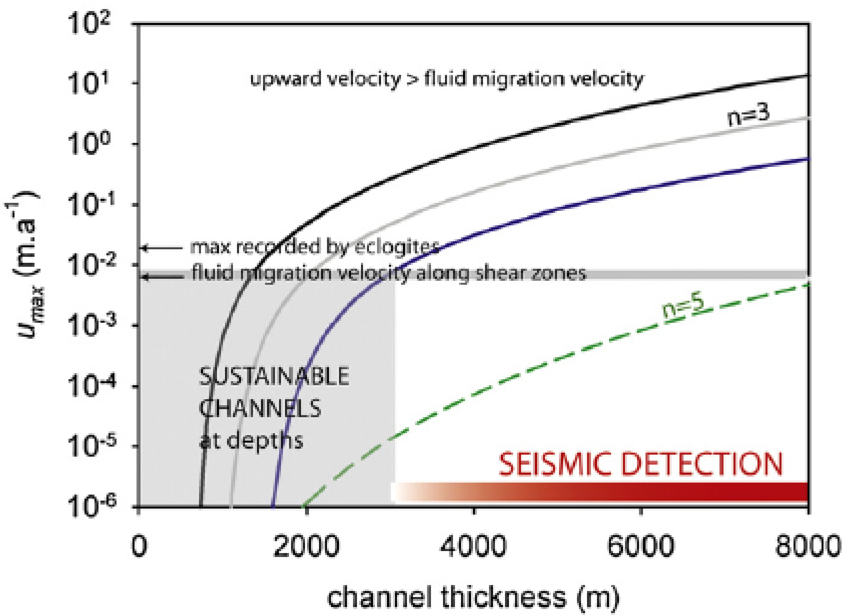
Angiboust et al., 2009,Terra Nova,



Flow law :

$$\dot{\varepsilon} = A\sigma^n \exp\left(-\frac{Ea+PV^*}{RT}\right)$$

3 < n < 5



Effective viscosity : 10^{19} pa.s

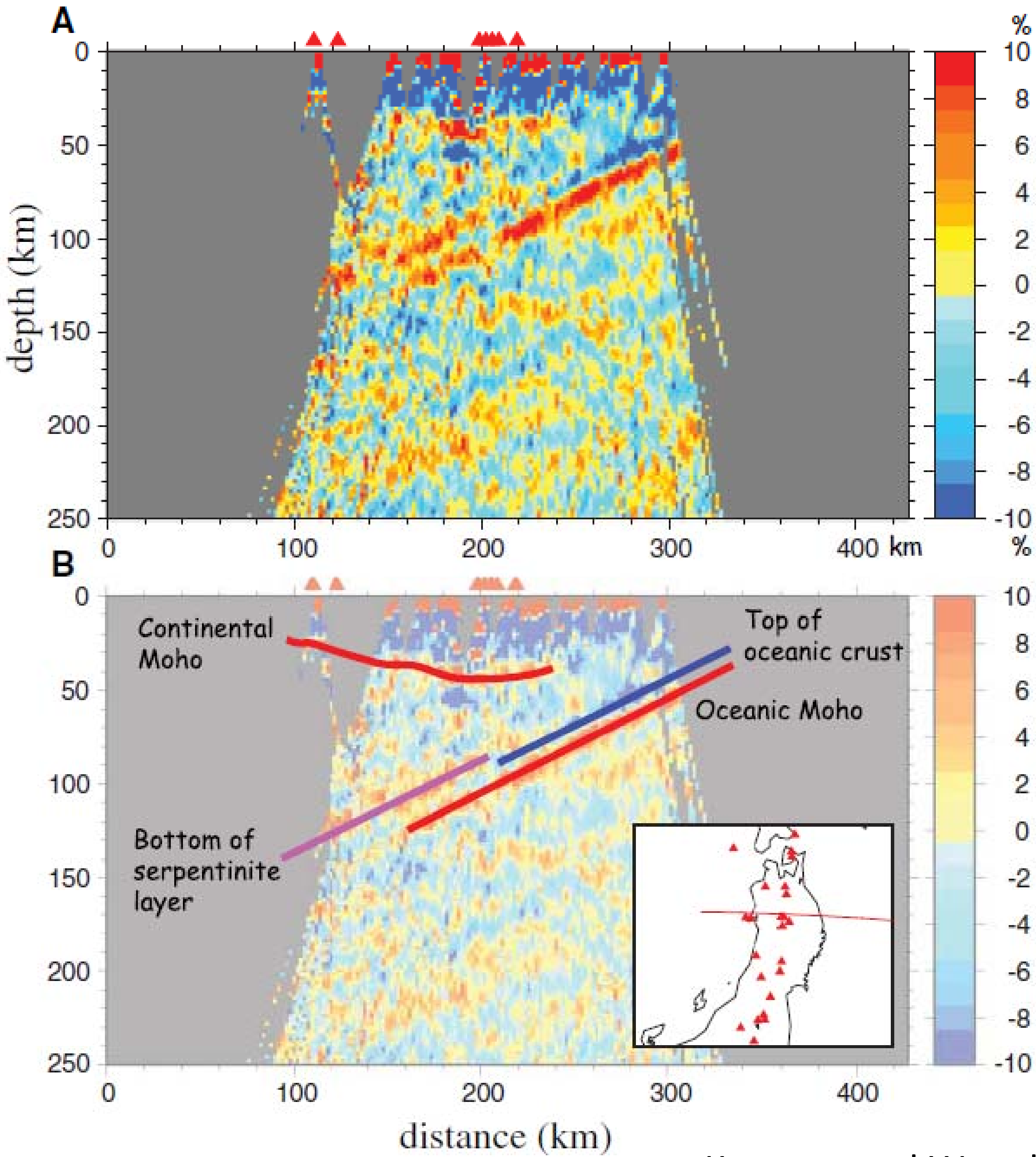
Schwartz et al., 2001

Hilairet and Reynard, 2009

Maximum depth of the

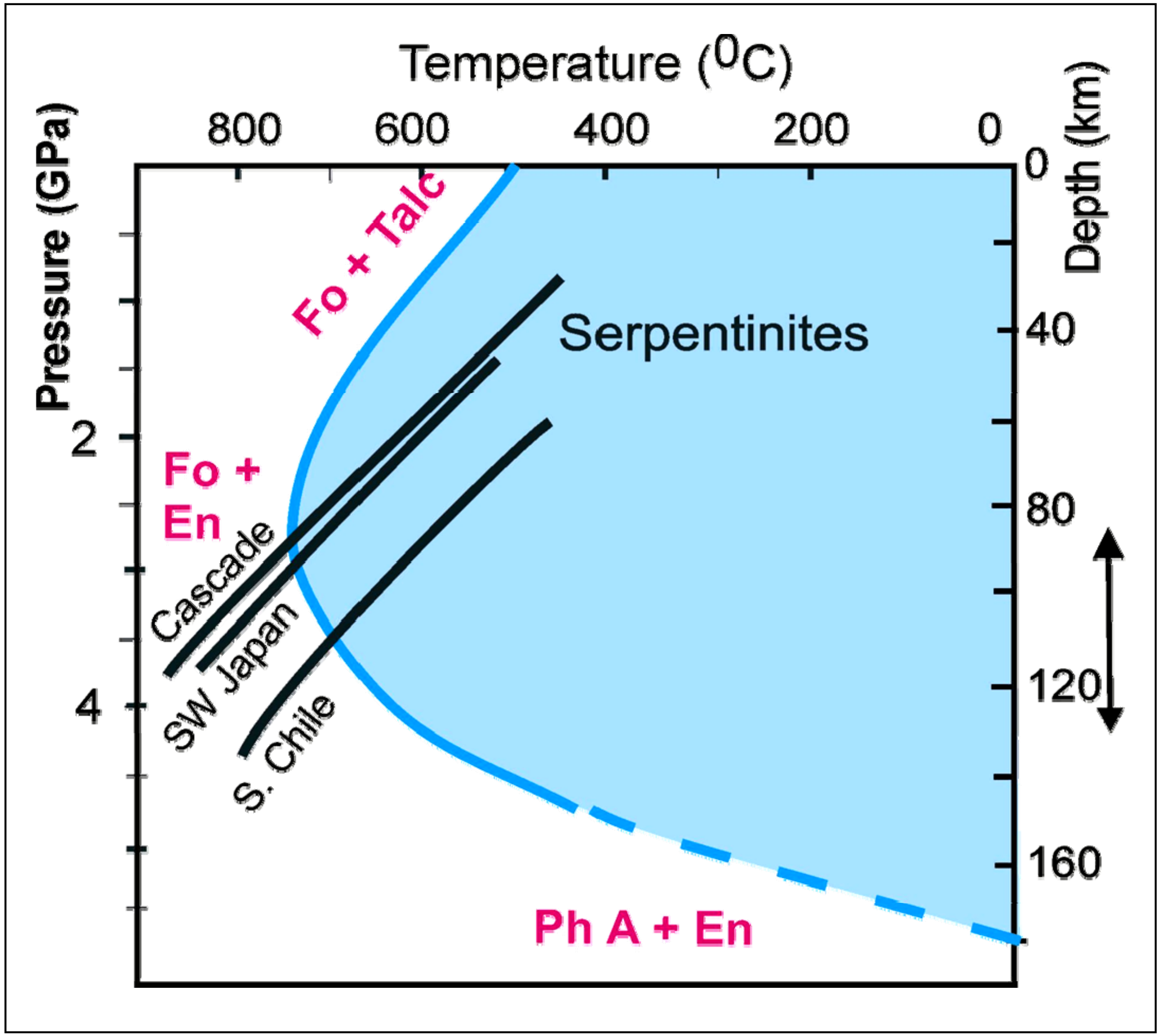
serpentinite subduction channel ?

Receiver Function



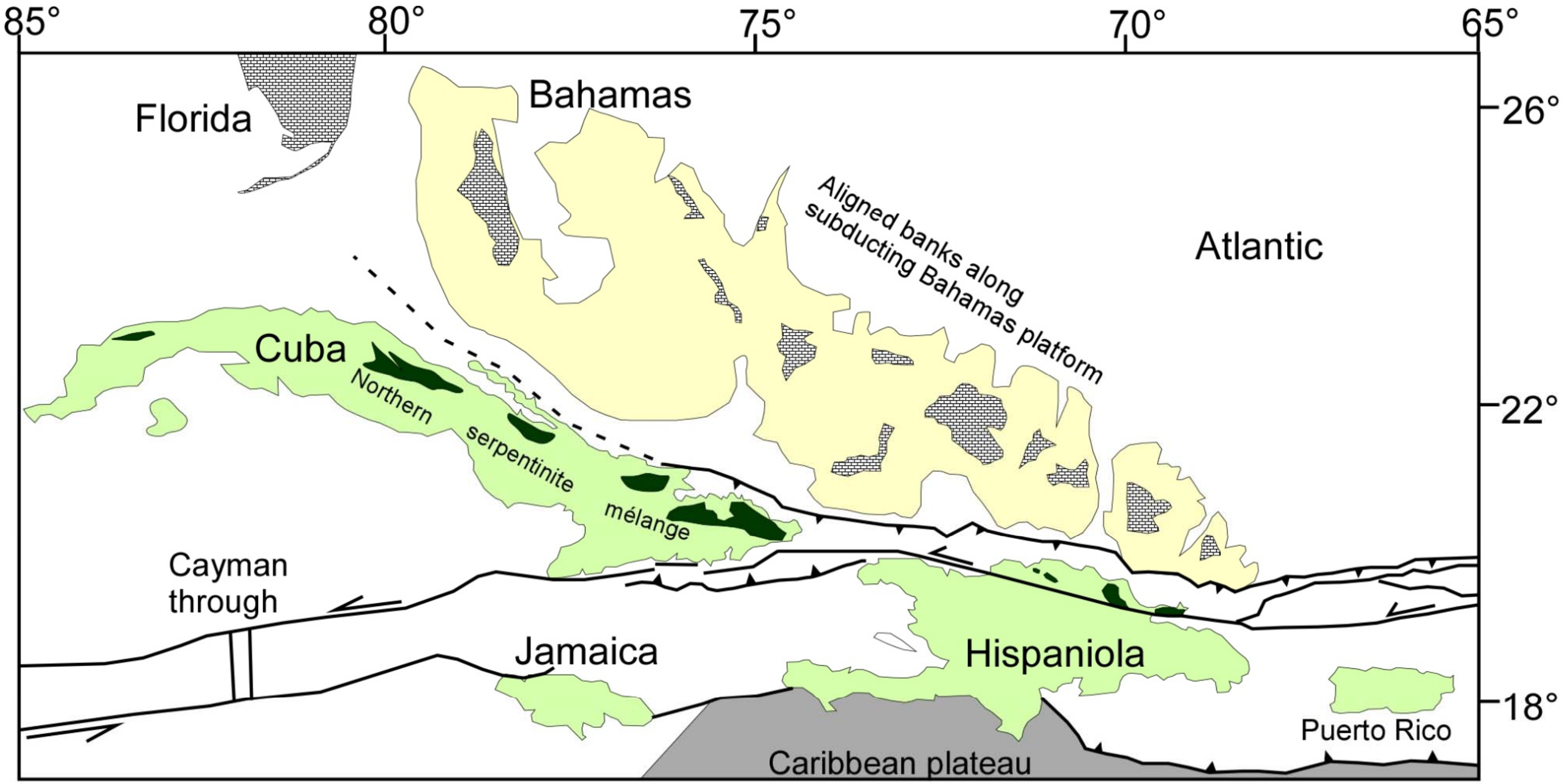
Kawatsu and Watada, Science, 2007

Deep stability of serpentinite

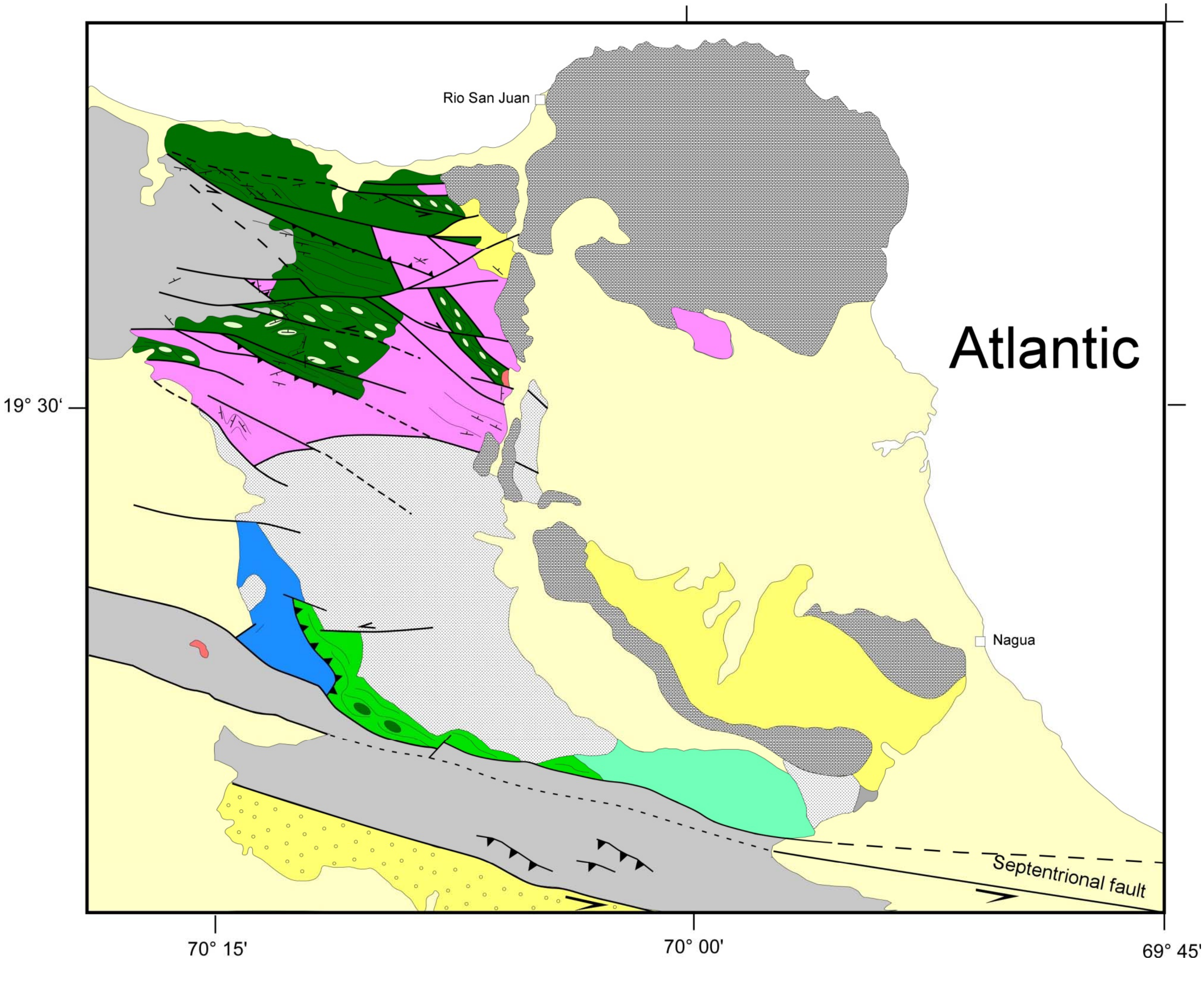


Hattori and Guillot, 2003

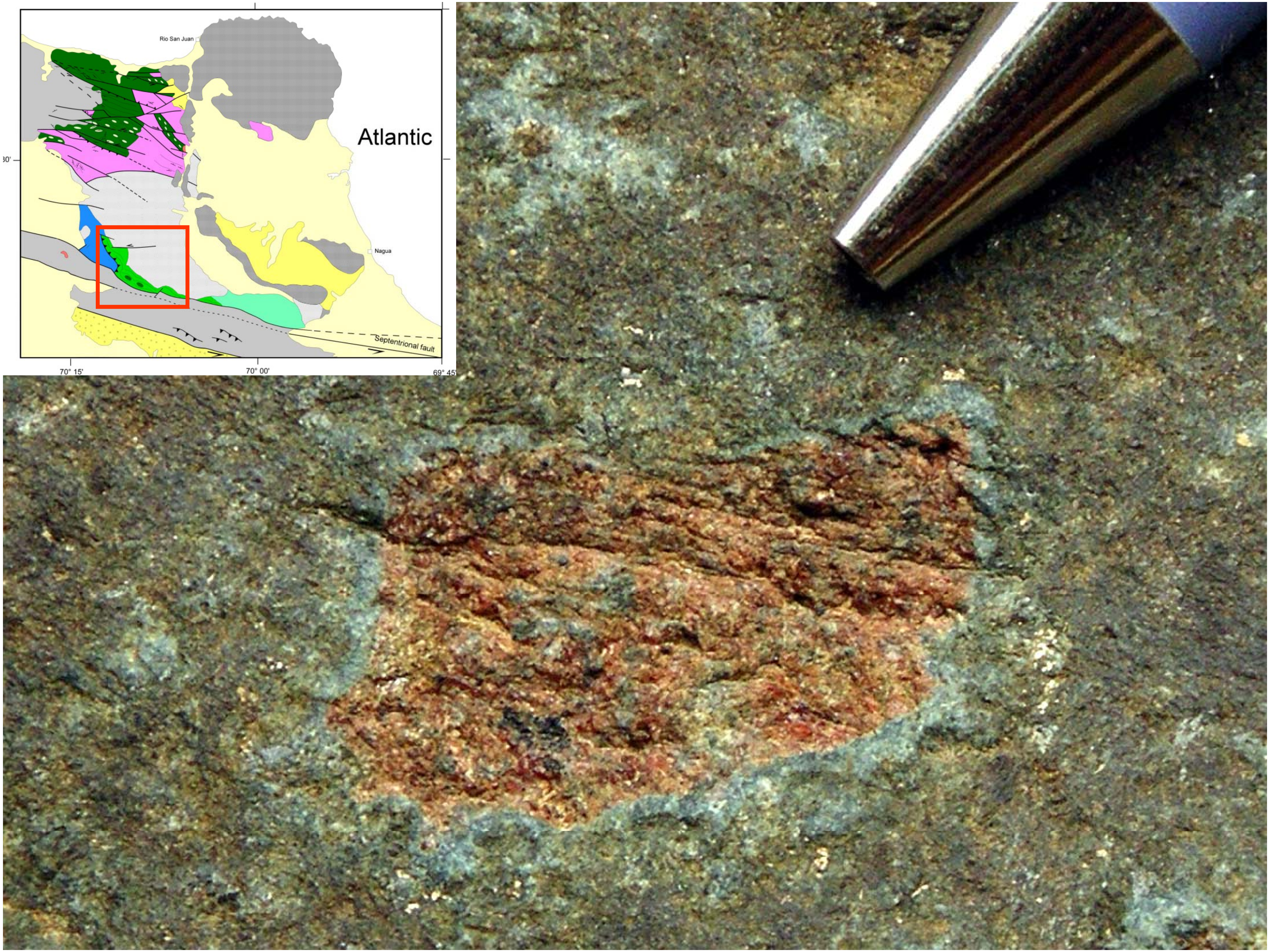
stability of serpentinites: Ulmer & Trommsdorff, '95; Wunder et al., '01; Peacock, '01
P-T paths: Peacock & Wang '99



Gorczyk et al, 2007
Saumur et al., 2010



Rio San Juan
Atlantic
Nagua
19° 30'
70° 15'
70° 00'
69° 45'
Septentrional fault


Rio San Juan
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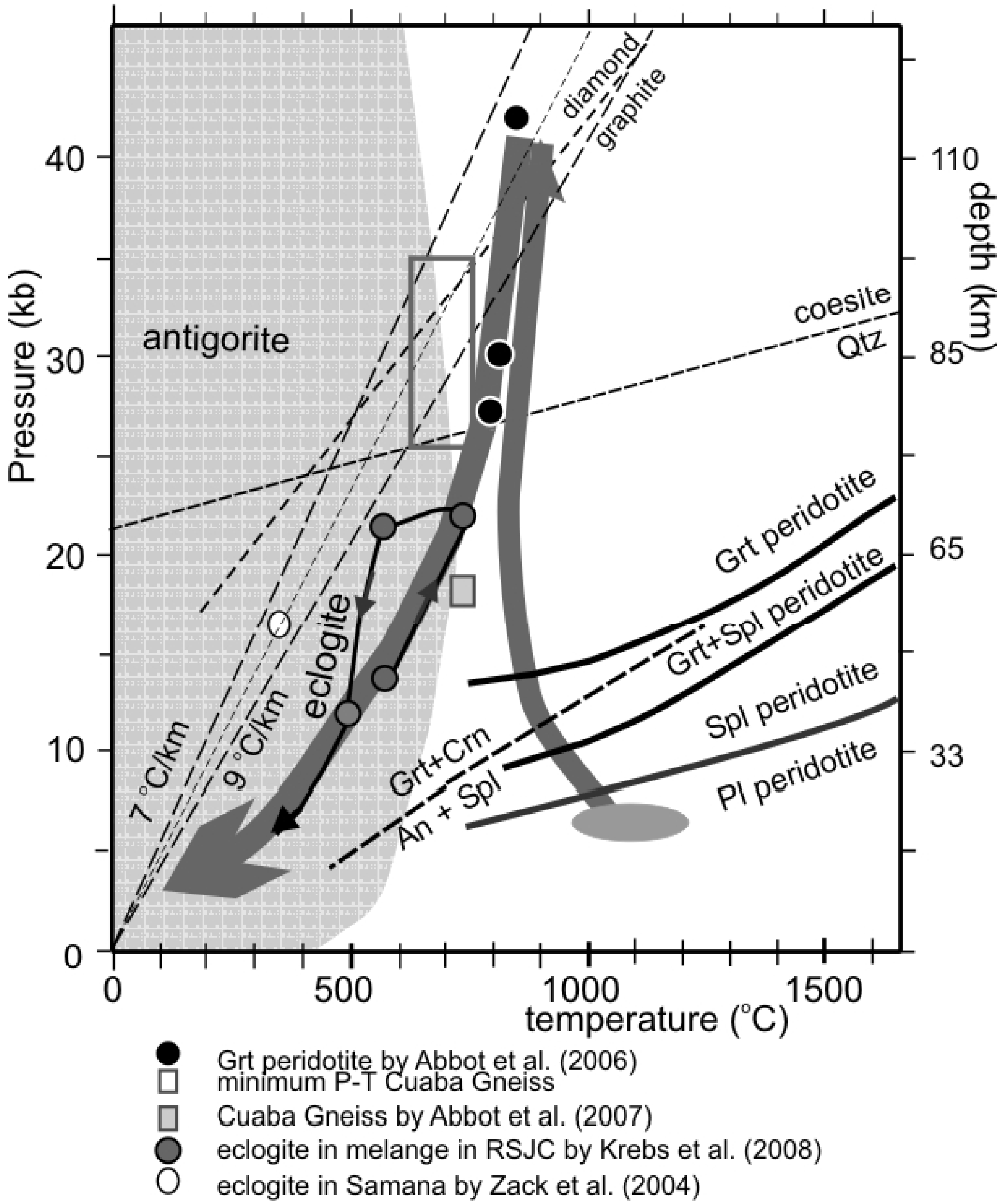
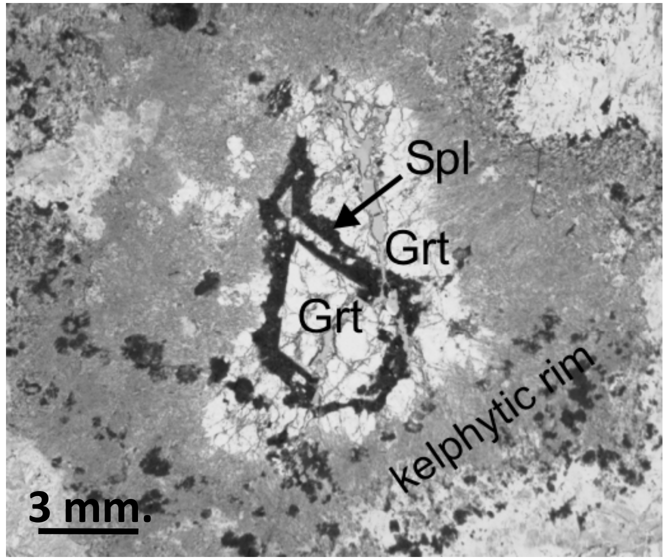
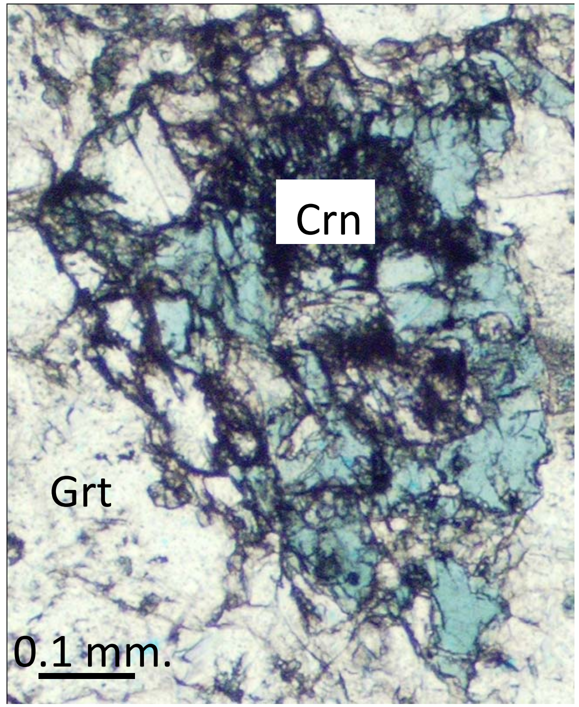
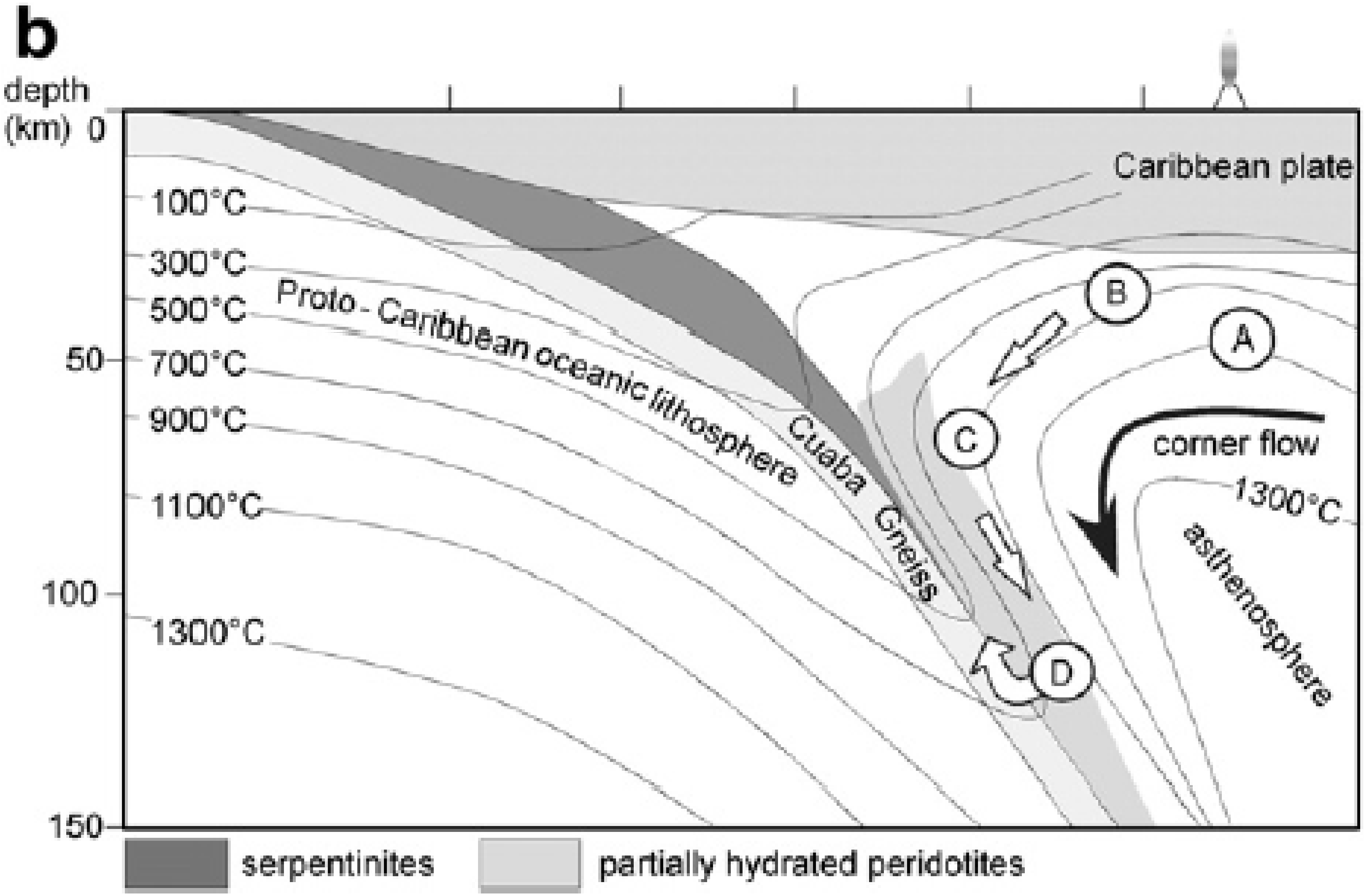




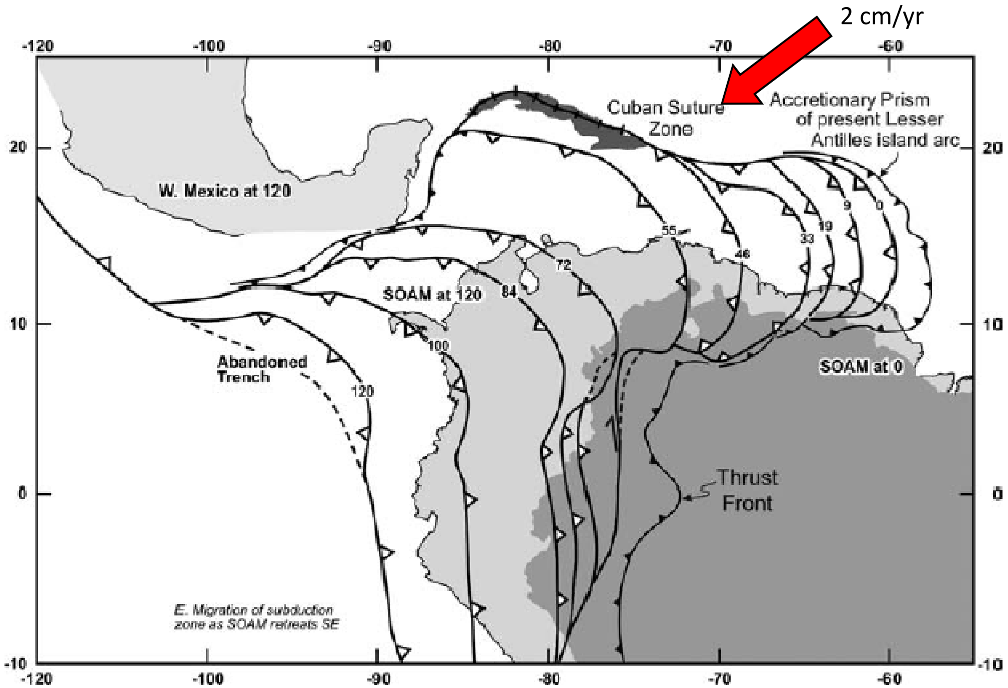


Hattori et al., Lithos, 2010

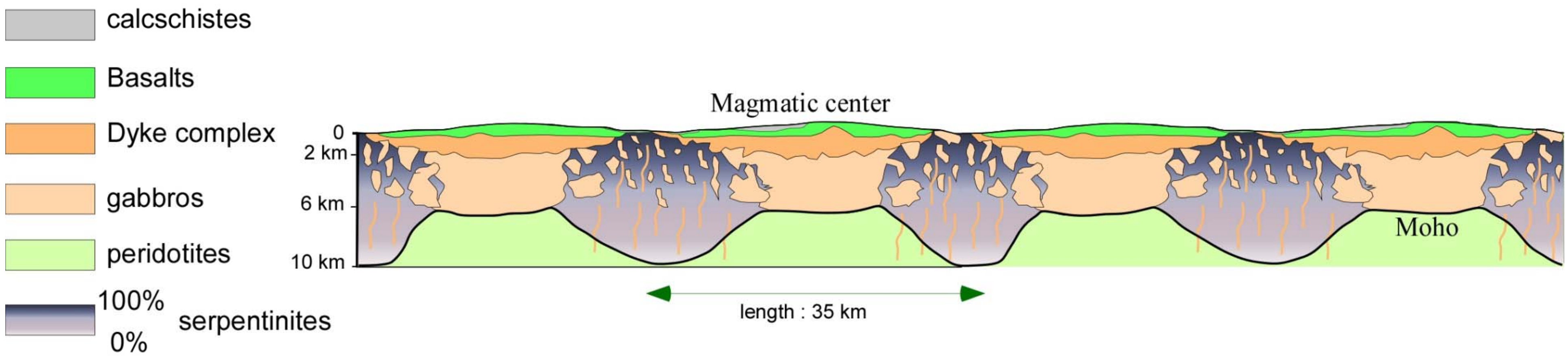


Hattori et al., Lithos, 2010

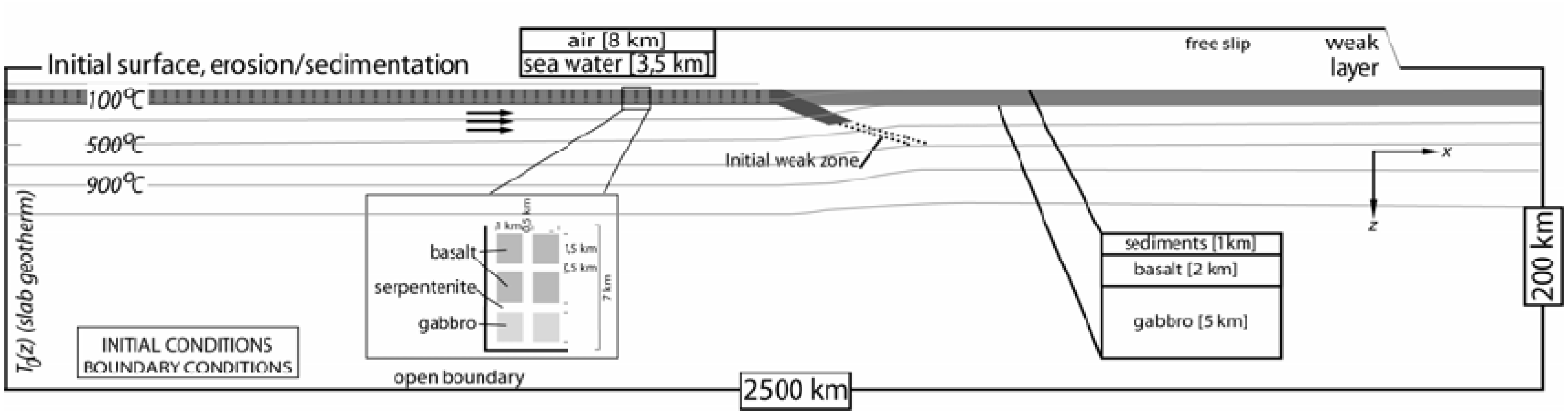
Modelling the serpentinite channel

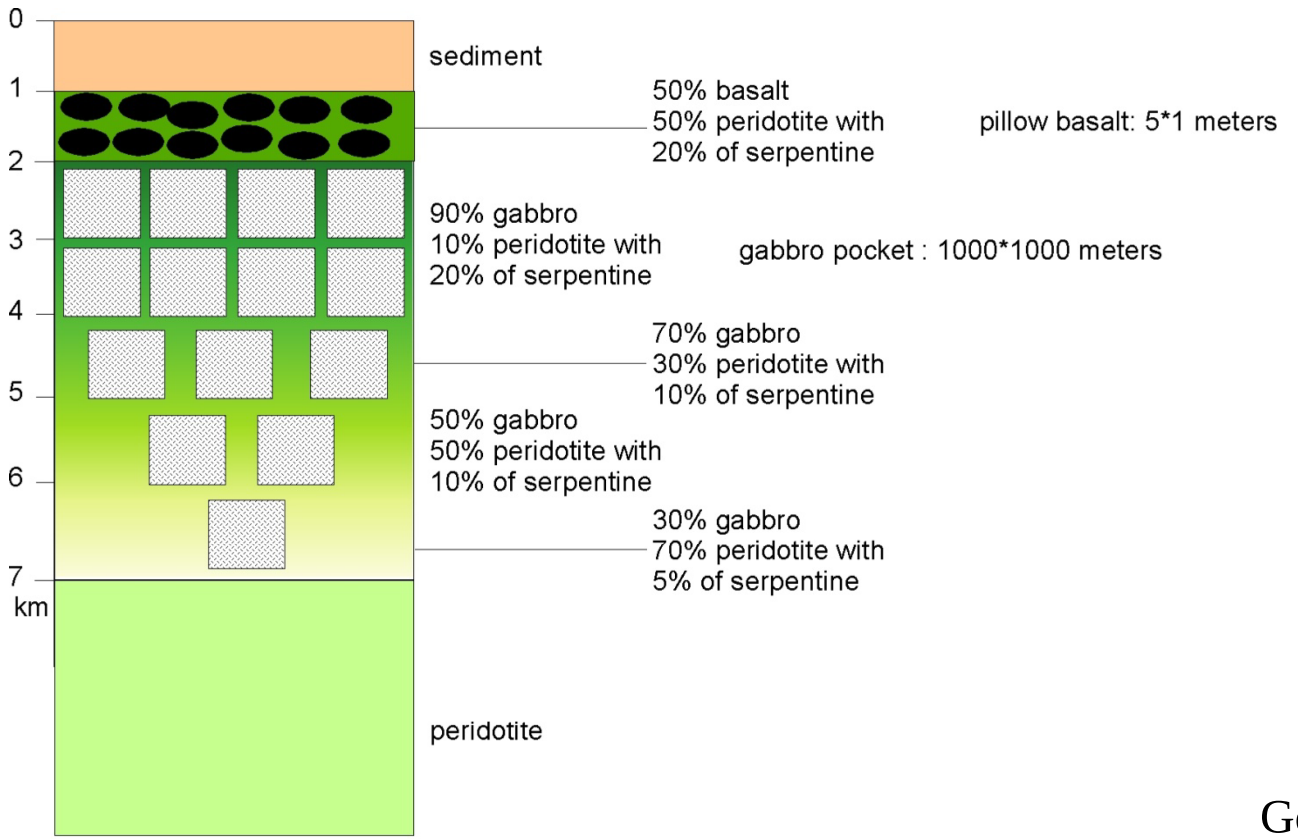


Atlantic-type oceanic floor

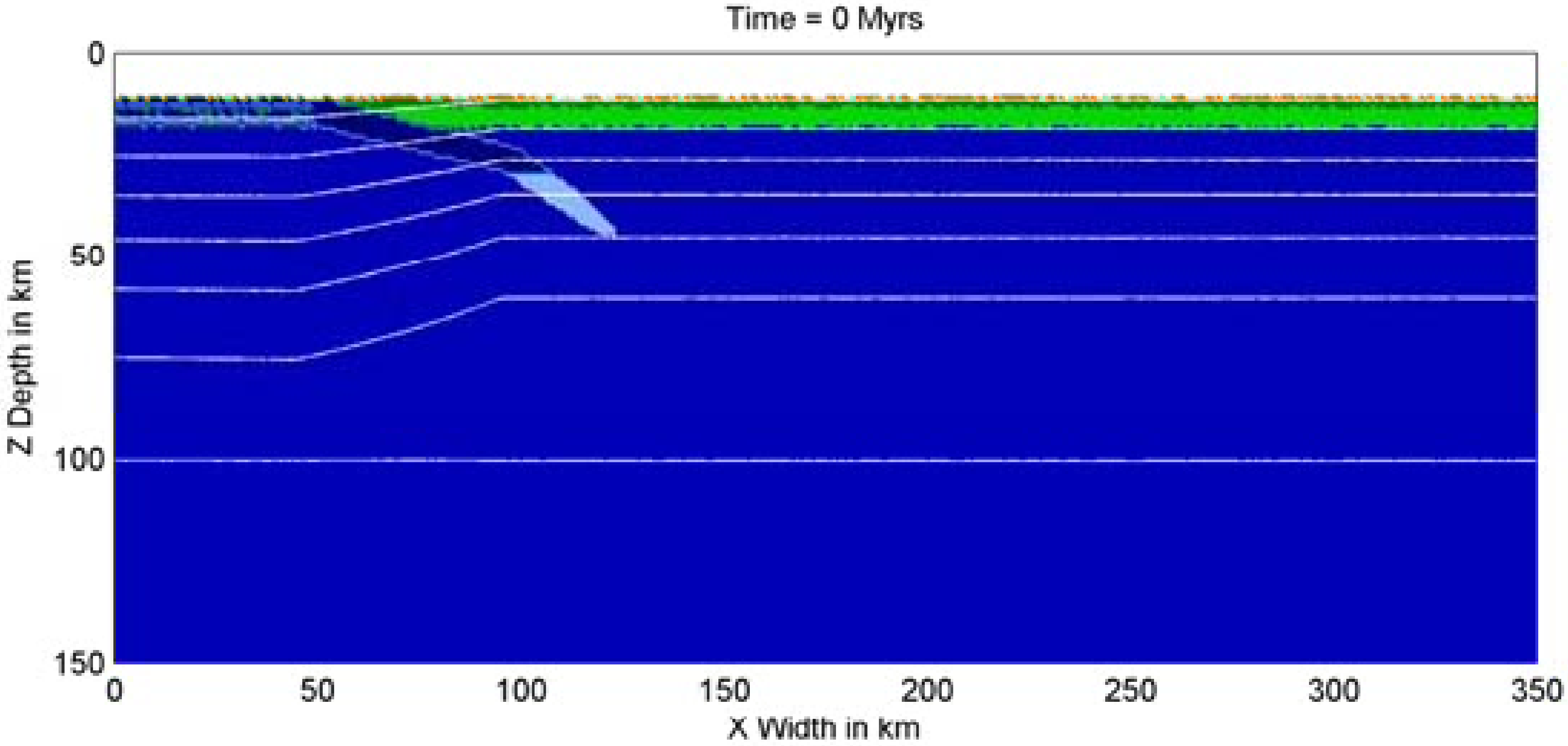


Cannat et al., 1995

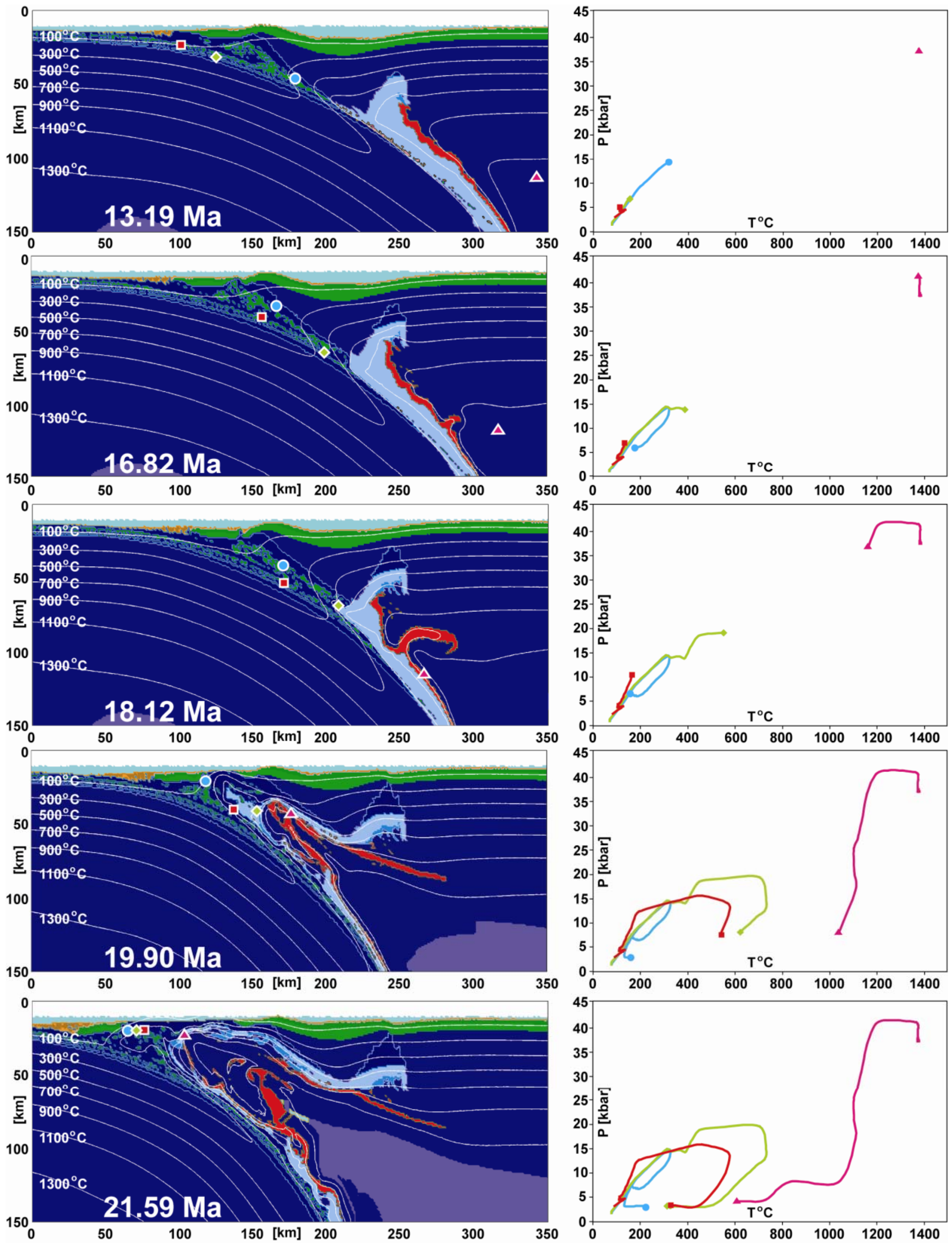


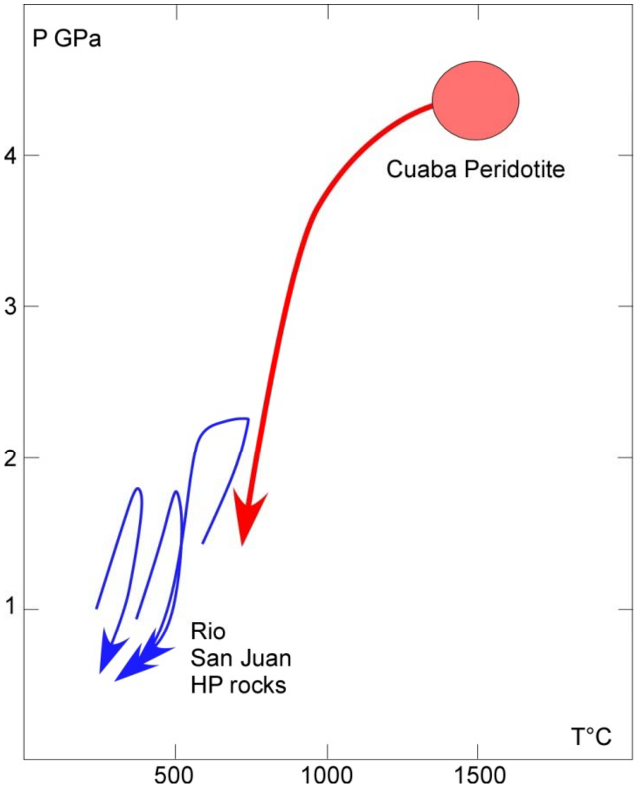


Gorczyk et al, 2007



Gorczyk et al, 2007.





after Abbott et al., 2006,
Krebs et al. 2007
Hattori et al., 2010