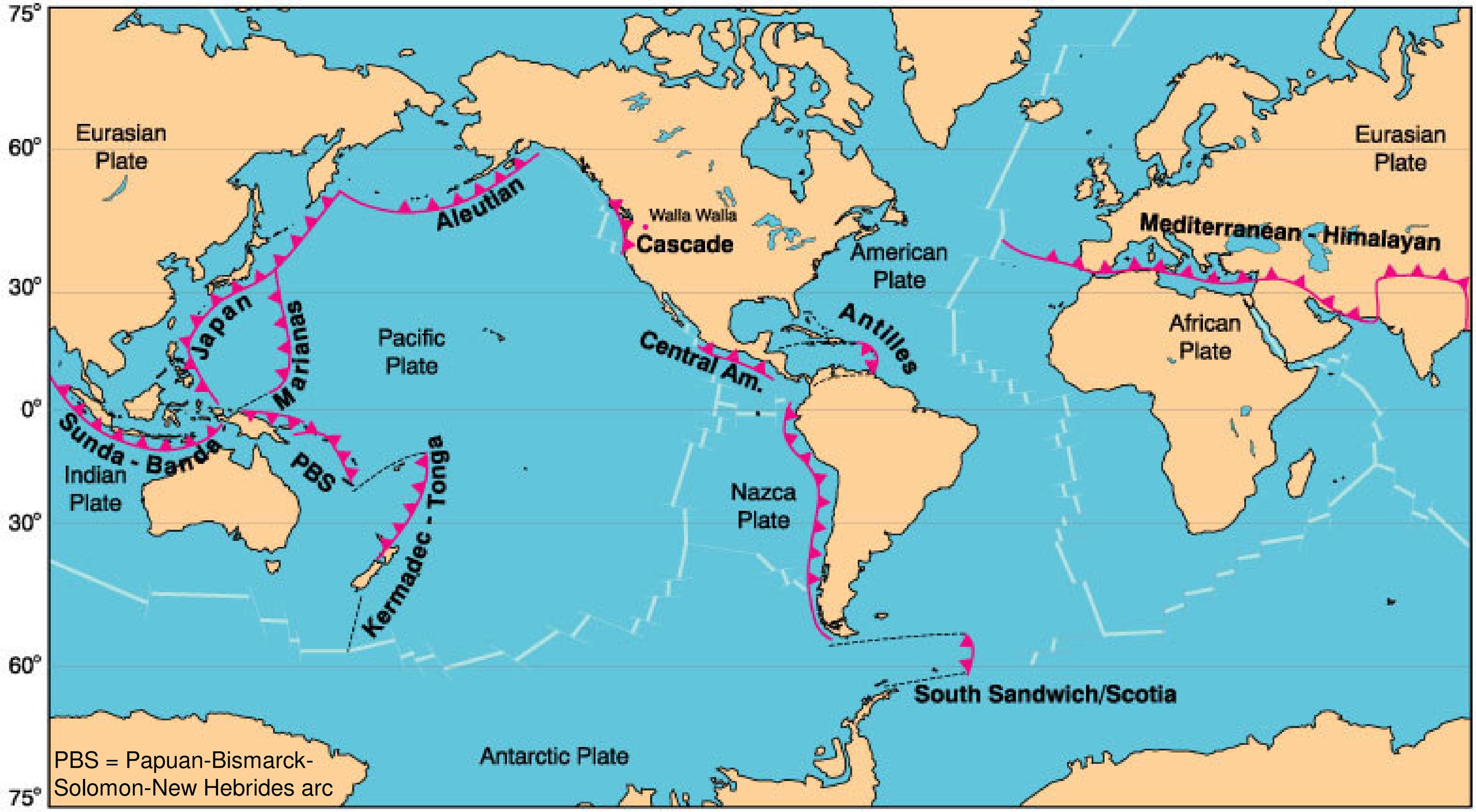
Subduction zones

Melt formation and crustal growth

Ocean-ocean → Island Arc
Ocean-continent → Continental Arc



Wilson (1989)

Growth of continents

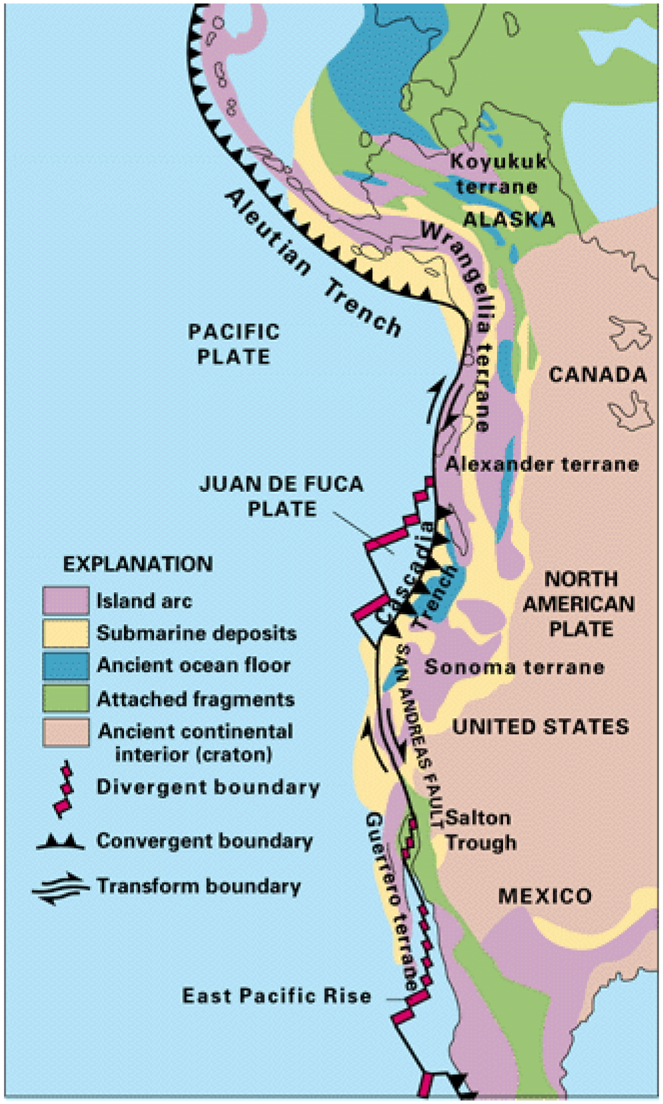
Accretion -collision tectonics

Lateral accretion at subduction zones has played a major role in the growth and evolution of the Circum Pacific margins.

More than 200 terranes have been recognized in the Cordillera in Western North America.

Most of these terranes added during the Mesozoic and Cenozoic, during which time the continental margin was extended by as much as 800km.

Most Cordilleran accreted terranes appear to represent fragments of continents, oceanic plateaus, or portions of arc systems



Subduction Zone Magmatism

- Distinctly different from other basaltic provinces:
  - Composition more diverse and silicic
  - More explosive than the quiescent basalts
  - Stratovolcanoes are the most common volcanic landform
- Major sites of differentiation in the evolution of the crust-mantle system
  - Studying the long term growth of the continental crust
  - Determining mass transfer between different geochemical reservoirs
- Volcanic hazards

Magma composition and eruption style

Factors that control eruptive style:

1. Silica content: high SiO_2 = increased explosively
2. Viscosity: high viscosity = increased explosively
3. Volatile content: high H_2O, CO_2, SO_2 = increased explosively

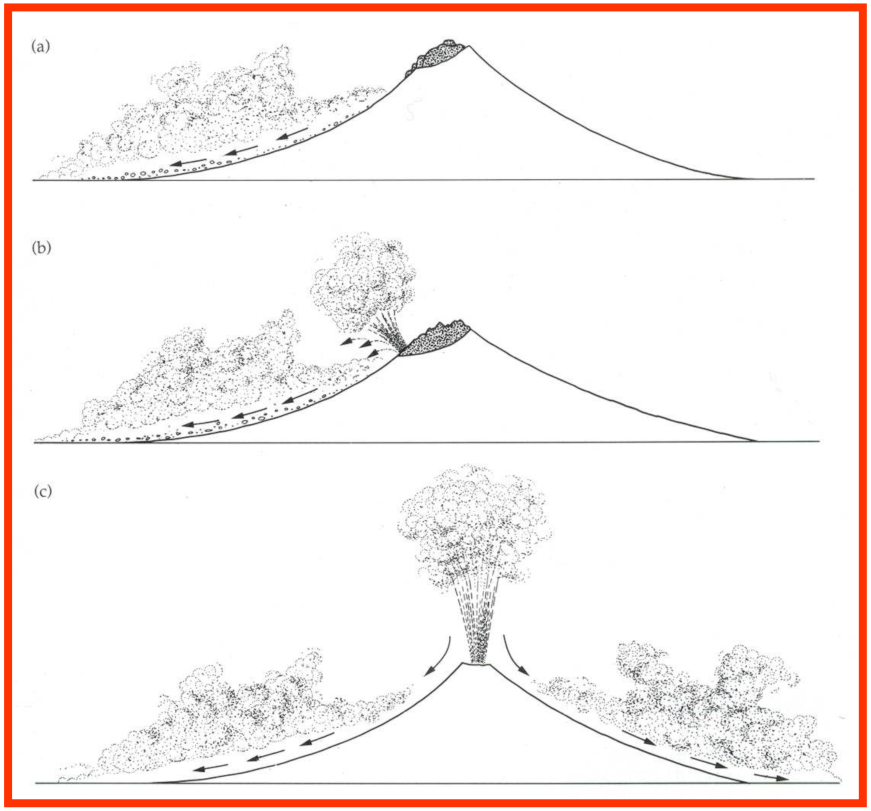
Volatile content and magma viscosity are dependant on magma chemistry which is influenced by plate tectonic setting

Pyroclastic flows ”pyros = (grich. Feuer), "klasto" (grich. Brocken)

Ignimbrites ”ignis” = (lat. Feuer), “imber” (lat. Regen)

- Gravity-driven flows
- Flow downslope and tend to be channelled in valleys
- Veolocity >10 ms^{-1} sometimes > 100 ms^{-1}
- Temp. between 100-250^{o}C (Montserrat) and 600^{o}C (Unzen)

Pyroclastic flows



1. Collapse of lava domes or flows
2. Gravitational collapse of eruption columns
3. Explosive disruption of a lava dome
4. Lateral blast after sector collapse of the edifice (e.g. Mount St Helens, 1980)

Lahars

Lahars - hyperconcentrated volcanic mud-flows
High density flows - up to 75% solids
Very erosive - pick up material as they flow downhill
May occur during or after an eruption

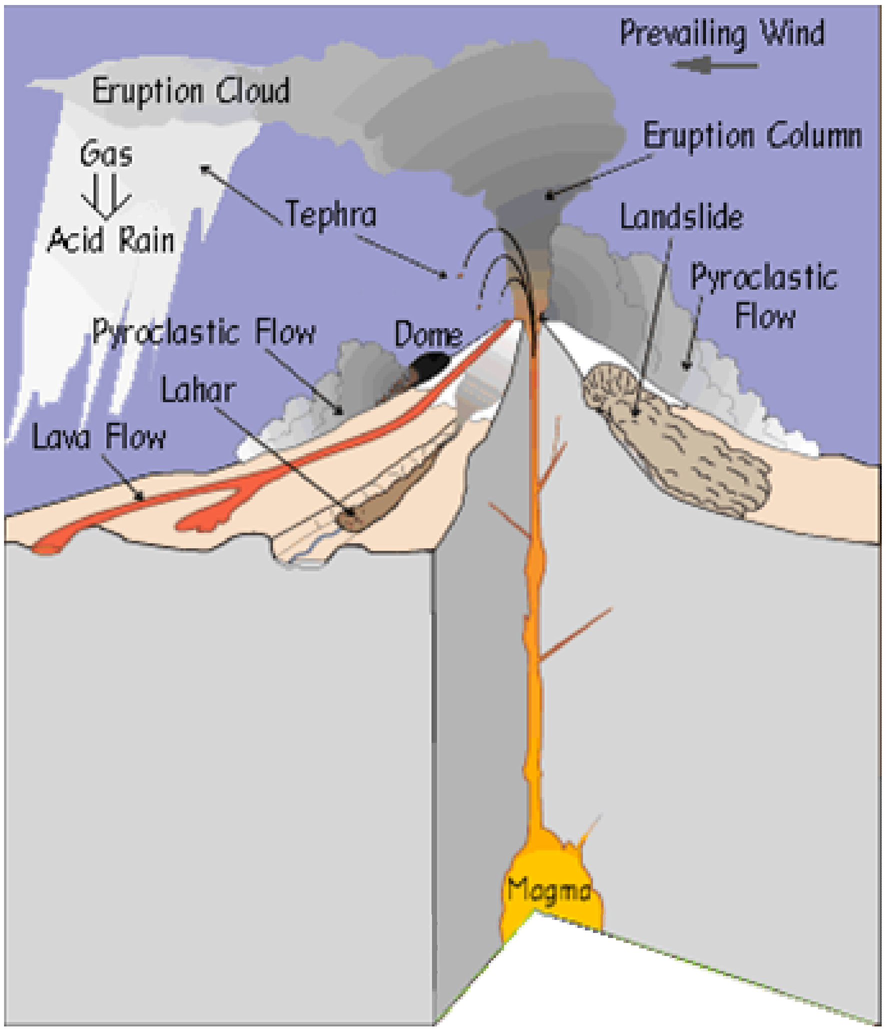
Formation of lahars requires:

1. **Adequate water source**
2. **Unconsolidated debris (e.g. pyroclasts, ash, soil)**
3. **Steep slopes at source**
4. **Triggering mechanism**

Lahars can be causedby:

Rapid addition of water: Sudden melting of snow and ice, torrential rain, breaching of crater lakes
2. Flank collapse: liquefaction of landslide material if sufficient pore/hydrothermal water available
3. Volcanic eruptions

Volcanic hazards



1. Lava flows
2. Pyroclastic flows
3. Ash and bomb falls
4. Acid rain
5. Fumaroles
6. Lahars (mud flows)
7. Landslides

Volcanoes and Climate

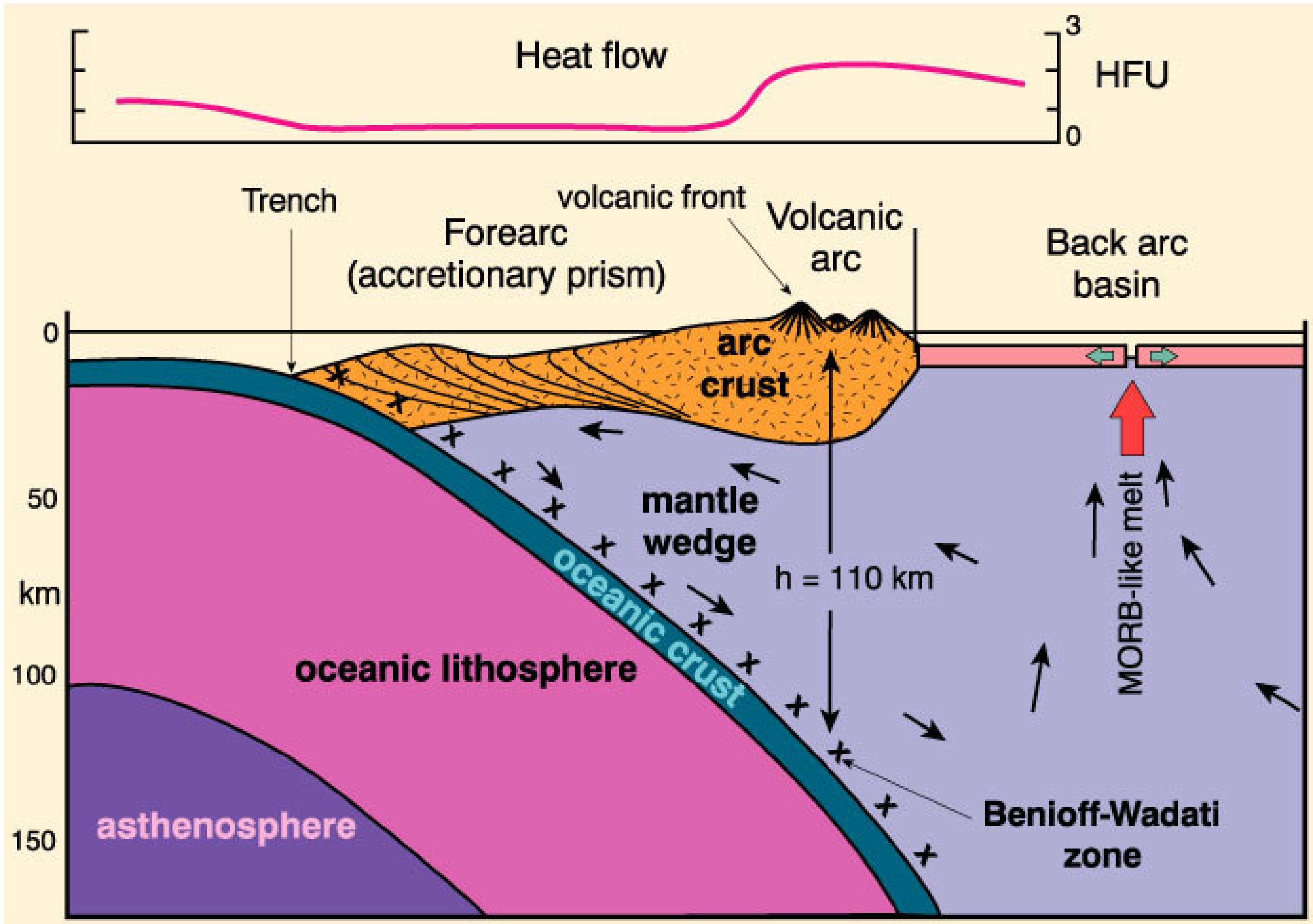
- Dust and SO_2 into air
- $SO_2 + H_2O \Rightarrow H_2SO_4$ (acid) droplets
- Scatters sun light – temperature drops (1-2℃)

  (effect lasts 2–5 years)

- CO_2 from volcanoes – greenhouse gas, warming

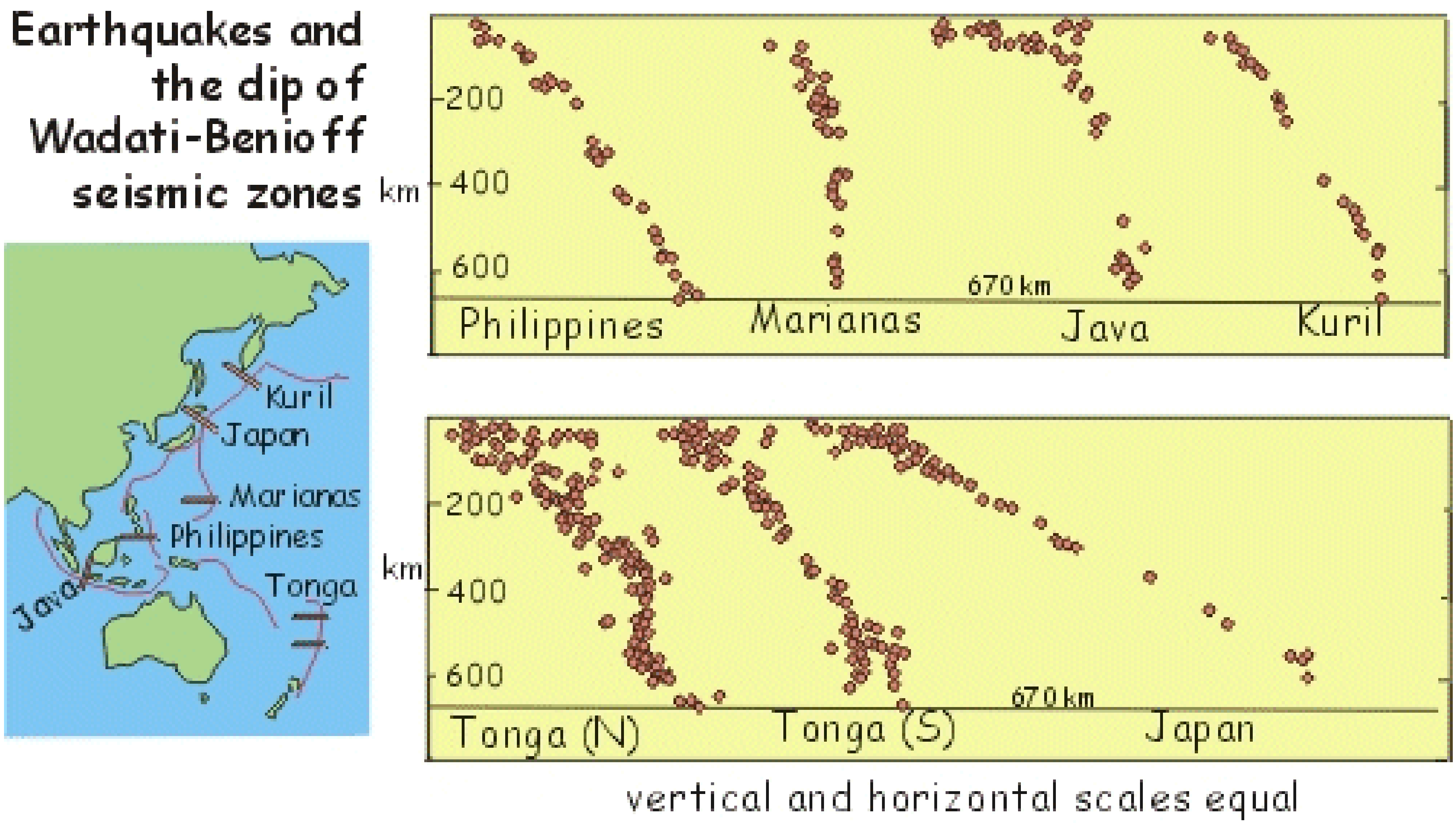
  (lasts longer)

Physiography of Subduction Zones

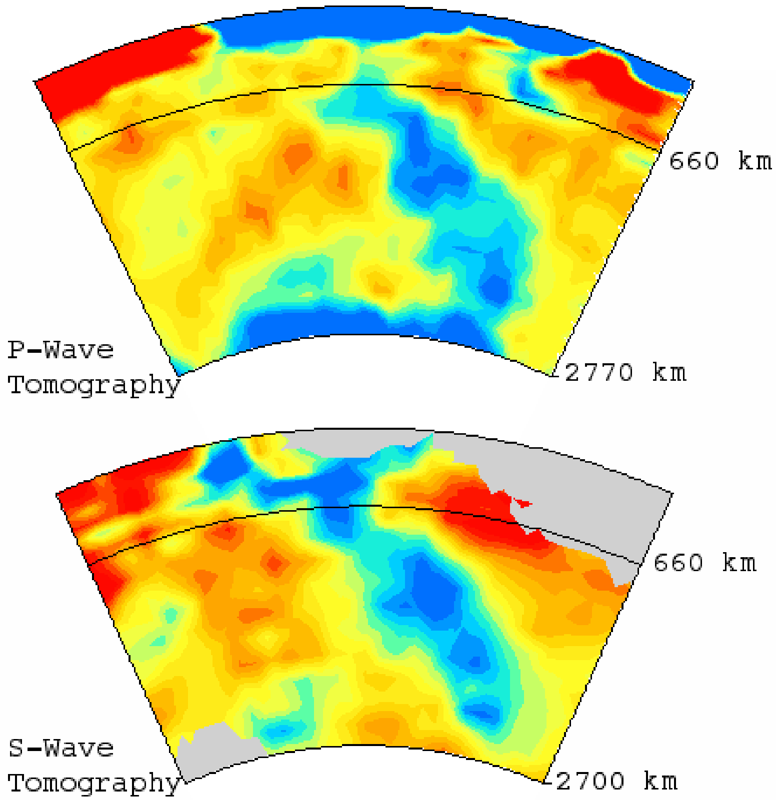


Gill 1981

Physiography of Subduction Zones



Seismische Tomographie



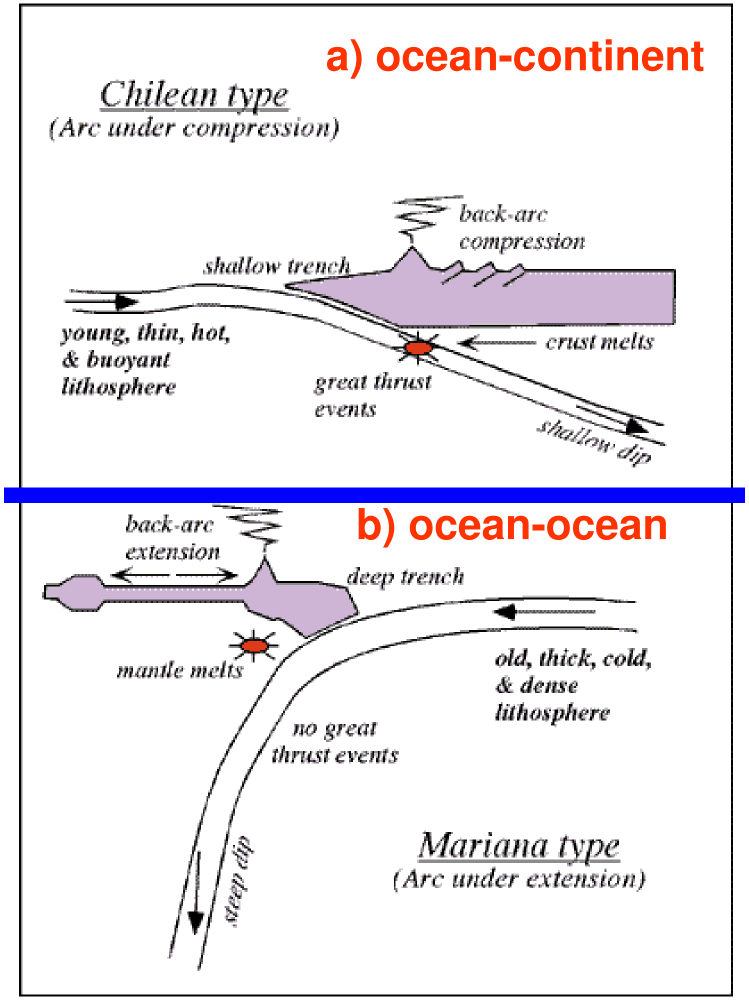
Seismische Tomographie liefert Information über die innere Struktur der Erde.

Mit dieser Methode kann z.B. die Subduktion von Litho-sphärenplatten in Tiefen >660 km sichtbar gemacht werden.

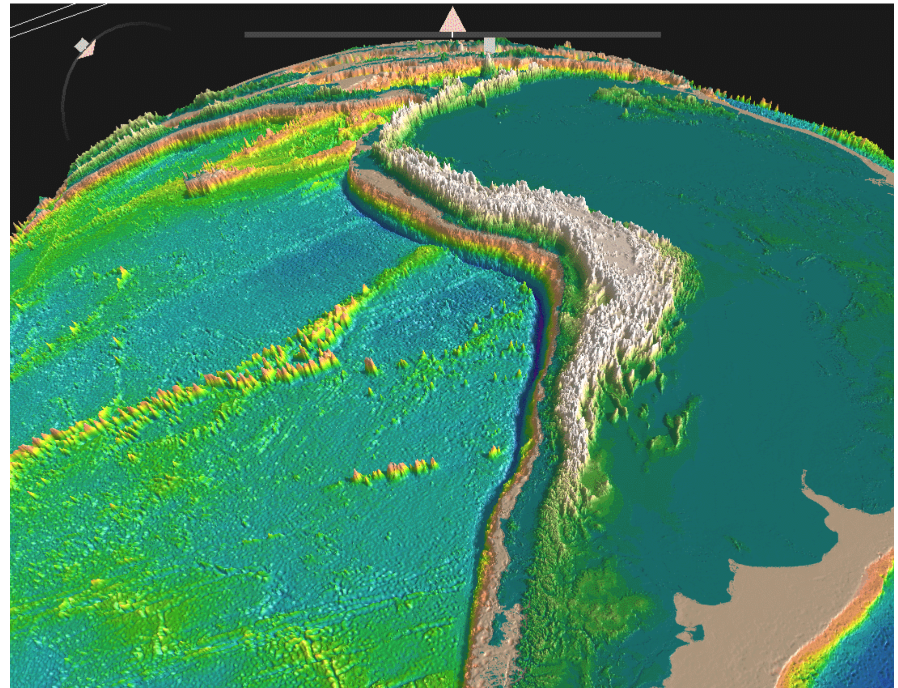
whole mantle vs. layered mantle convection?

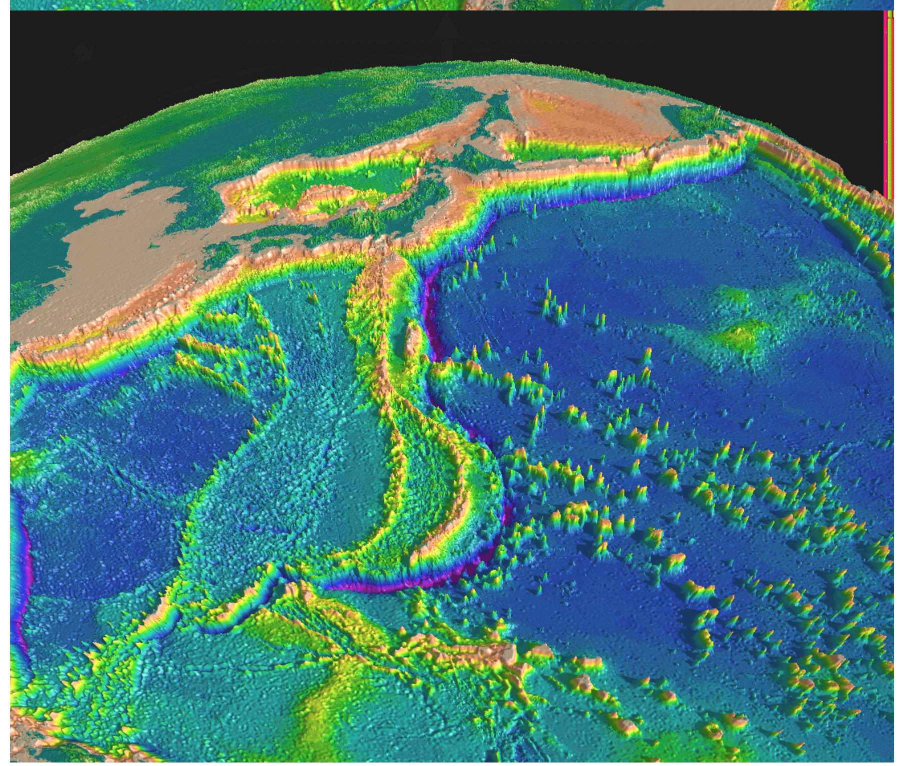
earthquakes cease at ~670 km …barrier?
tomography seems to indicate material passes through

Subduction zones

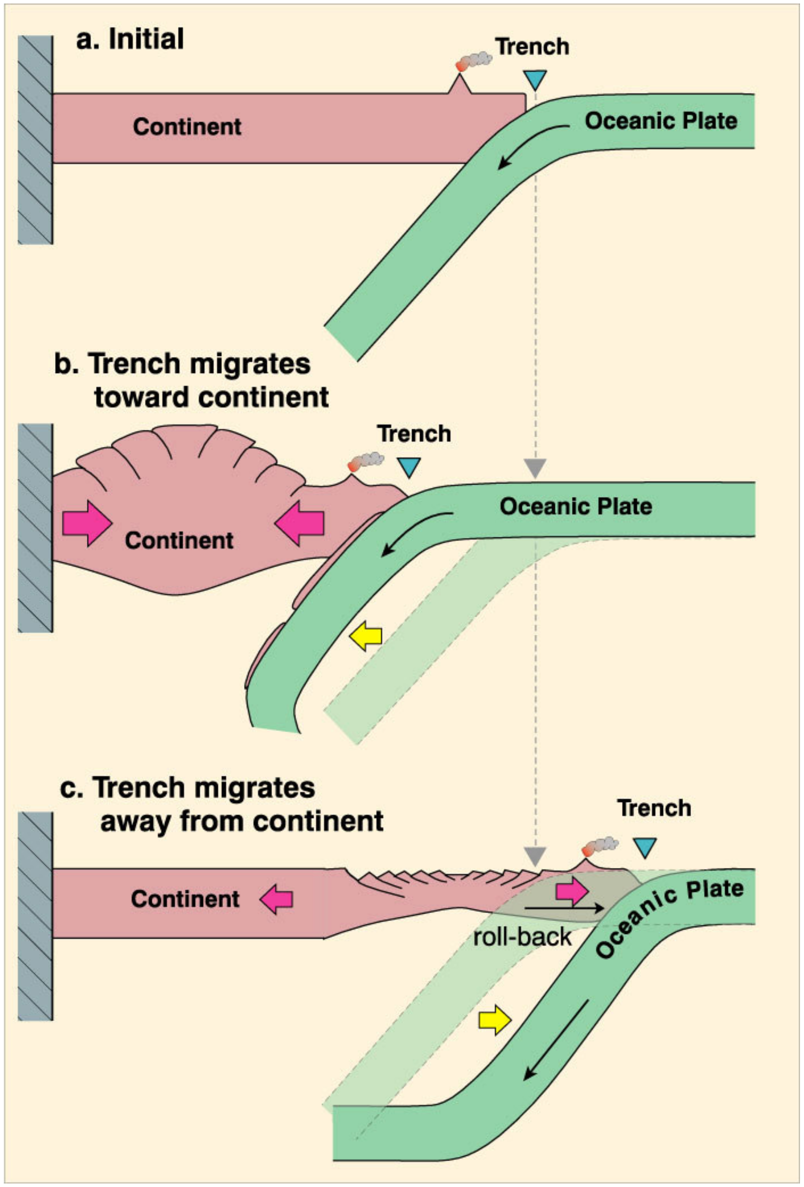


Stern (1998)



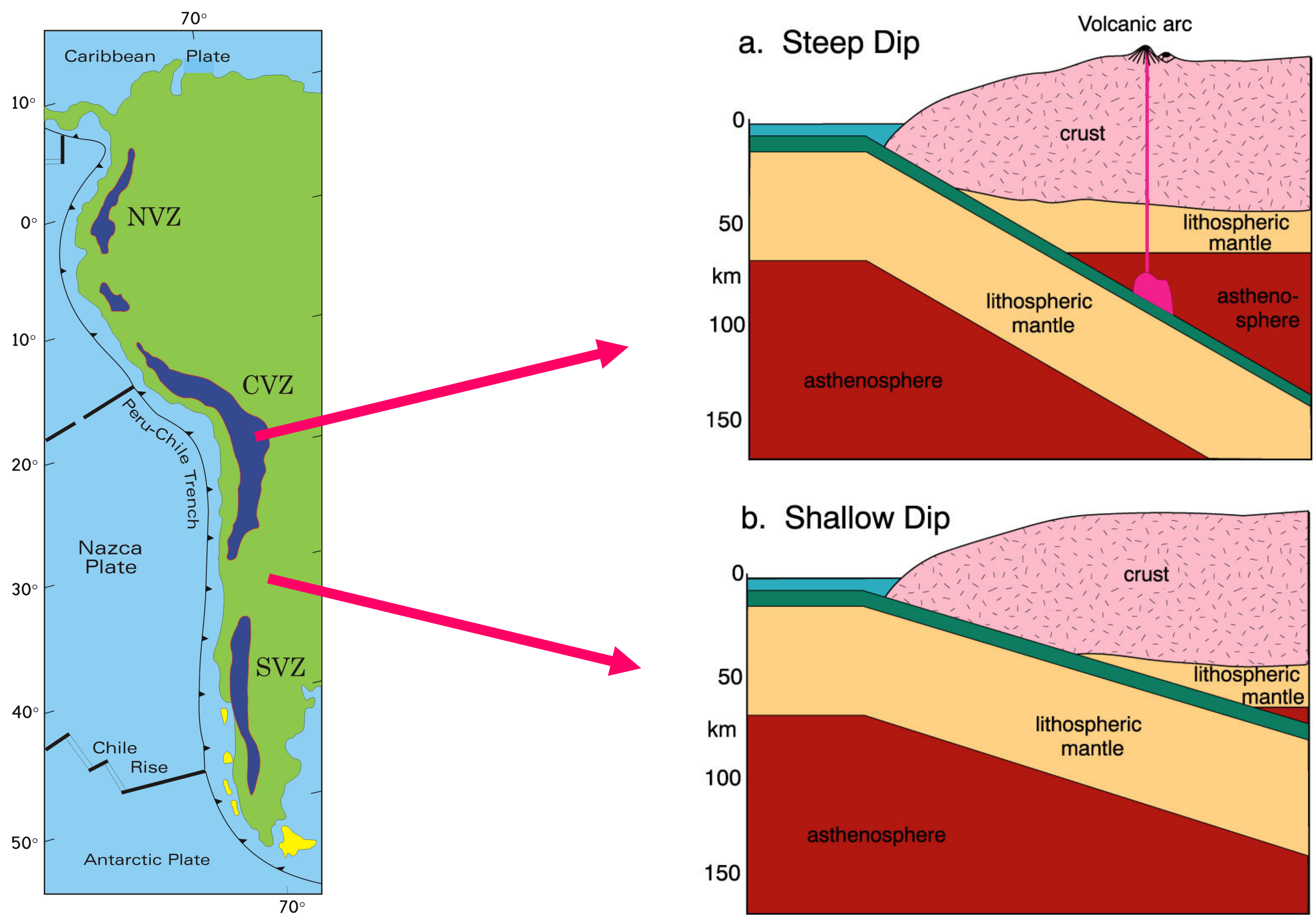


Cross sections through subduction zones

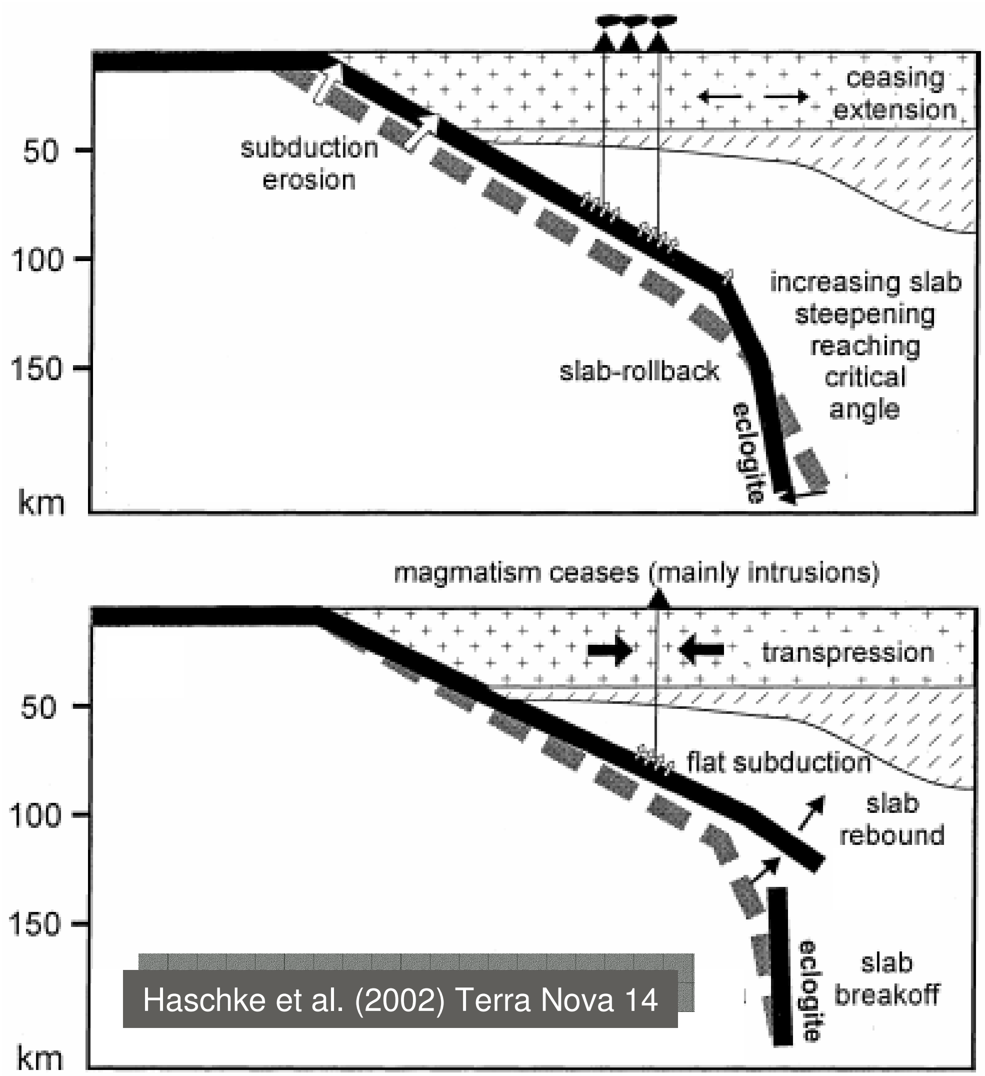


Stern (1998)

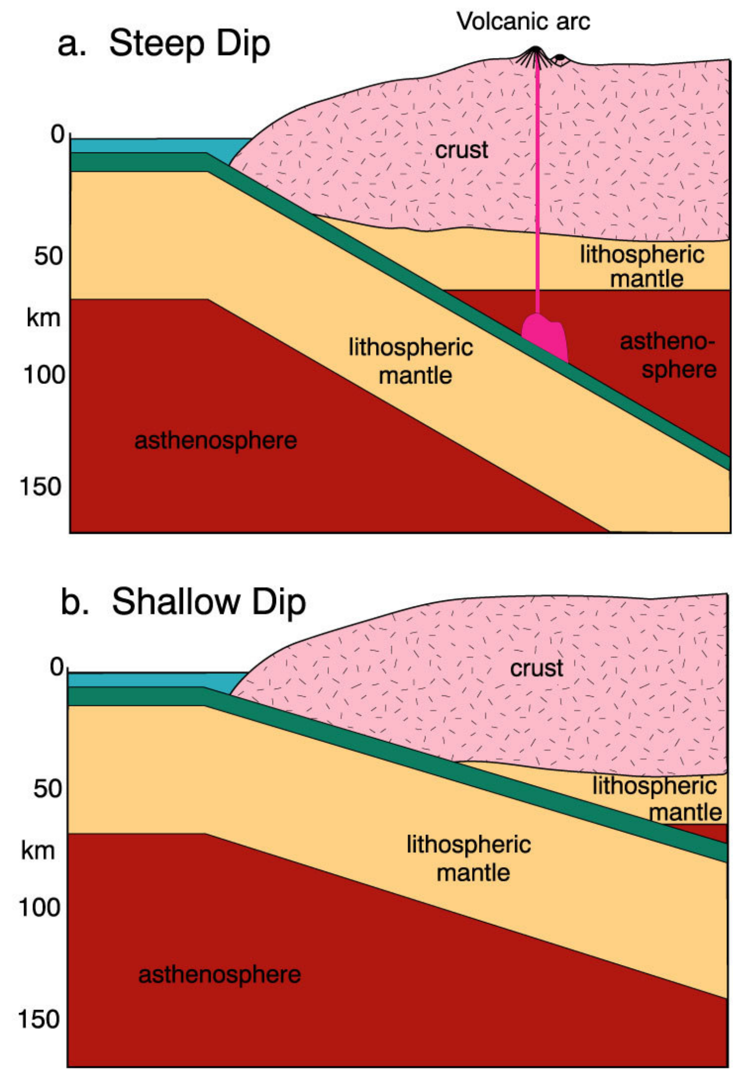
Steep versus flat subduction in the Andes



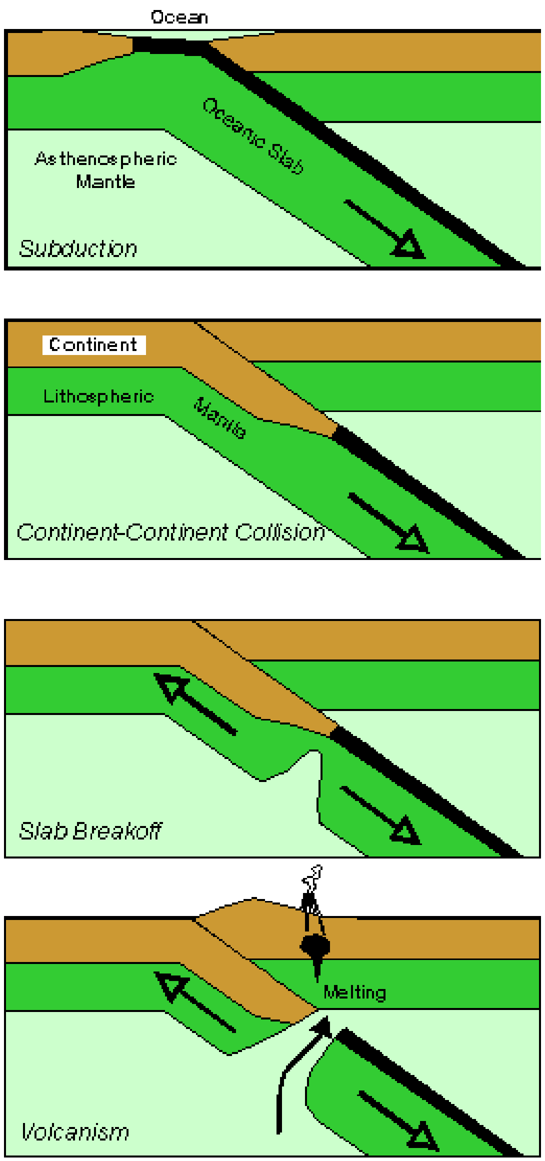
Steep versus flat subduction in the central Andes



Haschke et al. (2002) Terra Nova 14



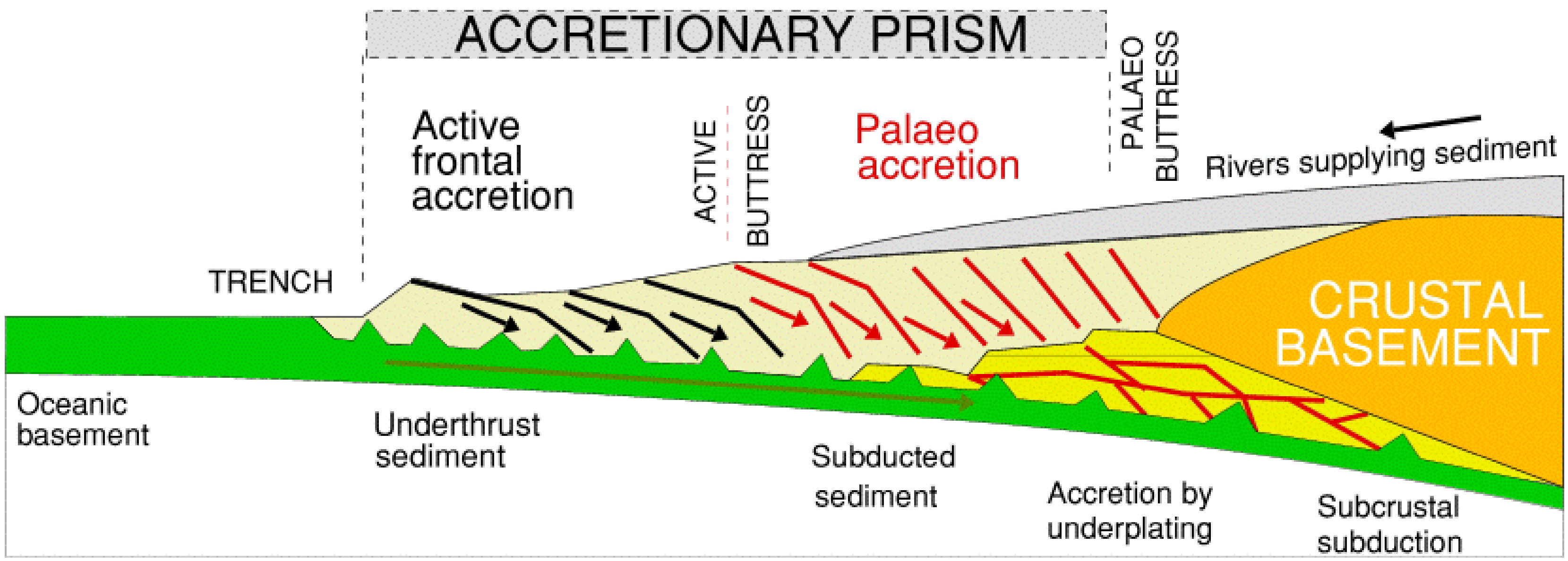
“Slab Breakoff” und Bildung eines “Slab Windows”



von Blanckenburg & Davies (1995) EPSL 129

Subduktionszonen

S-Chile- und Alaskatyp



Subduktionszonen