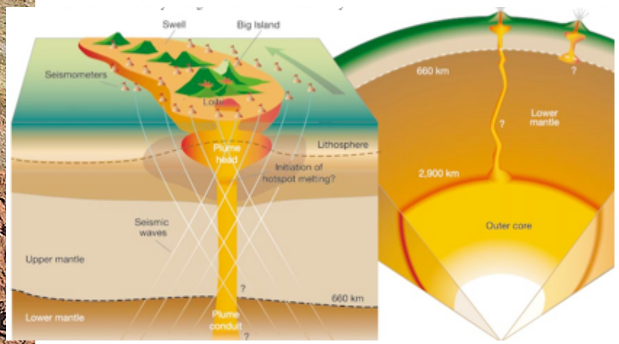
Plume-lithosphere interactions:

seismic data, models, and observations on xenoliths and peridotite massifs

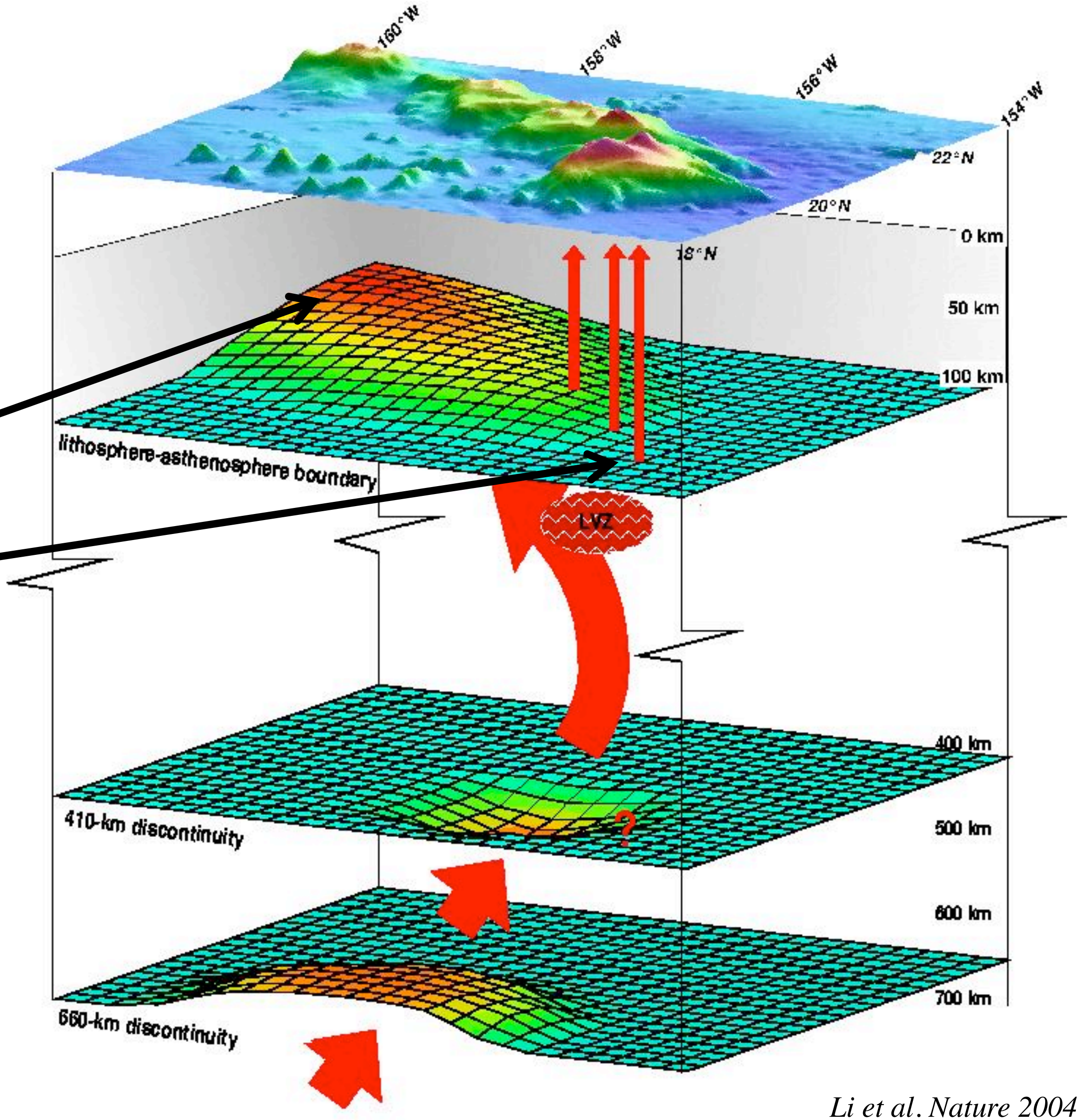
projects ESR 3, 4 & 9

Receiver functions: strong upwelling of the LAB beneath Hawaii



Oahu: LAB @ 50km

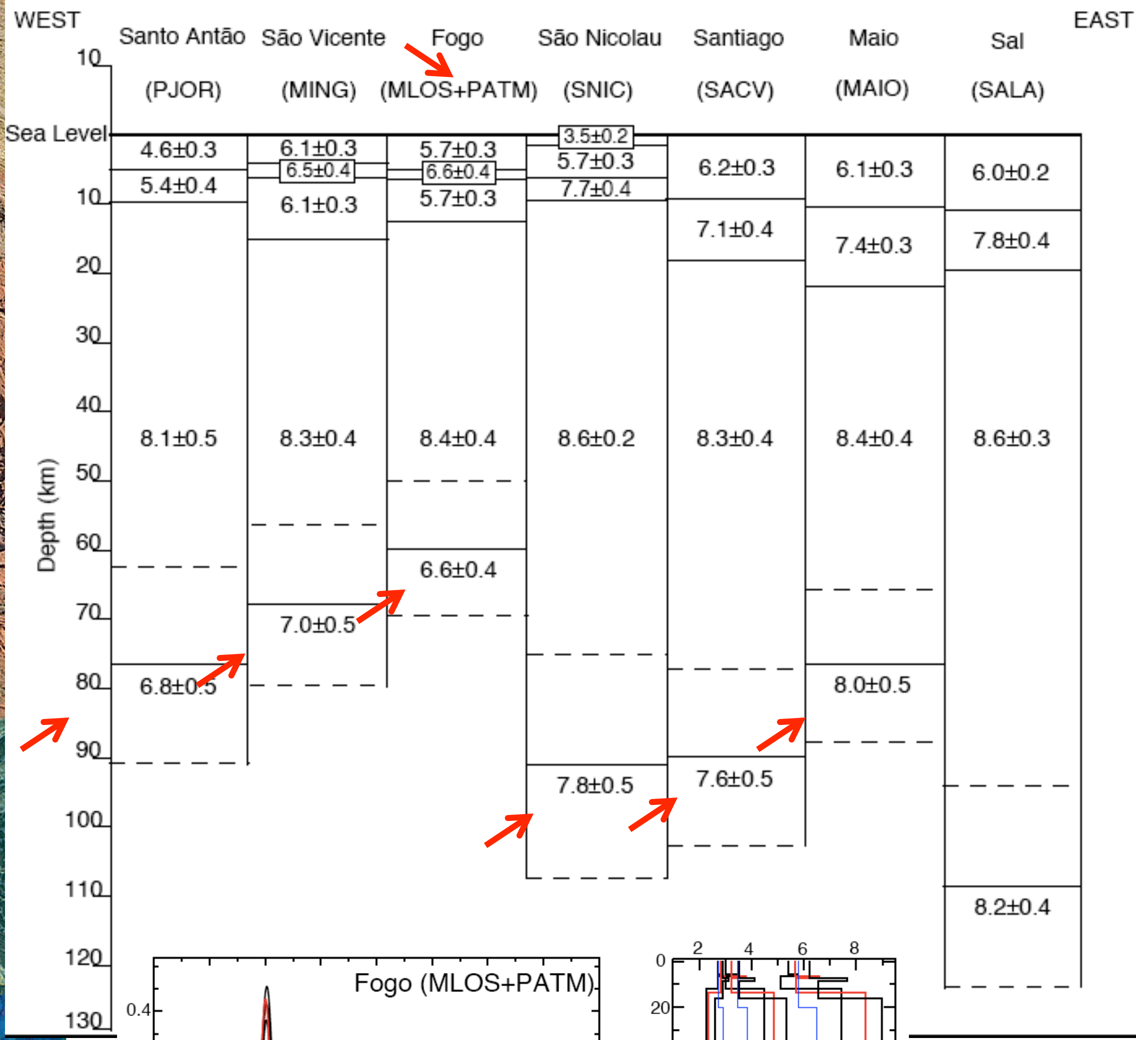
Hawaii: LAB @ 100km

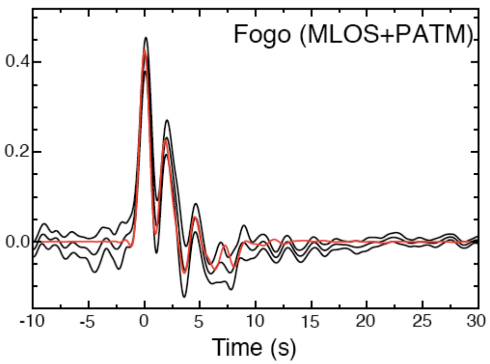


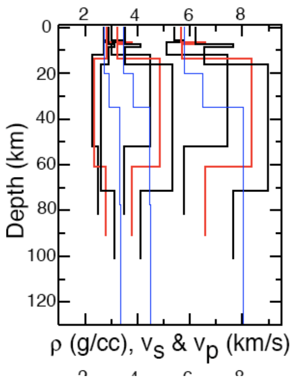
Li et al. Nature 2004

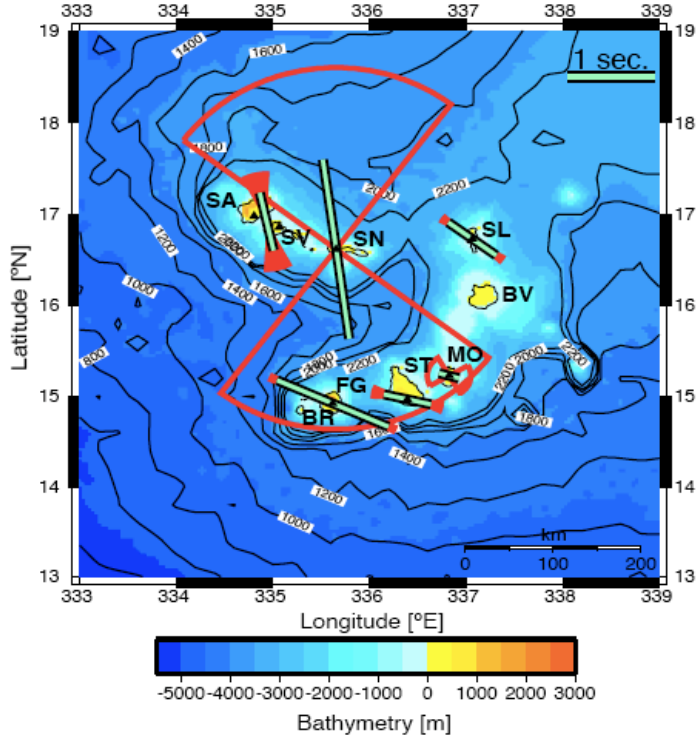
Géosciences Montpellier

Receiver functions: Cape Verde



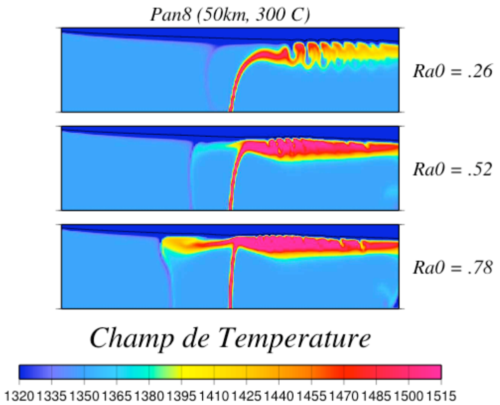






Thick crust,
high P velocities in the shallow lithosphere
&
strong decrease in seismic velocities @ 60-80 km depth

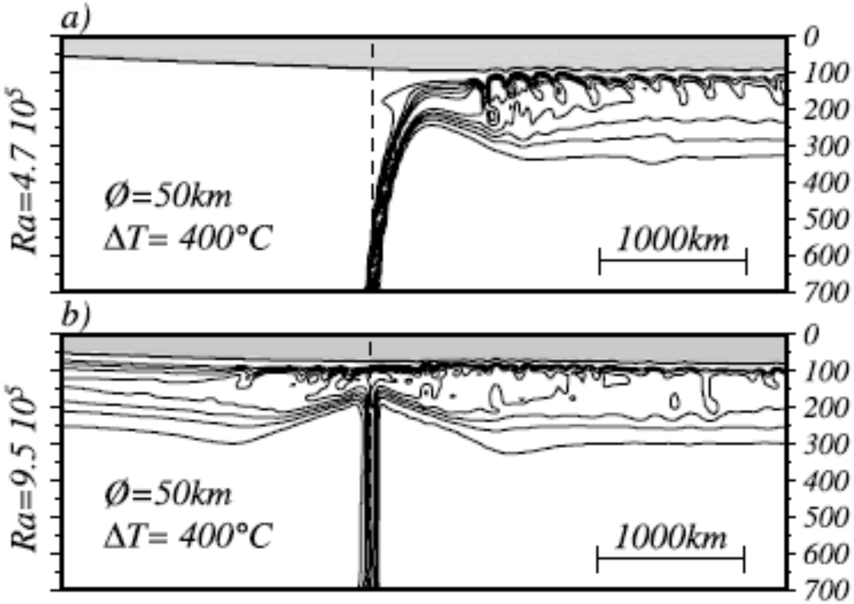
Lodge & Helffrich 2006 Geology

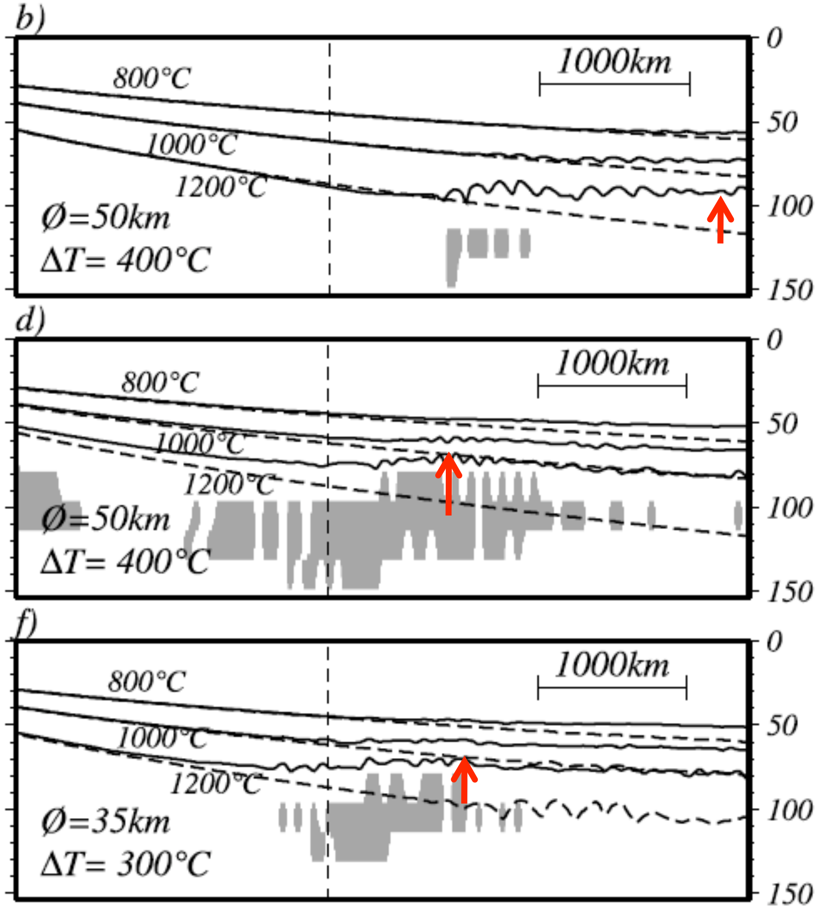


Numerical models: plume – lithosphere interaction beneath a fast moving plate

small-scale convection enhanced in the plume wake

- *1200°C isotherm raised by up to 30km*
- *800°C isotherm stable*

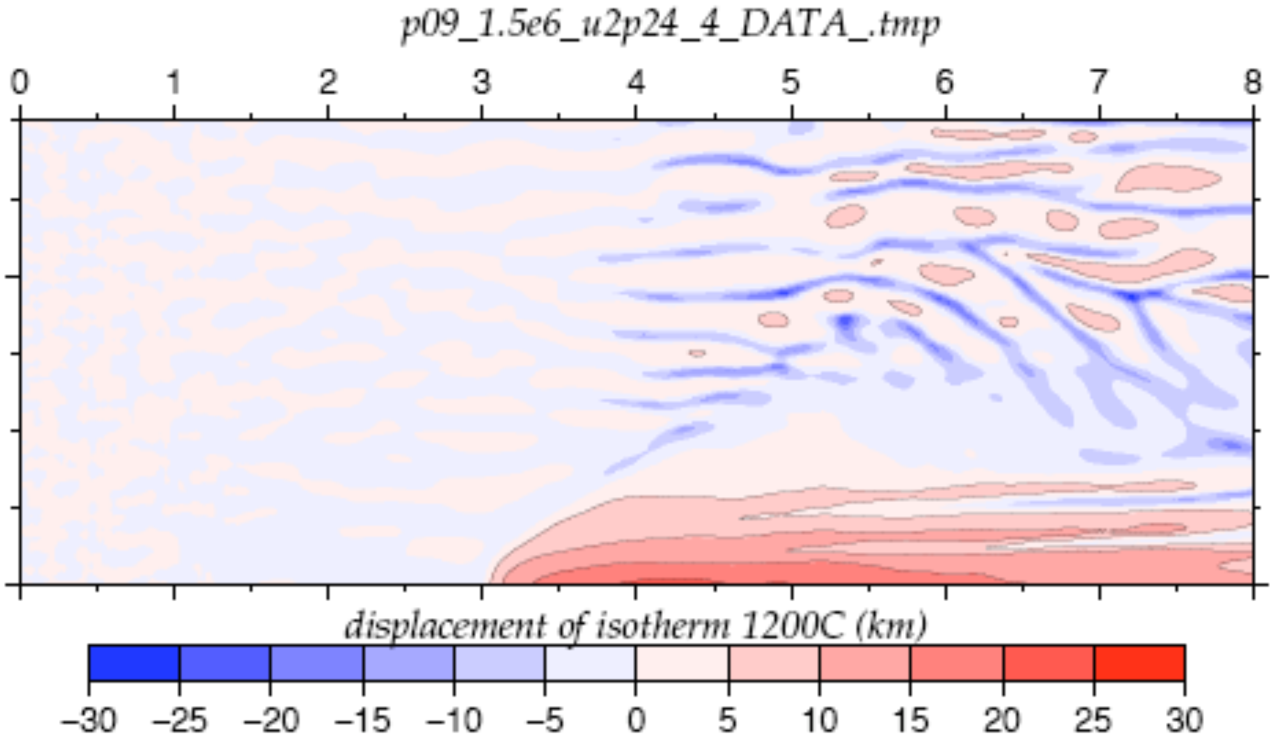




Thoraval et al. GRL 2006

Plume – lithosphere interaction beneath a fast moving plate

3D models = more buoyant plumes, but erosion ≤30km!



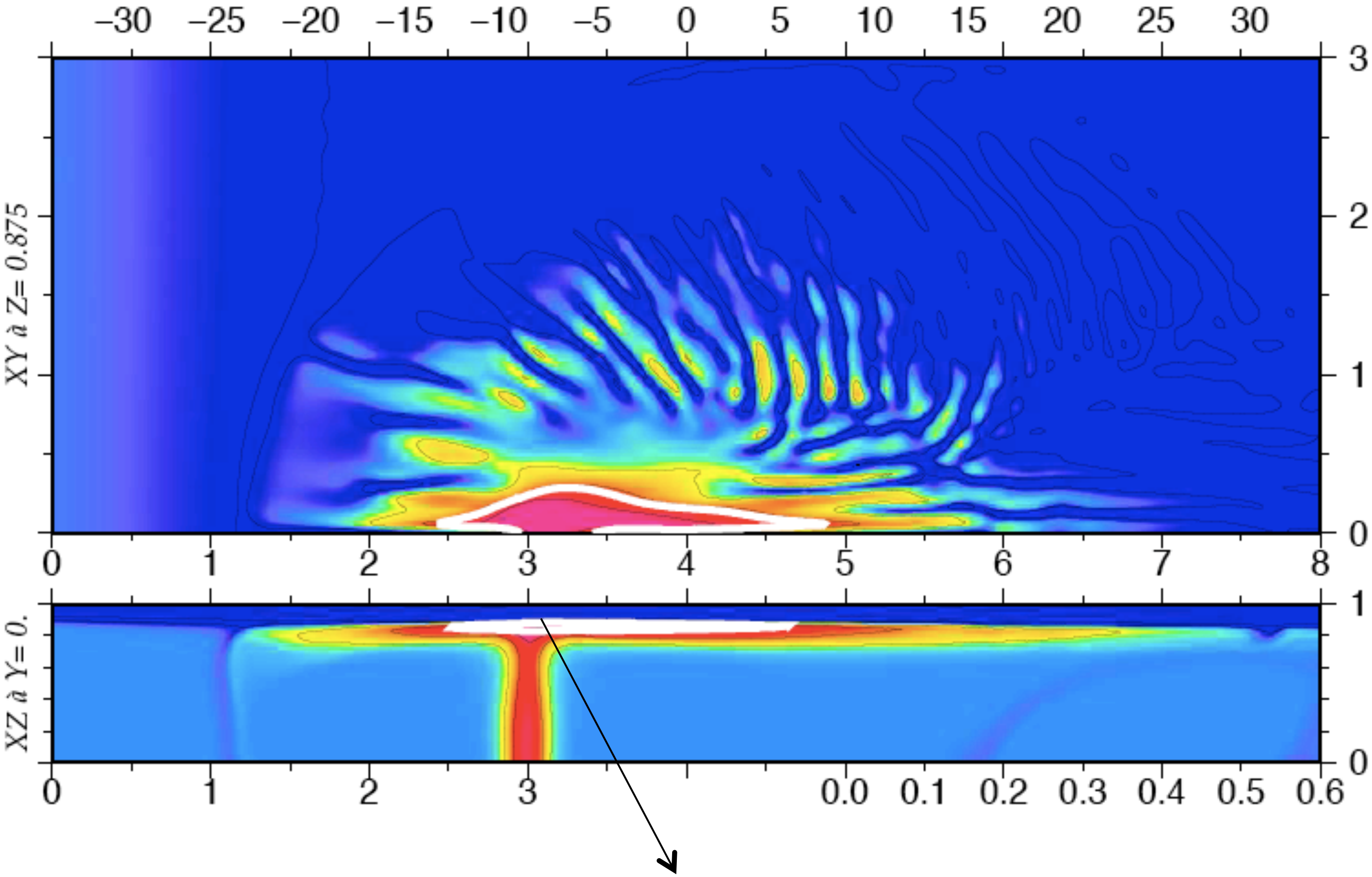
© C. Thoraval

How to renconcile these conflicting data?

Géosciences Montpellier

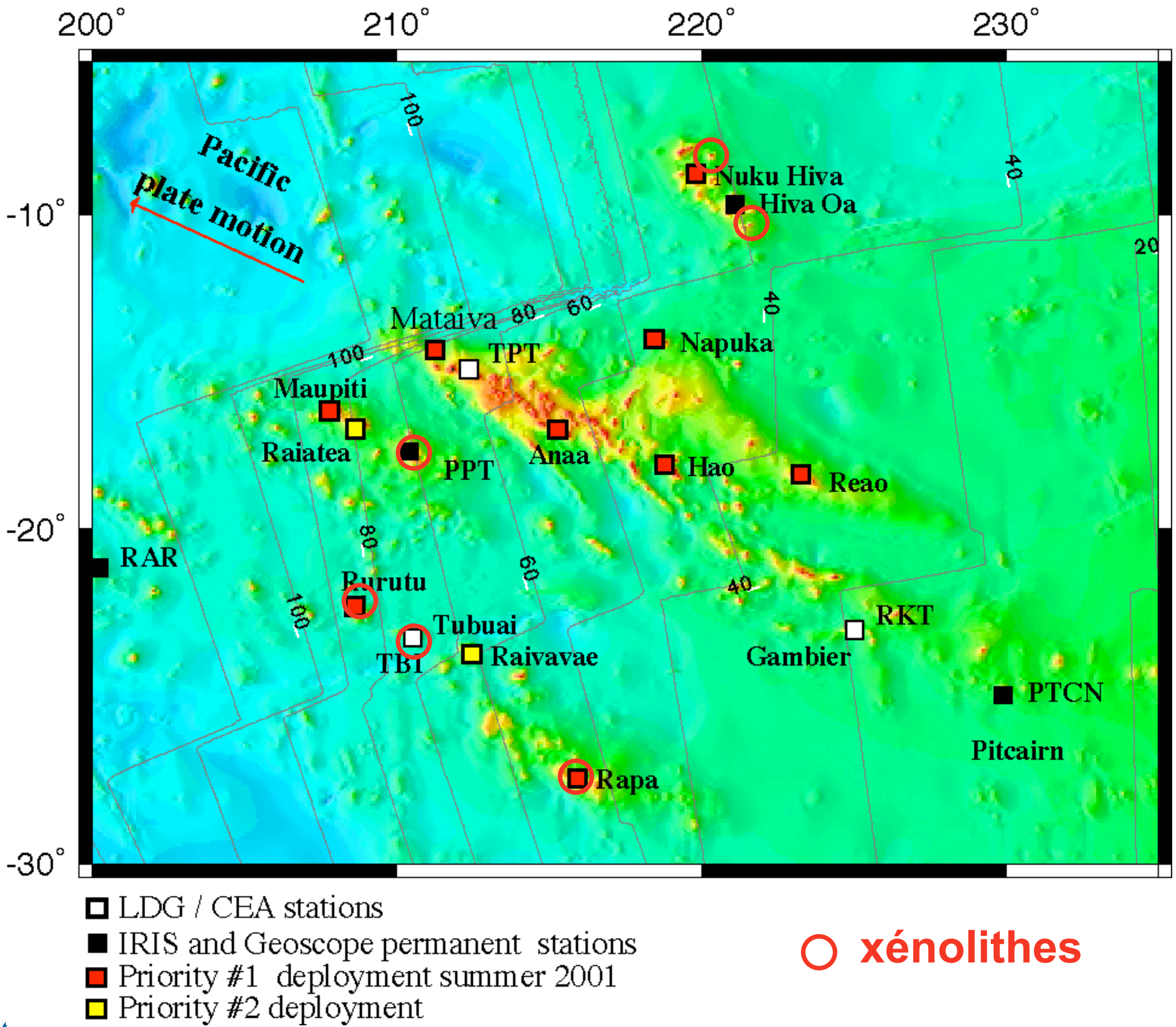
ESR9. ***How do mantle plumes help to thin and break up the lithosphere?***

Roberto AGRUSTA



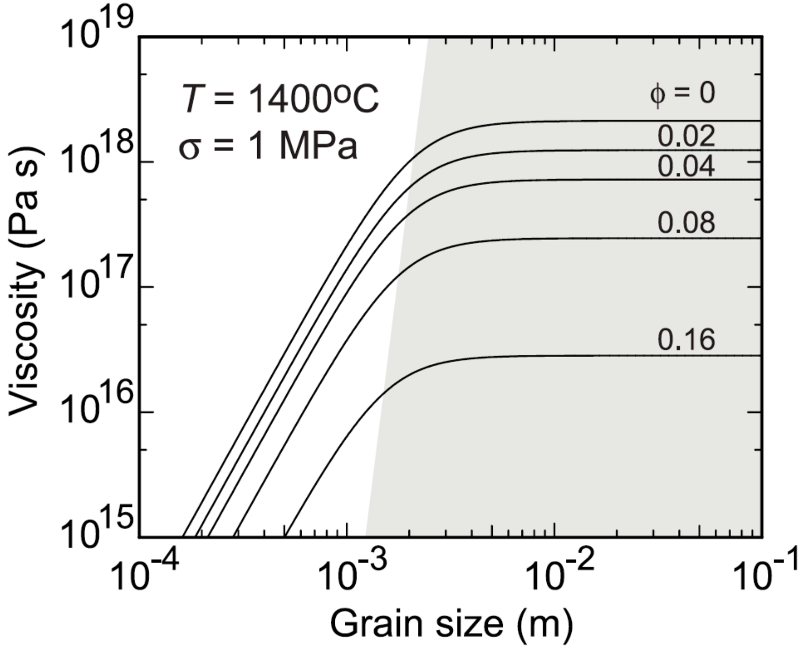
partial melting => reduce viscosity?
melt extraction => lower the density of the residue?

Receiver functions: LAB in the South Pacific superswell area?

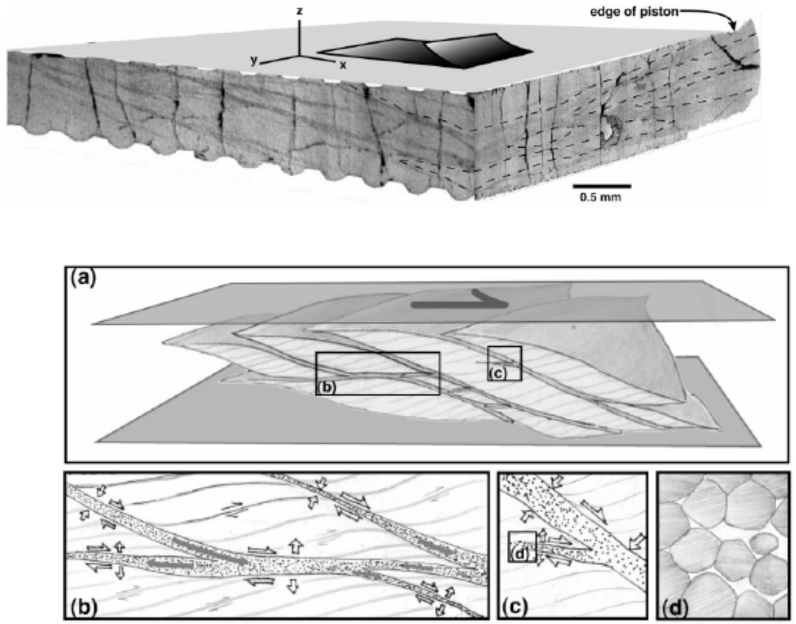


ESR3. ***Feedbacks between reactive melt transport, melt segregation, and deformation in the mantle***

Kate HIGGIE



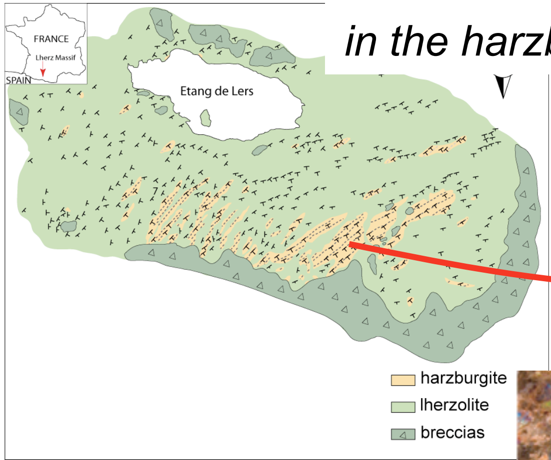
Kohlstedt & Mackwell 2008



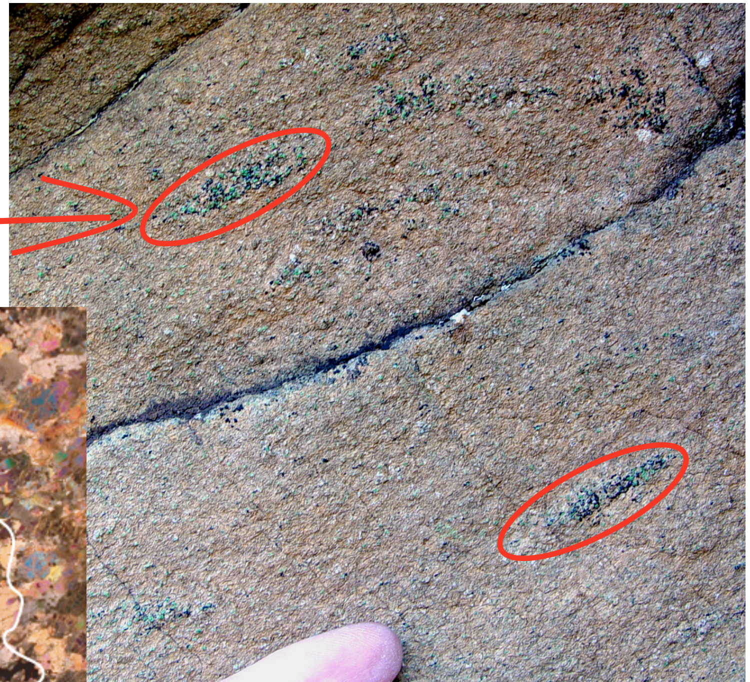
Holtzman & Kohlstedt 2007 JPet

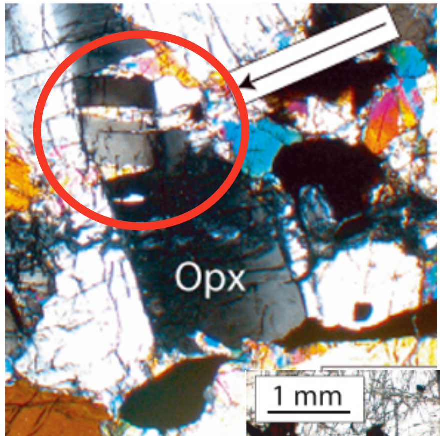
Lherz: feedbacks between melt percolation and deformation

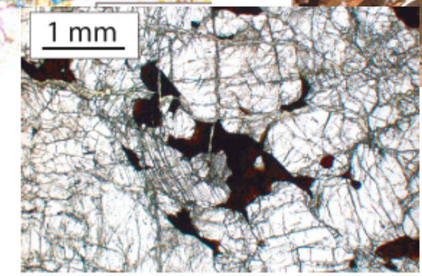
in the harzburgites:



websteritic (cpx+opx+sp rich) lenses flattened in the harzburgites' foliation plane







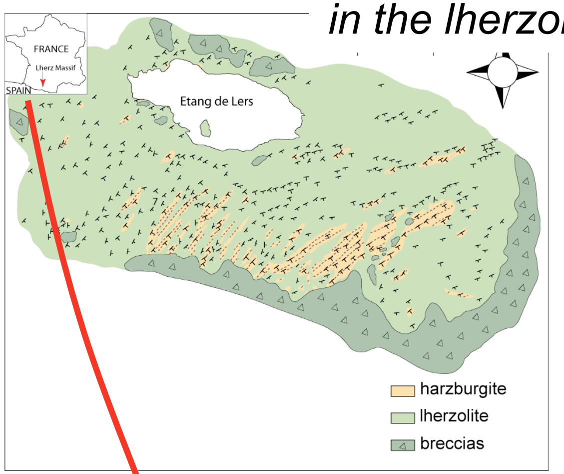
- *deformed olivine (inherited)*
- *deformed opx with en echellon fractures filled by undeformed cpx*
- *undeformed sp*

✓*percolation of small melt fractions controlled by the harzburgite foliation: anisotropic percolation under static (?) conditions*

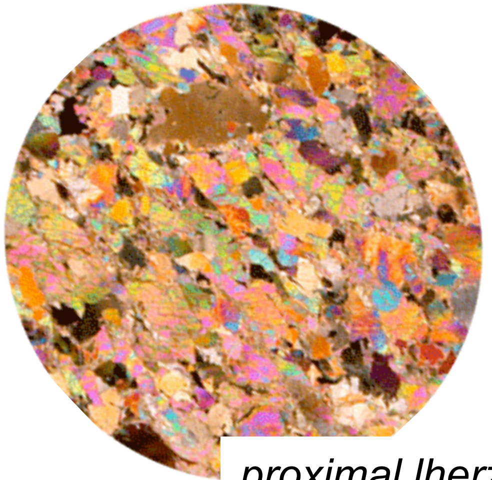
Le Roux et al. EPSL, 2008

Lherz: feedbacks between melt percolation and deformation

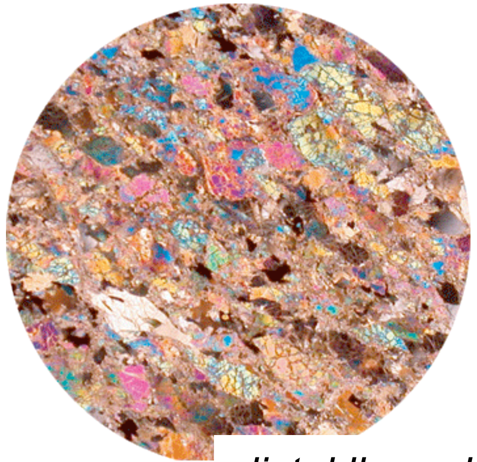
in the lherzolites



strain ↗ with ↗ distance from harzburgites contact (percolation front)



proximal lherzolite



distal lherzolite

highest strains = most fertile lherzolites

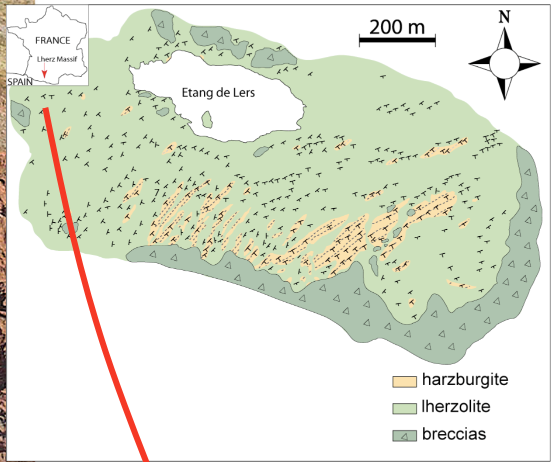
✓*melt-induced strain localization*

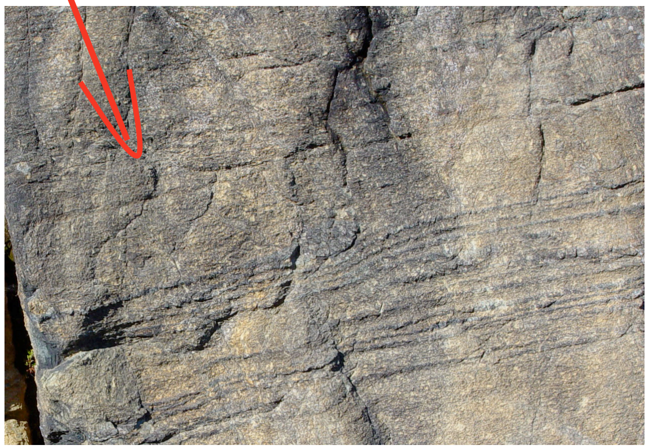
Géosciences Montpellier

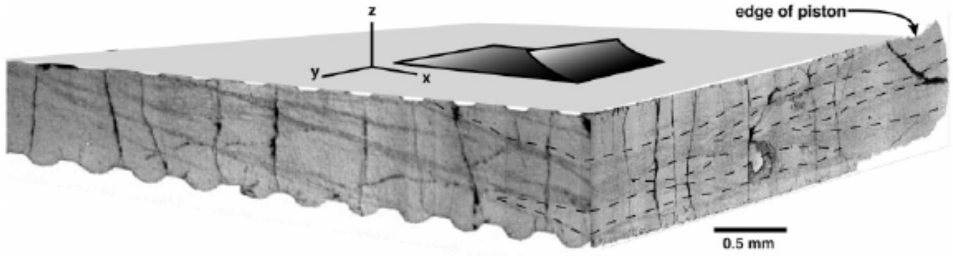
Le Roux et al. EPSL, 2008

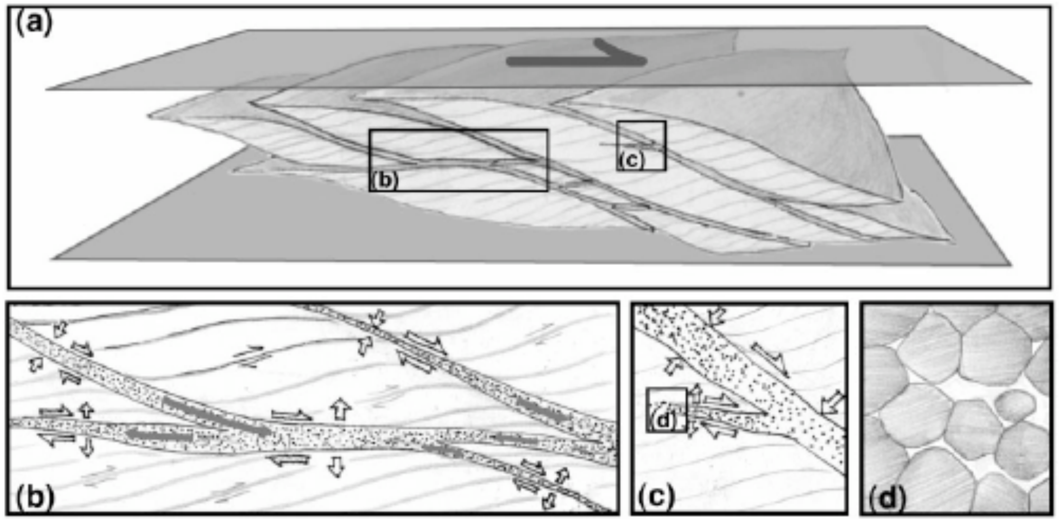
Lherz: feedbacks between melt percolation and deformation

layered lherzolites = melt segregation favored by shearing?





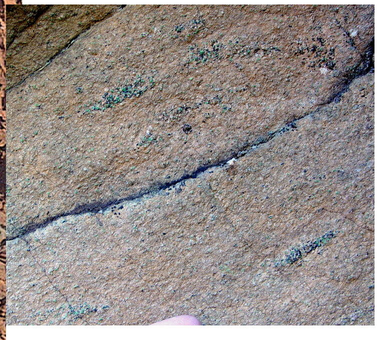


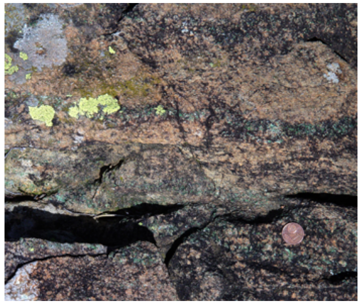


Holtzman & Kohlstedt 2007 JPet

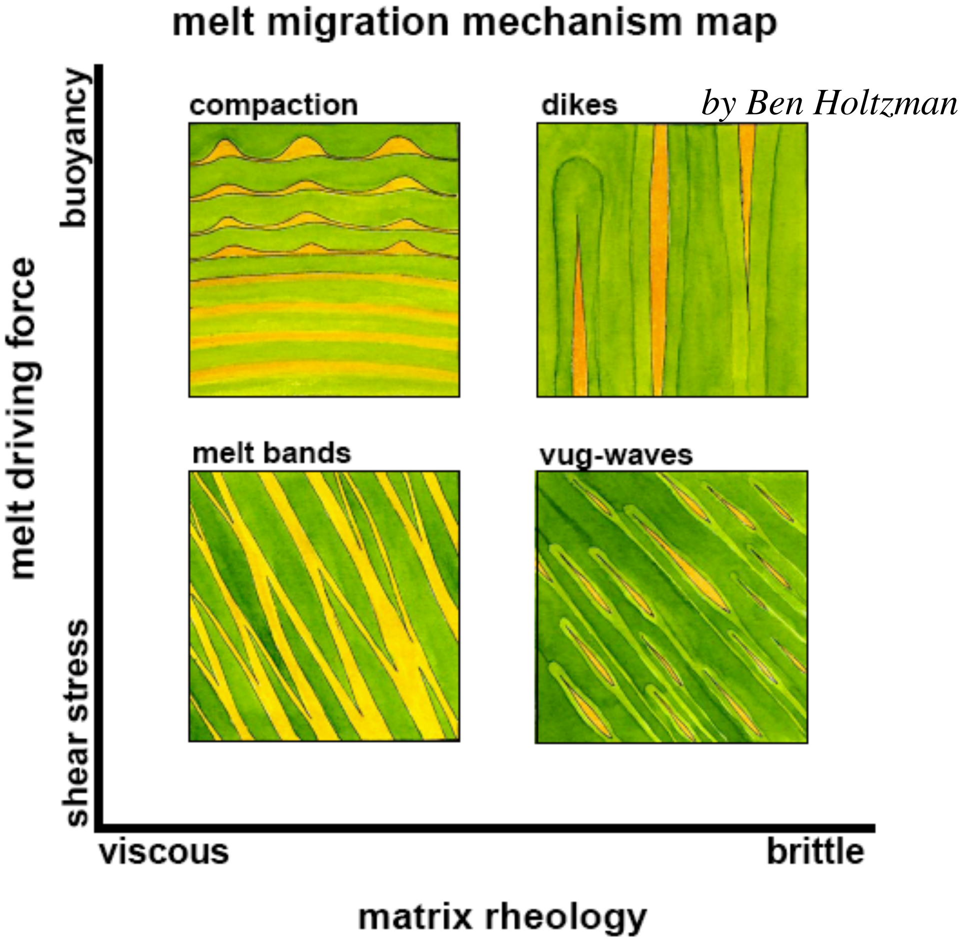
Le Roux et al. EPSL, 2008

- *field evidence for ≠ melt migration mechanisms*





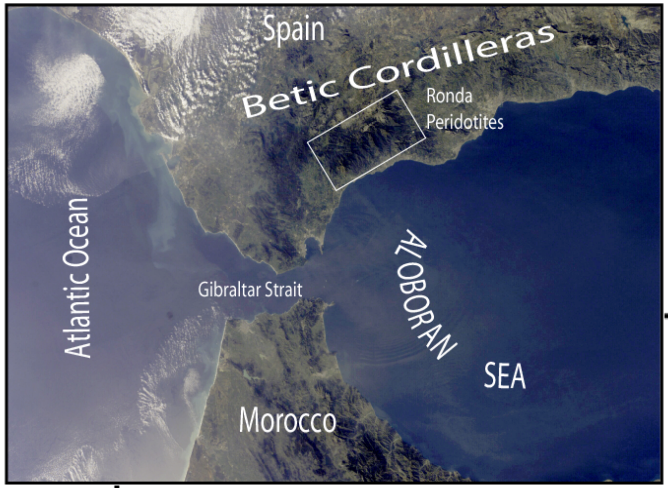
low shear stress + permeability anisotropy?

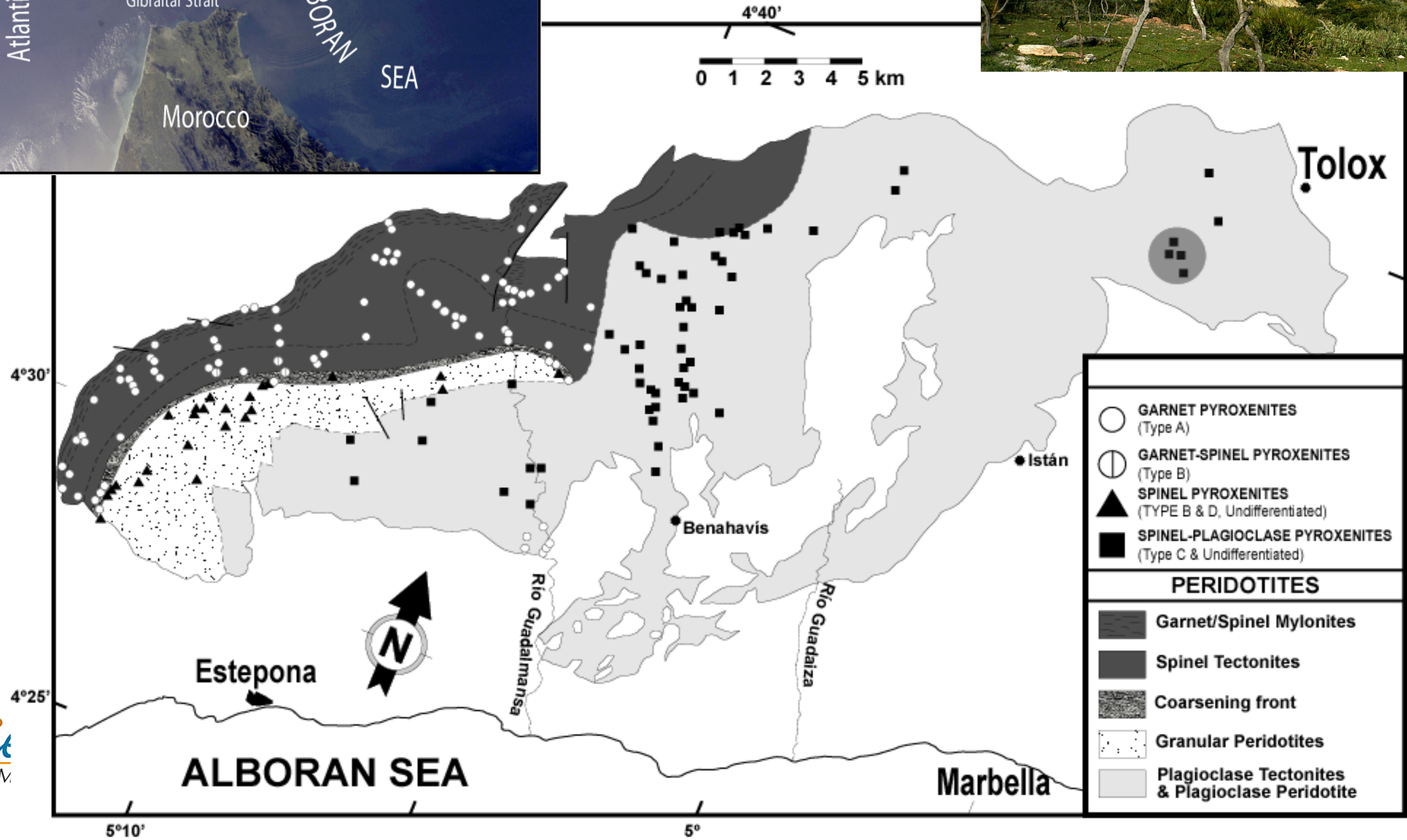


- *melt segregation (favored by shearing) + sampling bias : compositions ~4% Al_2O_3 in fertile lherzolite more likely a threshold for melt segregation rather than Primitive Mantle values?*

Géosciences Montpellier

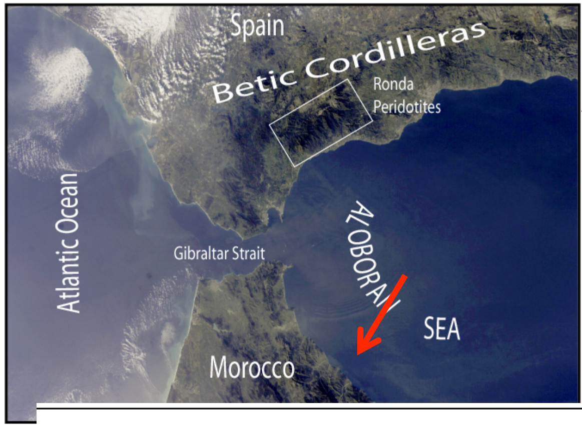
The Ronda peridotite massif

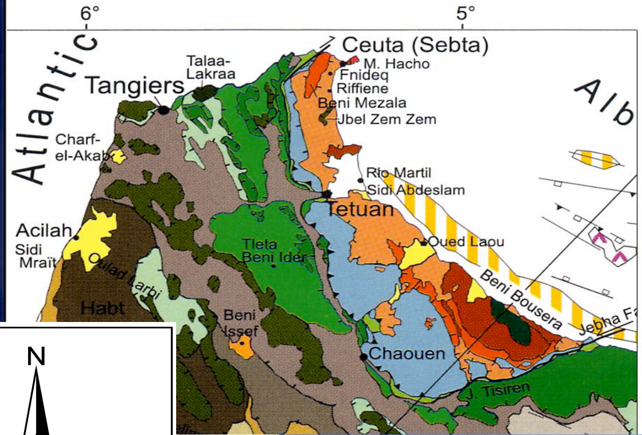


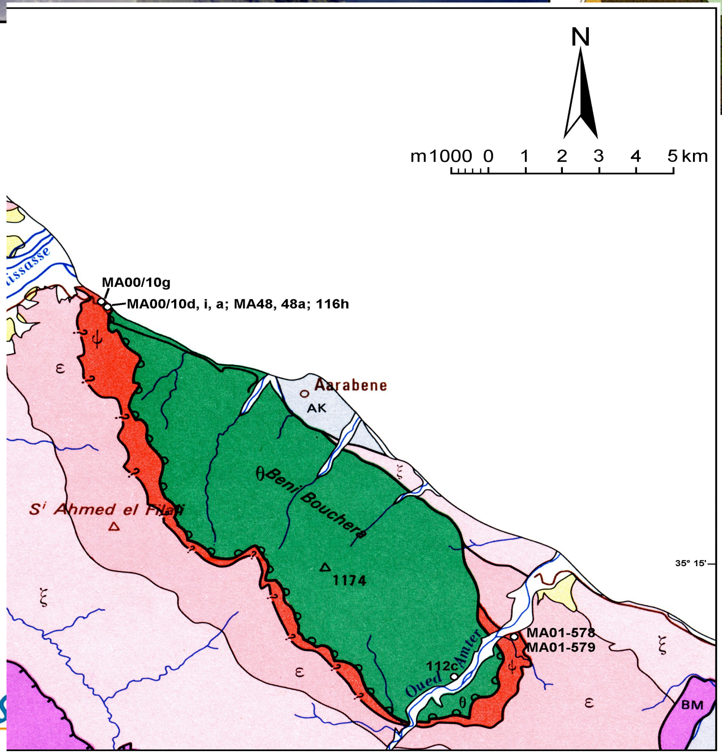


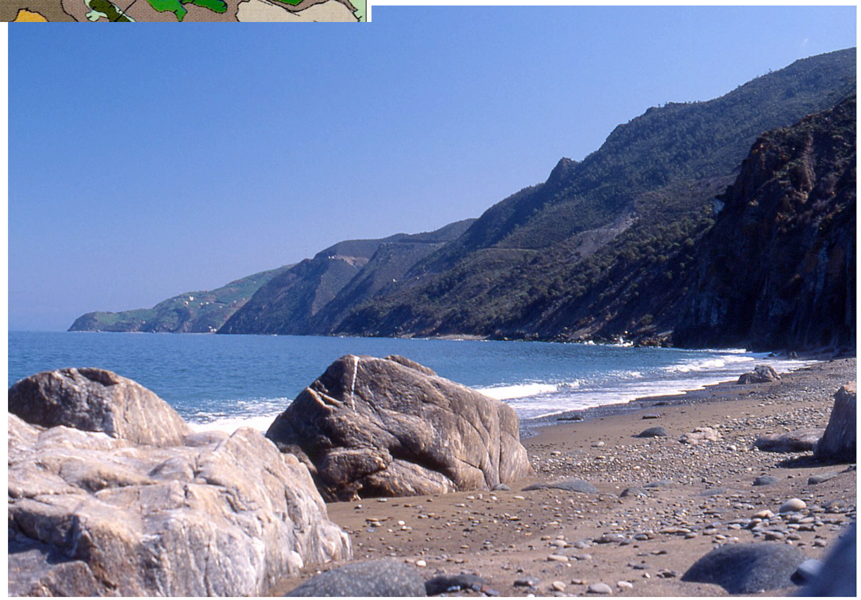
ESR4. ***The evolution of the subcontinental mantle lithosphere: petro-structural study of the Beni Boussera peridotite massif, Morocco***

Erwin FRETS

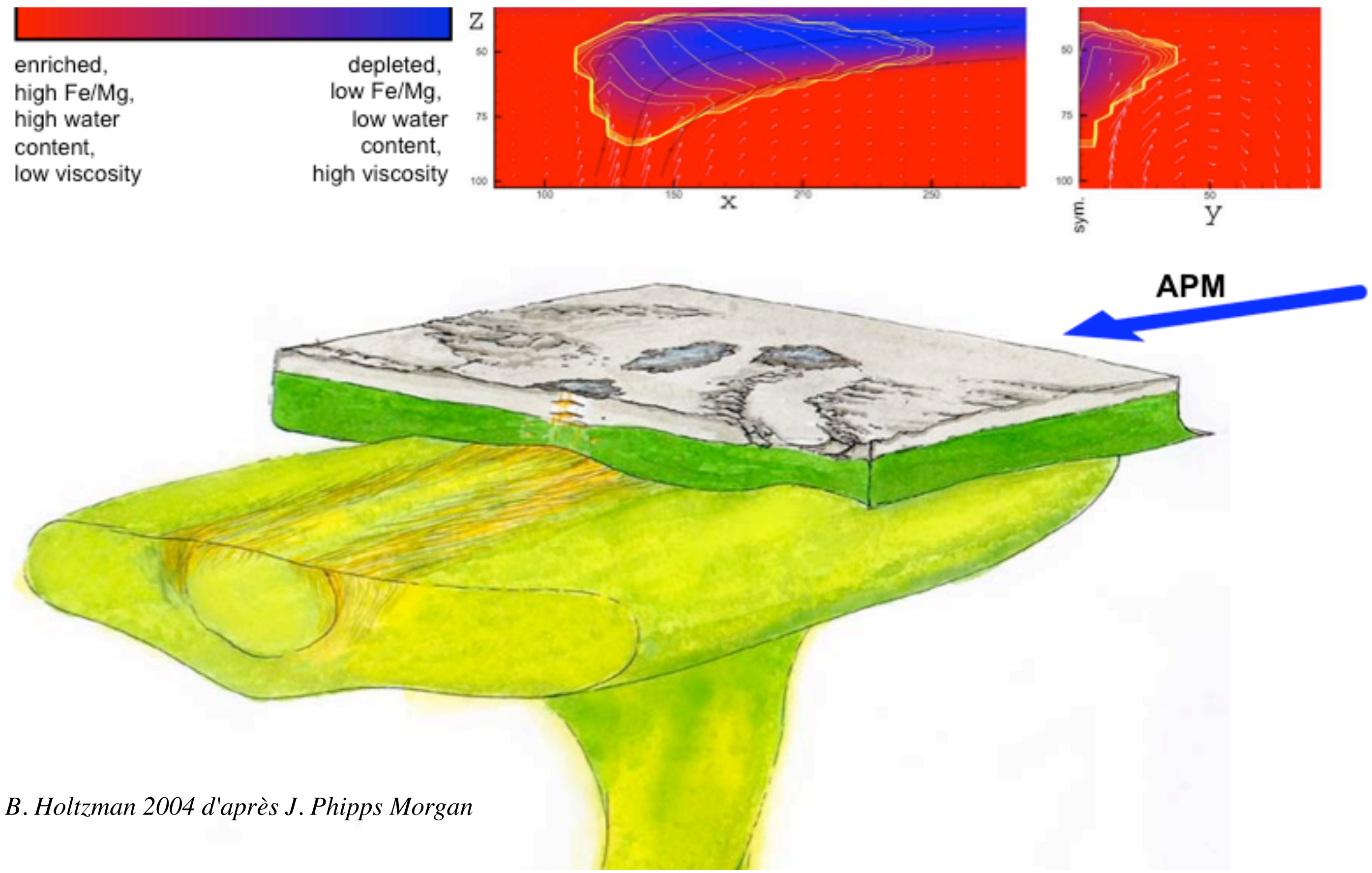








Variations in olivine water contents & viscosity due to melting?



B. Holtzman 2004 d'après J. Phipps Morgan