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State of Stress of Subducting Slabs from Viscoelastic Plane Strain Numerical Modelling

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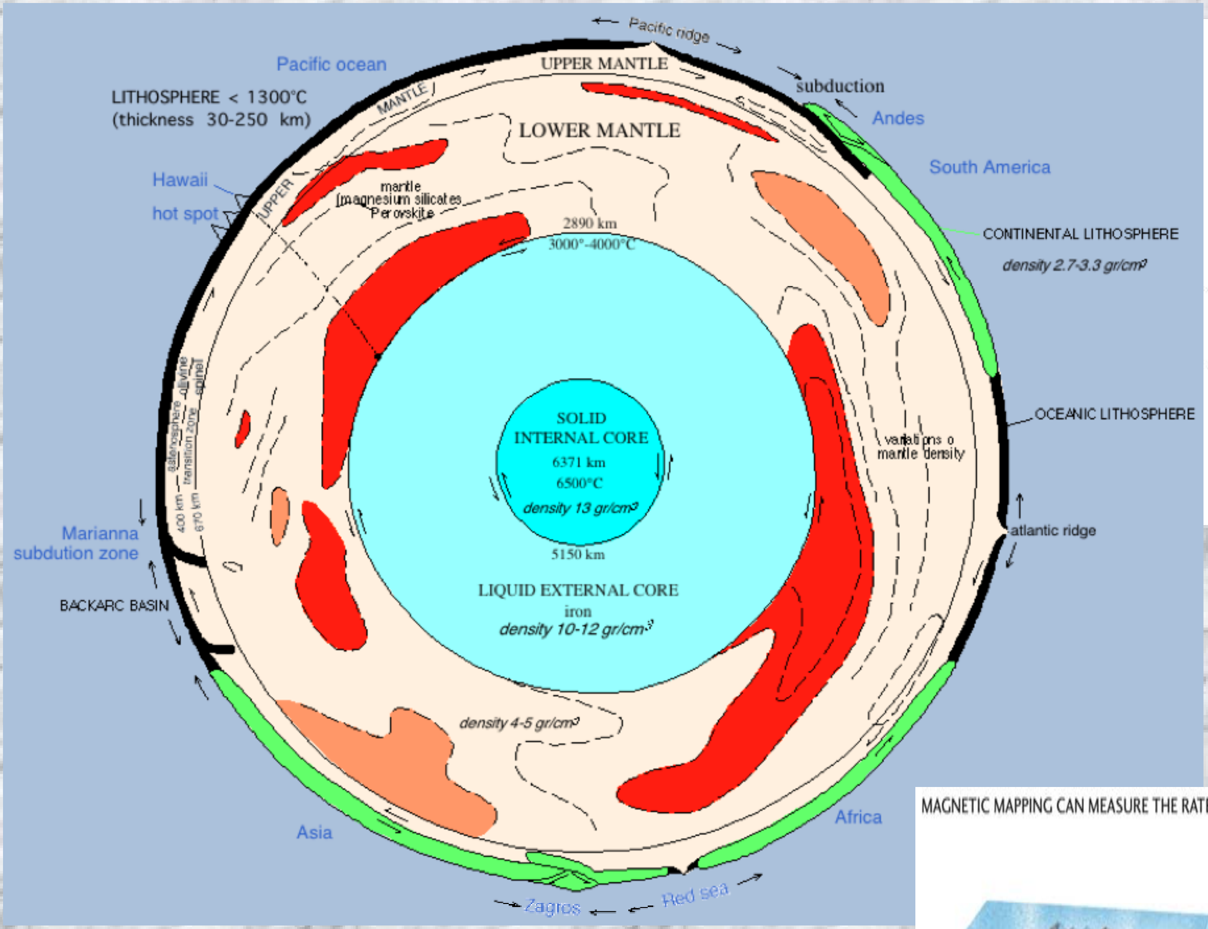
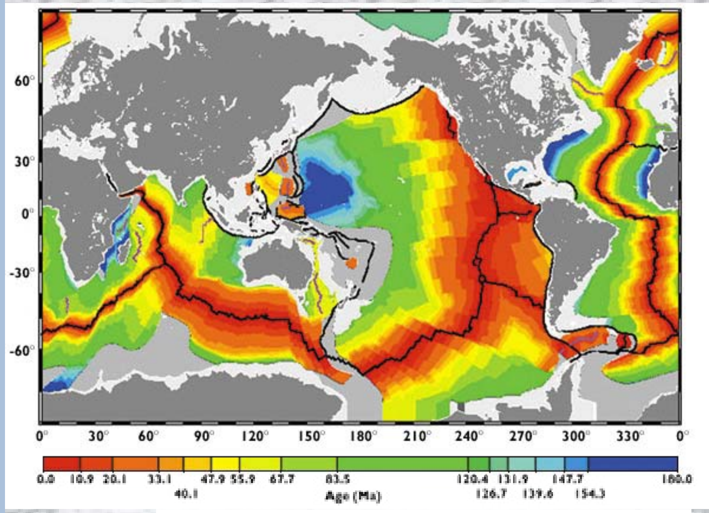
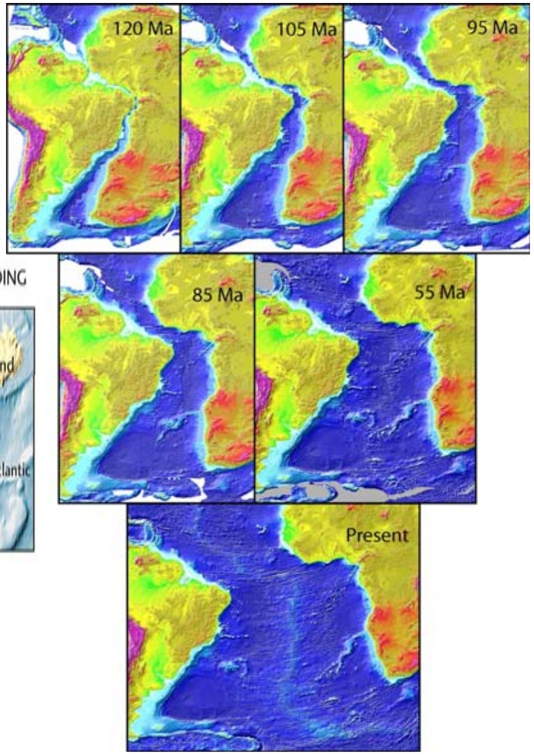
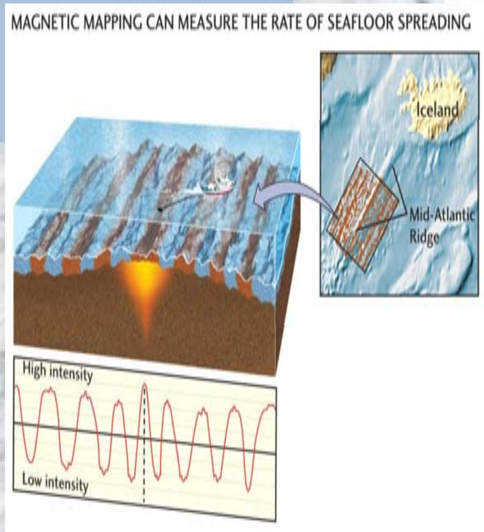
Earth’s geodynamics



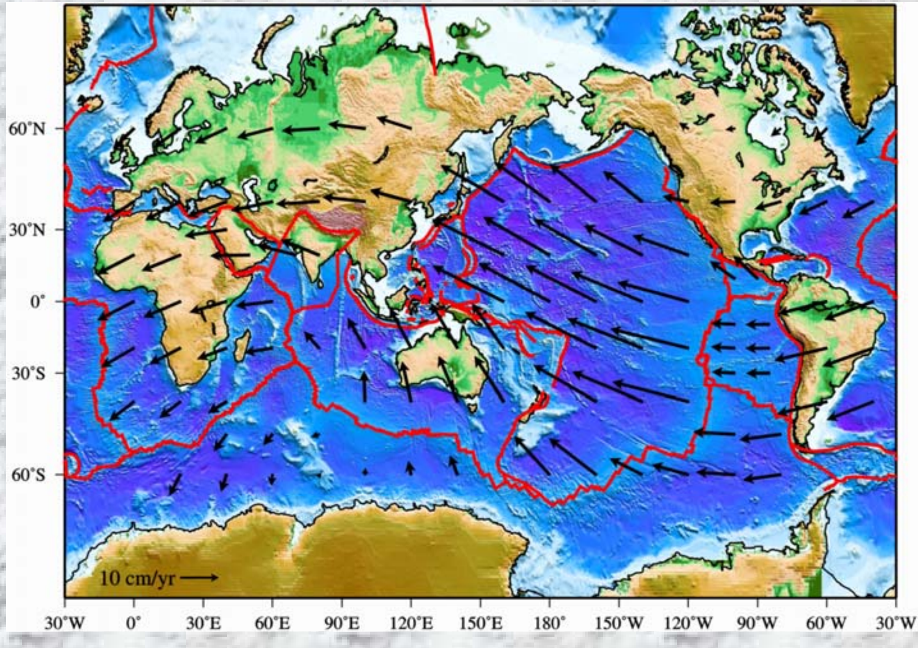




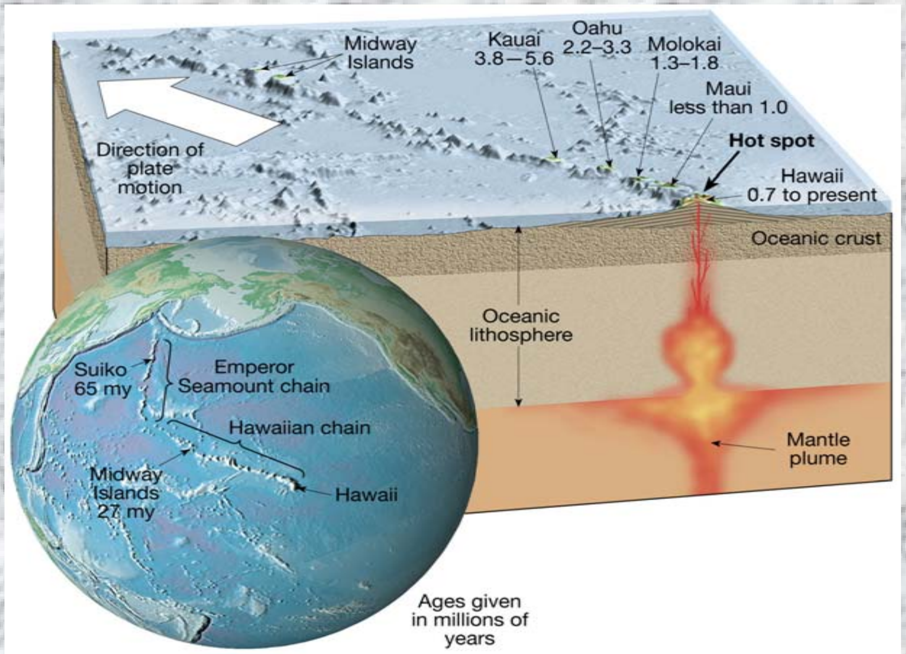


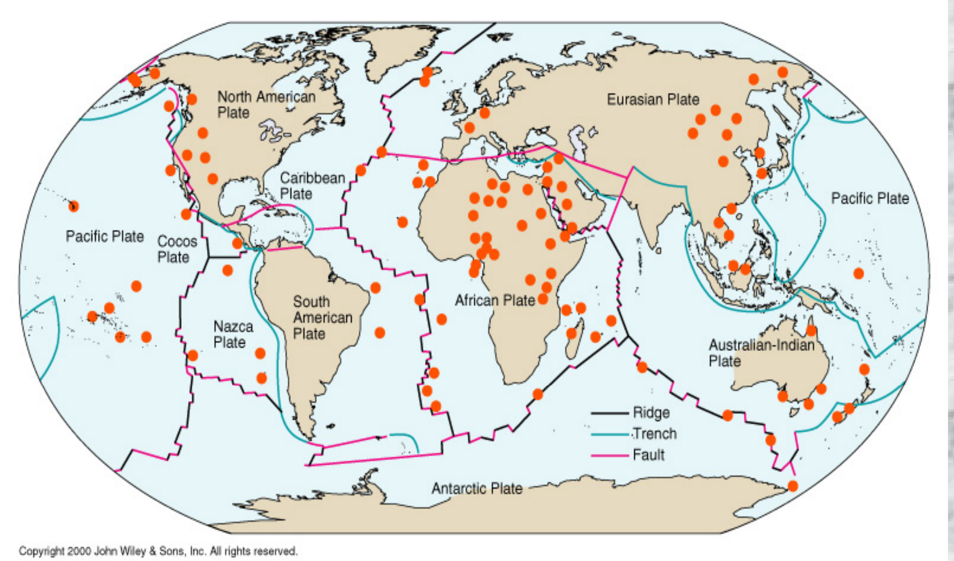
Relative plate motions

Hotspot tracks and absolute plate motions

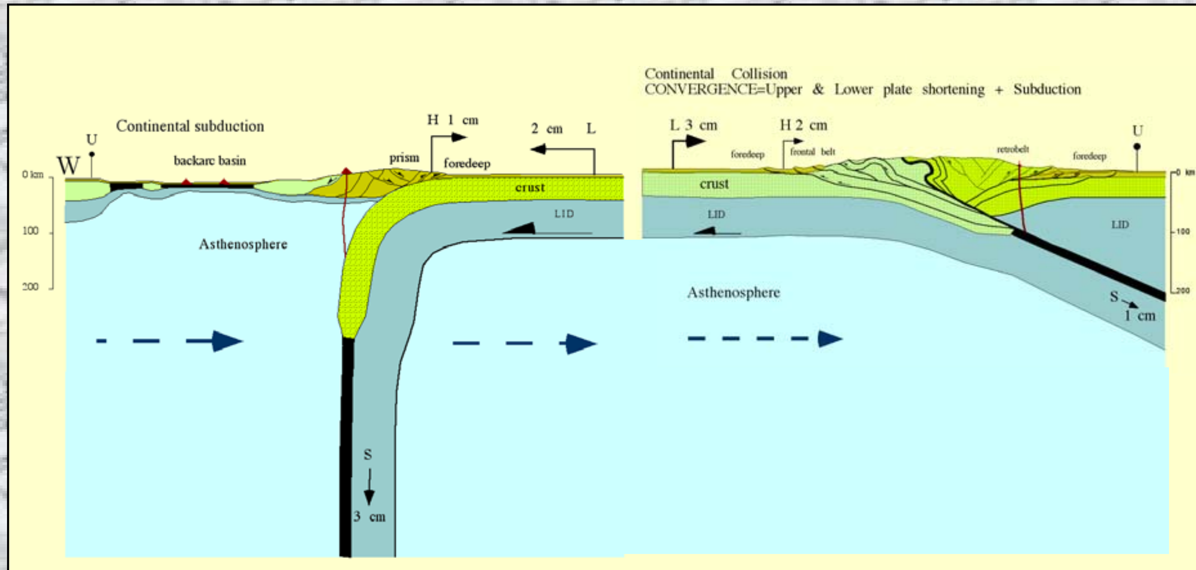


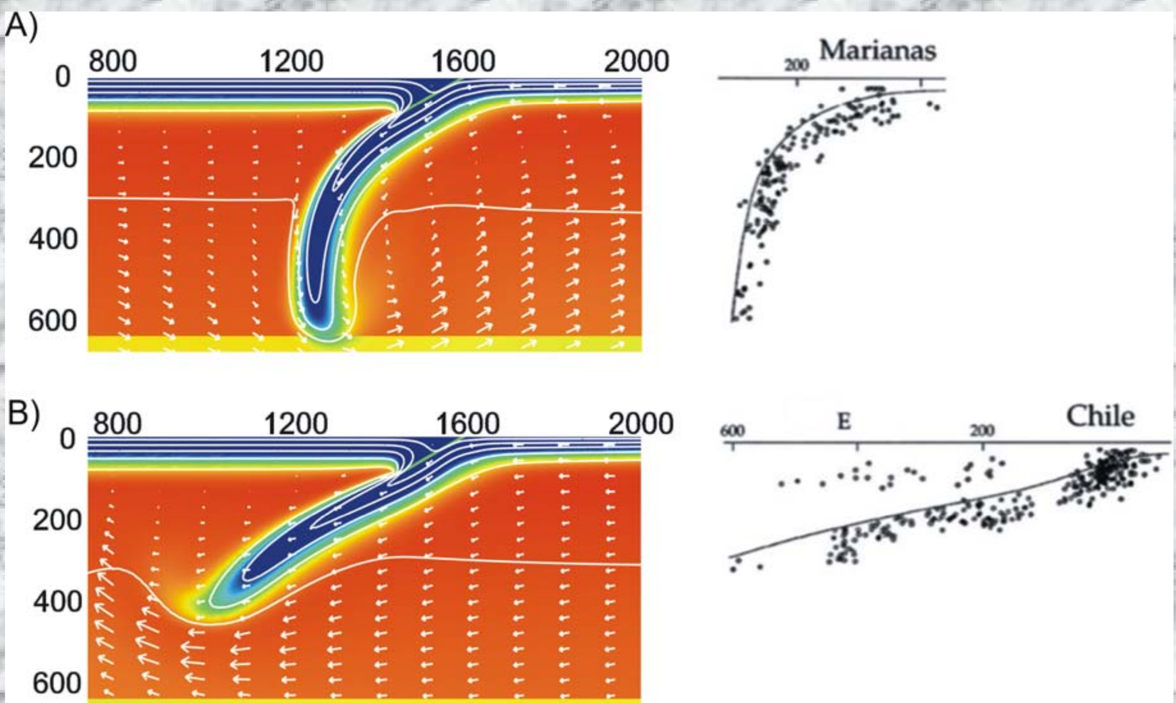
Cuffaro & Doglioni 2006





Westward drift vs. slab and orogen geometry

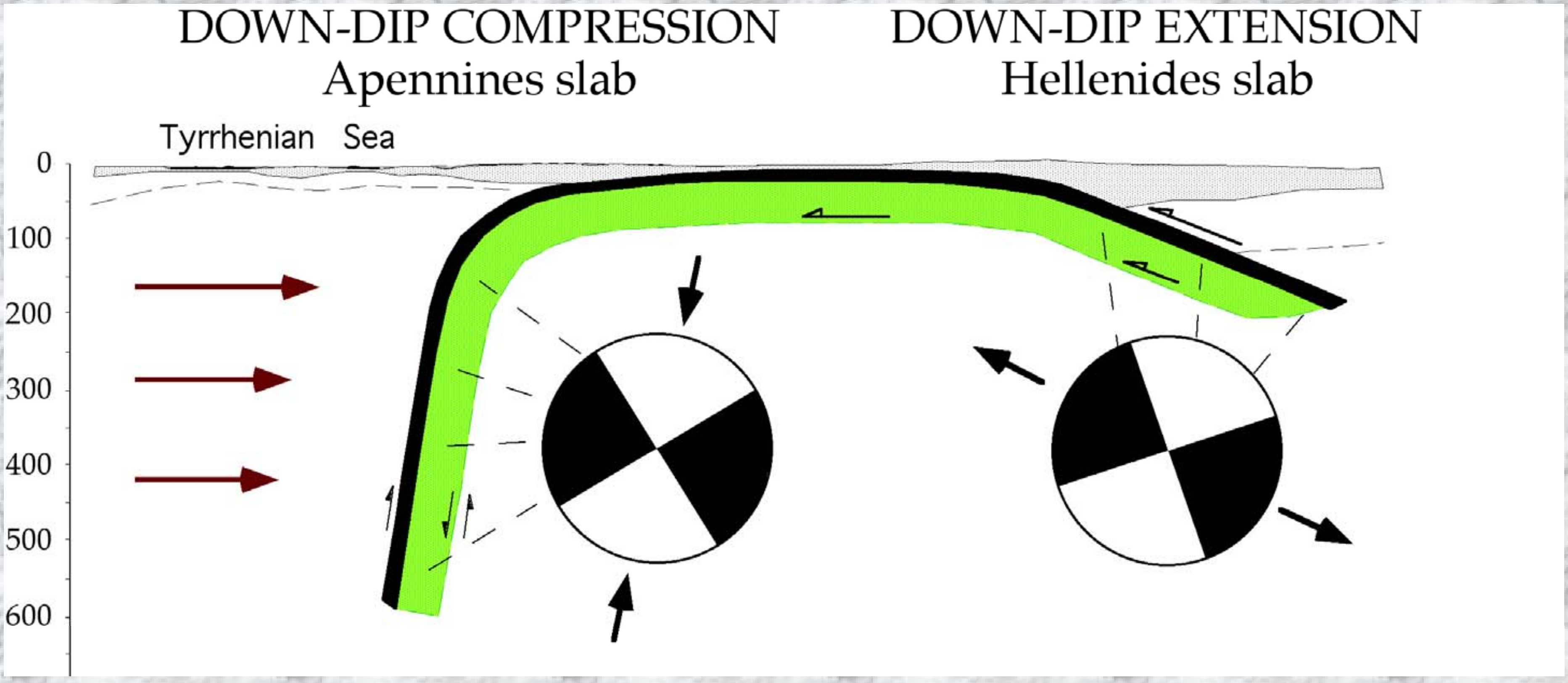




J. Rodríguez-González, A. M. Negredo, P. Petricca, E. Carminati, Modeling with COMSOL the interaction between subducting plates and mantle flow

Now at poster session

State of stress of subducting slabs



Why?

Plane strain viscoelastic model

Our plane strain dynamic modelling solves the compatibility equations

$$\varepsilon = \begin{Bmatrix} \varepsilon_x \\ \varepsilon_y \\ \varepsilon_{xy} \end{Bmatrix} = \begin{Bmatrix} \dfrac{\partial u}{\partial x} \\ \dfrac{\partial v}{\partial y} \\ \dfrac{\partial u}{\partial x} + \dfrac{\partial v}{\partial y} \end{Bmatrix} = \begin{bmatrix} \dfrac{\partial}{\partial x} & 0 \\ 0 & \dfrac{\partial}{\partial y} \\ \dfrac{\partial}{\partial y} & \dfrac{\partial}{\partial x} \end{bmatrix} \begin{Bmatrix} u \\ v \end{Bmatrix}.$$

the equilibrium equations for contiuous media

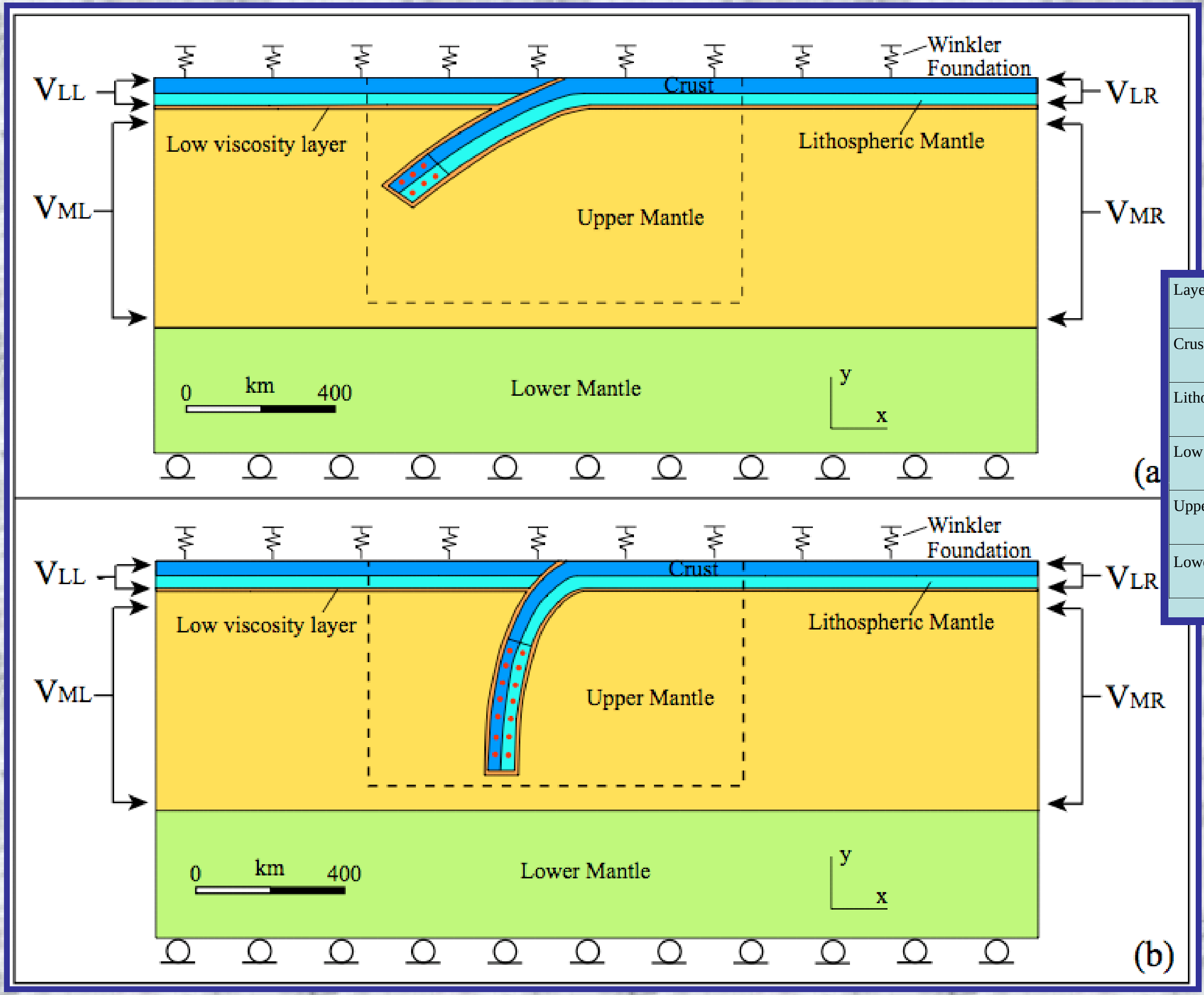
$$\frac{\partial \sigma_{ij}}{\partial x_i} + \rho X_i = \frac{\partial \sigma_{ji}}{\partial x_i} + \rho X_i = 0.$$

and the constitutive equations for Maxwell bodies

$$\dot{\varepsilon} = \frac{\dot{\sigma}}{2\mu_M} + \frac{\sigma}{2\eta_M}$$

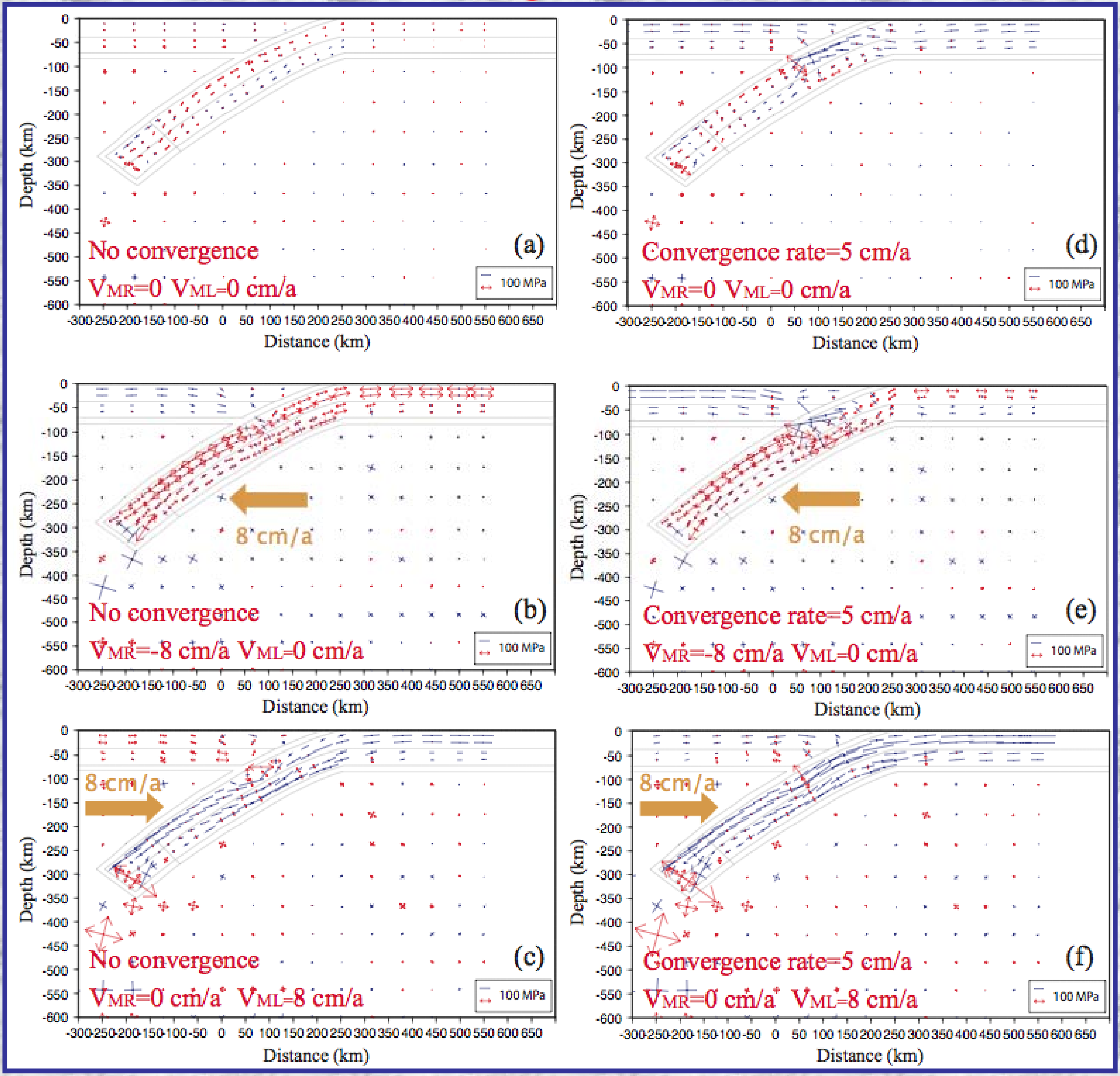
Plane strain viscoelastic model

Geometry an boundary conditions

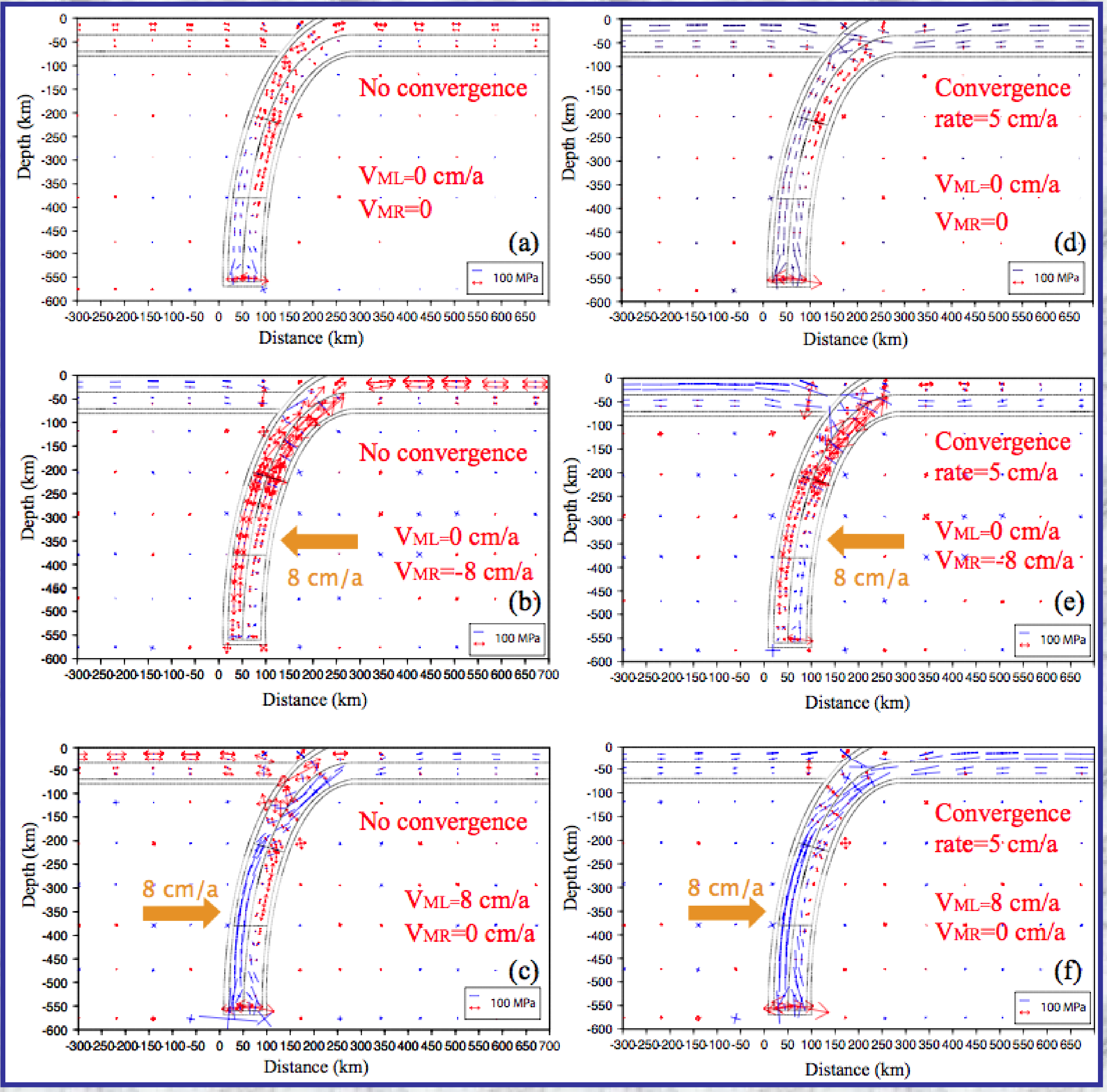


Layer	Young modulus (Pa)	Viscosity (Pa ˙ s)	PoissonÕsratio
Crust	$6x10^{10}$	$1x10^{24}$	0,25
Lithospheric mantle	$1.75x10^{11}$	$5x10^{22}$	0.27
Low viscosity layer	$1.27x10^{11}$	$5x10^{17}$	0.27
Upper mantle	$1.75x10^{11}$	$1x10^{21}$	0.27
Lower mantle	$1.27x10^{11}$	$1x10^{22}$	0.27

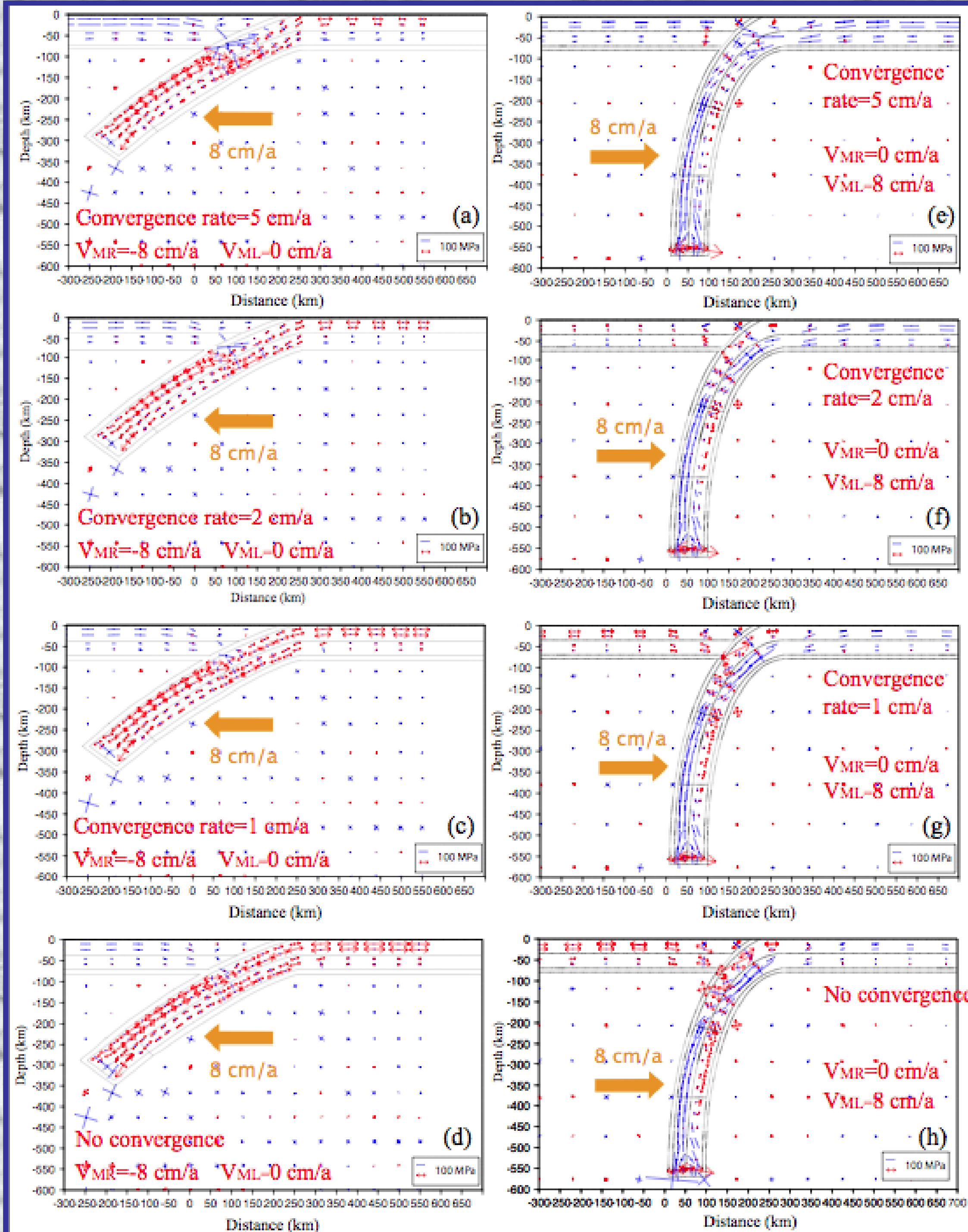
Modeling results



Modeling results



Modeling results



Conclusions

1) **Absolute plate kinematics strongly controls the state of stress in subducting slabs**; down-dip compression is enhanced by mantle flow opposing the dip of the slab, whereas overall down-dip tension is favored by mantle flow in the same direction of the slab dip.

2) Convergence between upper and lower plates controls the state of stress in the upper plate (in particular compression is enhanced by active convergence) while it does minimally affect the stress in the slab.

3) In cases of no (or slow) convergence, tension in the upper plate is enhanced by mantle flow opposing the dip of the slab, whereas compression is favored by mantle flow in the same direction of the slab dip.