



## Vorlesung

# *The D<sup>4</sup> - Likely Source Region of Mantle Plumes*

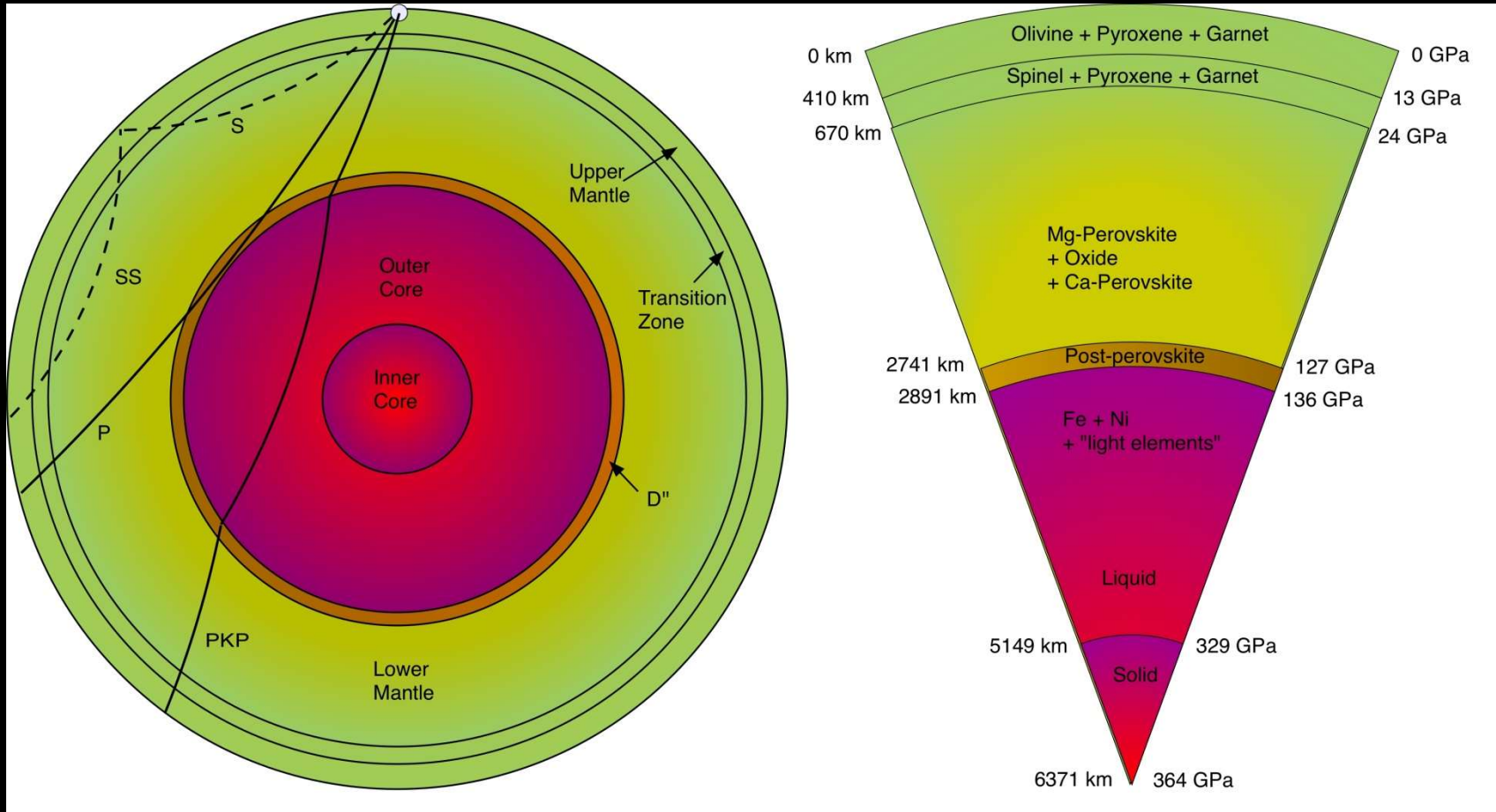
**F.E. Brenker**

Institut für Geowissenschaften  
FE Mineralogie  
JWG-Universität Frankfurt

# Aufbau des Erdmantels

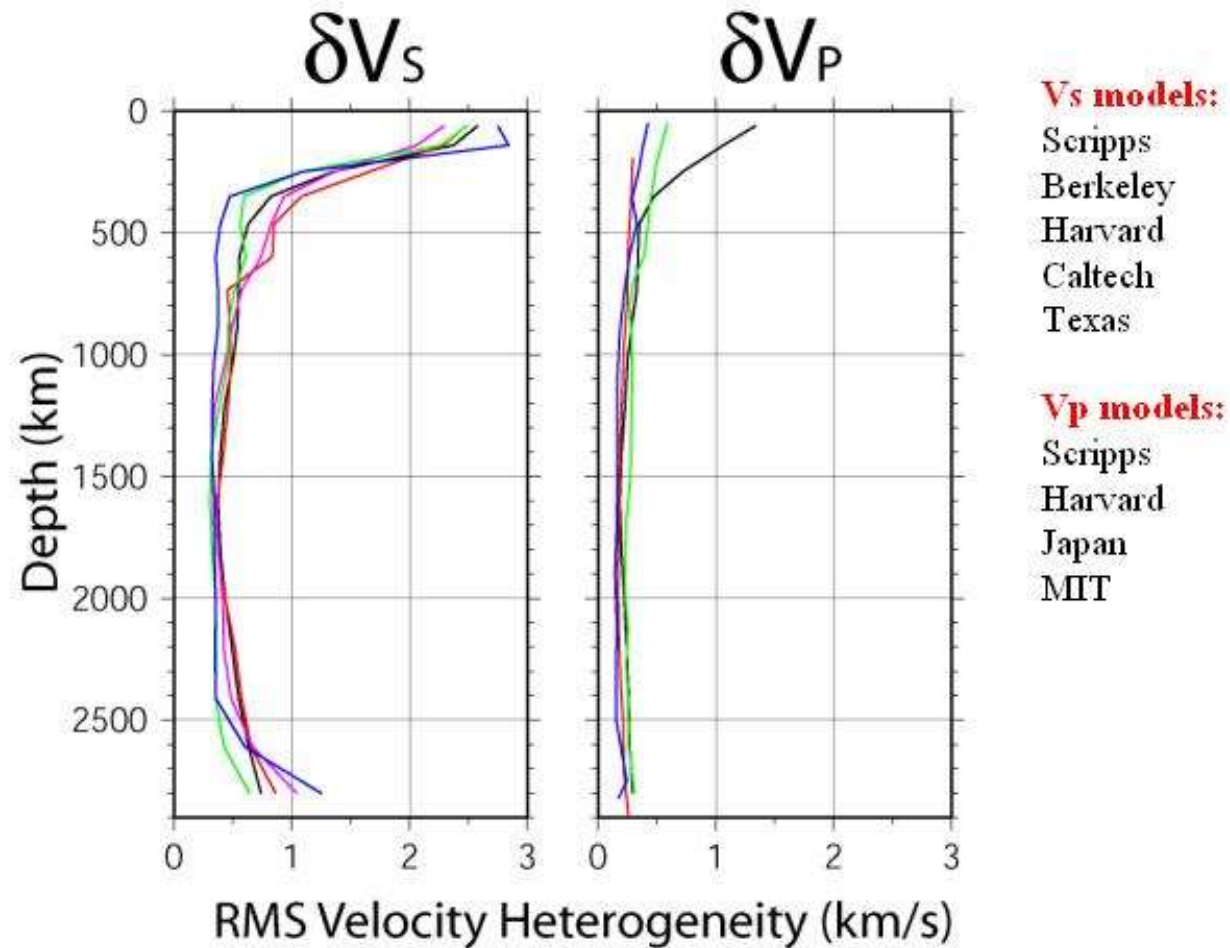
## D''

# D" Weitere Grenzschicht im Unteren Erdmantel

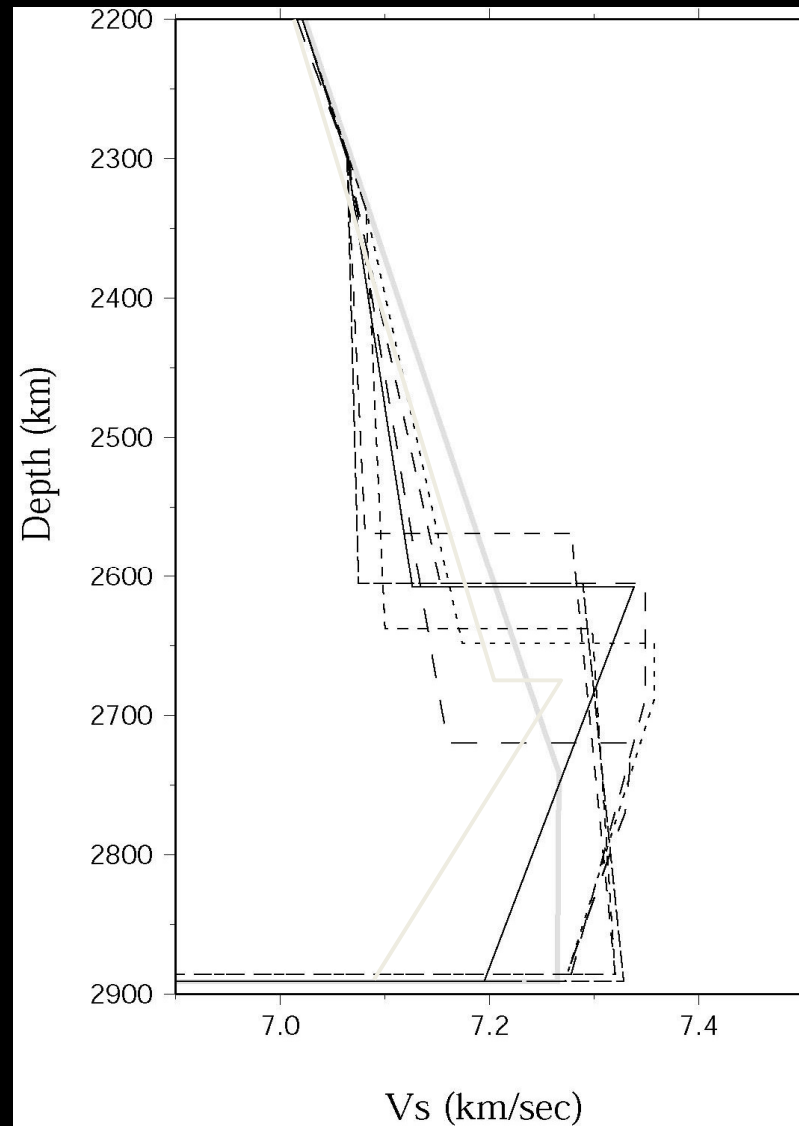


Laufzeitenentwicklung  
zur CMB?

# D“ Heterogene Grenzschicht im Unteren Erdmantel



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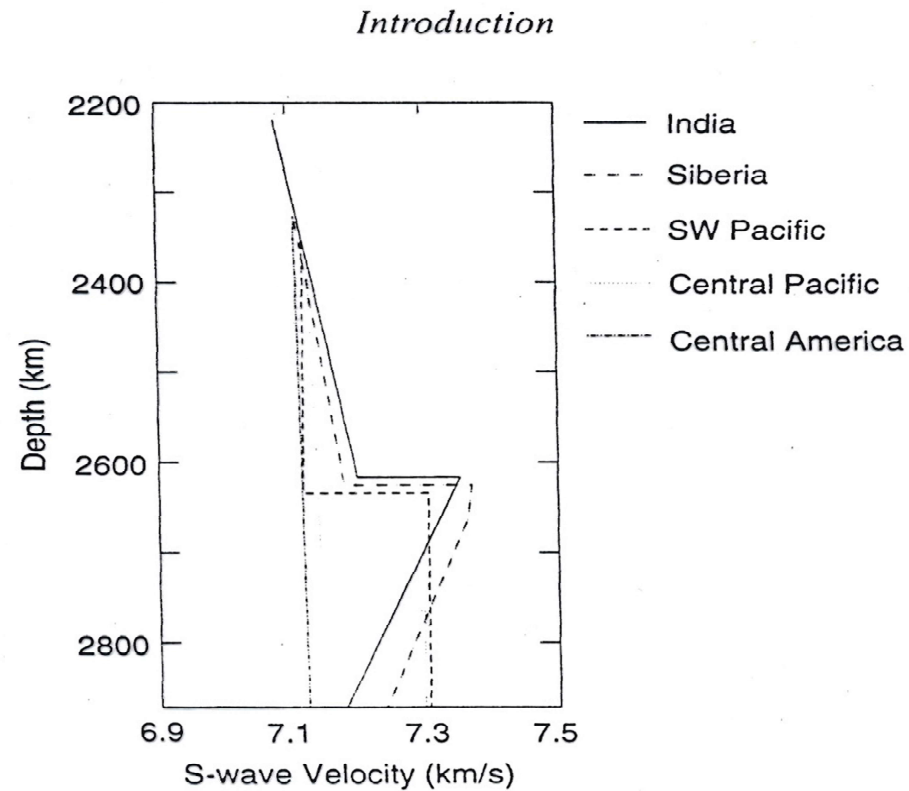
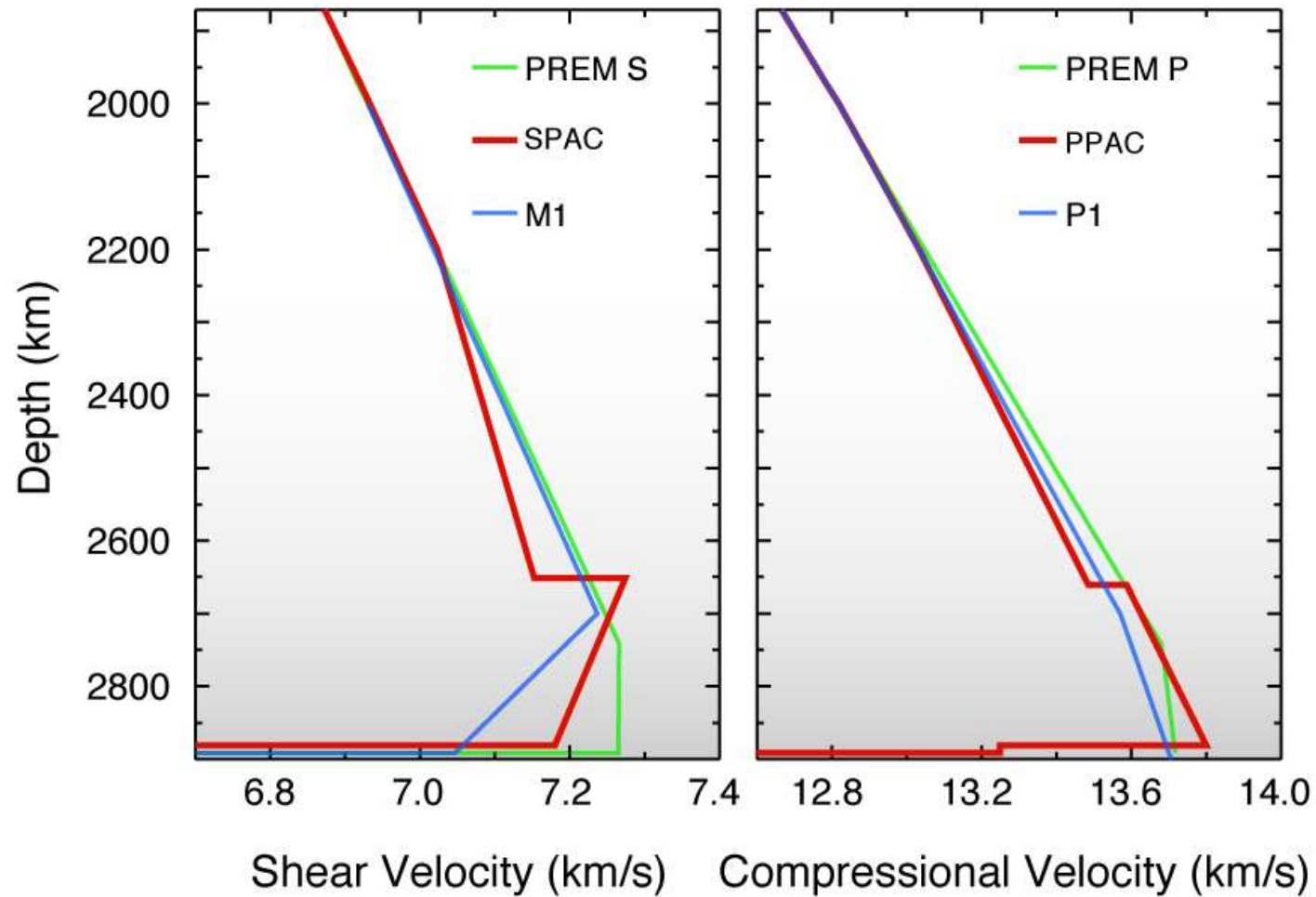


Figure 1.5. S-wave velocity distributions in the D'' layer indicate significant lateral heterogeneity. Data from Knittle and Jeanloz (1991).

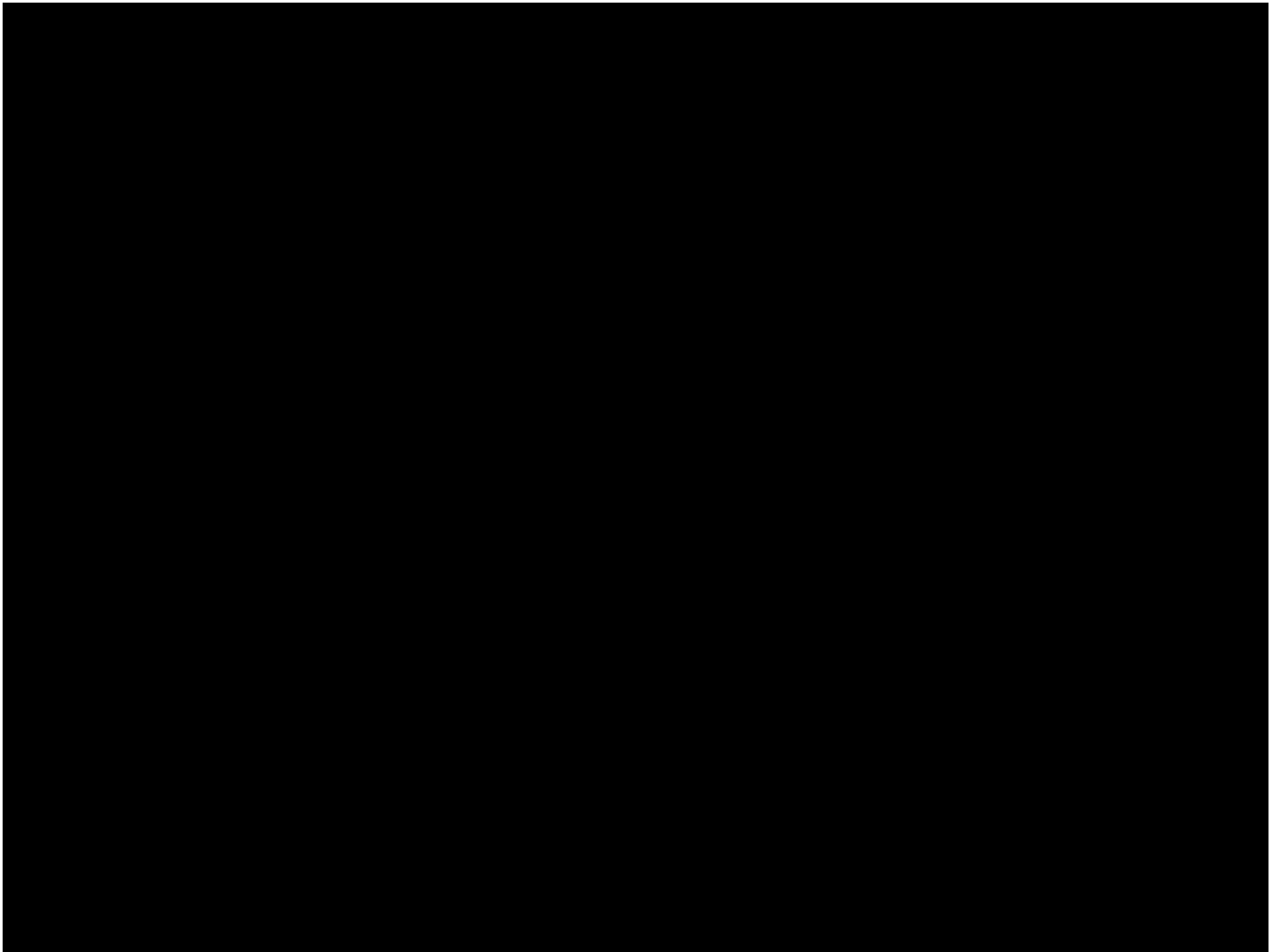




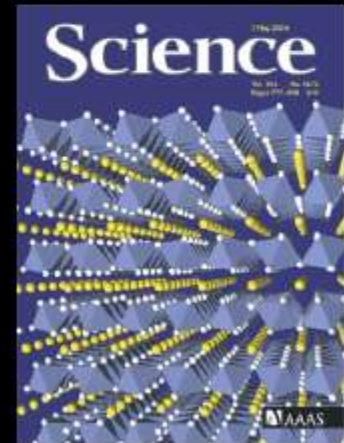
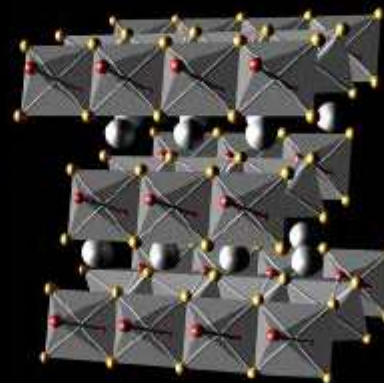
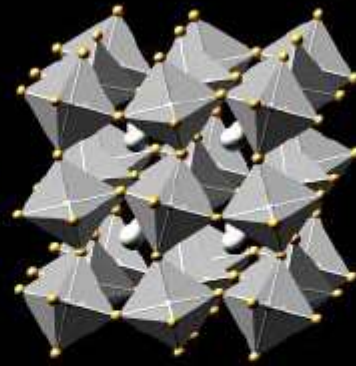
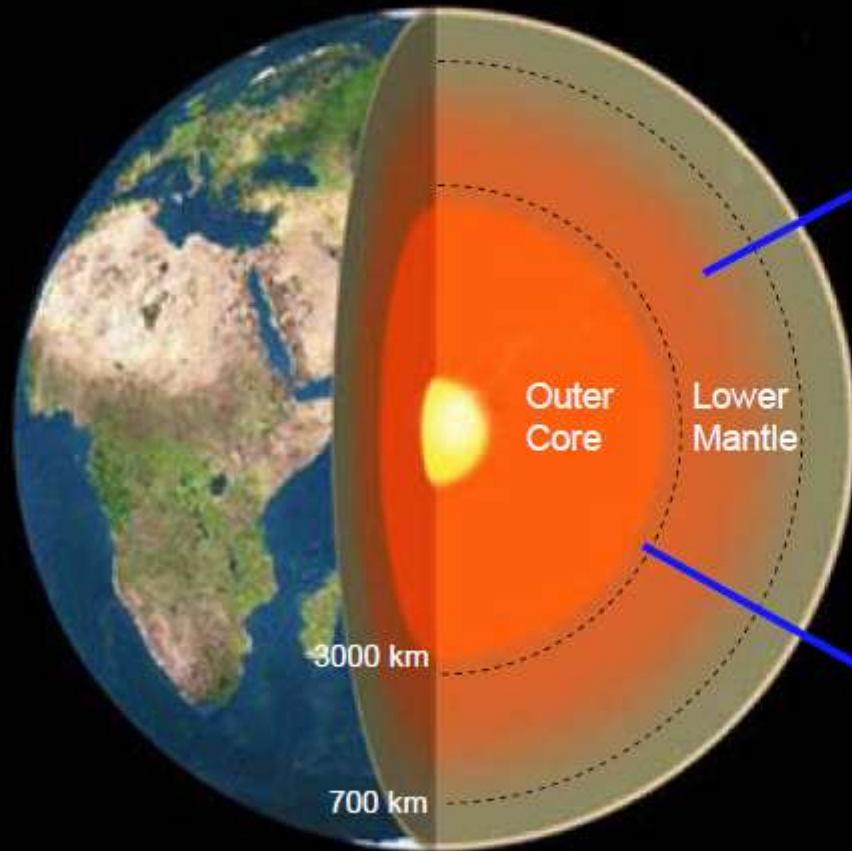
# Lower Mantle Velocity Models



Mögliche Ursachen für  
die  $D''$  ?

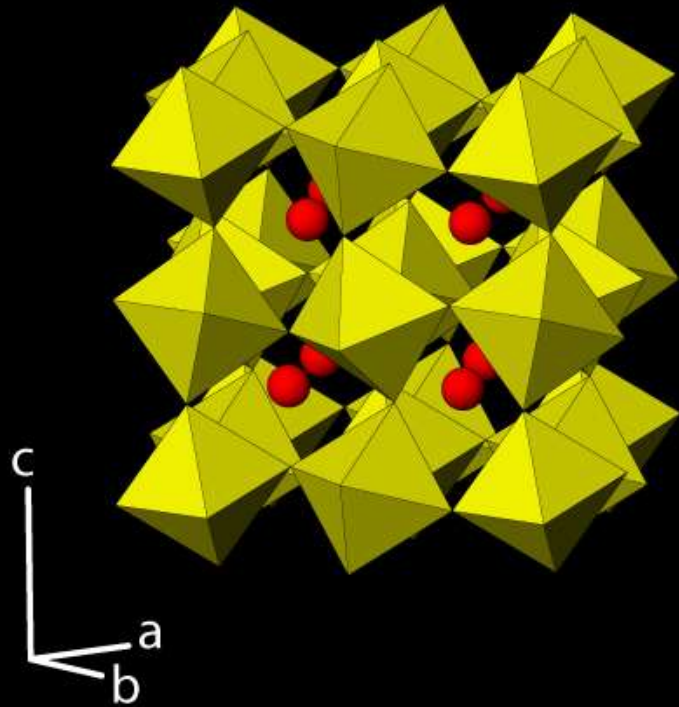


# The Post-Perovskite Transition

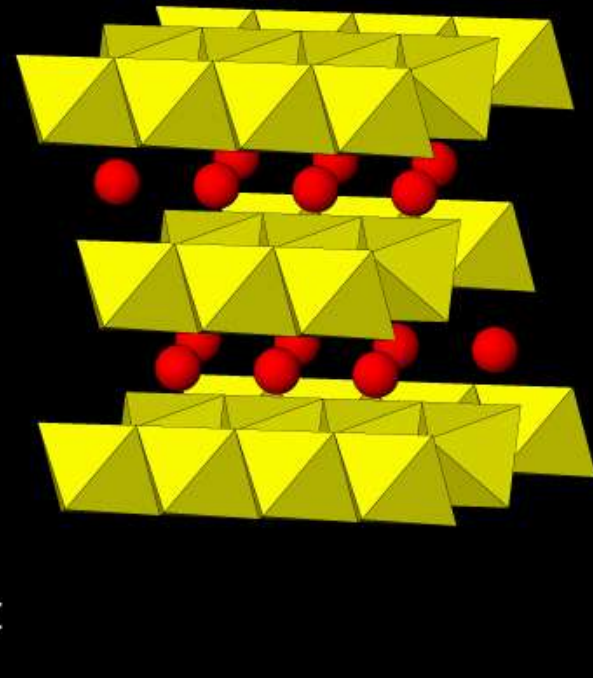


Murakami et al. (2004) *Science*  
Oganov and Ono (2004) *Nature*  
Shim et al. (2004) *GRL*

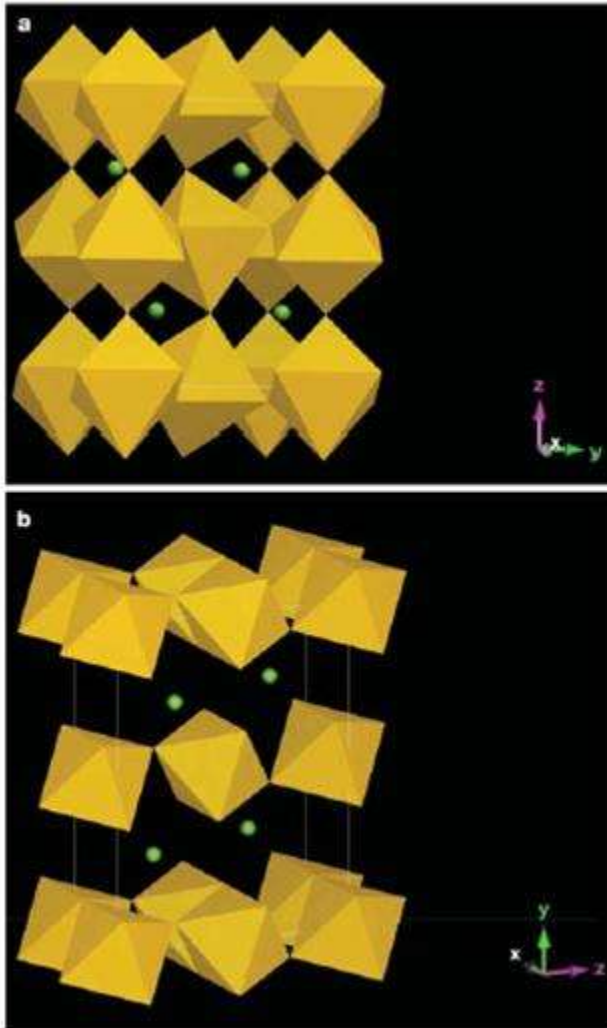
# Post-Perovskite Transition



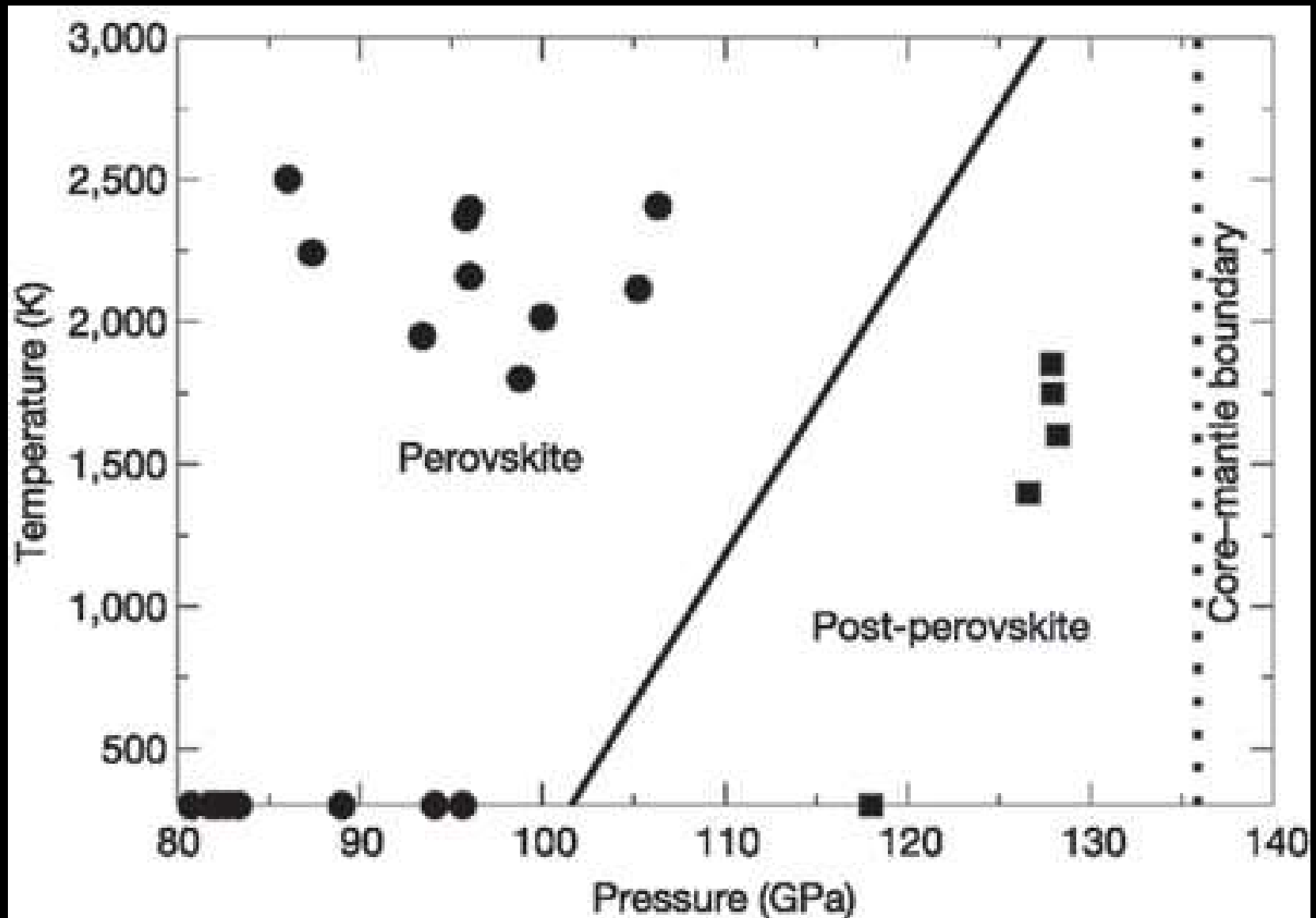
MgSiO<sub>3</sub> Perovskite  
(orthorhombic, *Pbnm*)



MgSiO<sub>3</sub> Post-Perovskite  
(orthorhombic, *Cmcm*)

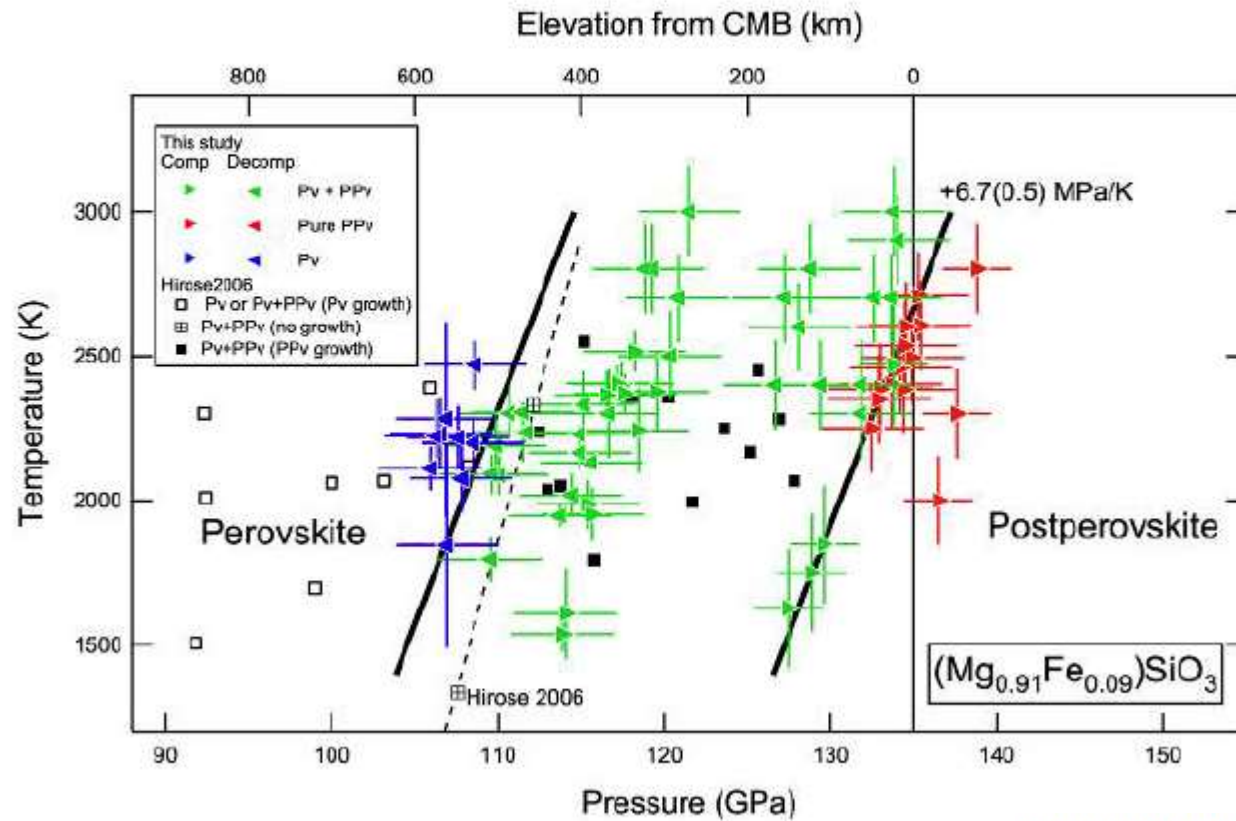


**Figure 1** The unit cell structures of MgSiO<sub>3</sub>: **a**, Perovskite; **b**, post-perovskite. The spheres represent Mg, and the octahedra represent Si with sixfold oxygen coordination.



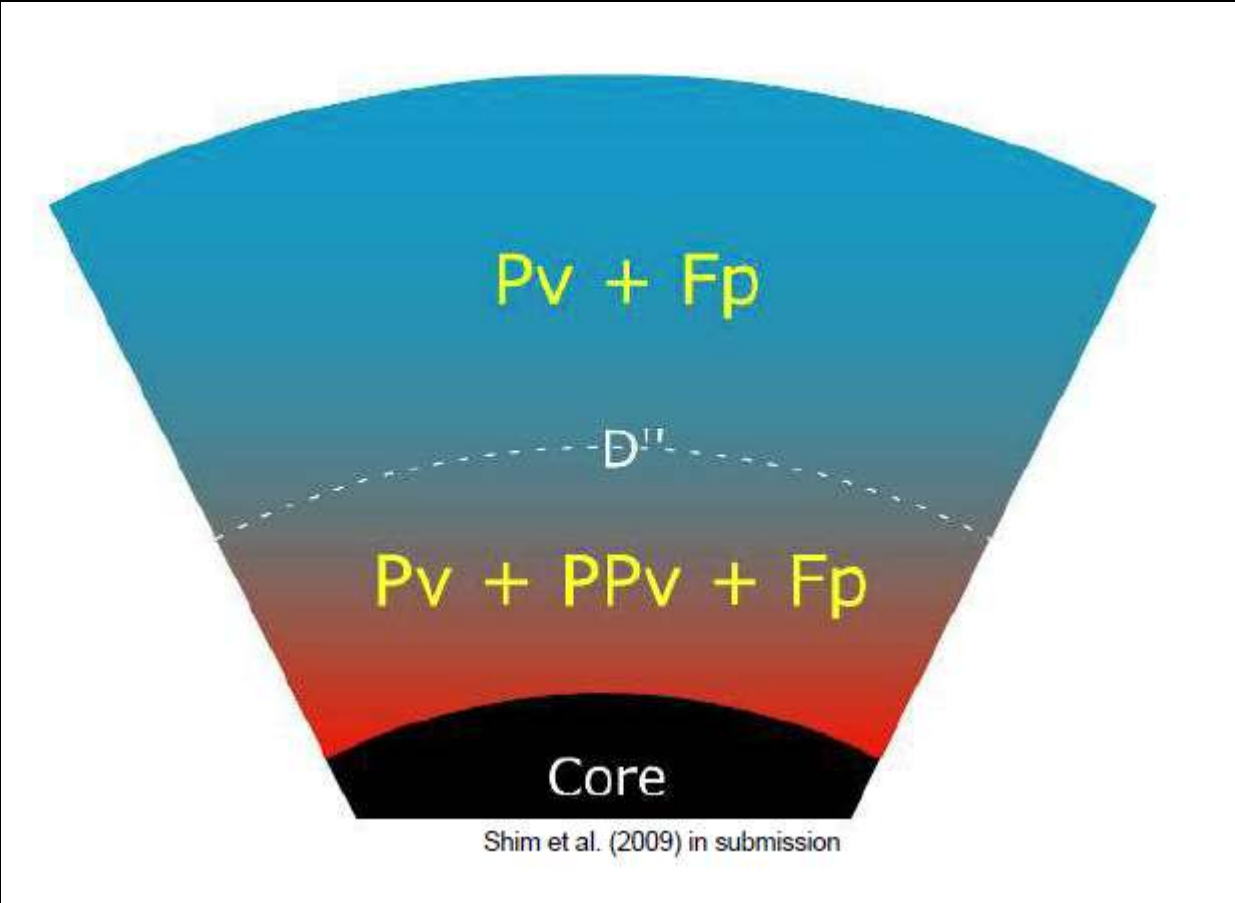
Oganov and Ono, 2004

# The Post-Perovskite Transition

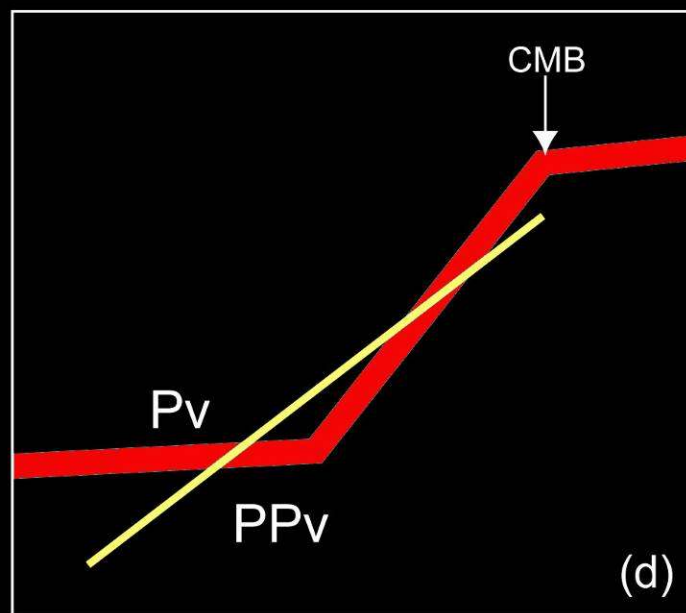
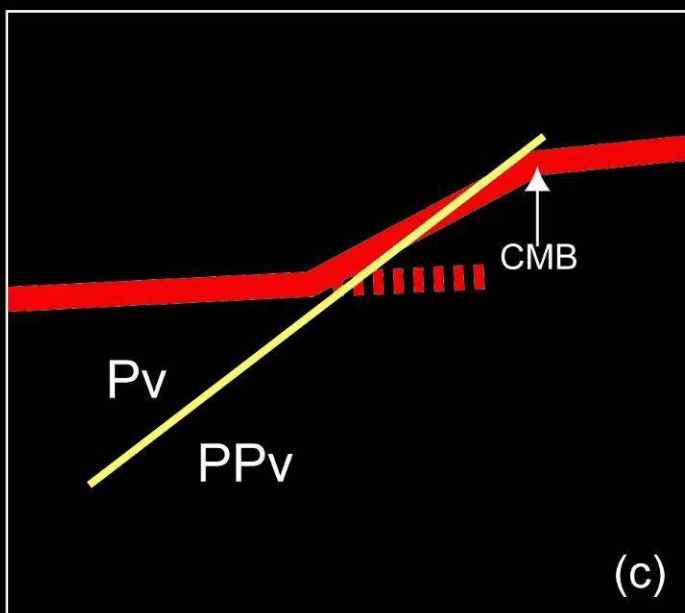
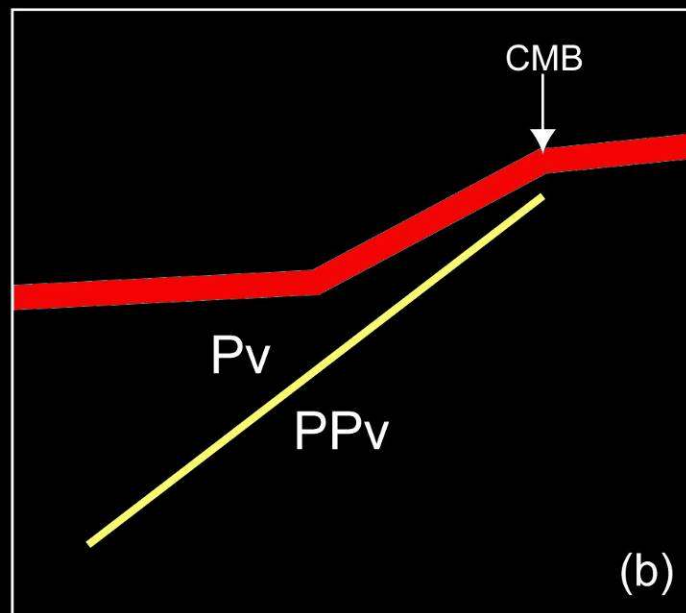
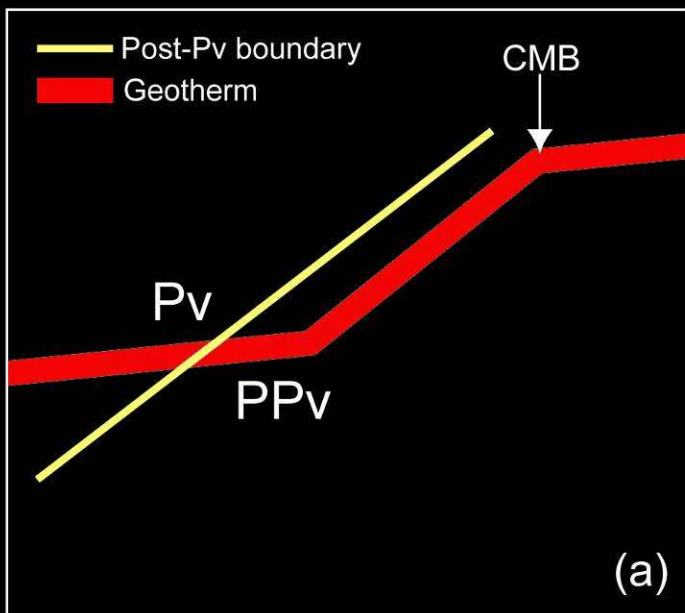


Shim et al. (2009) in submission





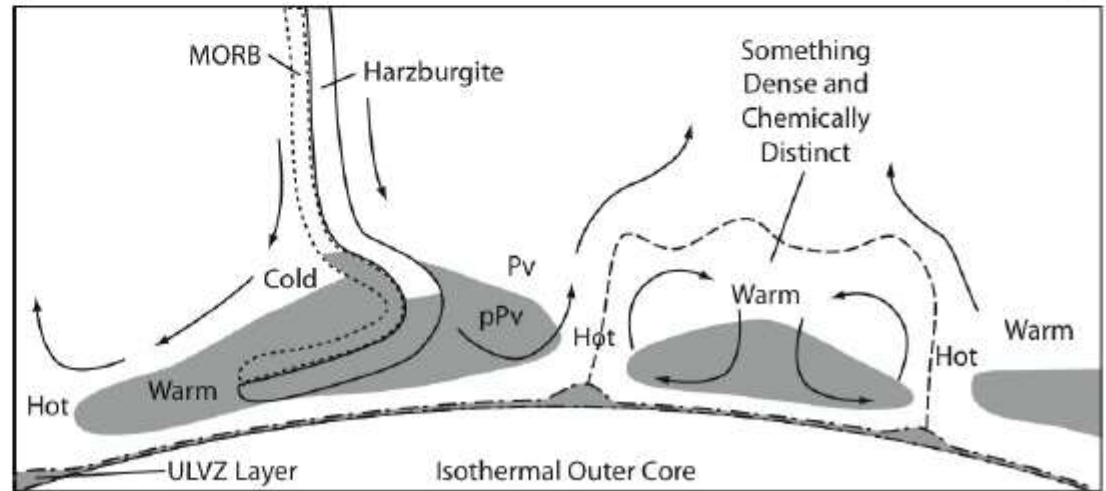
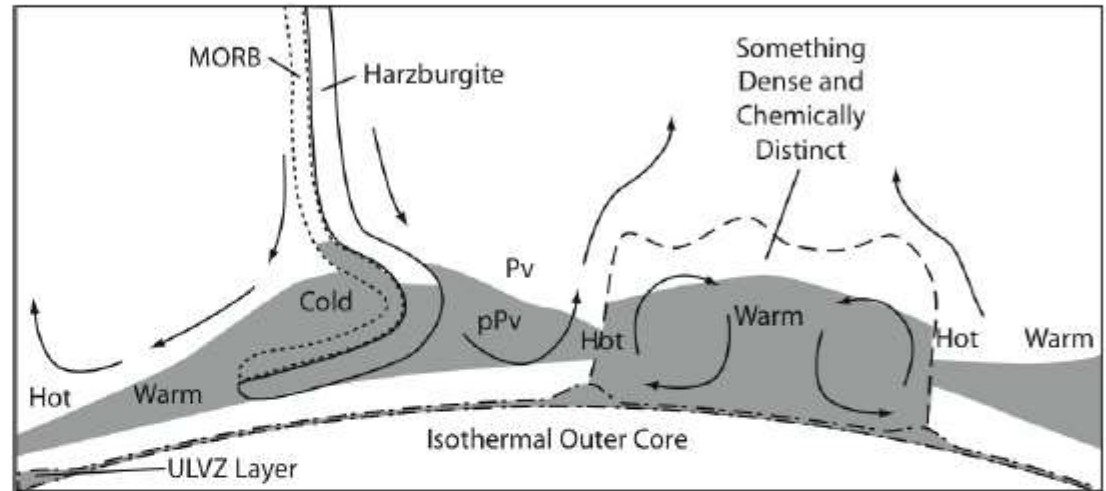
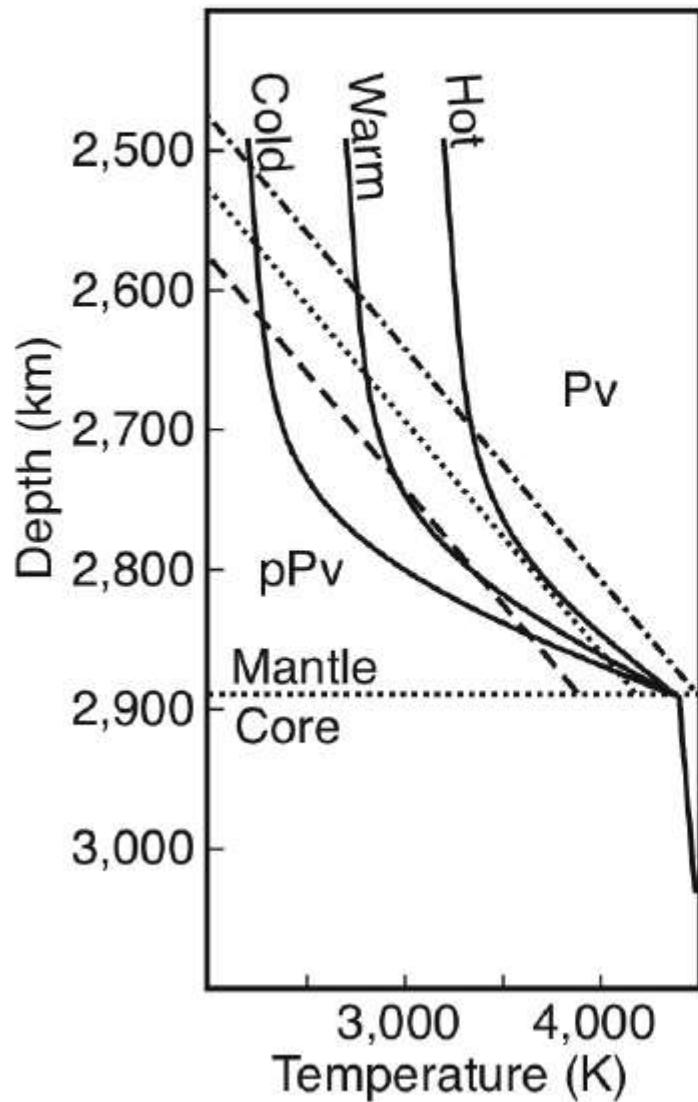
Temperature



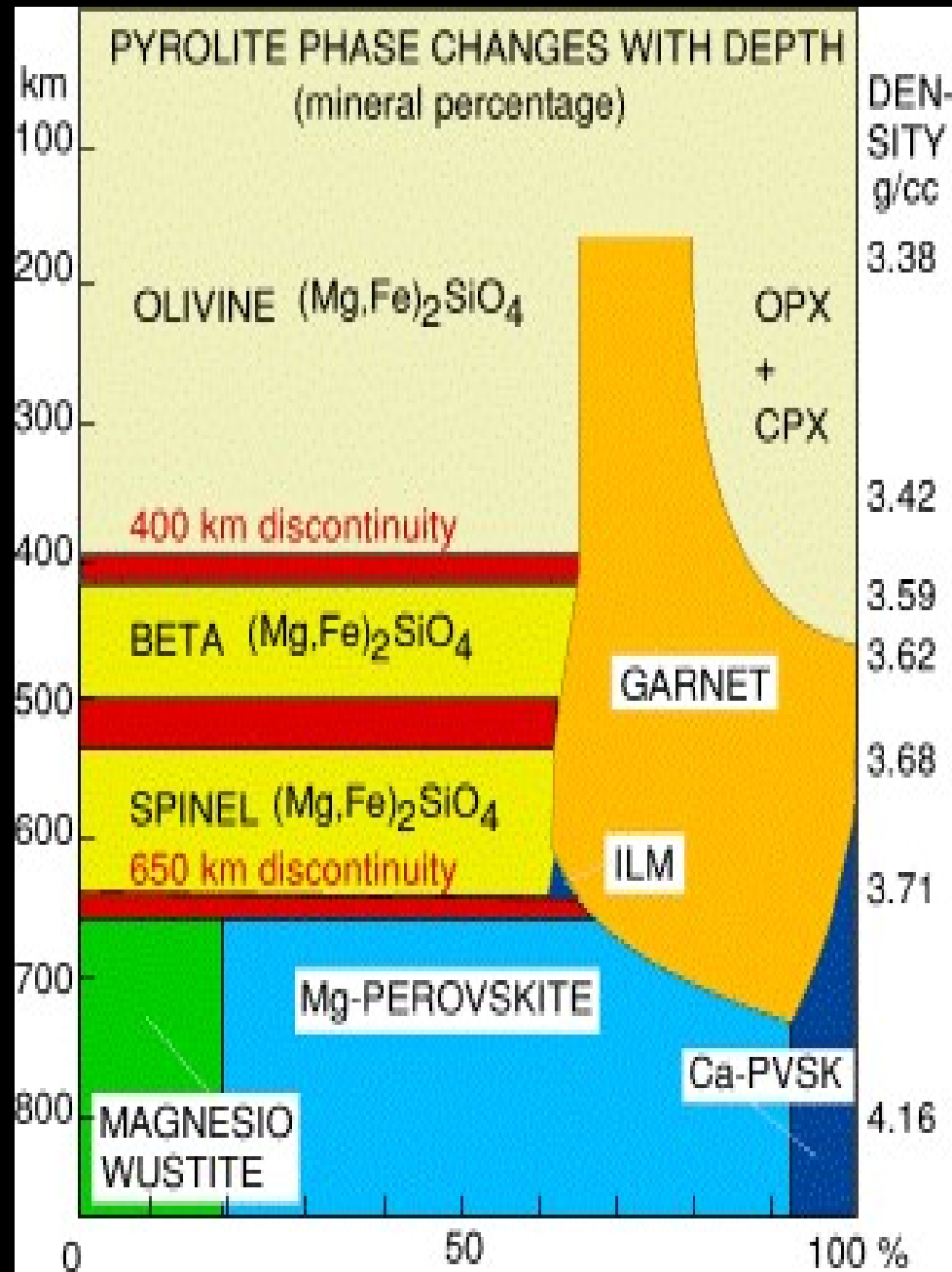
Depth

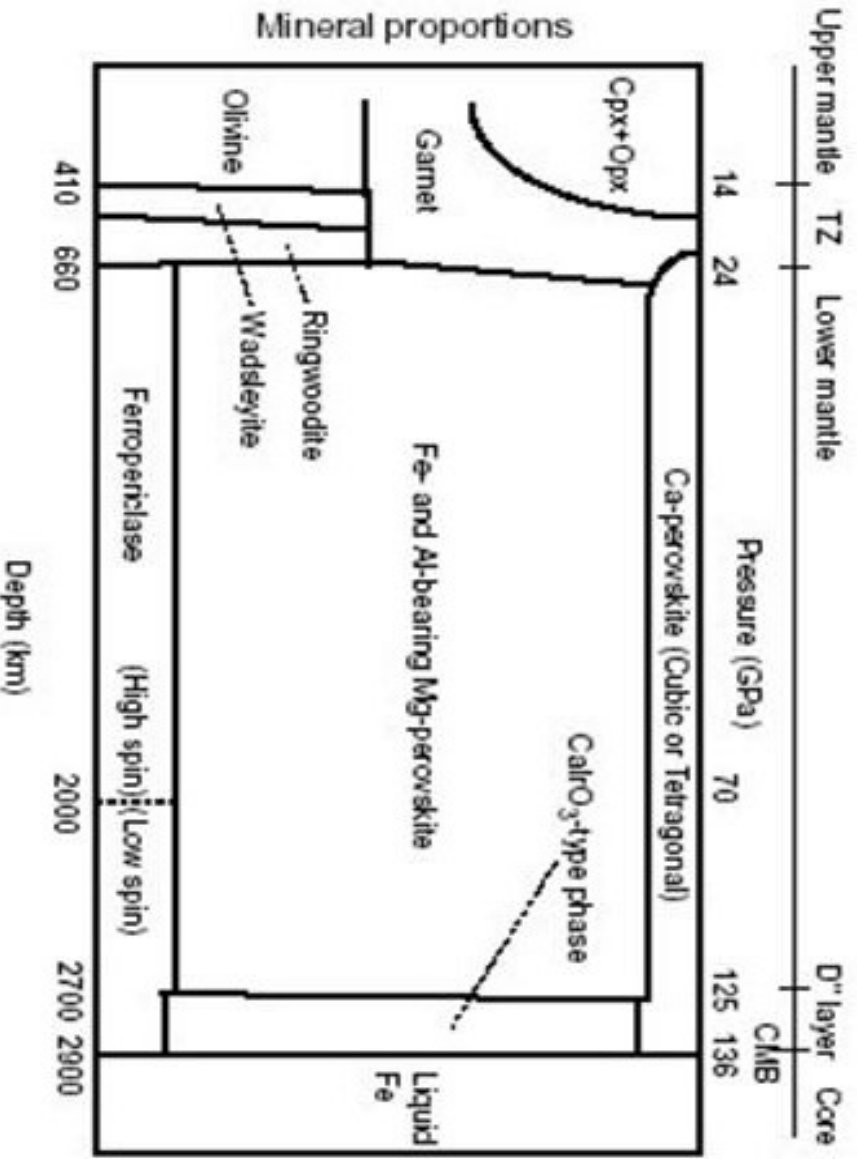


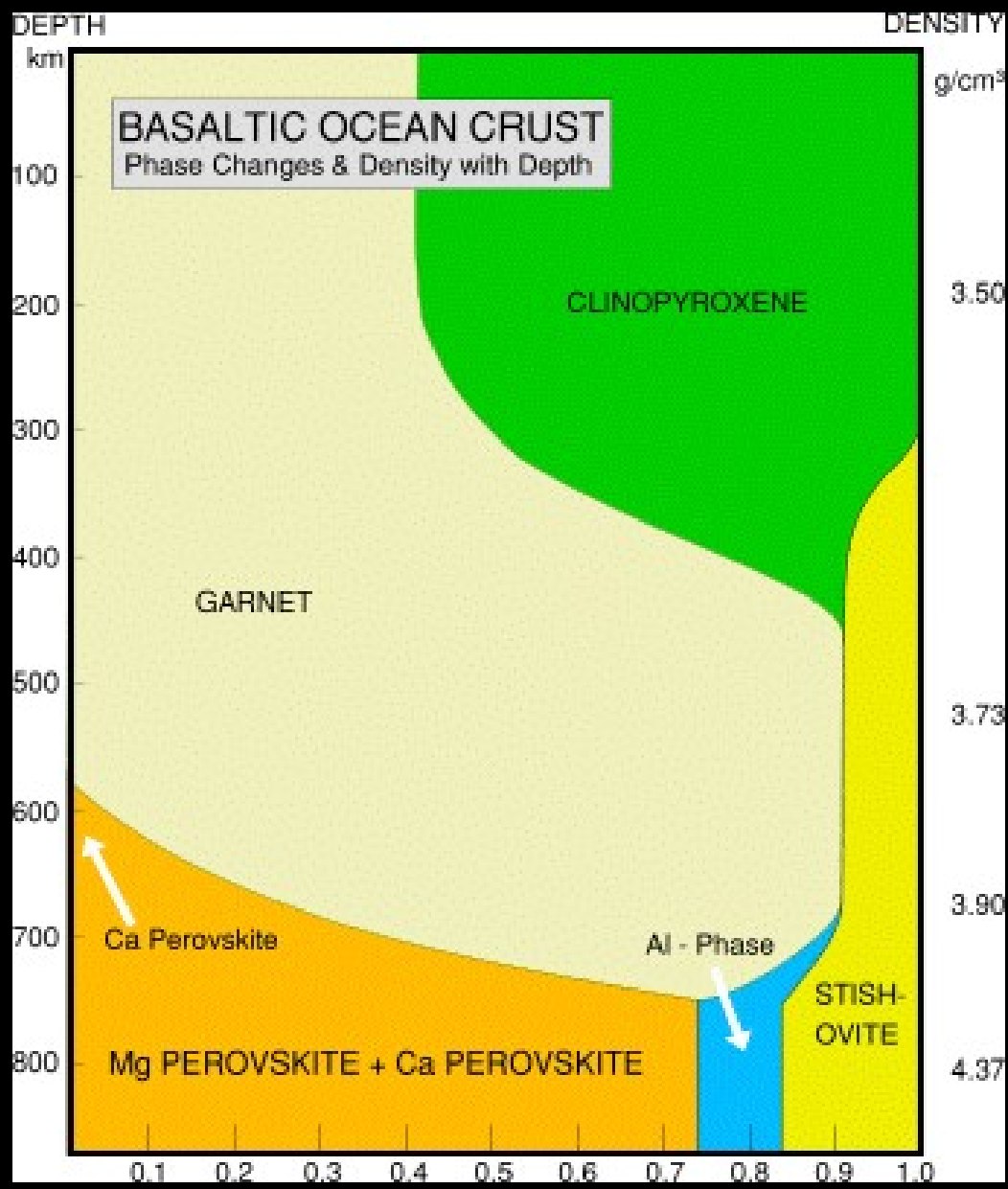
# Possible structures above CMB



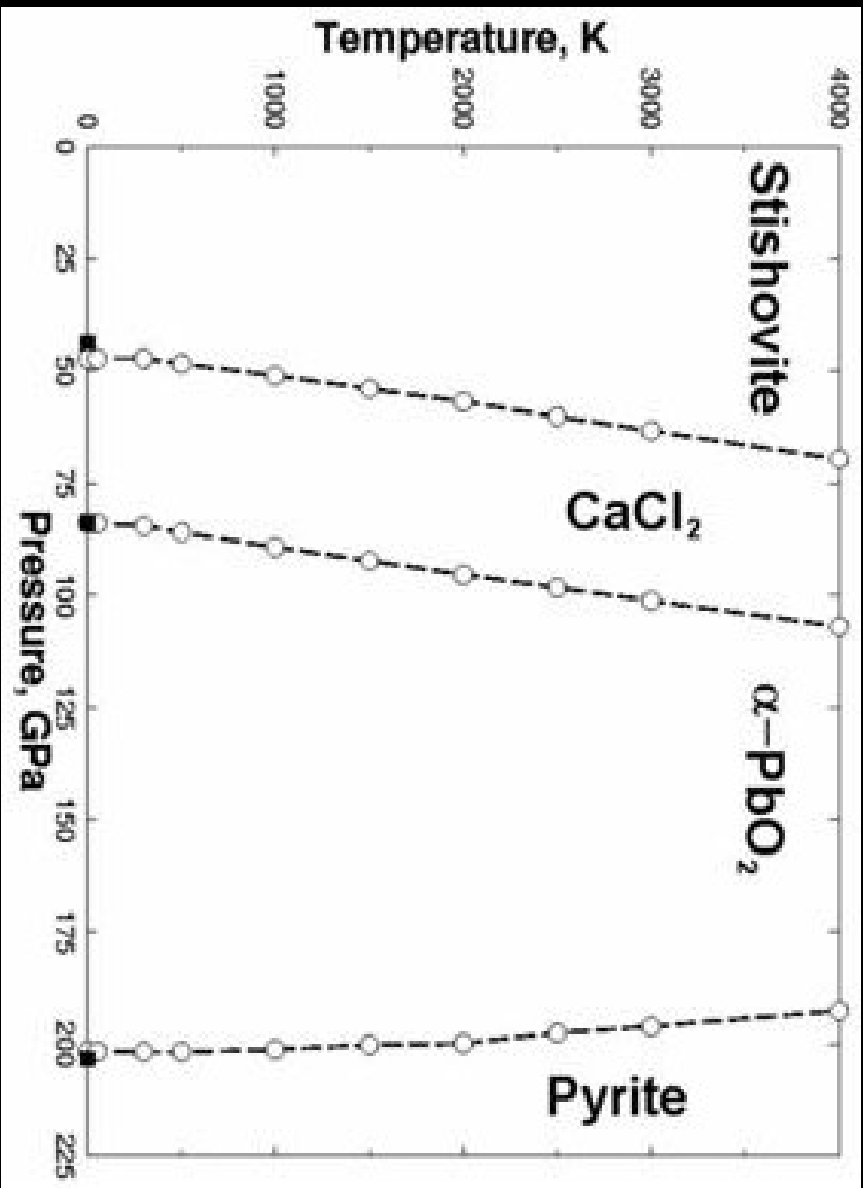
# Aufbau des Erdmantels Details



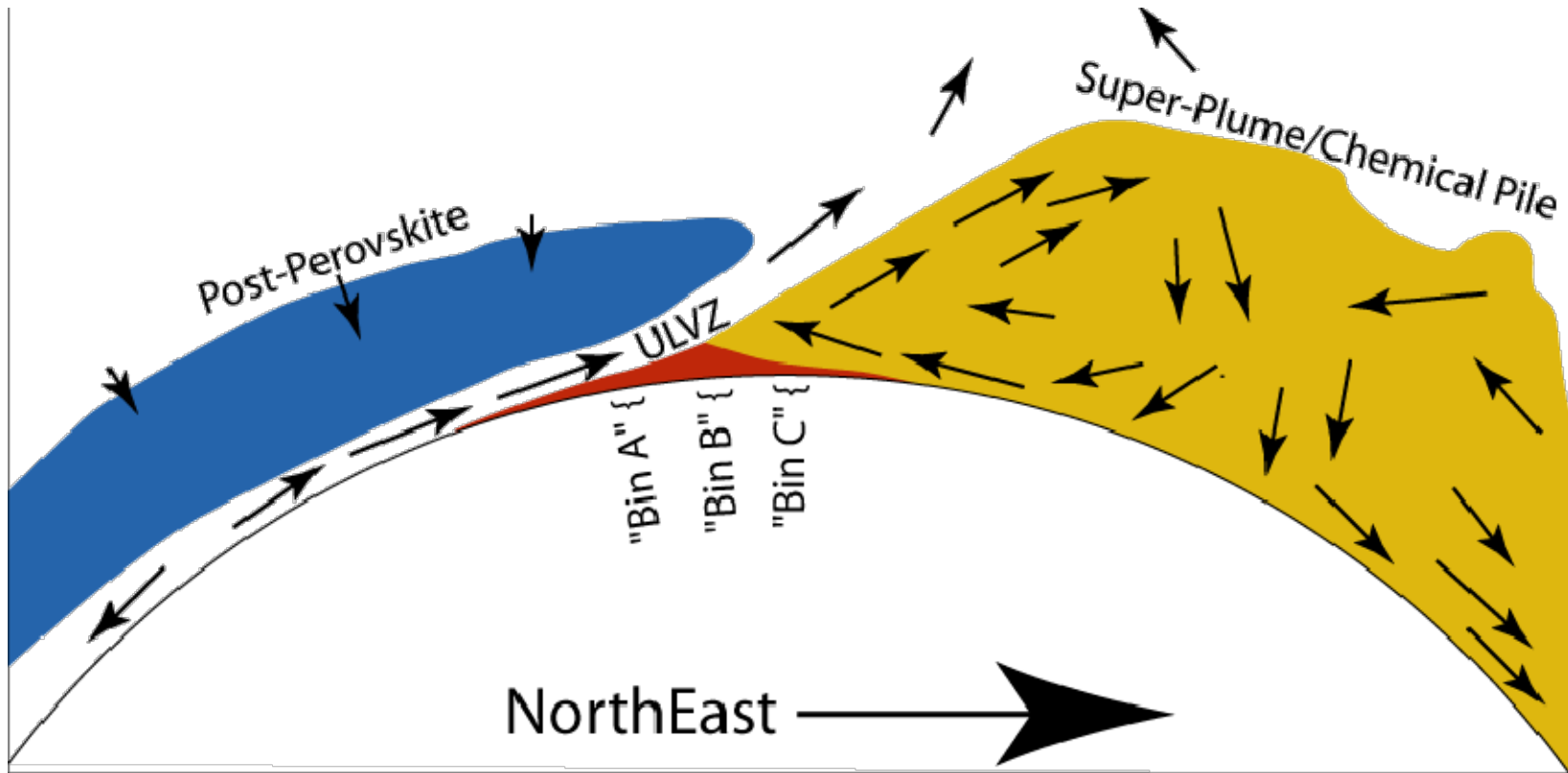








Aufbau des Erdmantels  
LL(S)VP – Large Low Shear Velocity  
Province



# A Typical Deep-Earth Cross Section

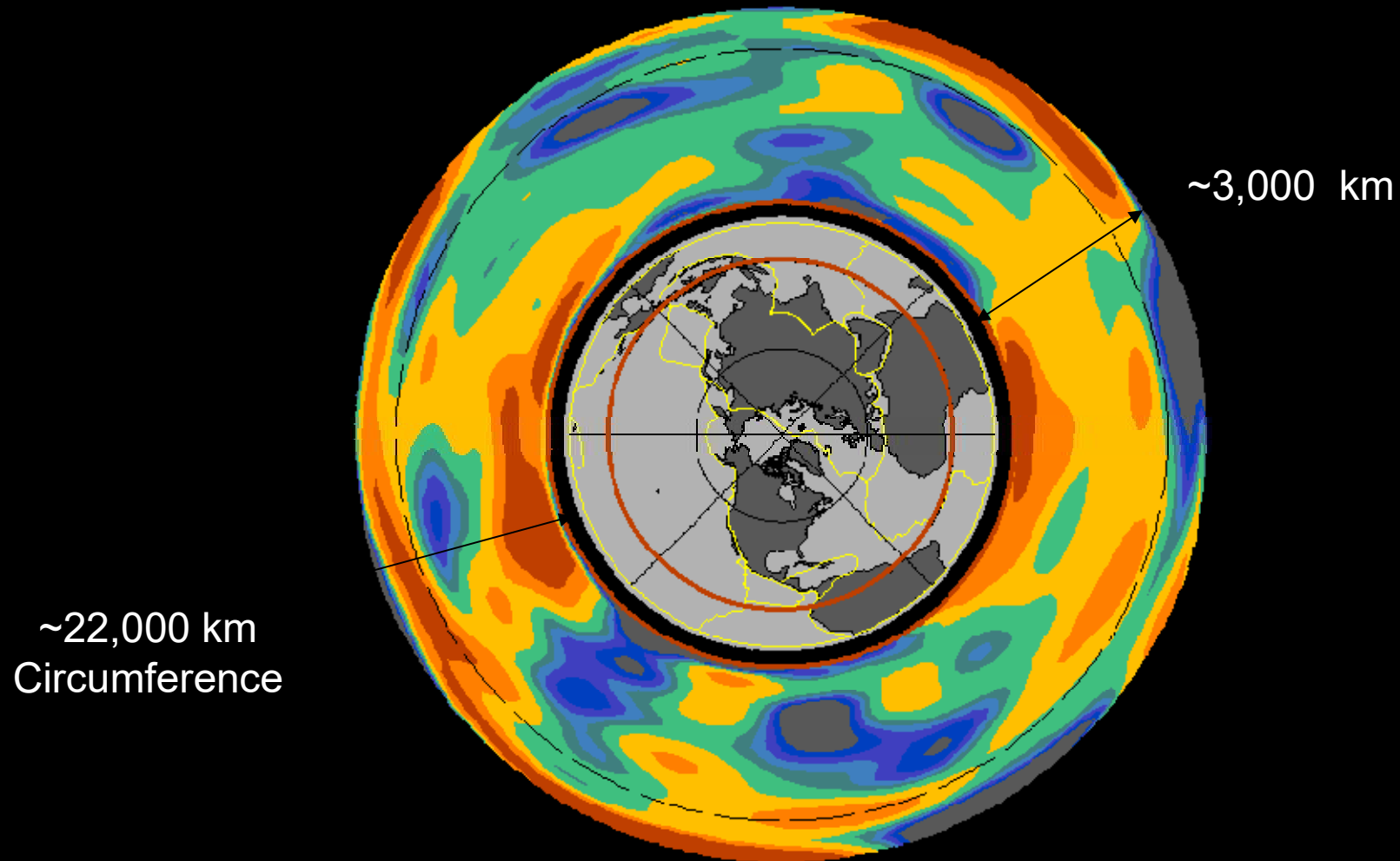
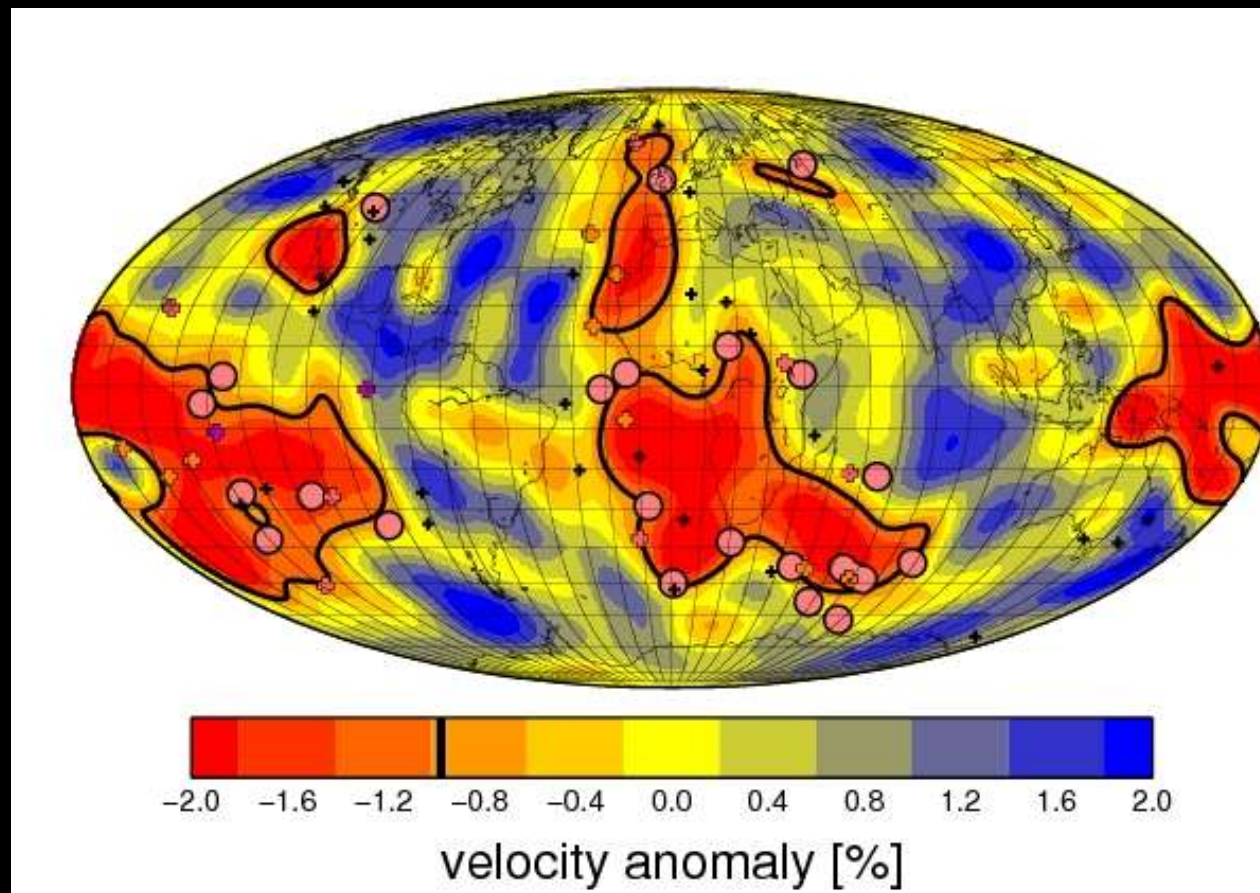


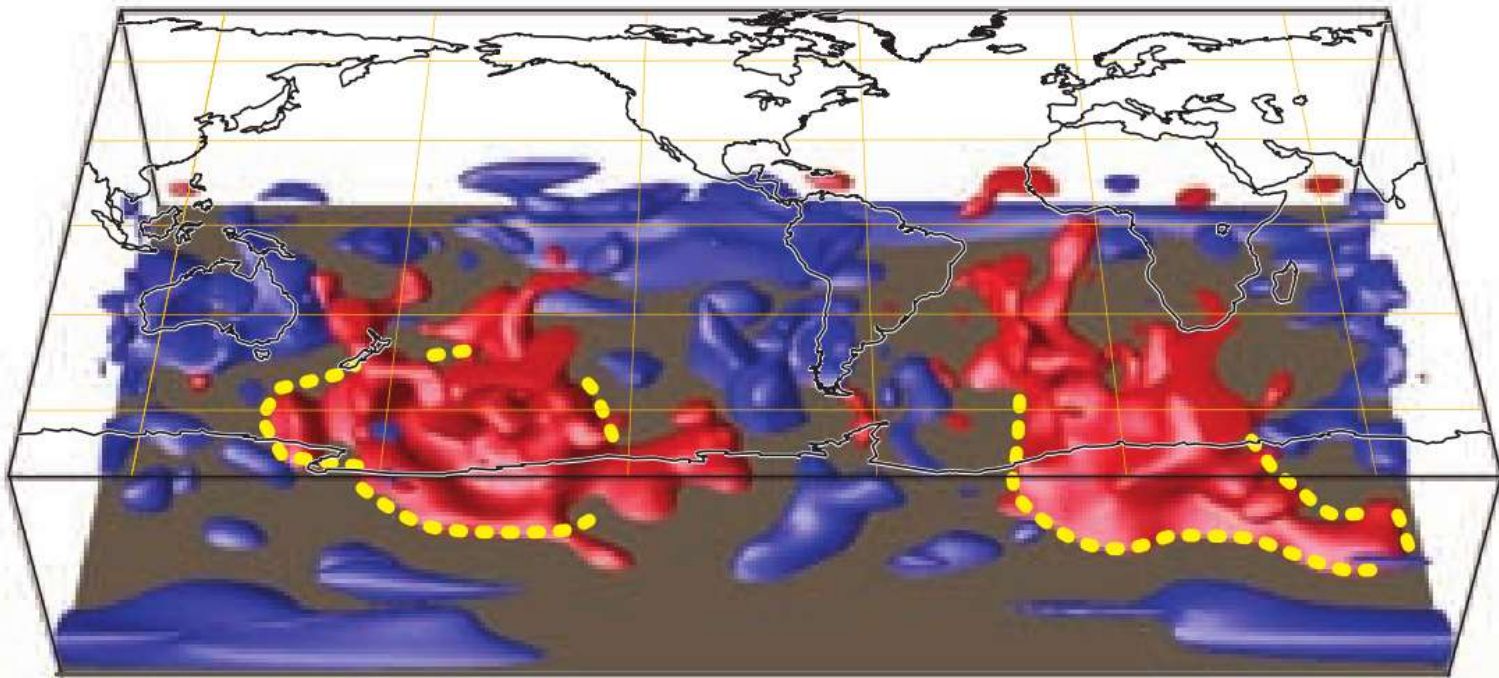
Image courtesy of Adam Dziewonski

*Large Low (Shear) Velocity Provinces* in the deep mantle are robust features of all recent tomography models



*Large Low (Shear) Velocity Provinces* in the deep mantle are robust features of all recent tomography models

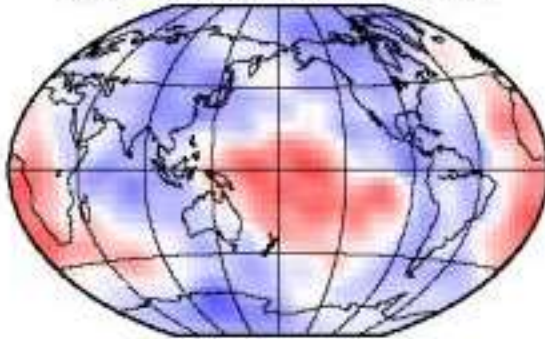
**A** Deep-mantle shear velocities



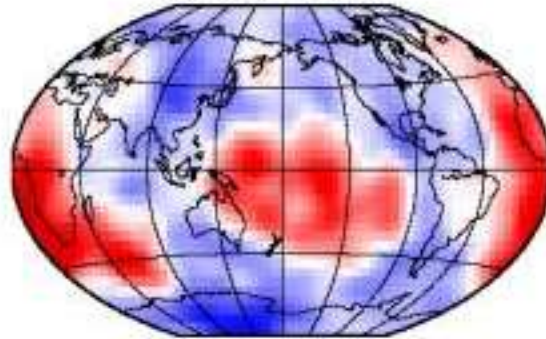
*Gennaro et al., Science 2008*

# Heterogenität im Unteren Erdmantel auf großen Längenskalen – weltweite Verteilung

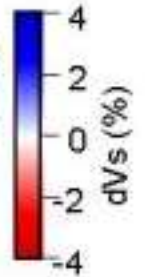
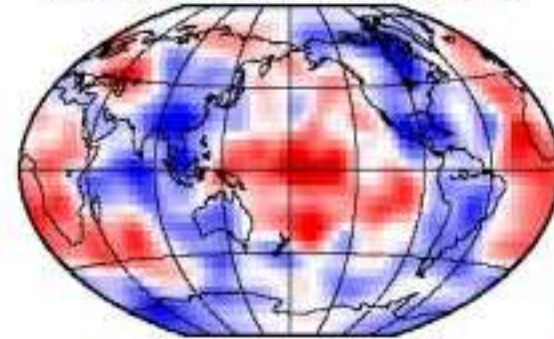
(a) dVs: Ritsema & Van Heijst



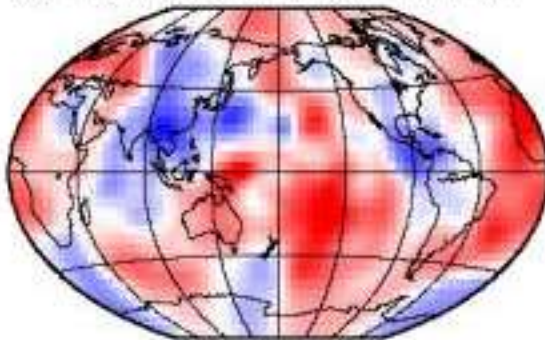
(b) dVs: Grand



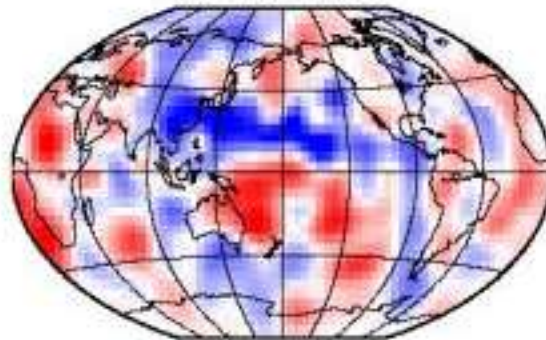
(c) dVs: Mengin & Romanowicz



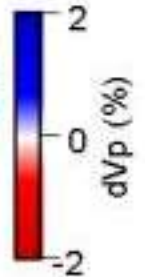
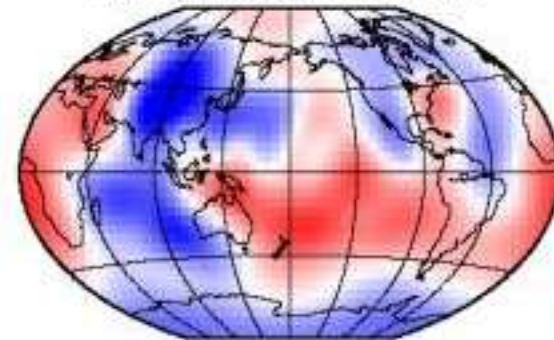
(d) dVp: Karason & van der Hilst



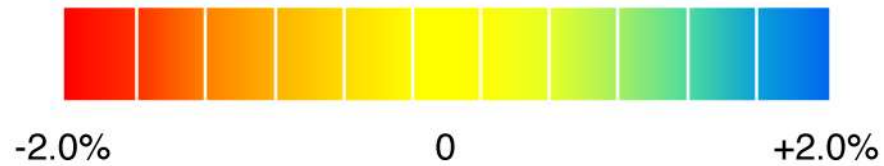
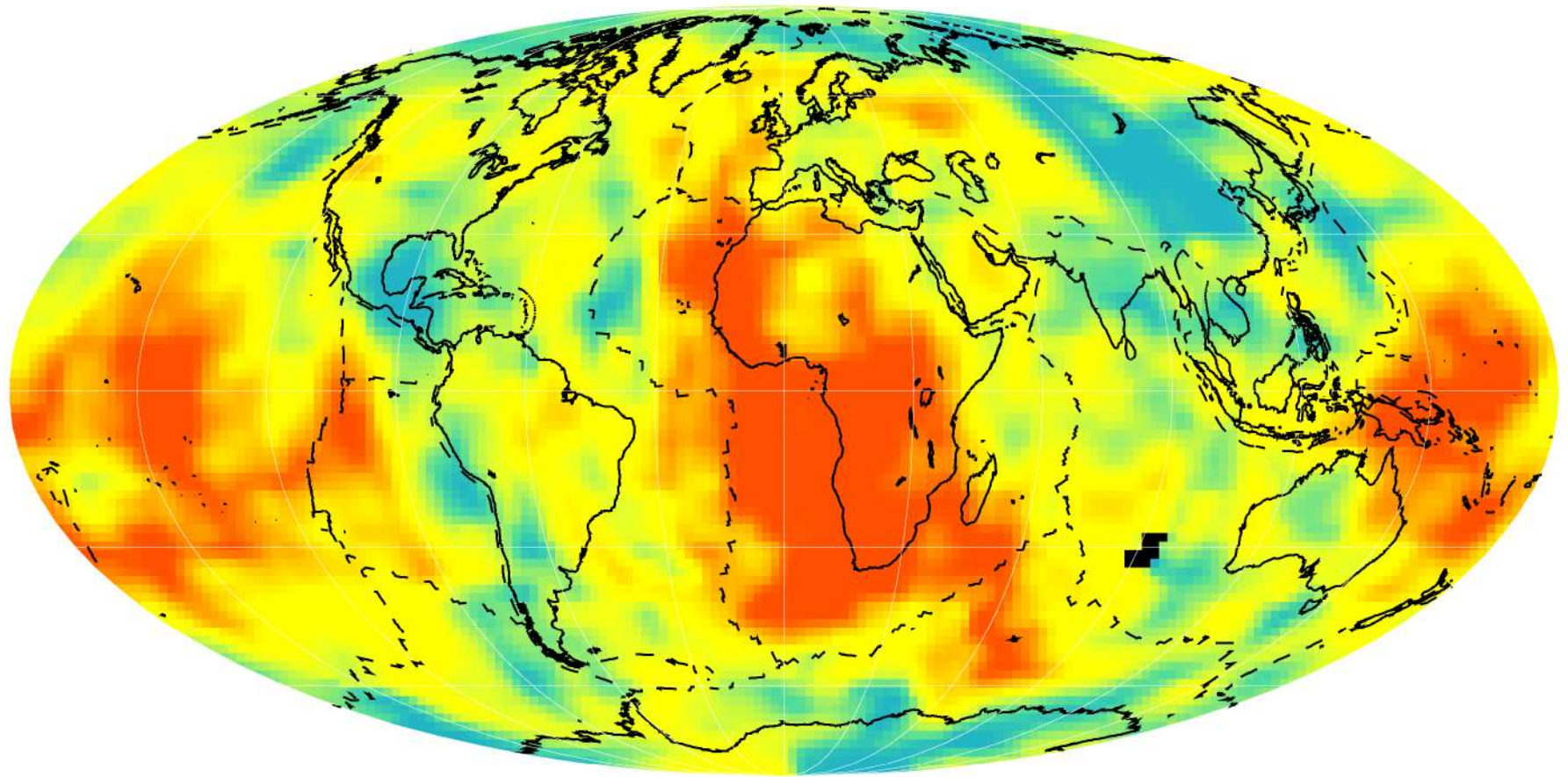
(e) dVp: Zhao



(f) dVp: Bolton & Masters

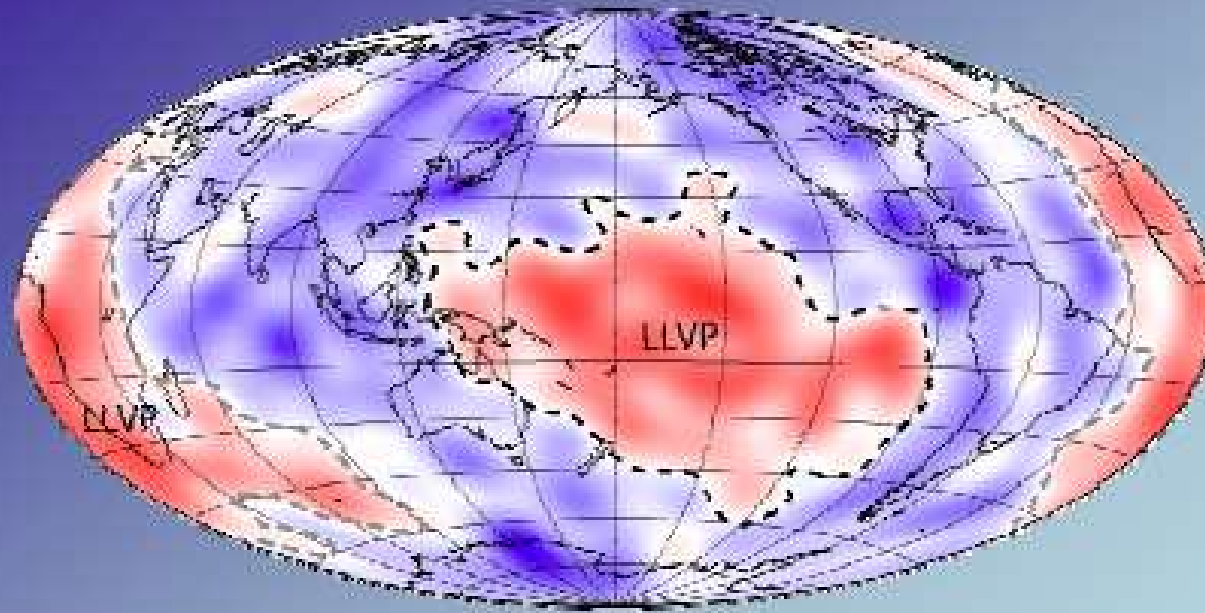


# Shear Velocity at the Base of the Mantle





## Long wavelength tomography view



2880 km

[Tomography; Ritsema and van Heijst, 2001]

UNIVERSITY OF LEEDS

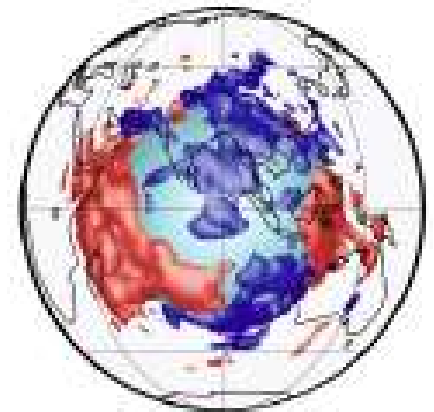
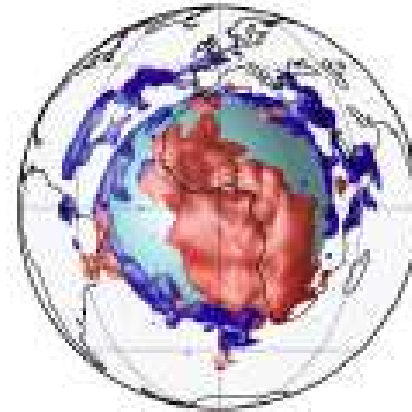
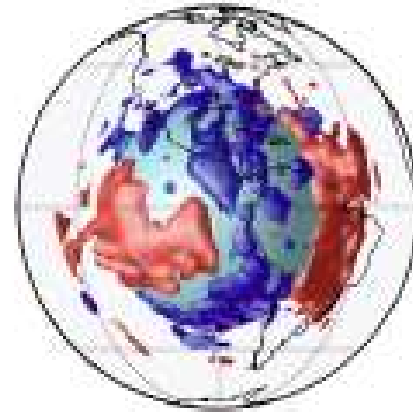
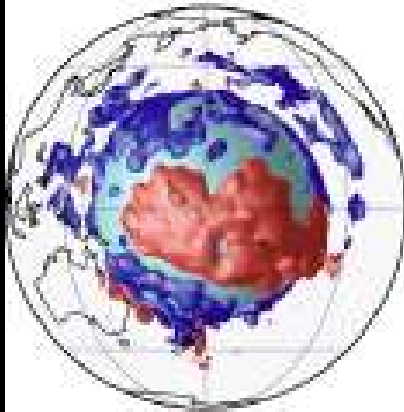
$|\delta V_S| > 0.7\% (1100-2891 \text{ km})$   
[Grand, 2002]

-180°

-90°

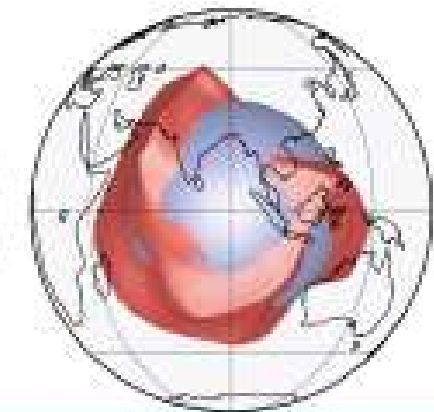
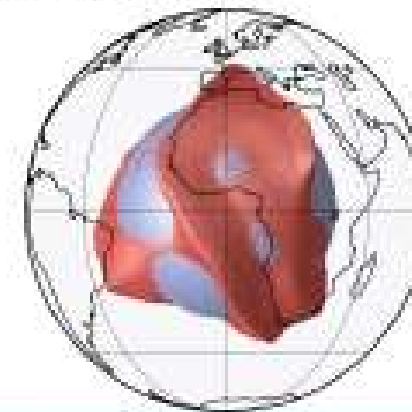
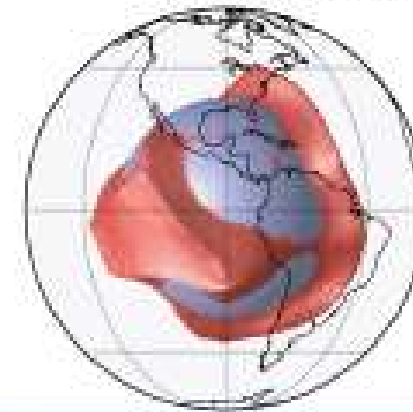
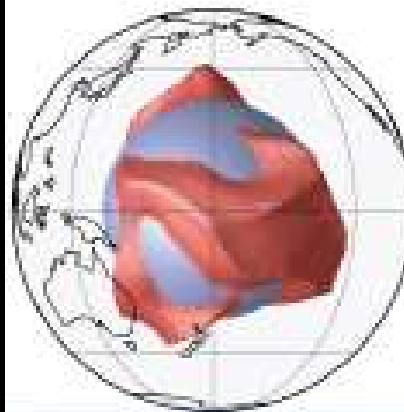
0°

90°

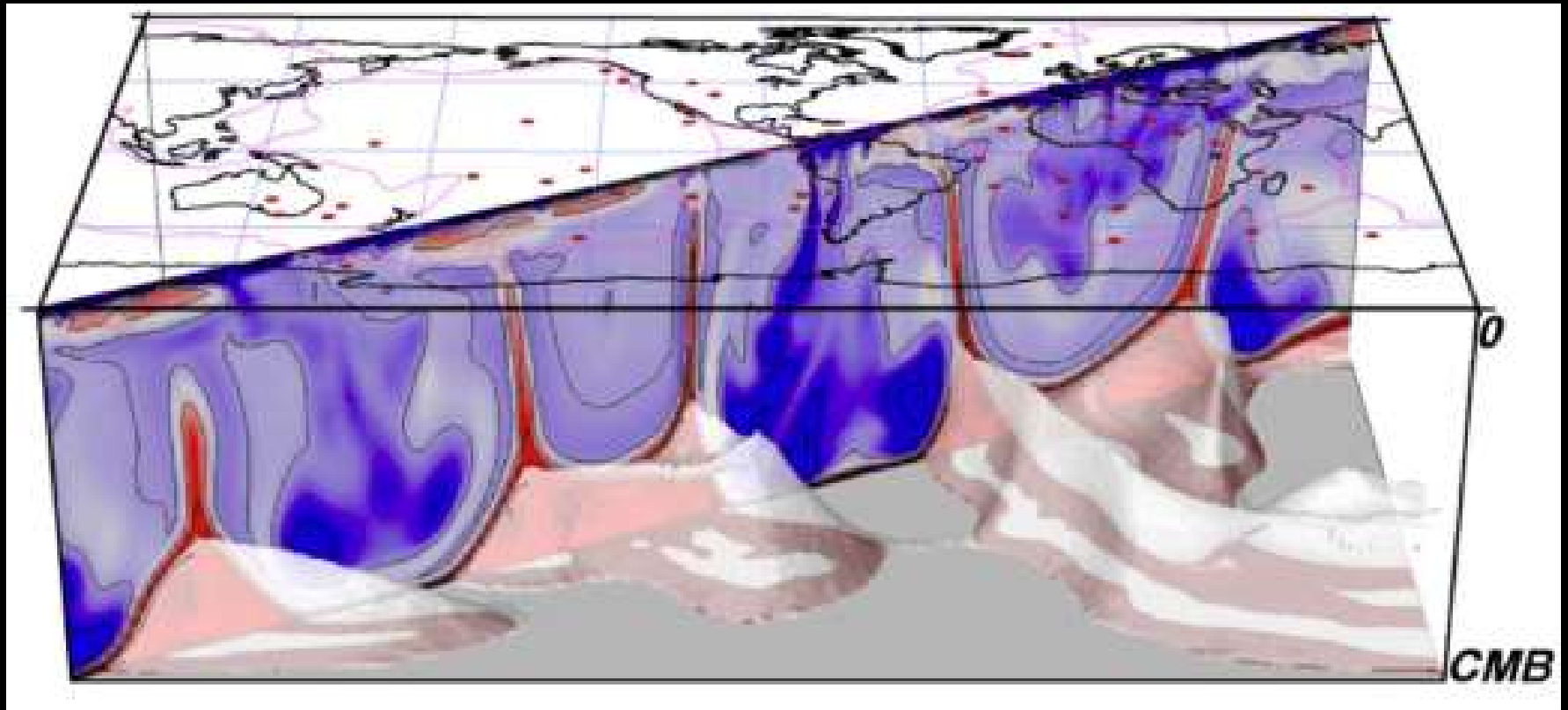


*Dense material piles*

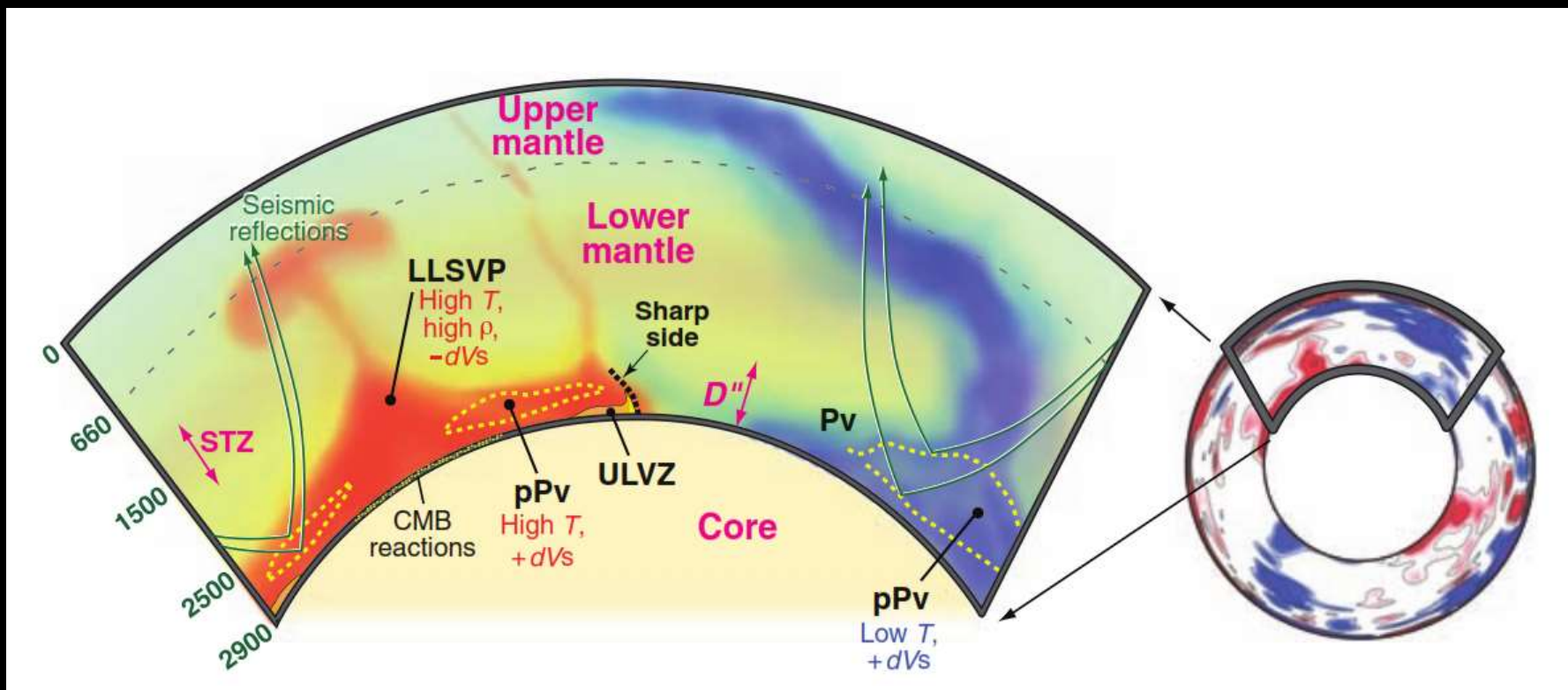
[McNamara and Zhong, 2005]



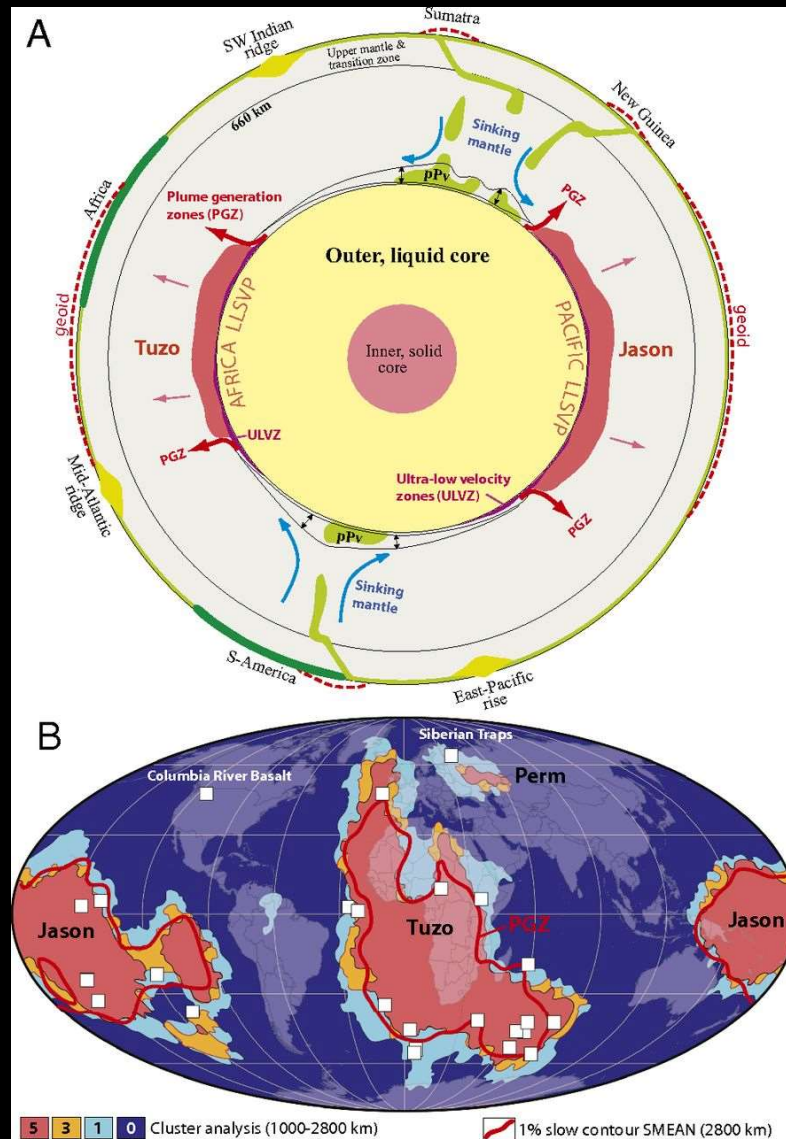
Thermal Plumes or Thermo-chemical Piles ?



McNamara & Zhong, 2005



Gennaro et al., Science 2008



Trond H. Torsvik et al. PNAS 2014;111:8735-8740