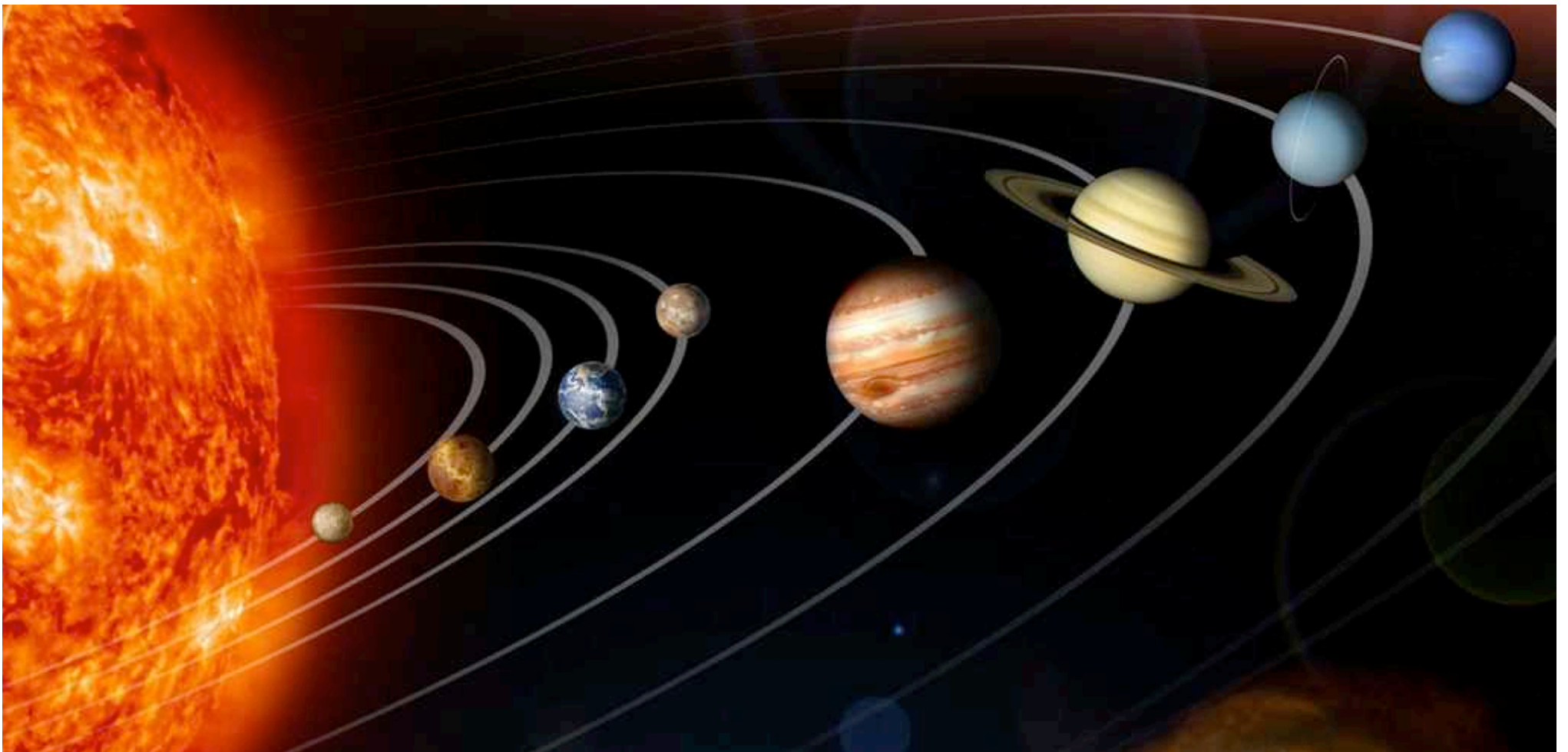


Tatort Plattengrenze

Renée Heilbronner

5. Nov. 12. Nov. 19. Nov. 26. Nov.



Merkur, **V**enus, **E**rde, **M**ars, **J**upiter, **S**aturn, **U**ranus, **N**eptun, **P**luto

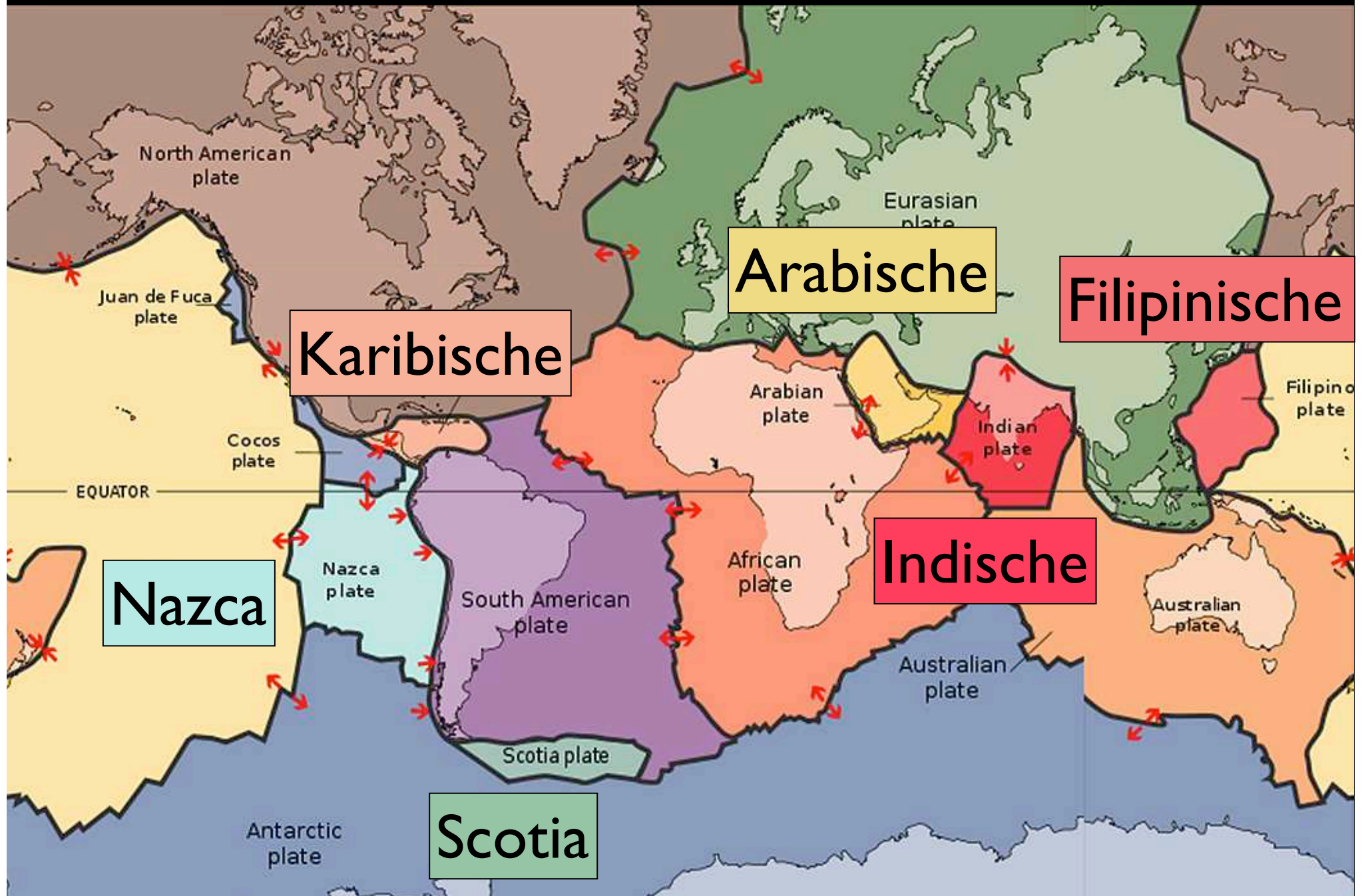
"**M**ein **V**ater erklärt **m**ir jeden **S**onntag **u**nsere **n**eun **P**laneten"

"**M**an **v**ergisst **e**inen **M**enschen **i**n **s**einem **U**nglück **n**ie (**P**unkt)"

Die 8 grossen tektonischen Platten

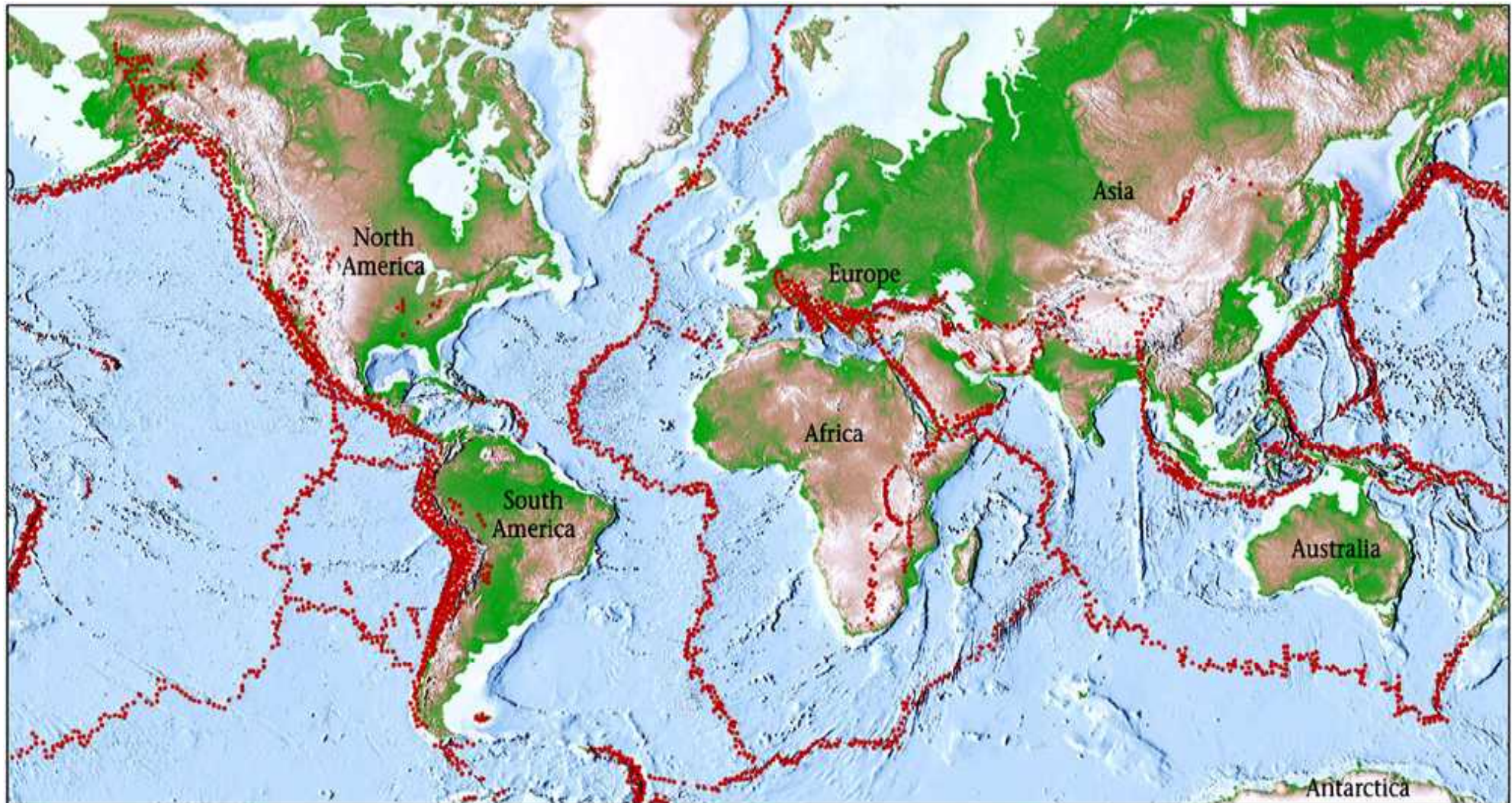


Die 6 kleineren tektonischen Platten



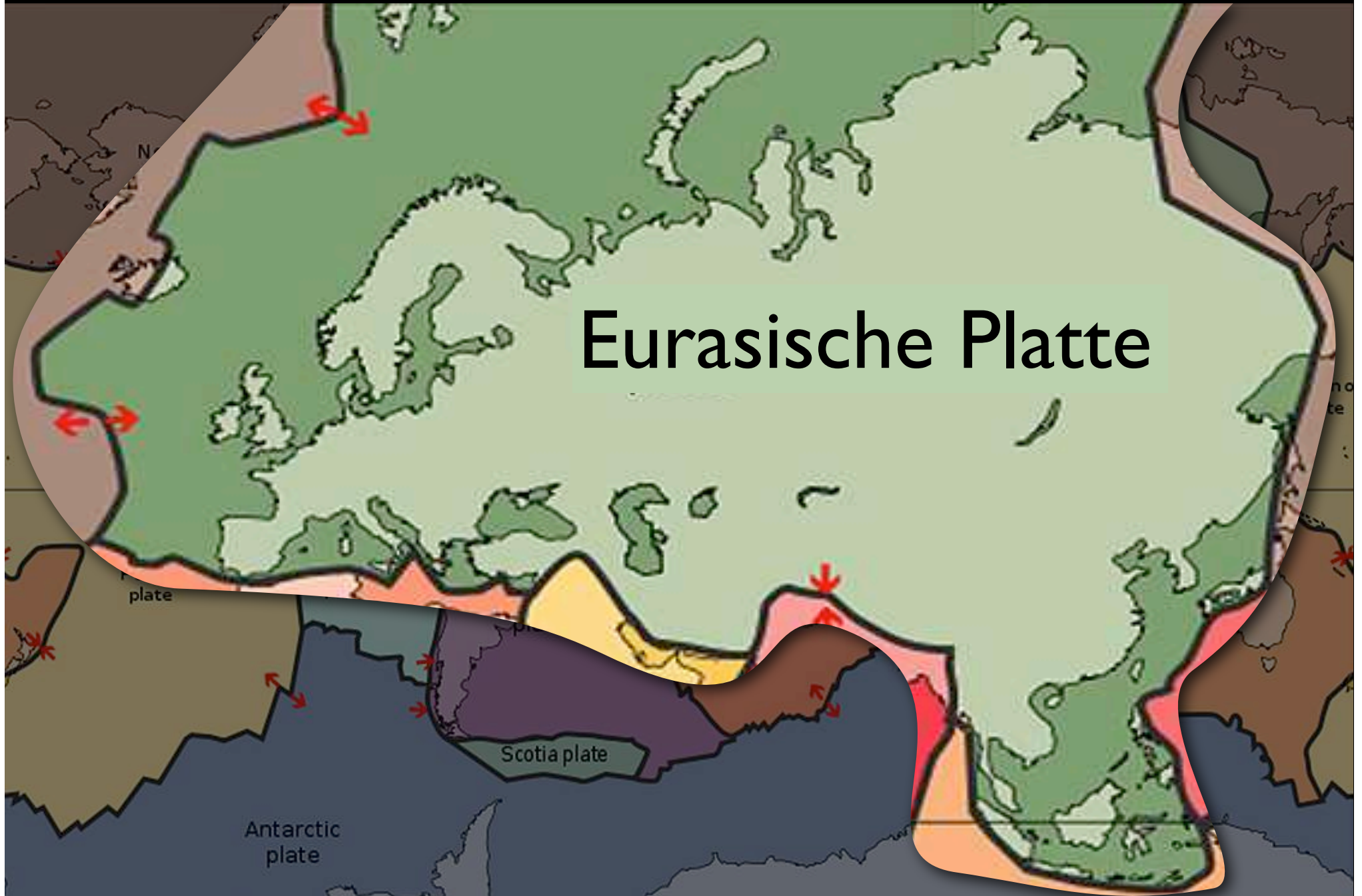
Plattengrenzen

plate boundaries
seismicity (earth quakes)

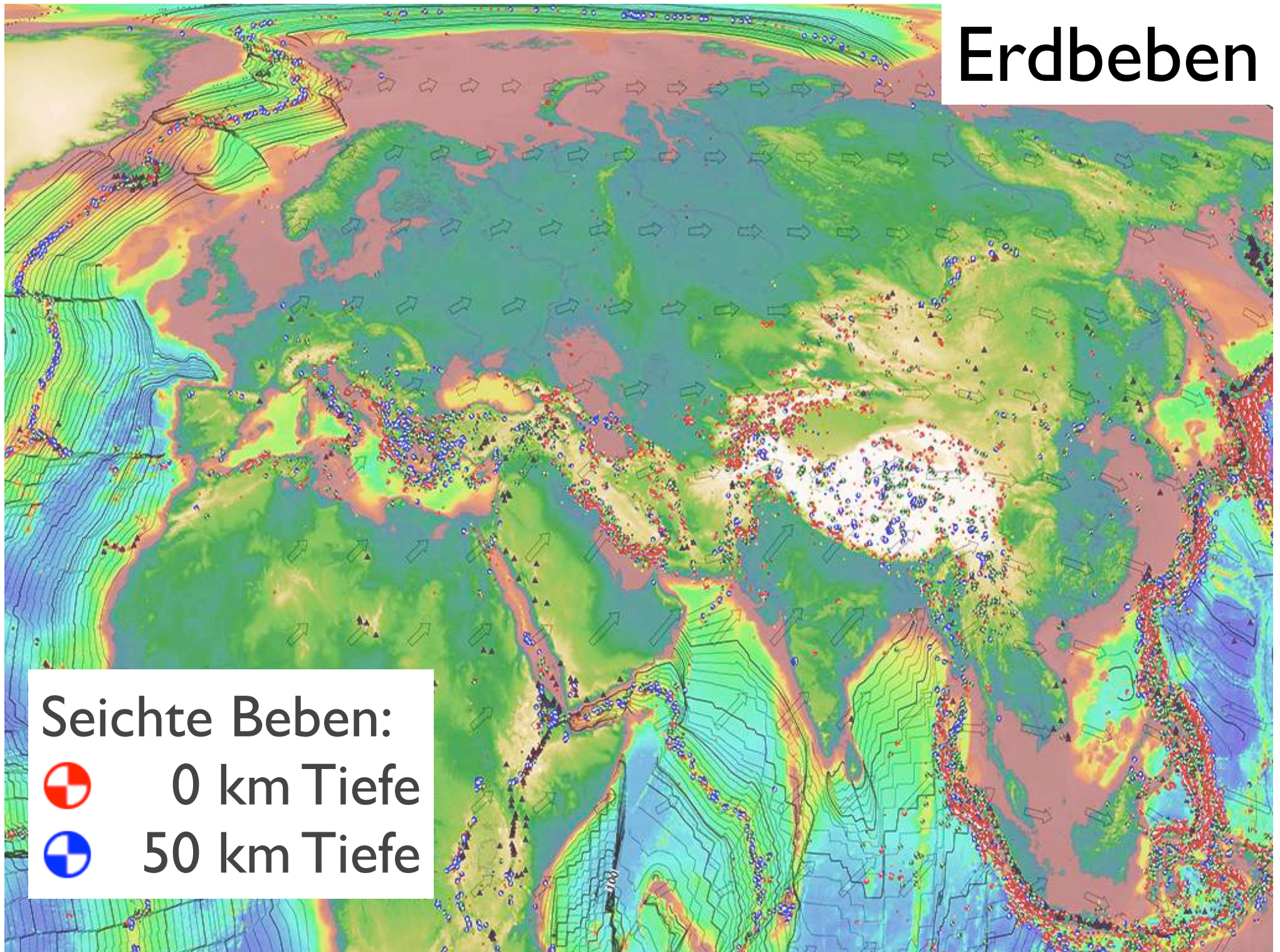


Plattentektonisches Puzzle

Eurasische Platte



Erdbeben



Seichte Beben:

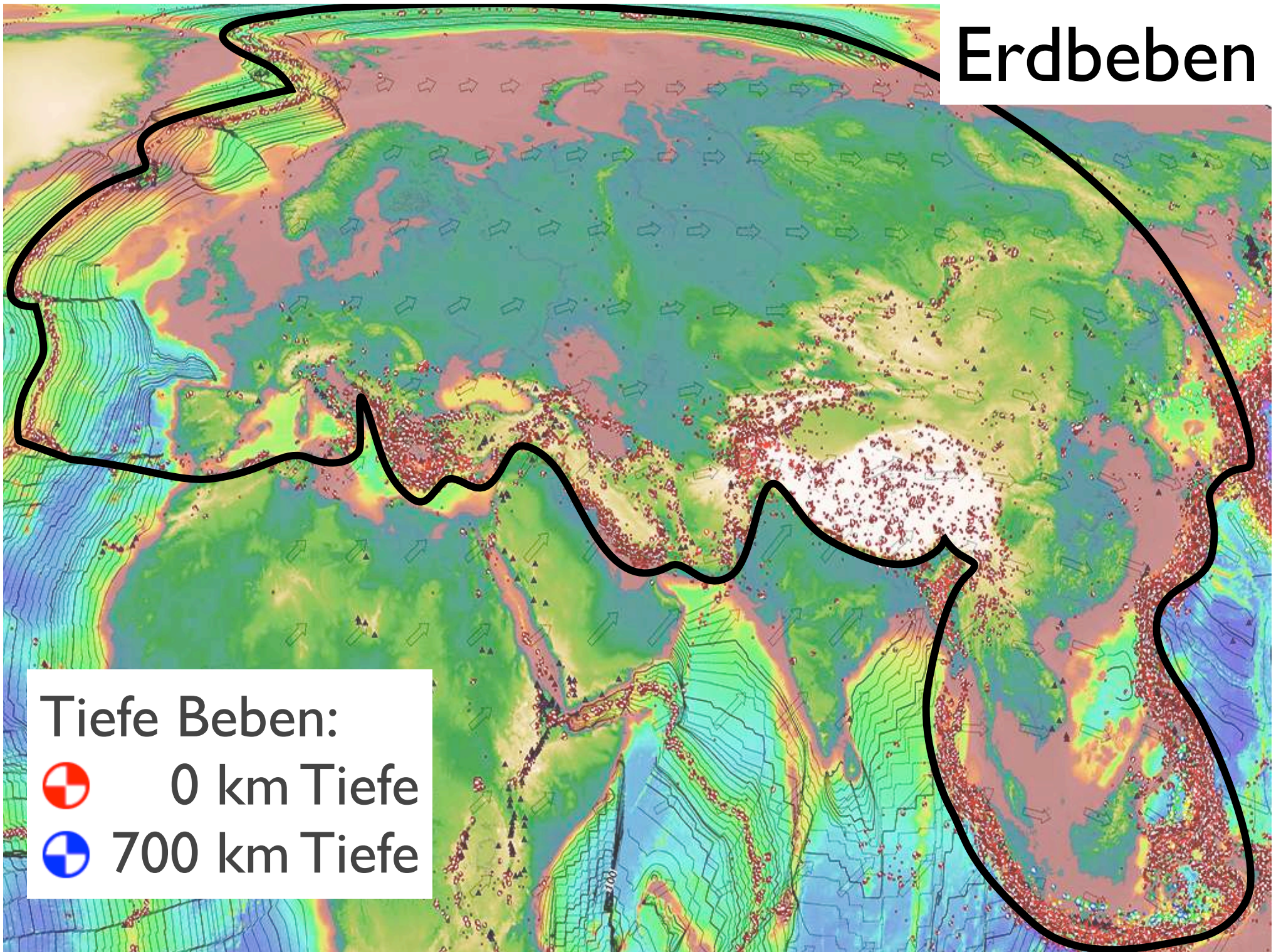


0 km Tiefe



50 km Tiefe

Erdbeben



Nachbarn

Nordamerikanische

Nordamerikanische

Eurasische Platte

Pazifische

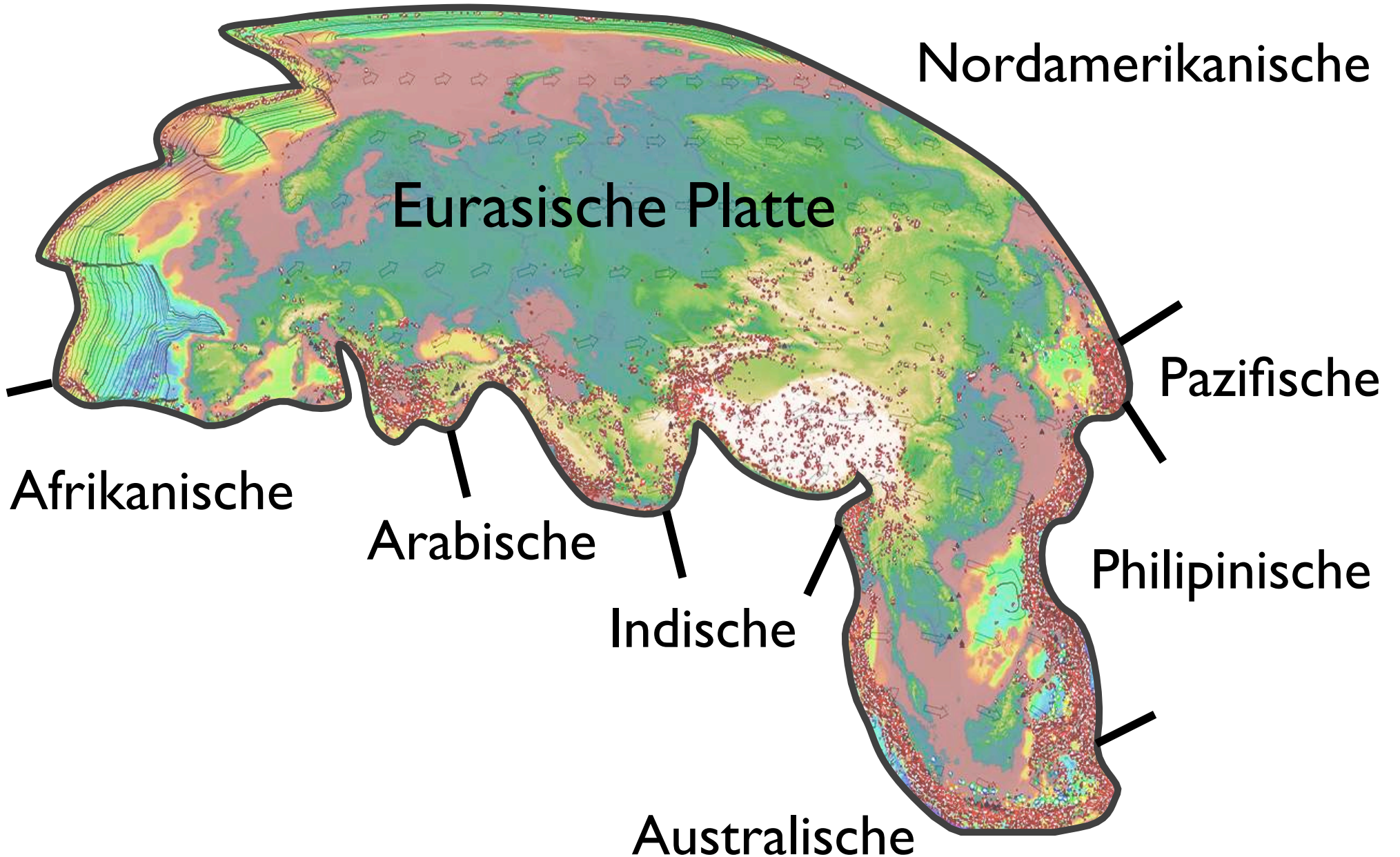
Afrikanische

Arabische

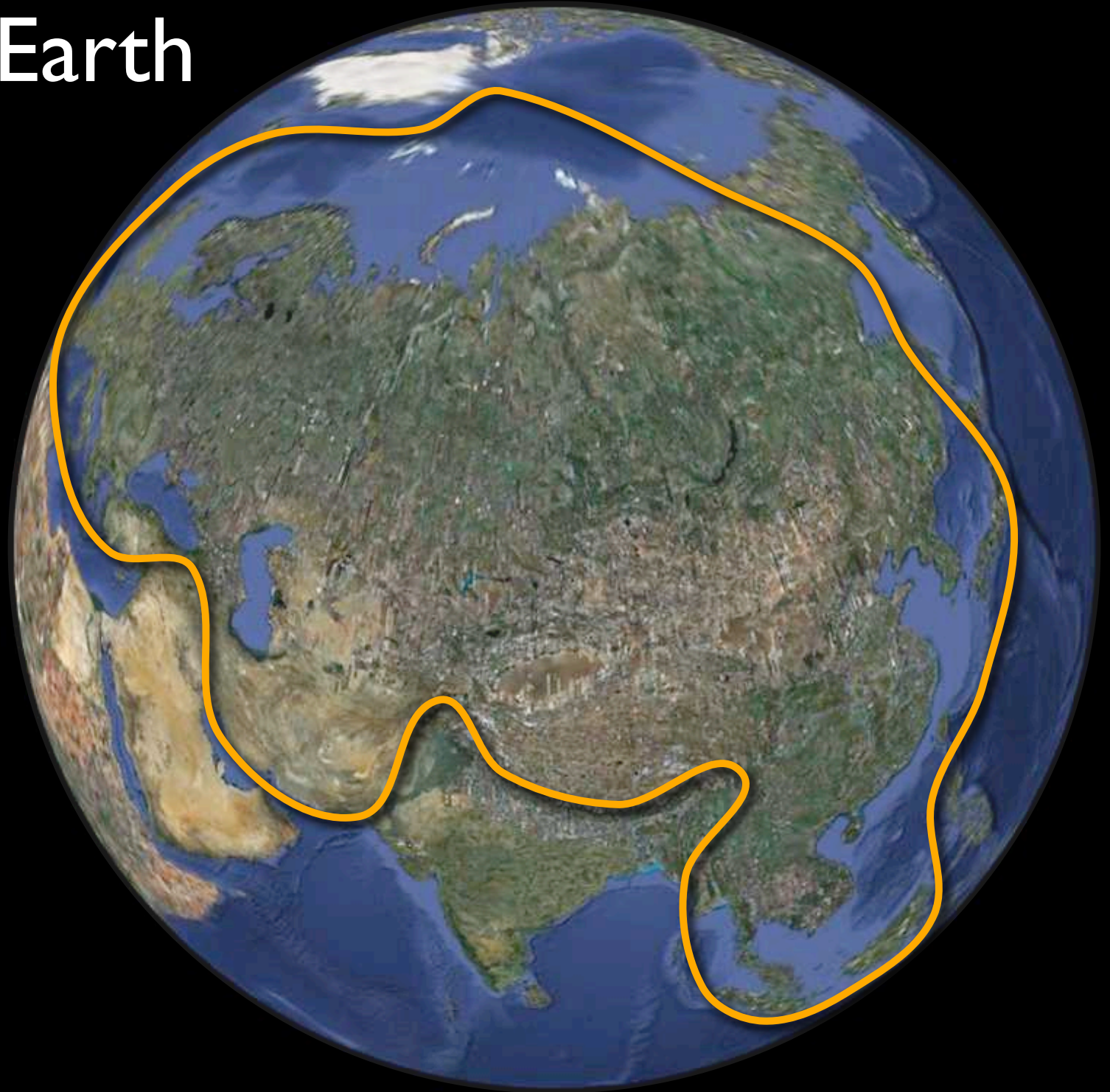
Philippinische

Indische

Australische



google Earth



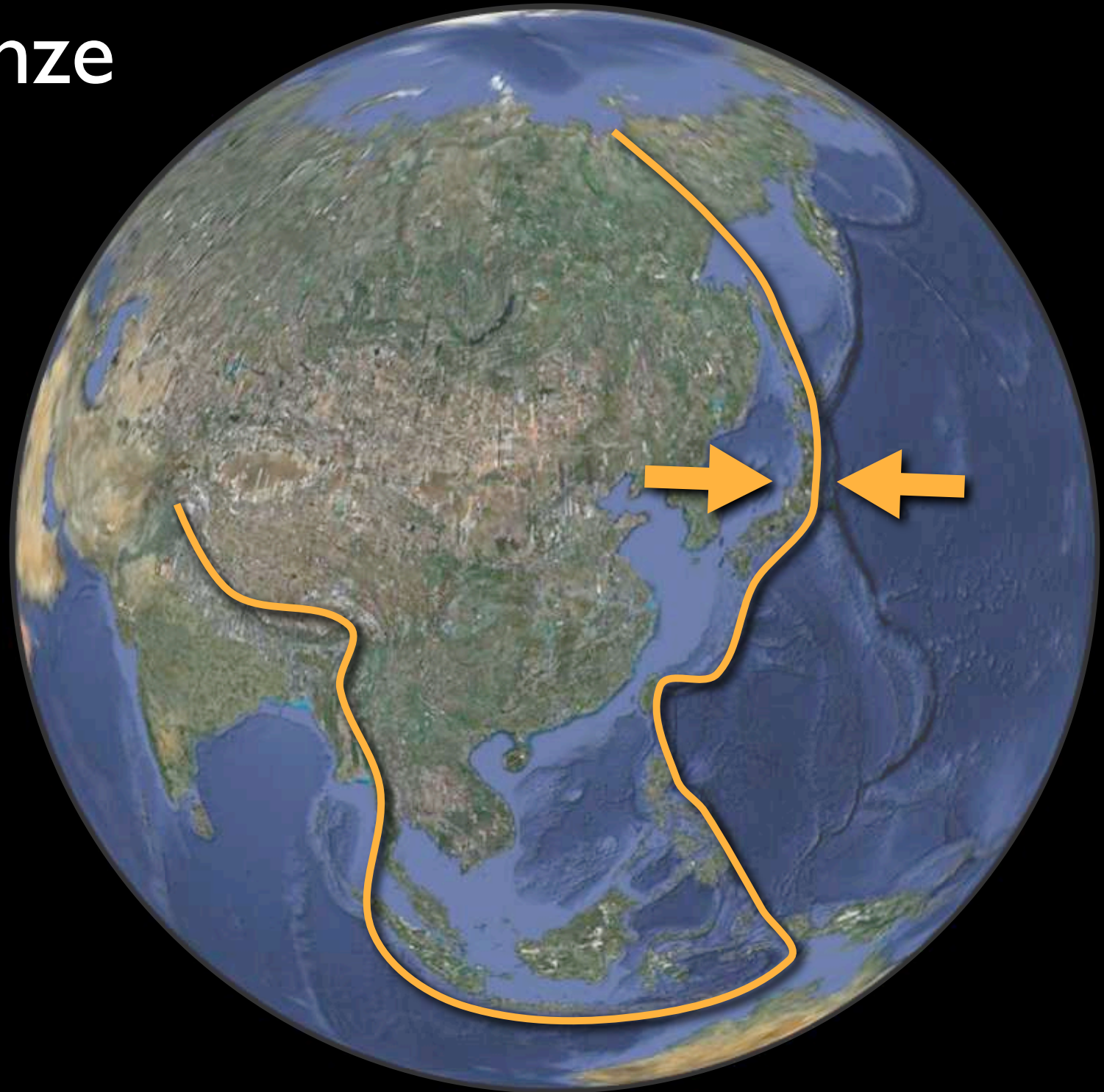
Westgrenze



Nordgrenze



Ostgrenze



Südgrenze



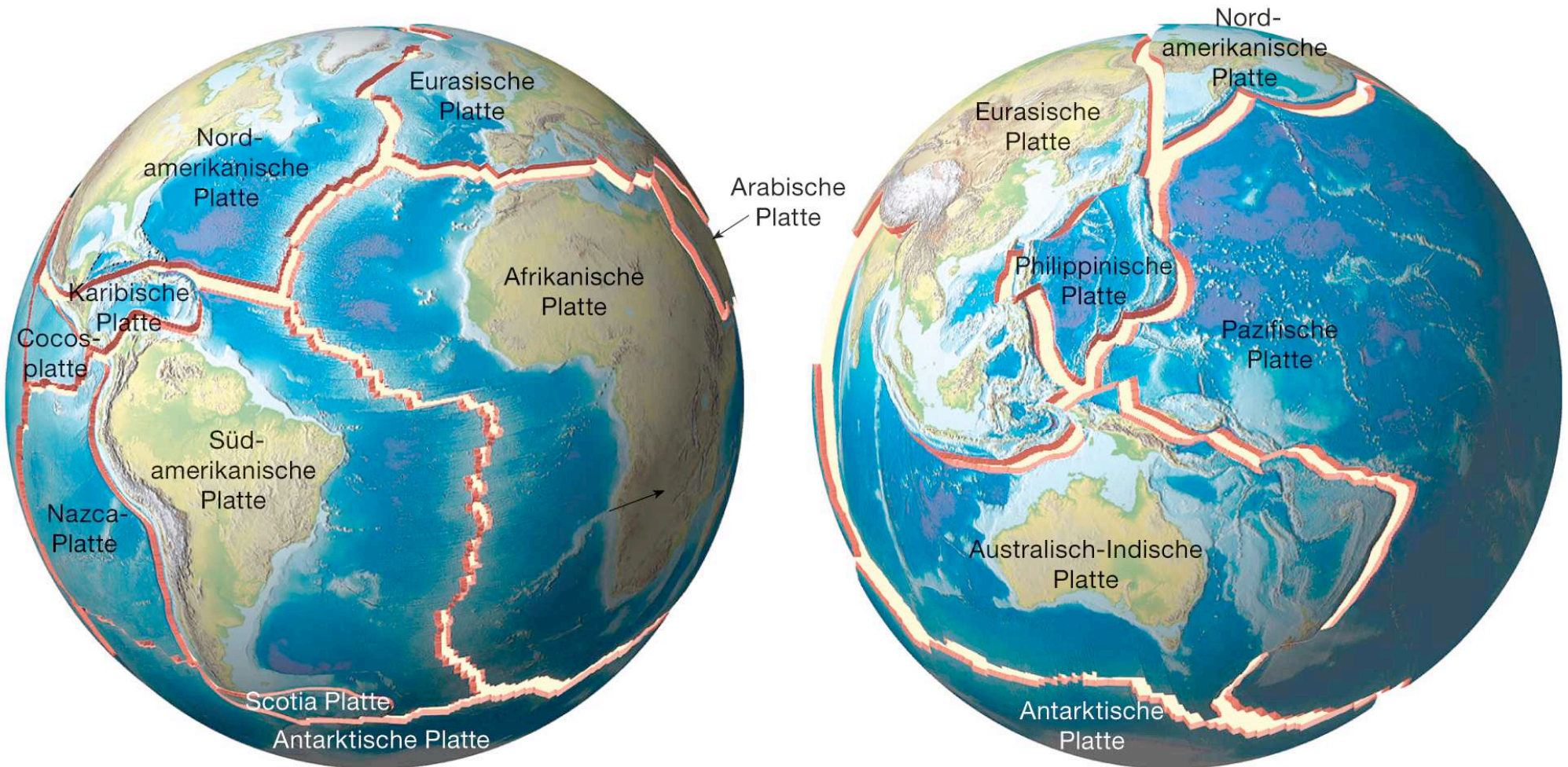
Theorie der Plattentektonik



Erdoberfläche besteht aus ca. 20 Platten;
davon etwa 8 grosse und 6 mittlere

Alle Platten (ausser der Pazifischen) bestehen
aus kontinentalen und ozeanischen Anteilen.

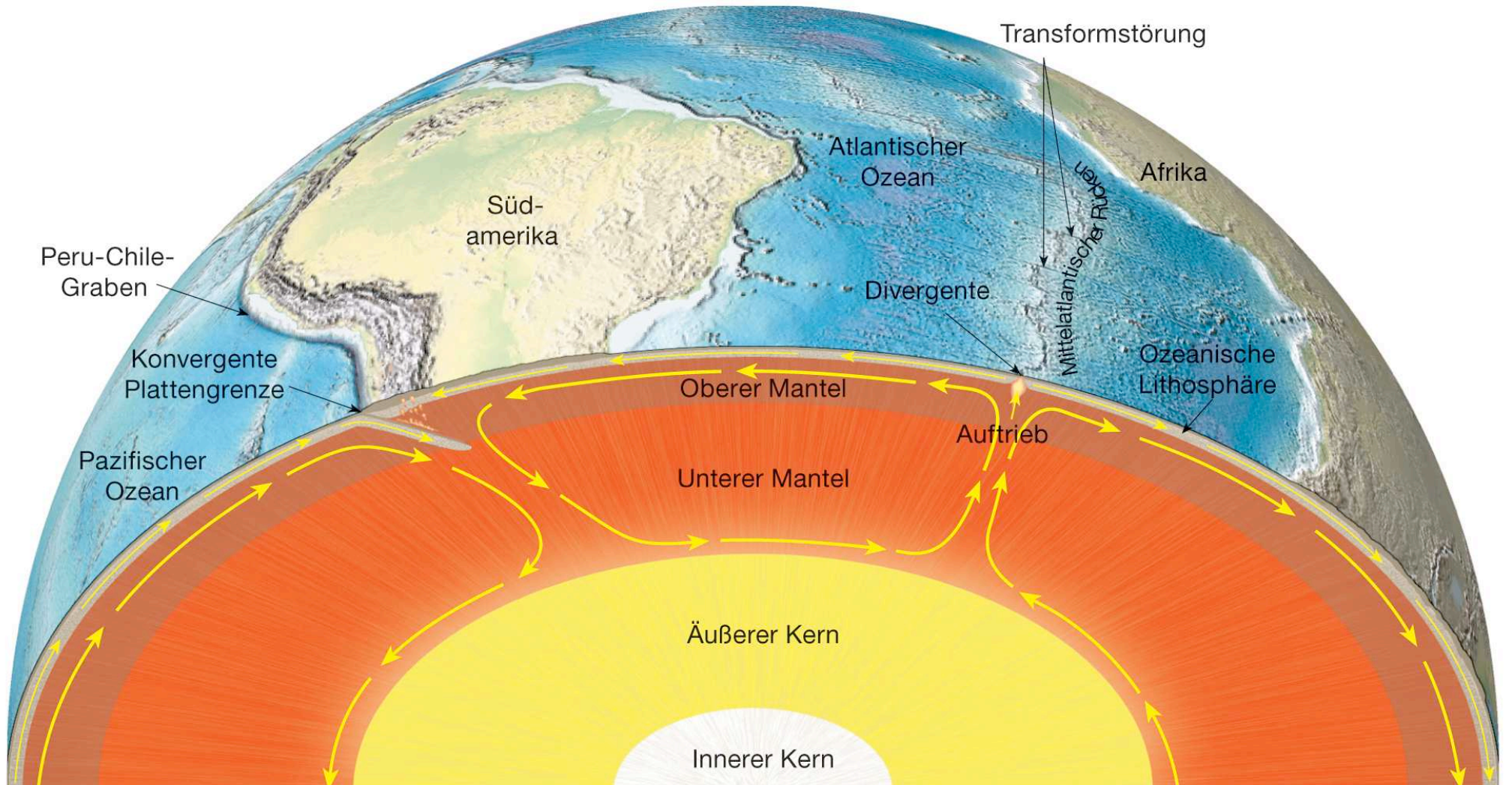
das plattentektonische Modell



Platten bestehen

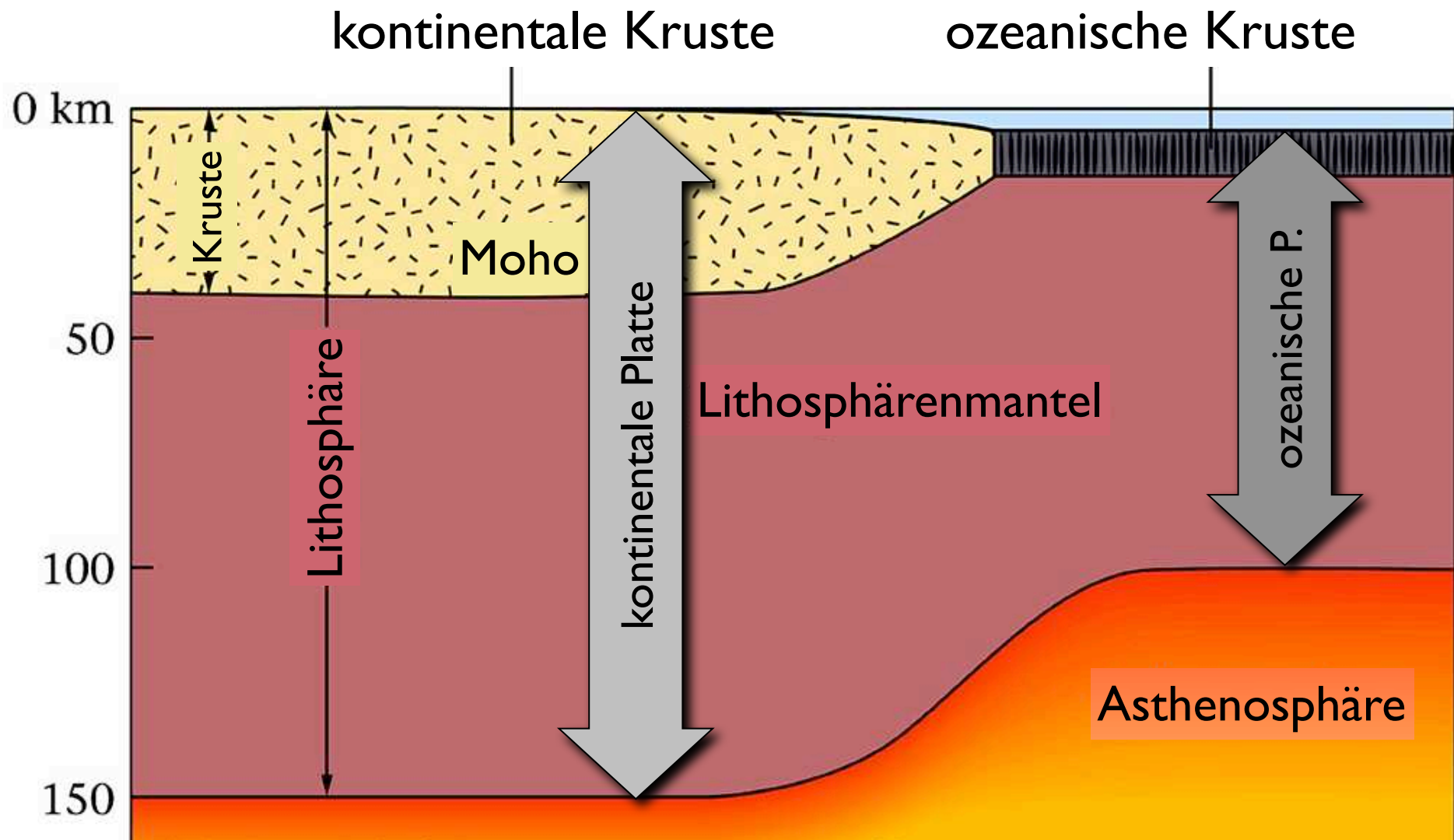
aus kontinentalen Anteilen
und ozeanischen Anteilen

das plattentektonische Modell



**Erdoberfläche entsteht an konstruktiven Plattengrenzen
verschwindet an destruktiven Plattengrenzen**

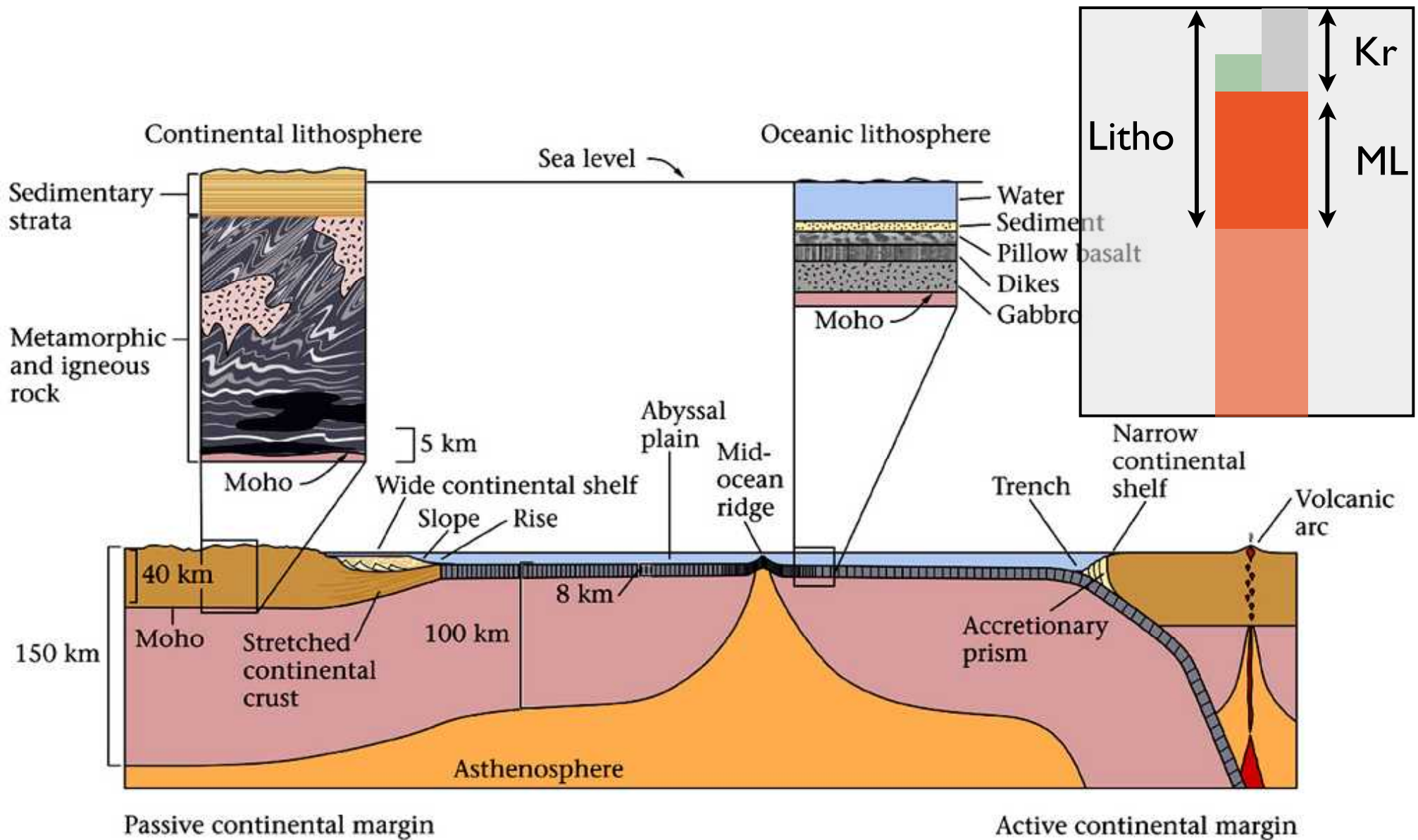
das plattentektonische Modell



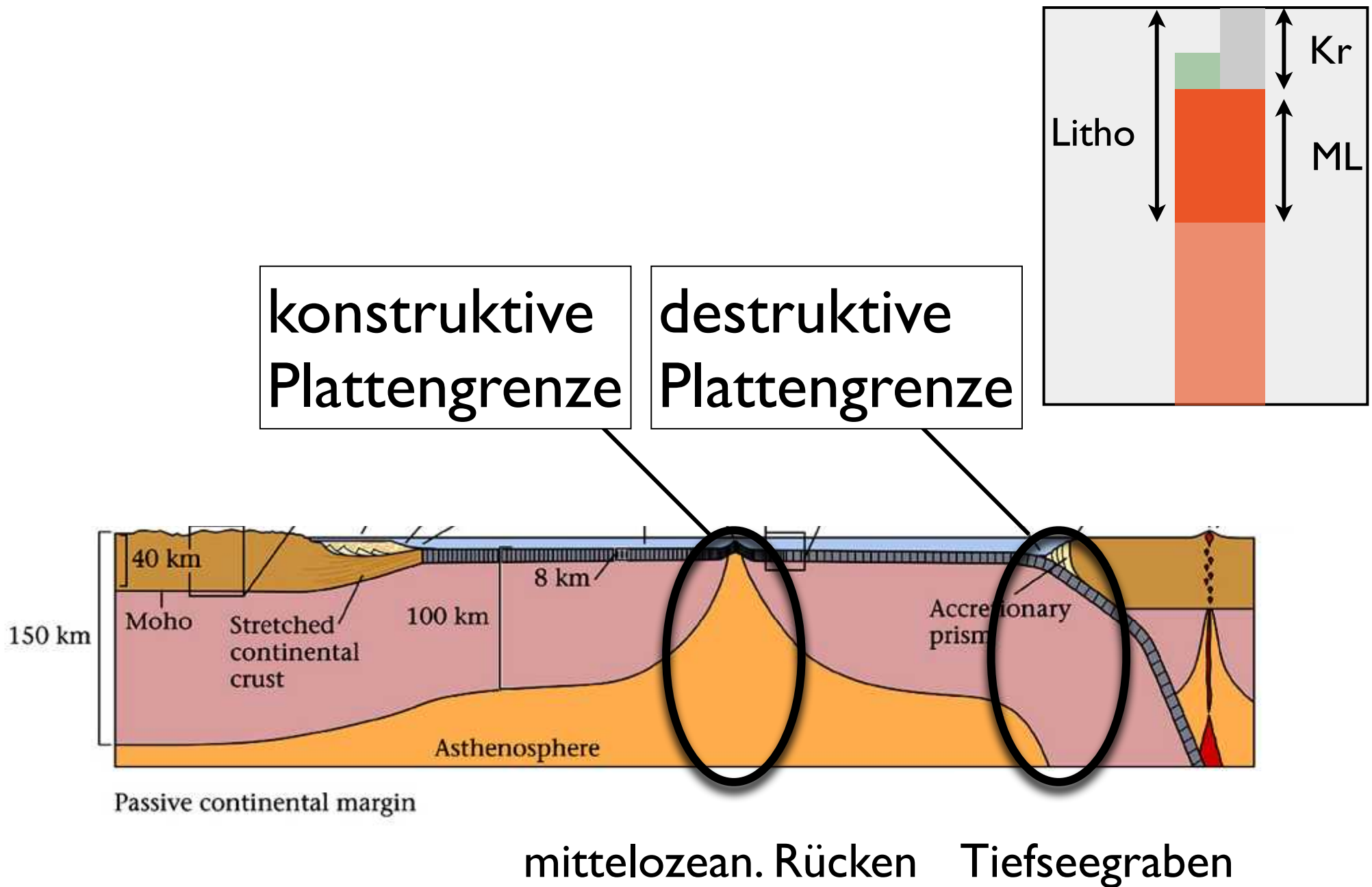
Platten sind Lithosphärenplatten:

Kruste
Mantel

Lithosphärenplatten



Lithosphärenplatten



Erkennen von Platten

Interaktion an Plattengrenzen (Seismik)

drei Typen Grenzen

konstruktive

distensive

destruktive

kompresive

konservative

Transform-

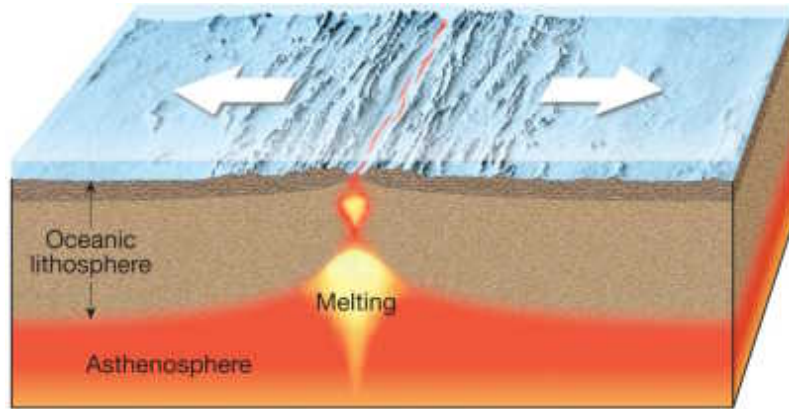
jede Platte hat alle drei Typen von Grenzen

neue Grenzen entstehen, wenn das

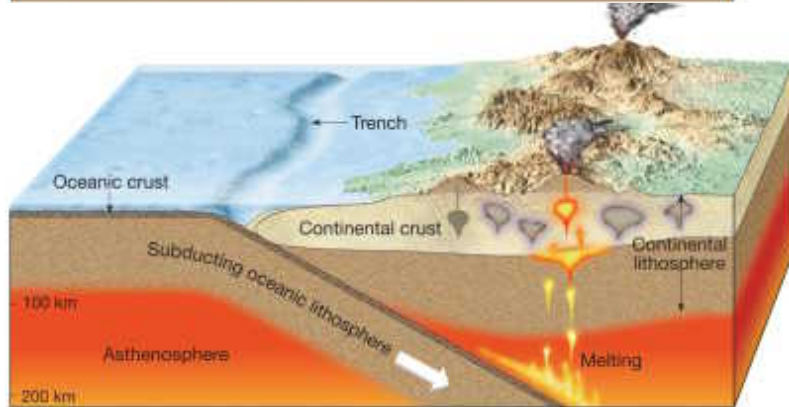
Bewegungsmuster / Kräftefeld ändert

Platten können Spannungen übertragen

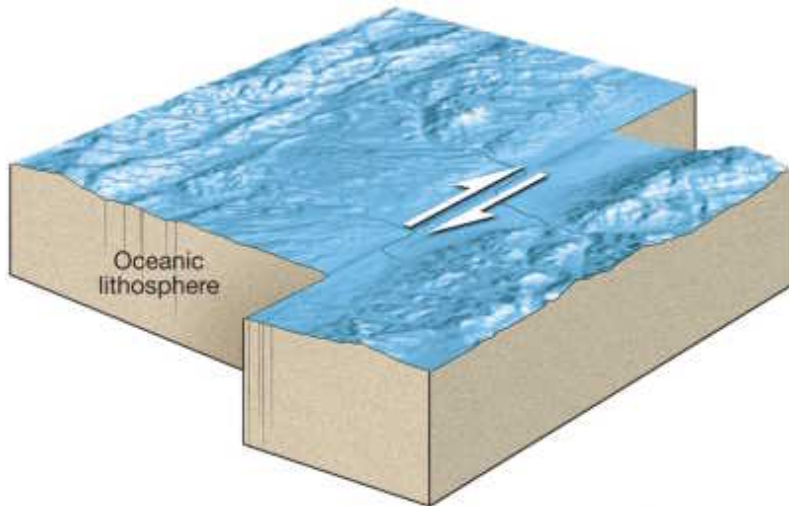
3 types of plate boundaries



divergent - constructive



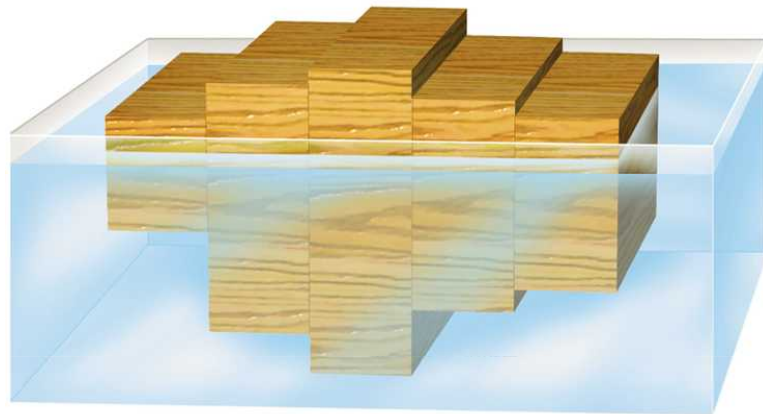
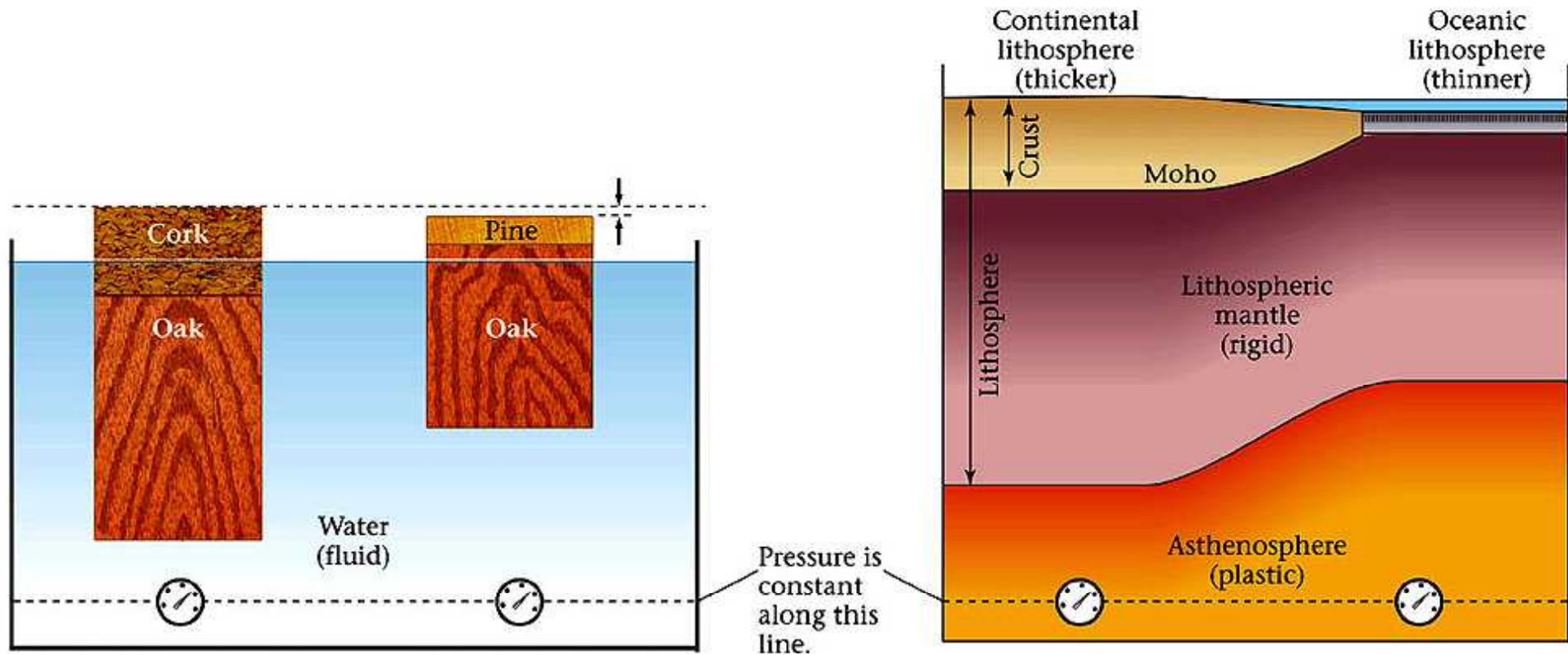
convergent - destructive



transform fault - conserving

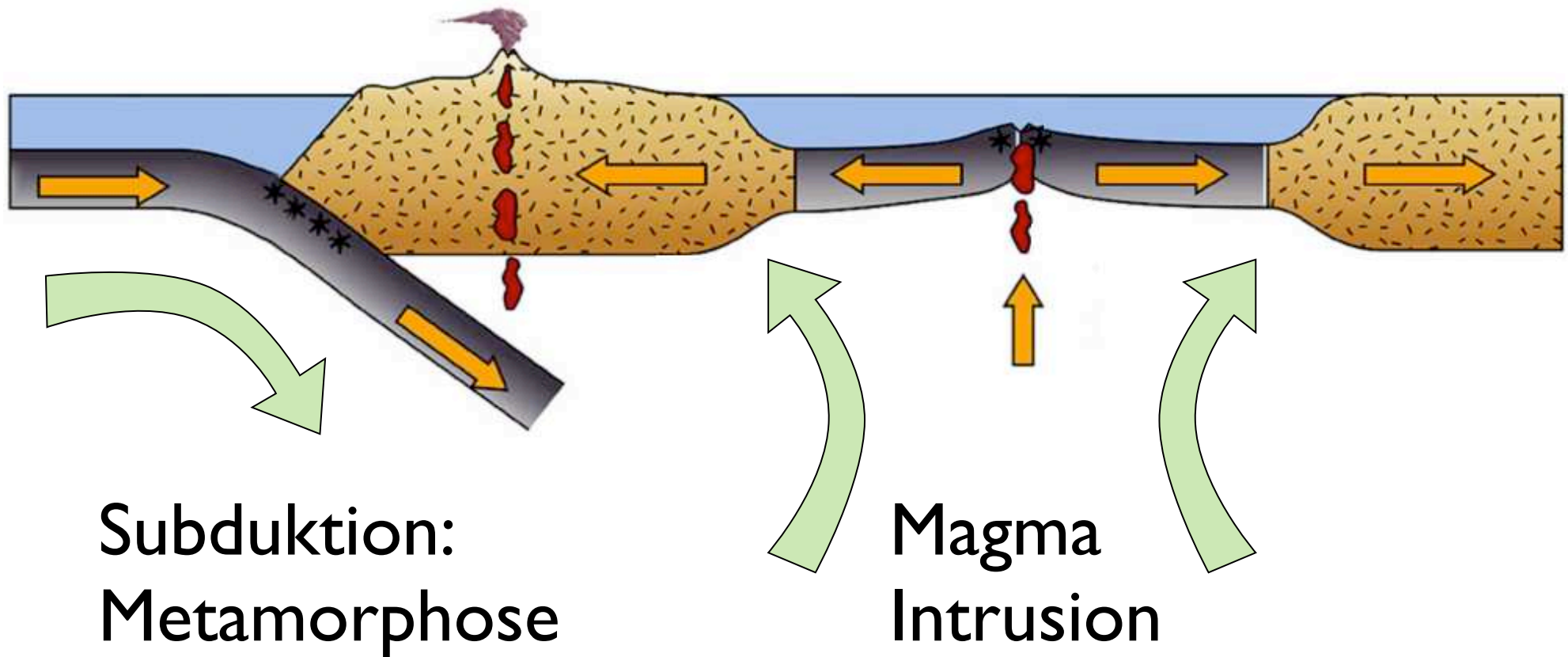


Das Prinzip der Isostasie



Archimedes
Gewicht der Platte =
verdrängter Mantel

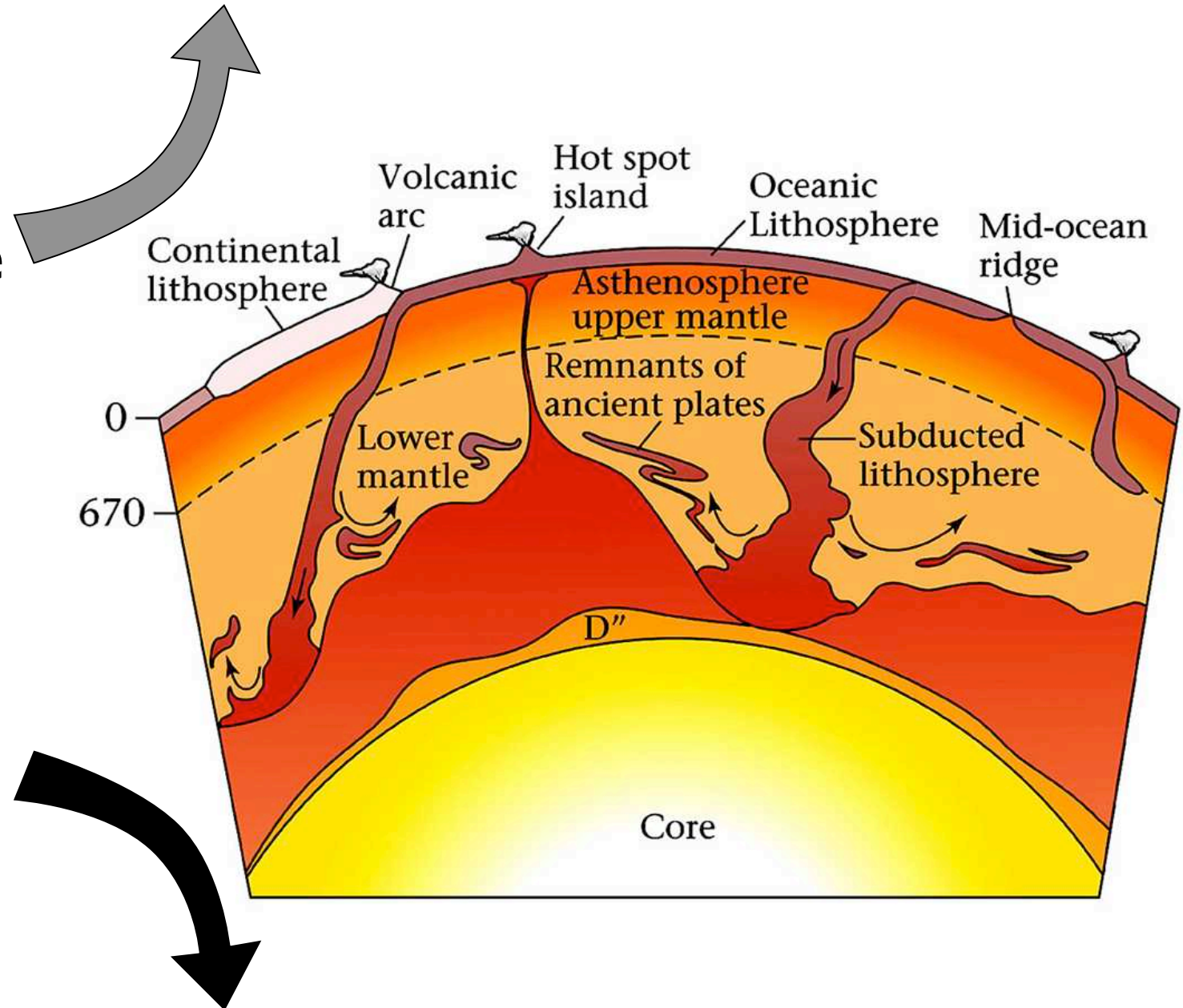
Plattentektonischer Kreislauf



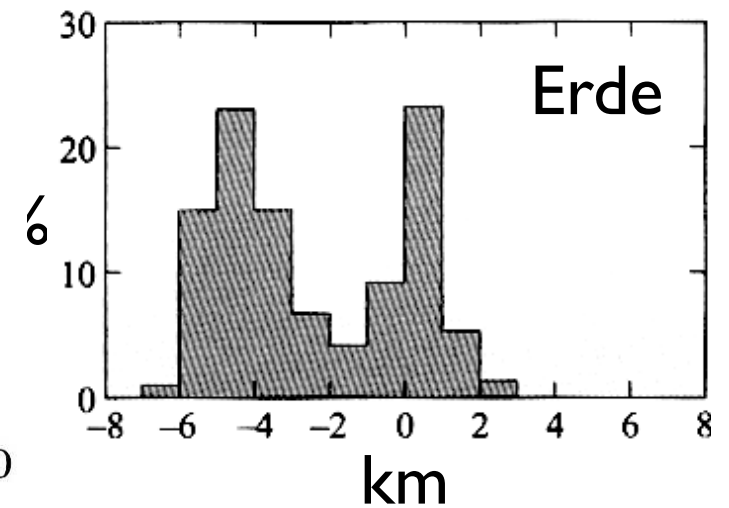
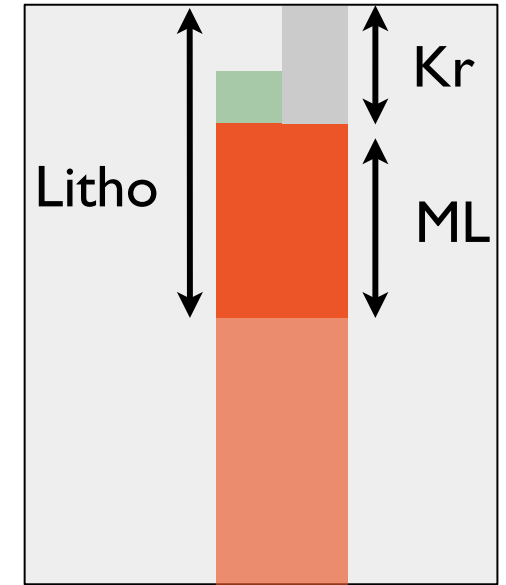
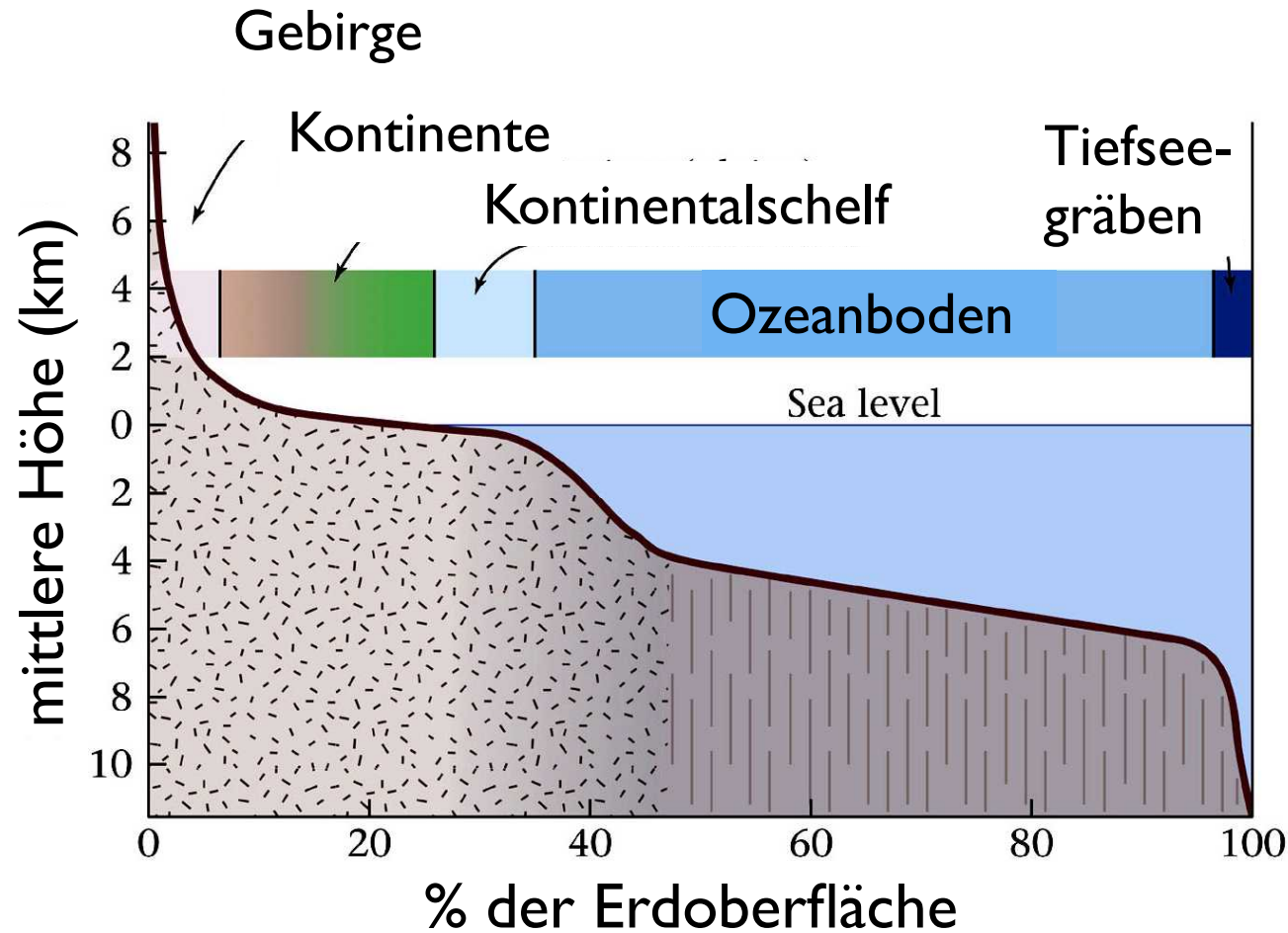
Plattentektonischer Kreislauf

leichte
kontinentale
Kruste /
Platte

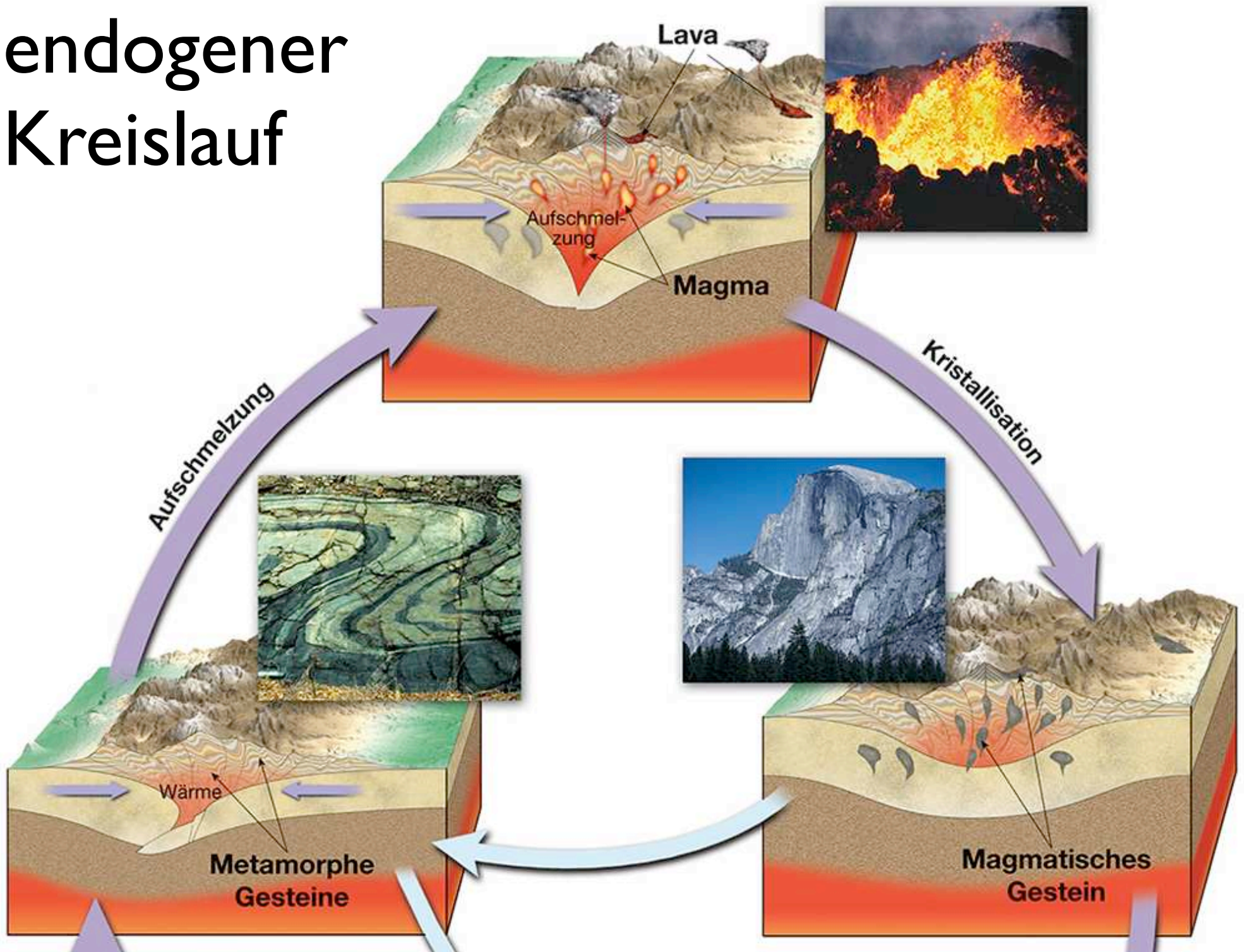
schwere
ozeanische
Kruste /
Platte

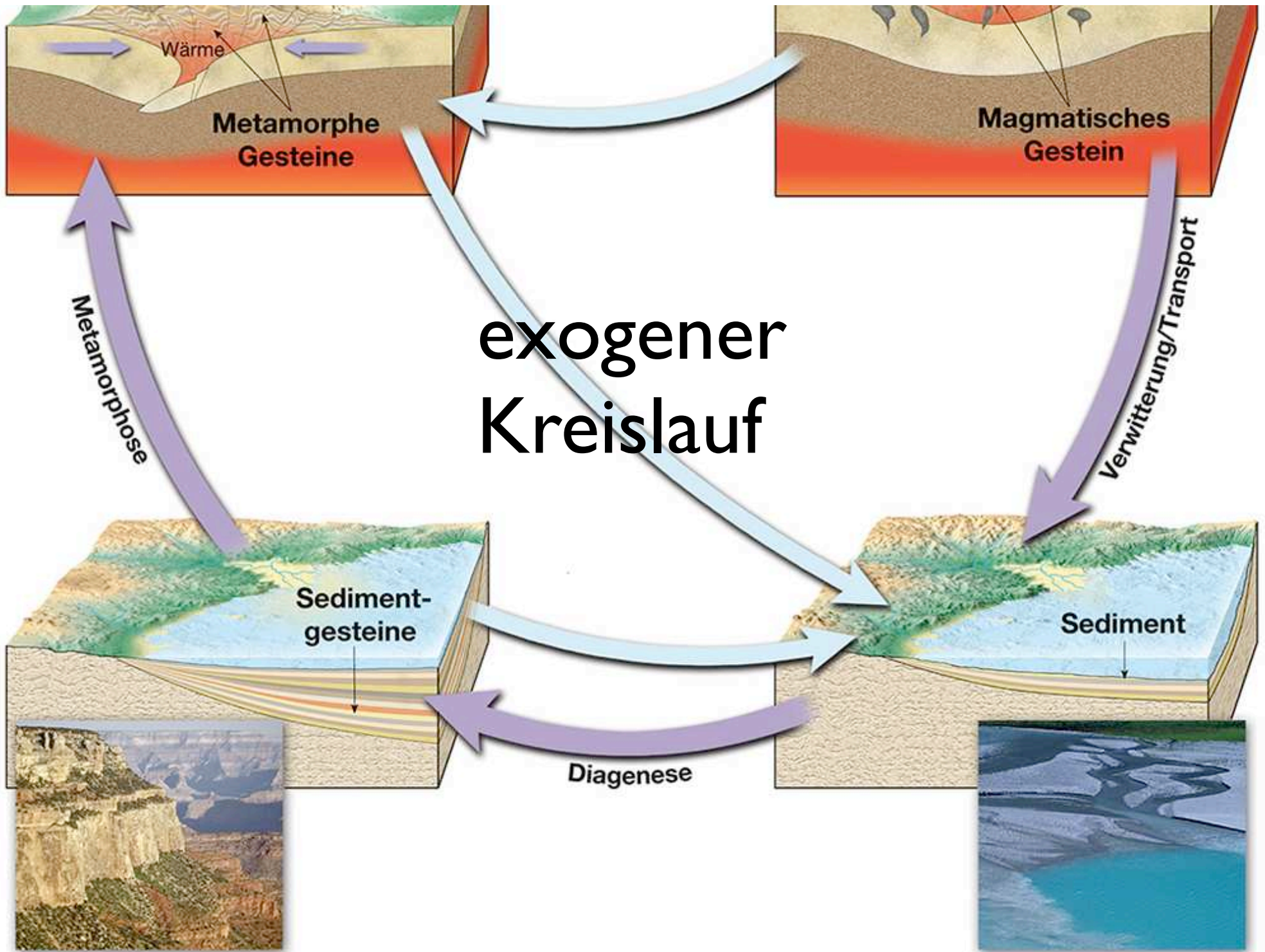


Hypsometrisches Histogramm

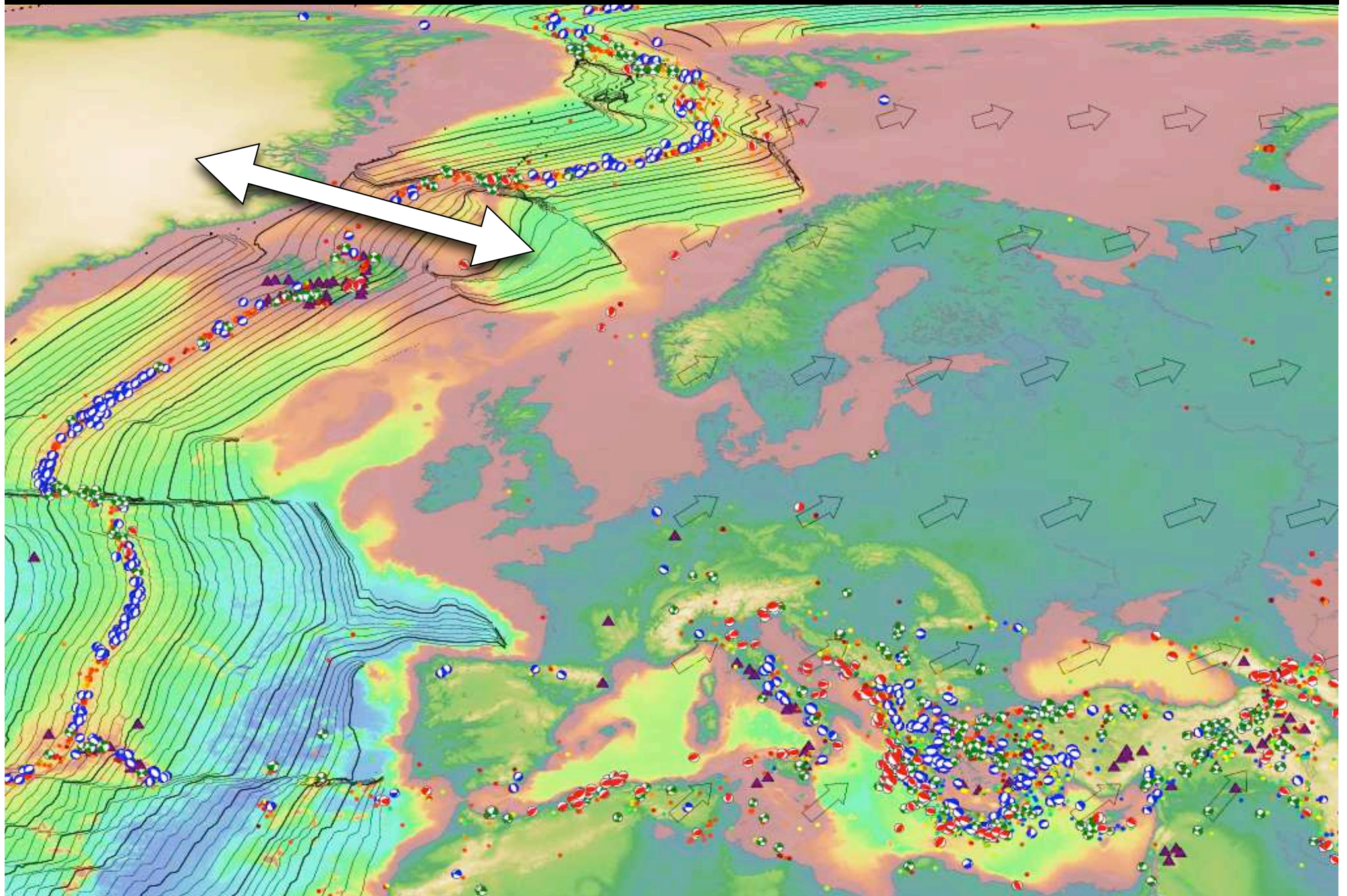


endogener Kreislauf

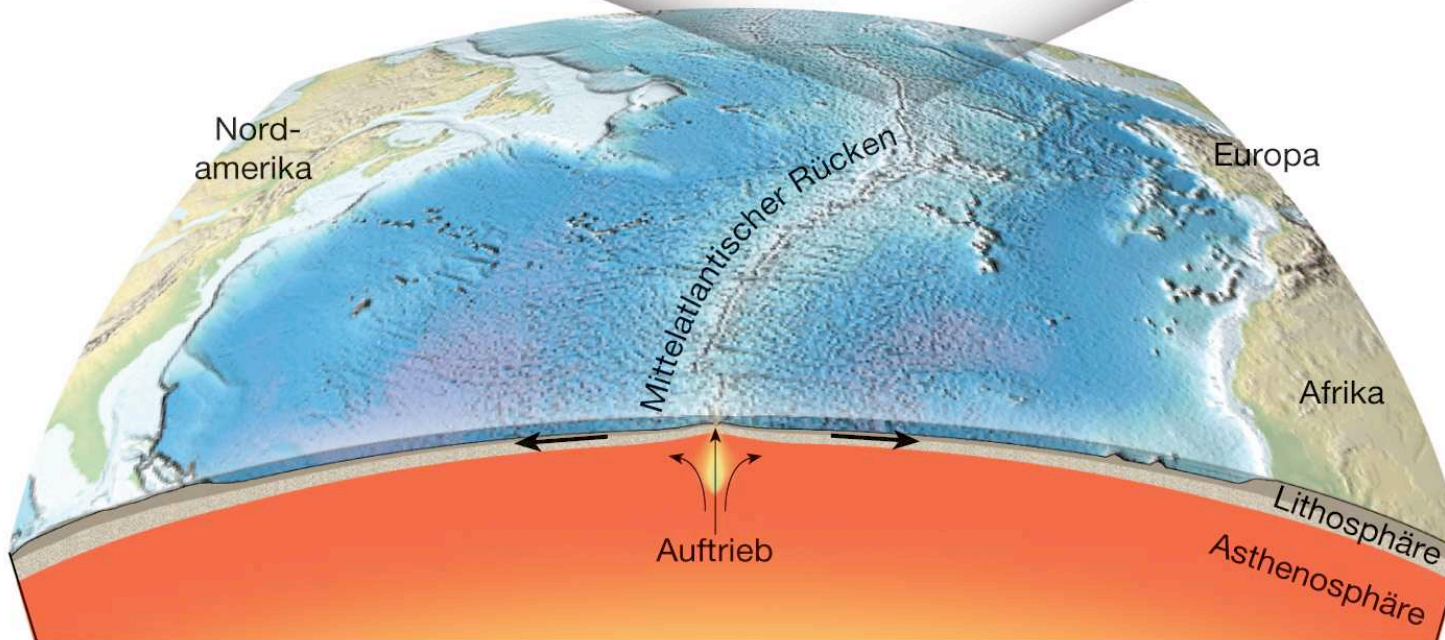
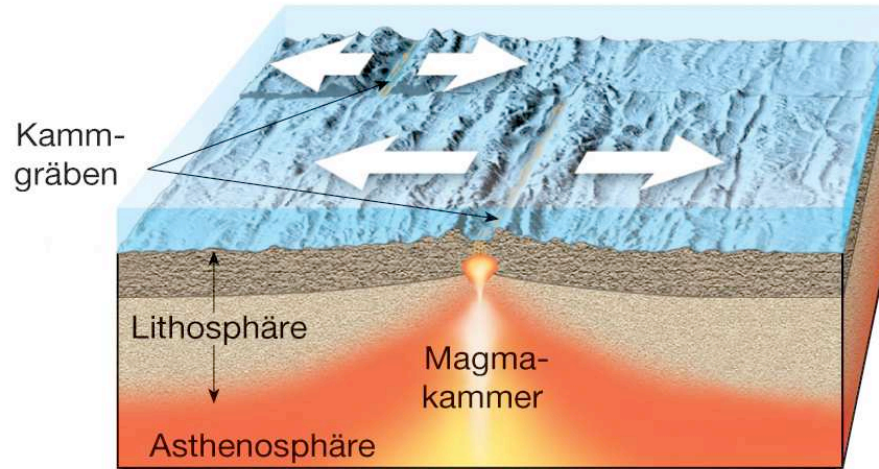




konstruktive Plattengrenze

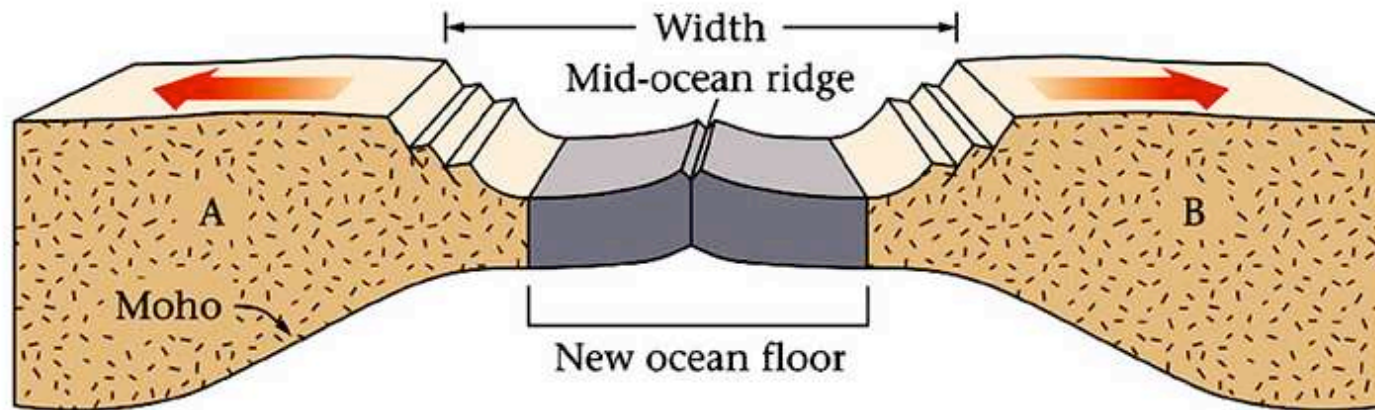


Konstruktive Plattengrenzen

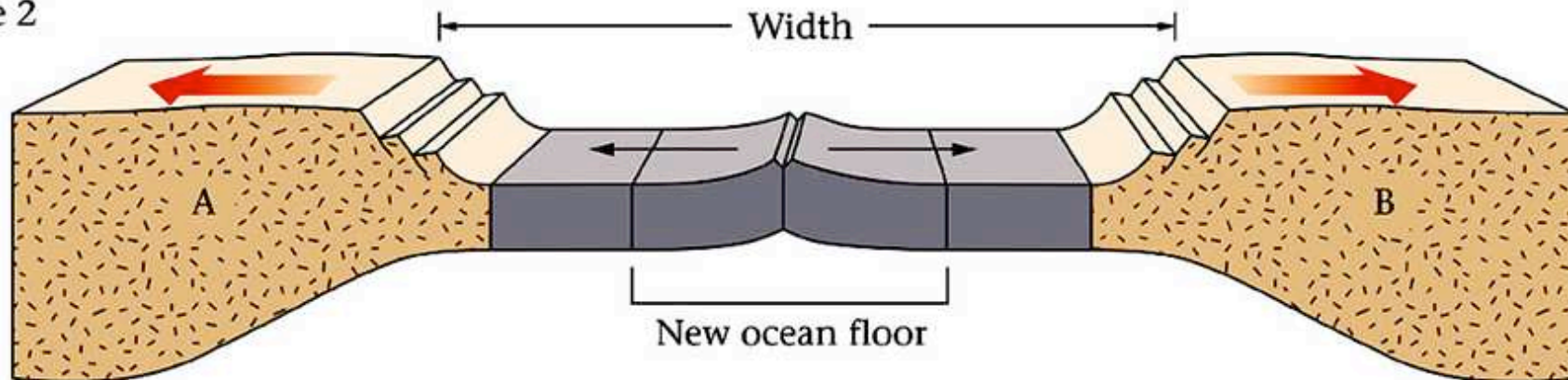


konstruktiv
=
divergent
=
distensiv

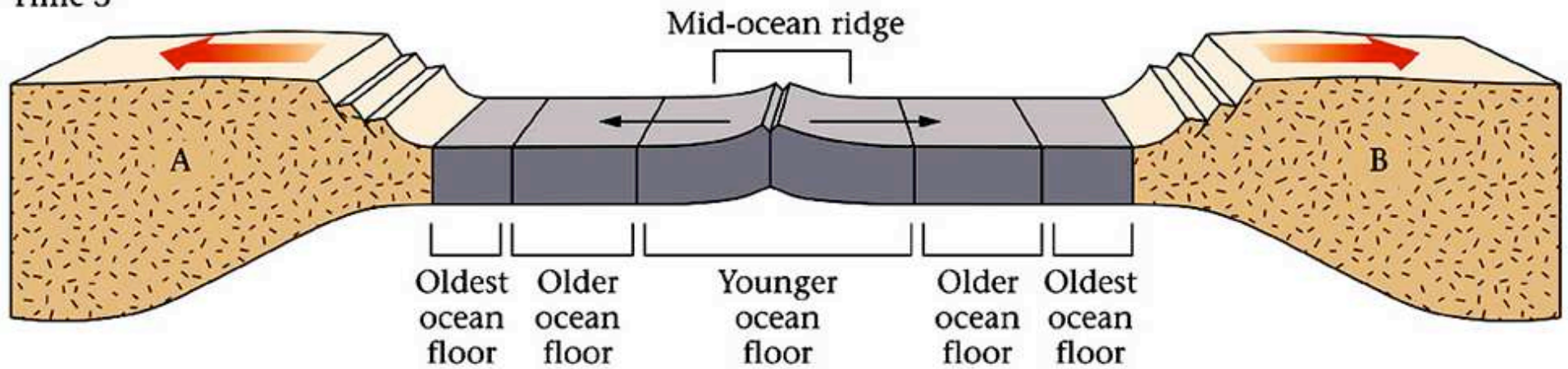
Time 1



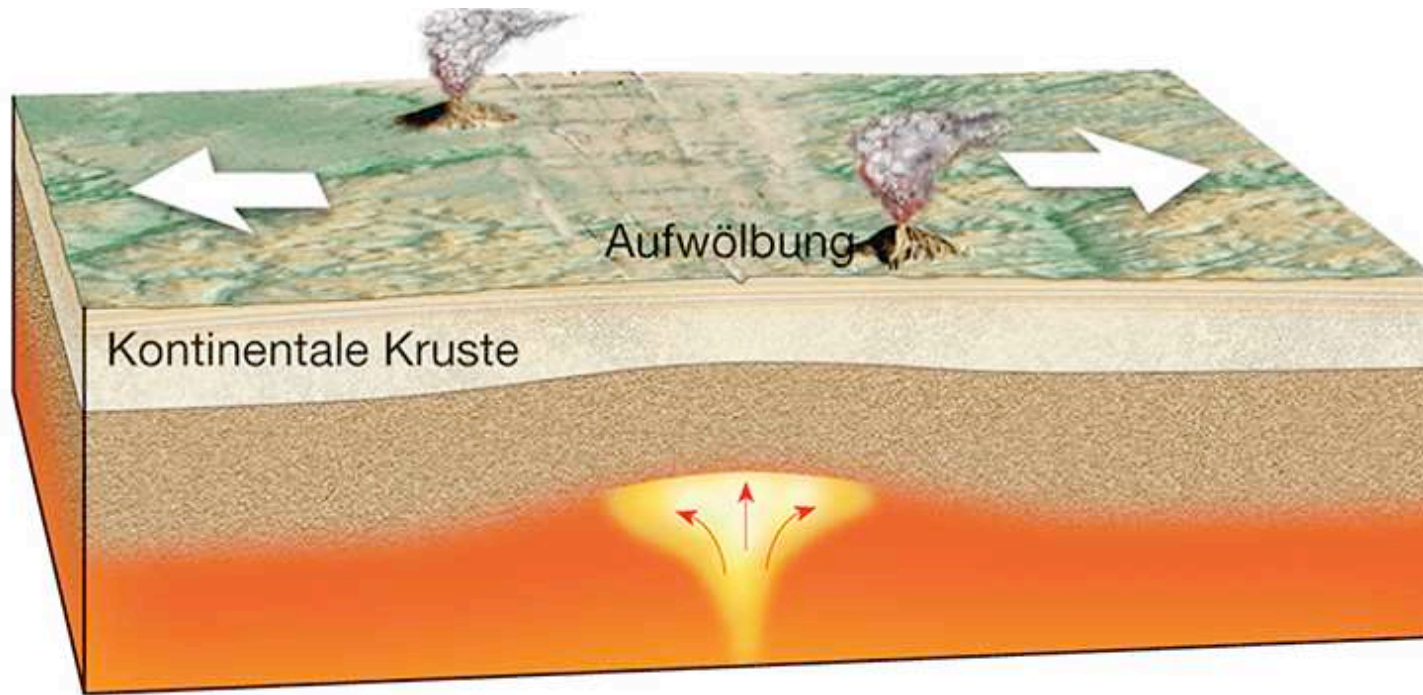
Time 2



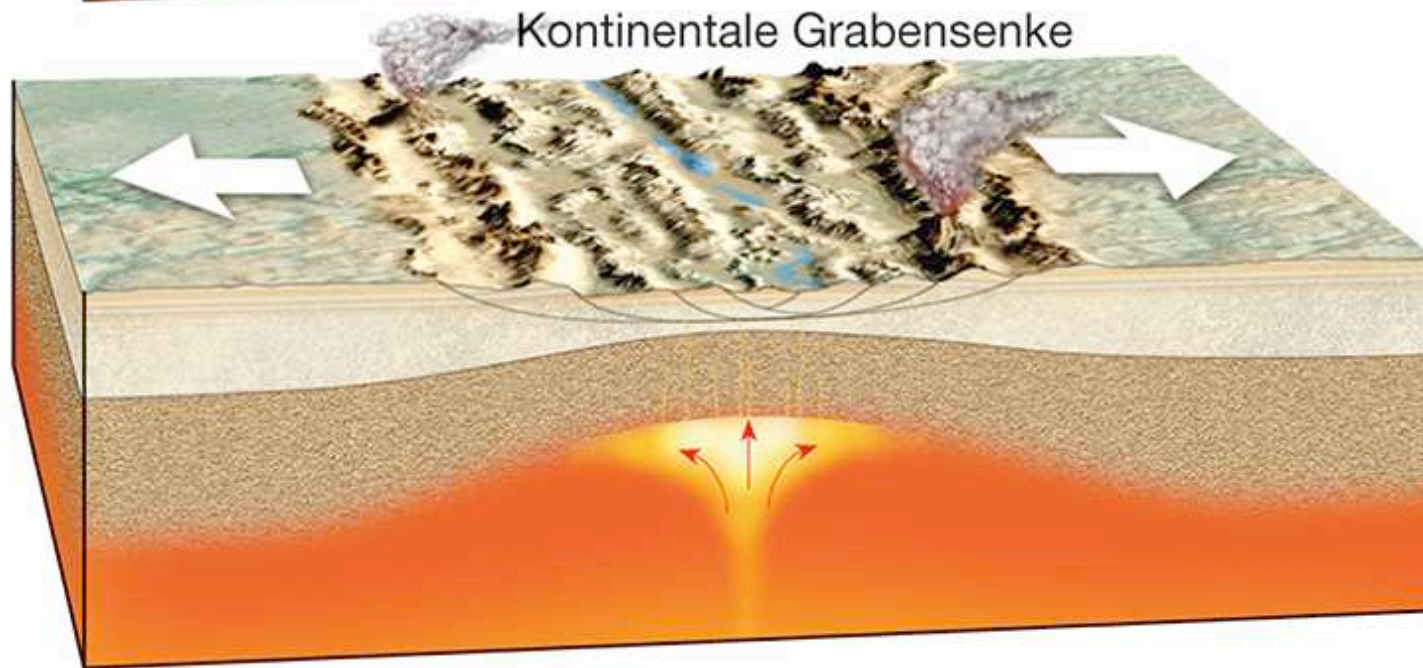
Time 3



Vom kontinentalen Grabenbruch ...

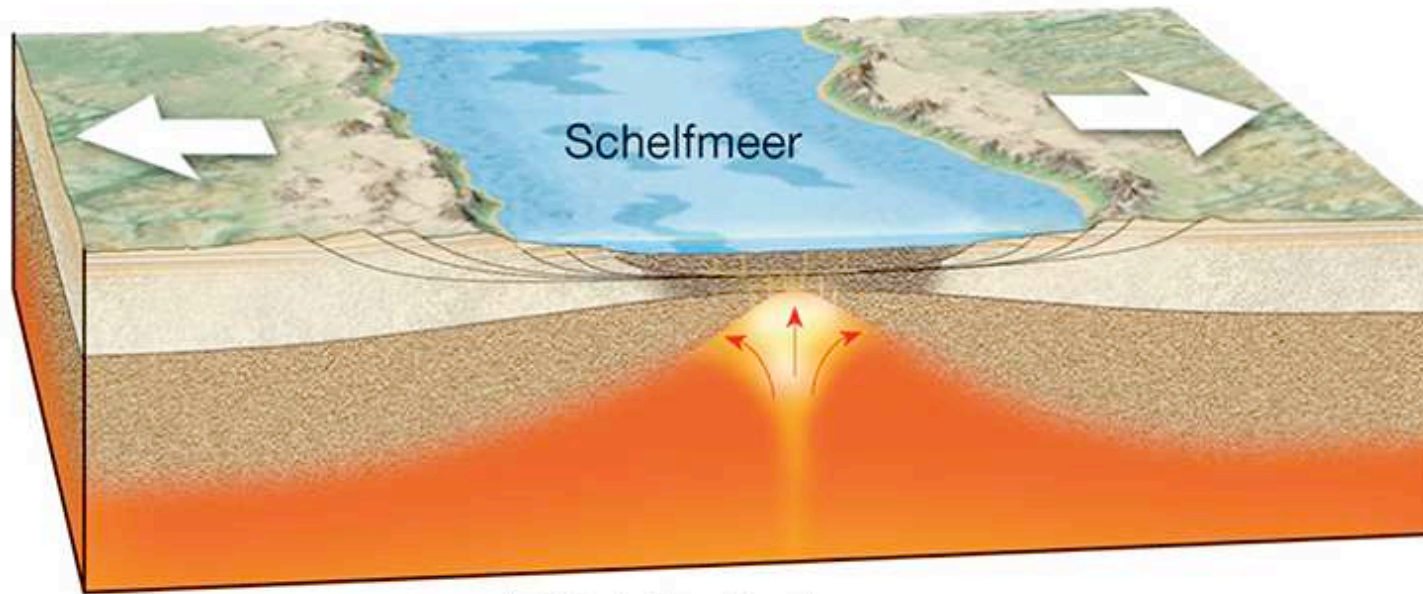


A.

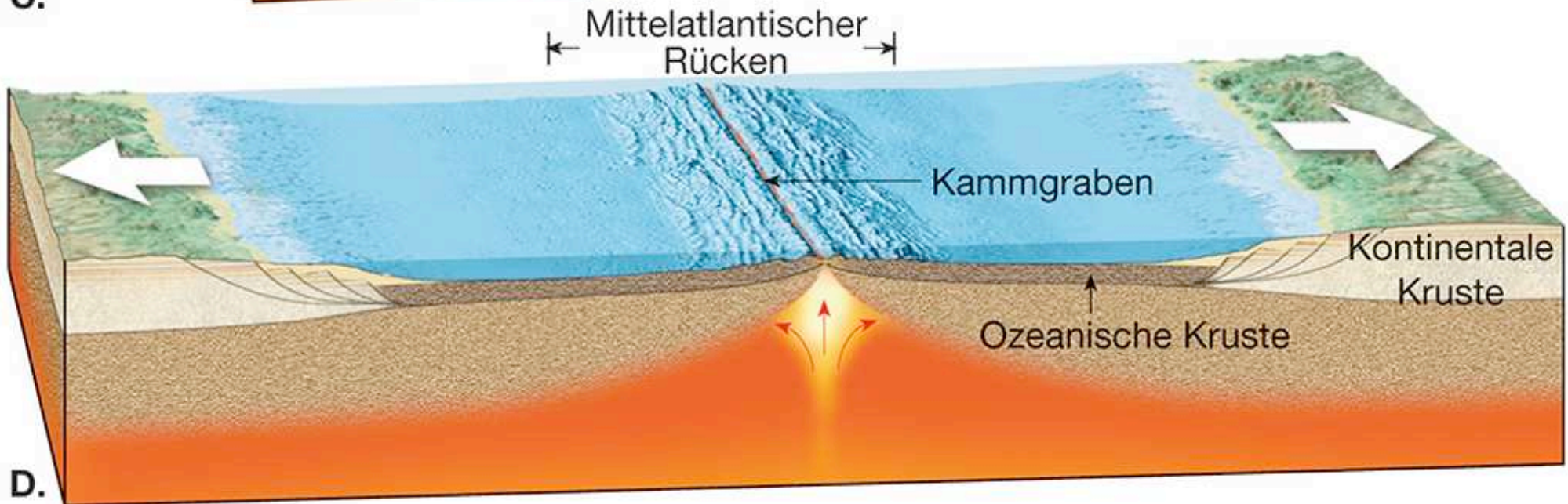


B.

... zum Ozeanbecken

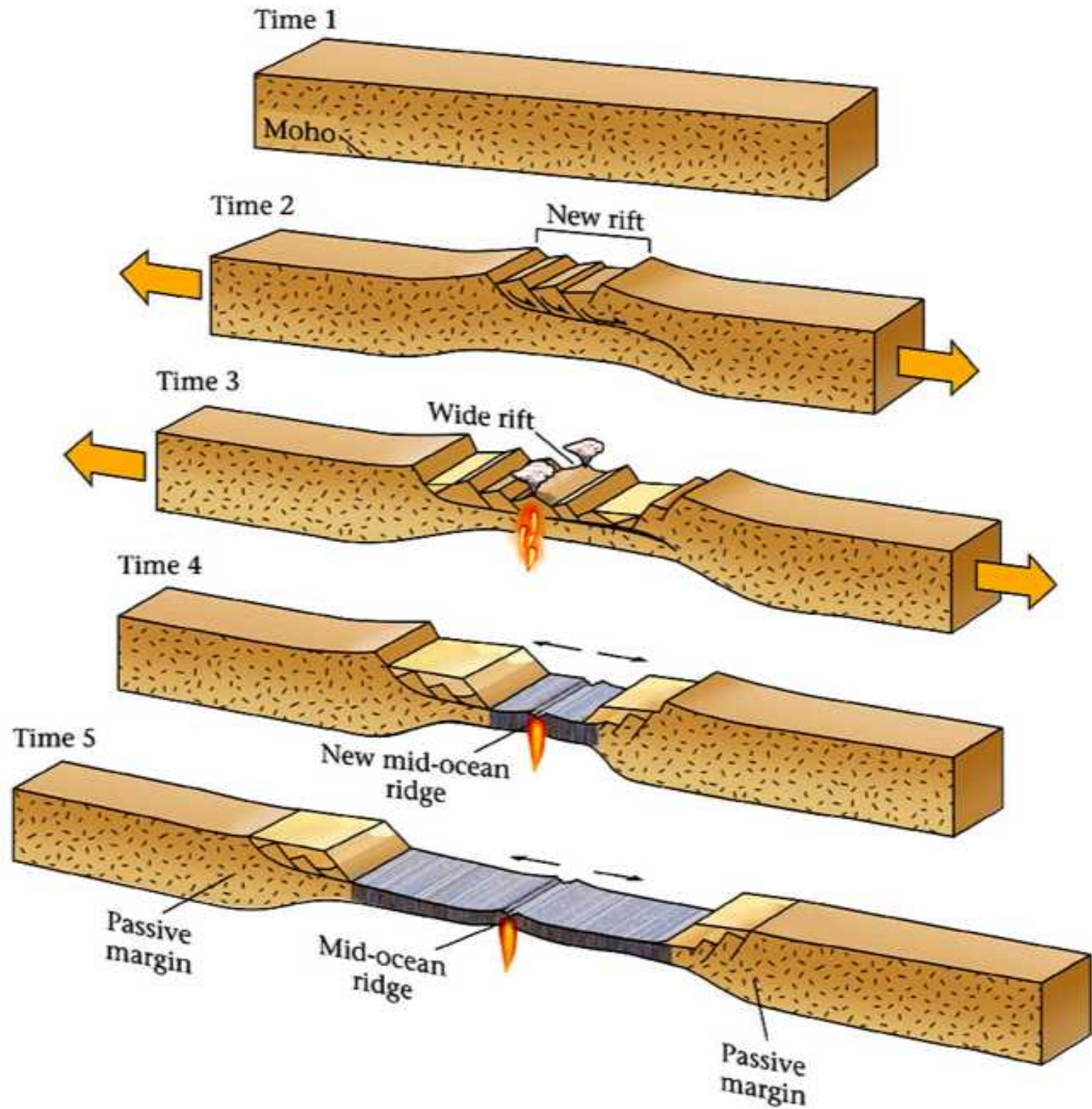


C.

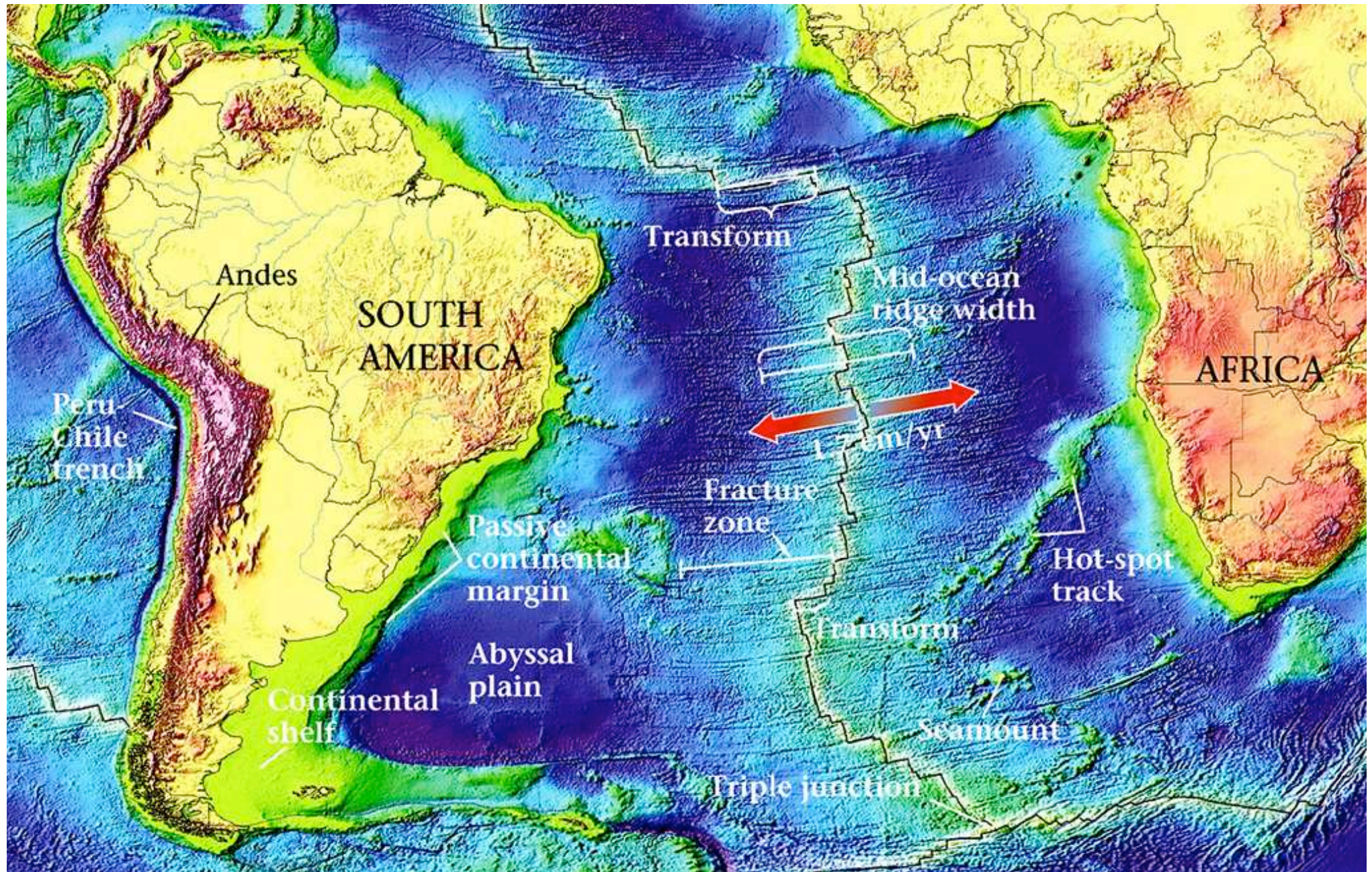


D.

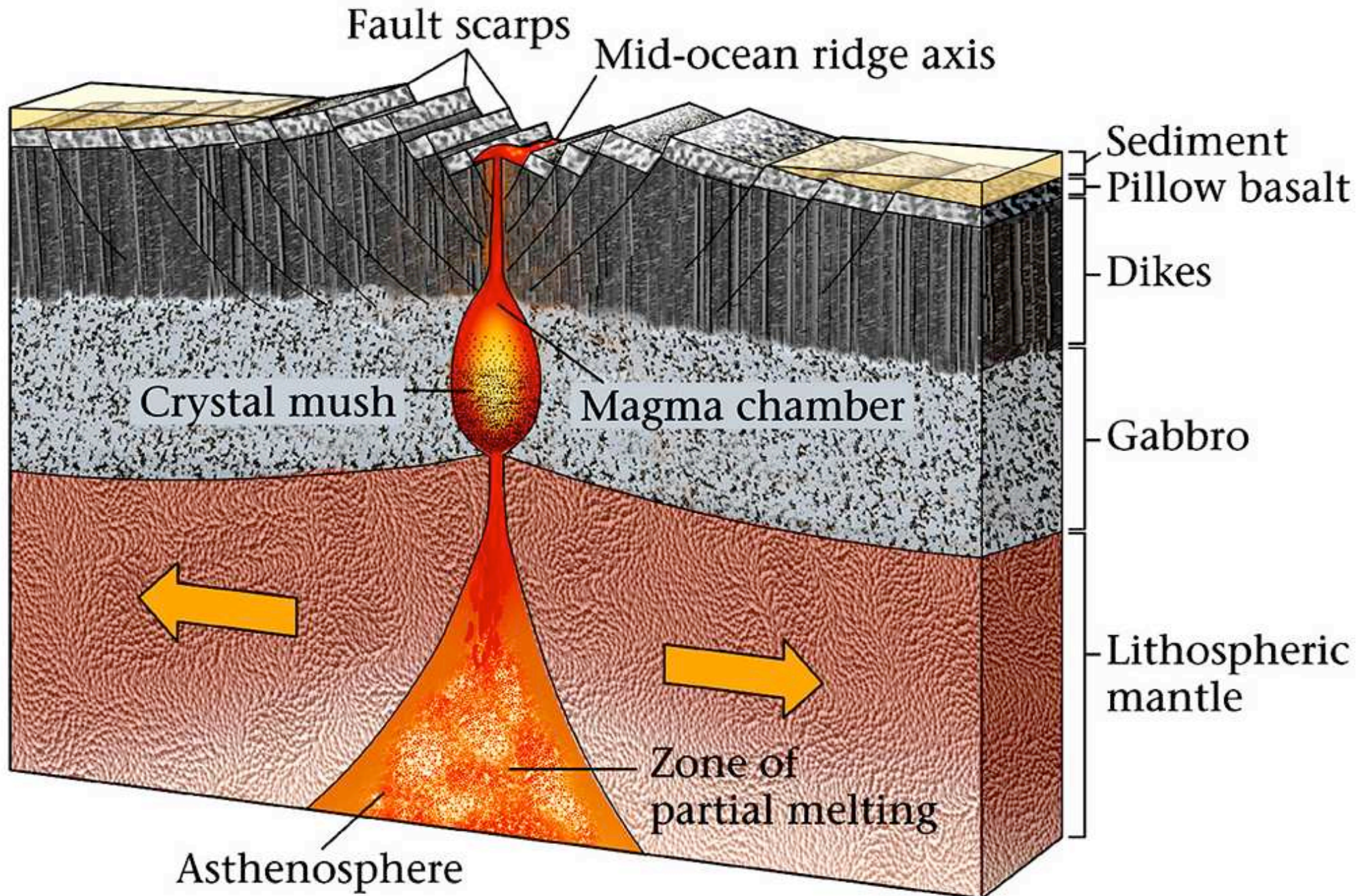
Schema



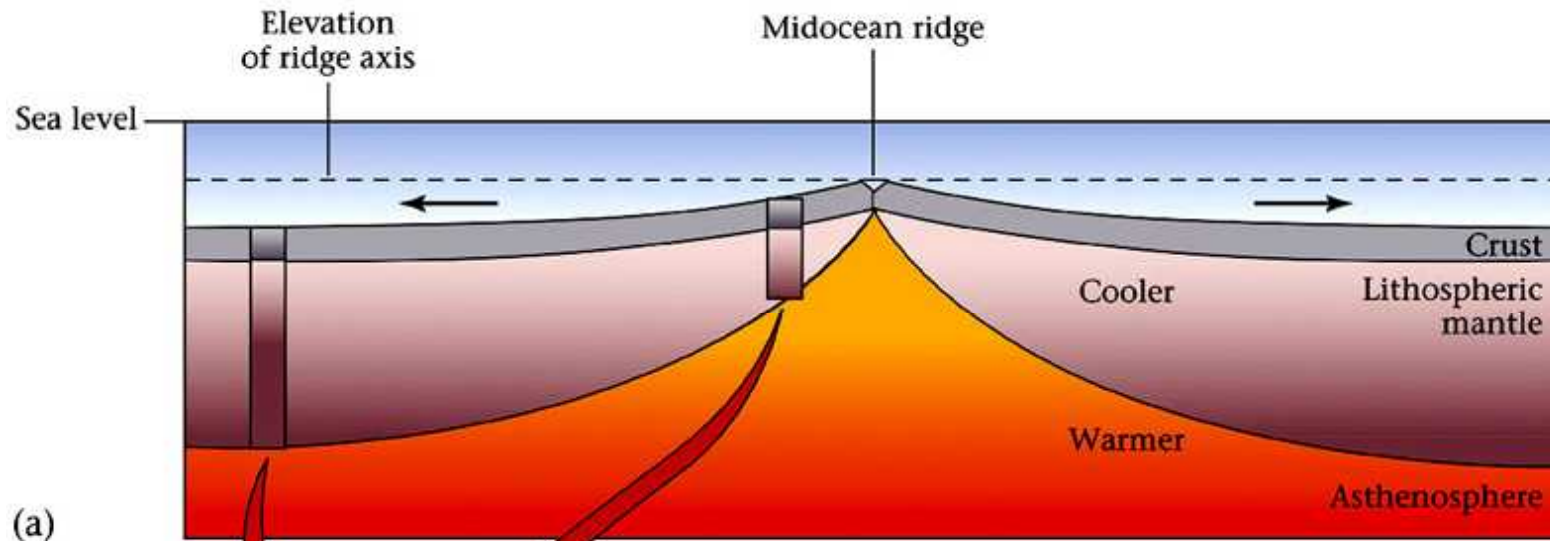
Mittelatlantisches Rückensystem



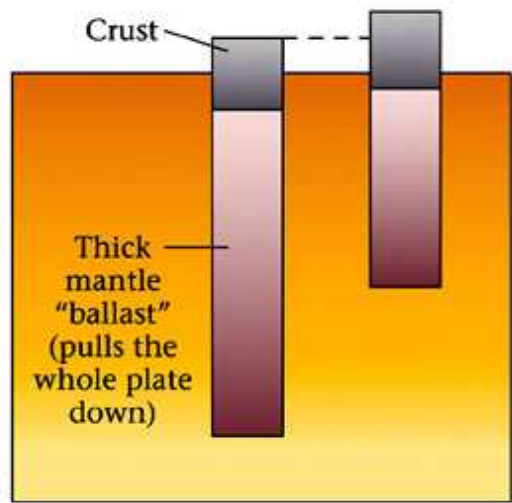
Bildung ozeanischer Kruste



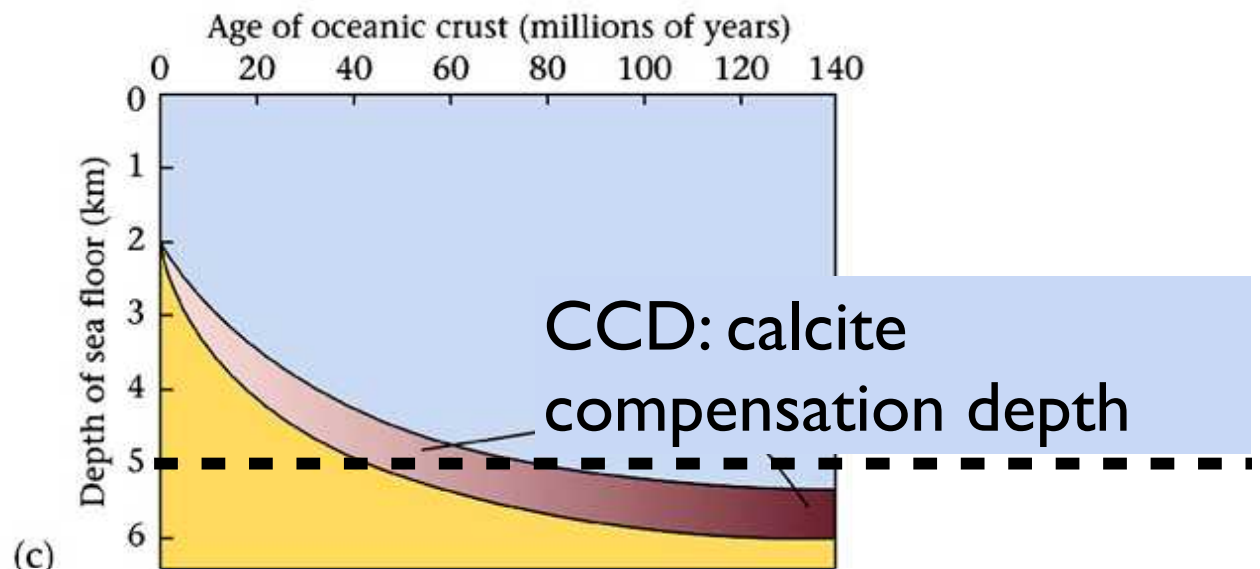
älter ... kälter ... dichter ... tiefer



(a)



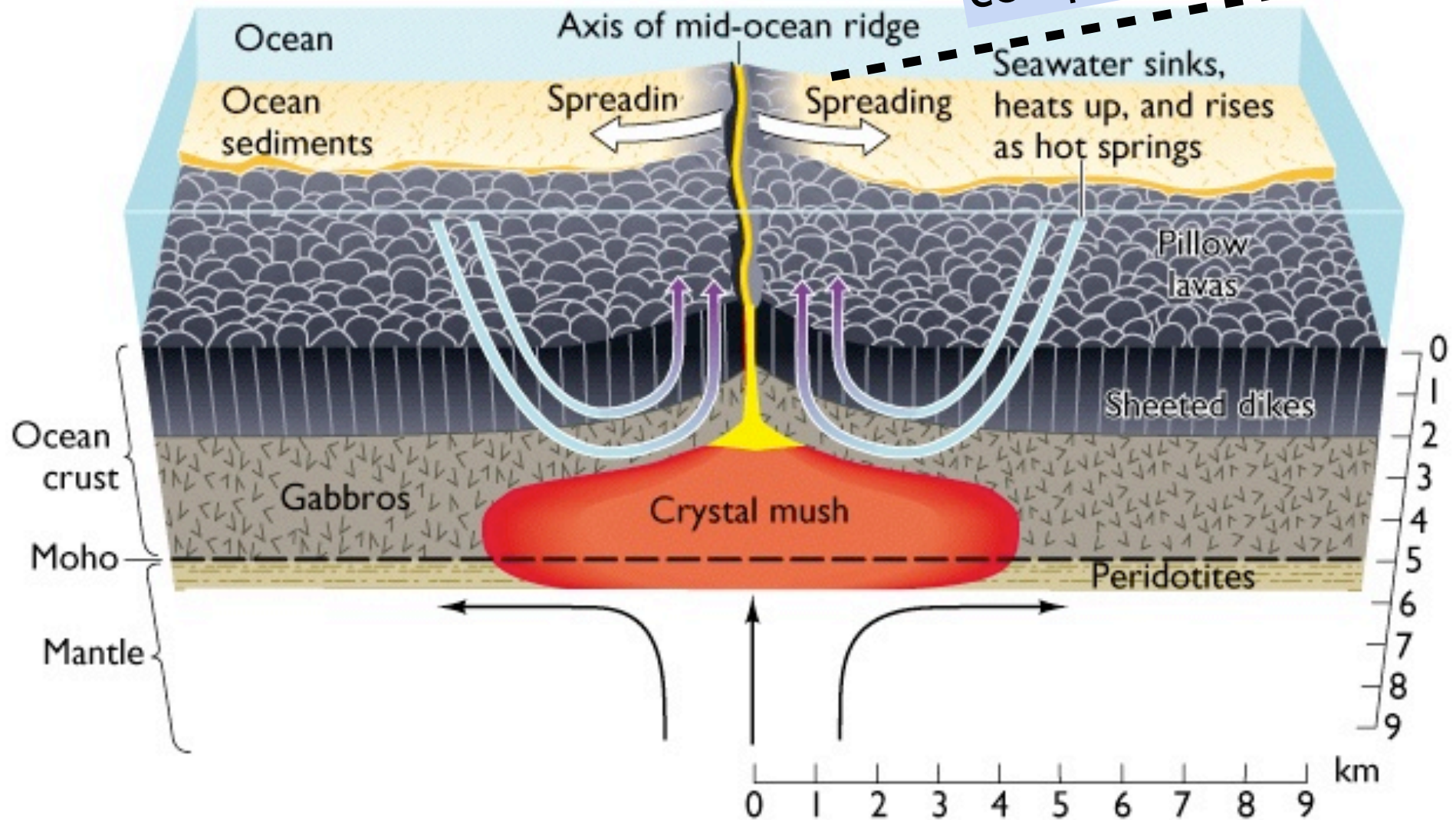
(b)



(c)

Ozeanische Kruste

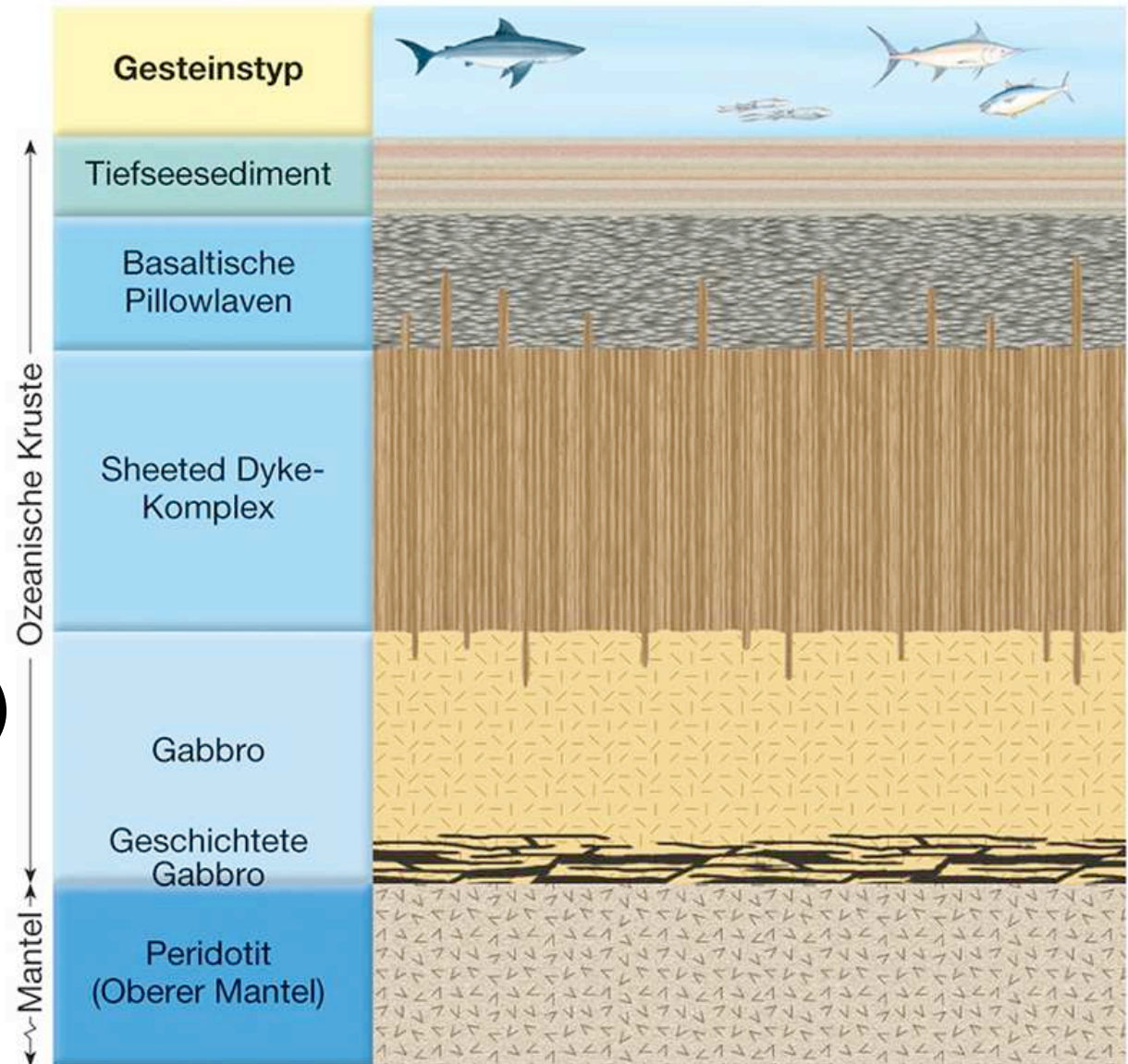
CCD: calcite compensation depth



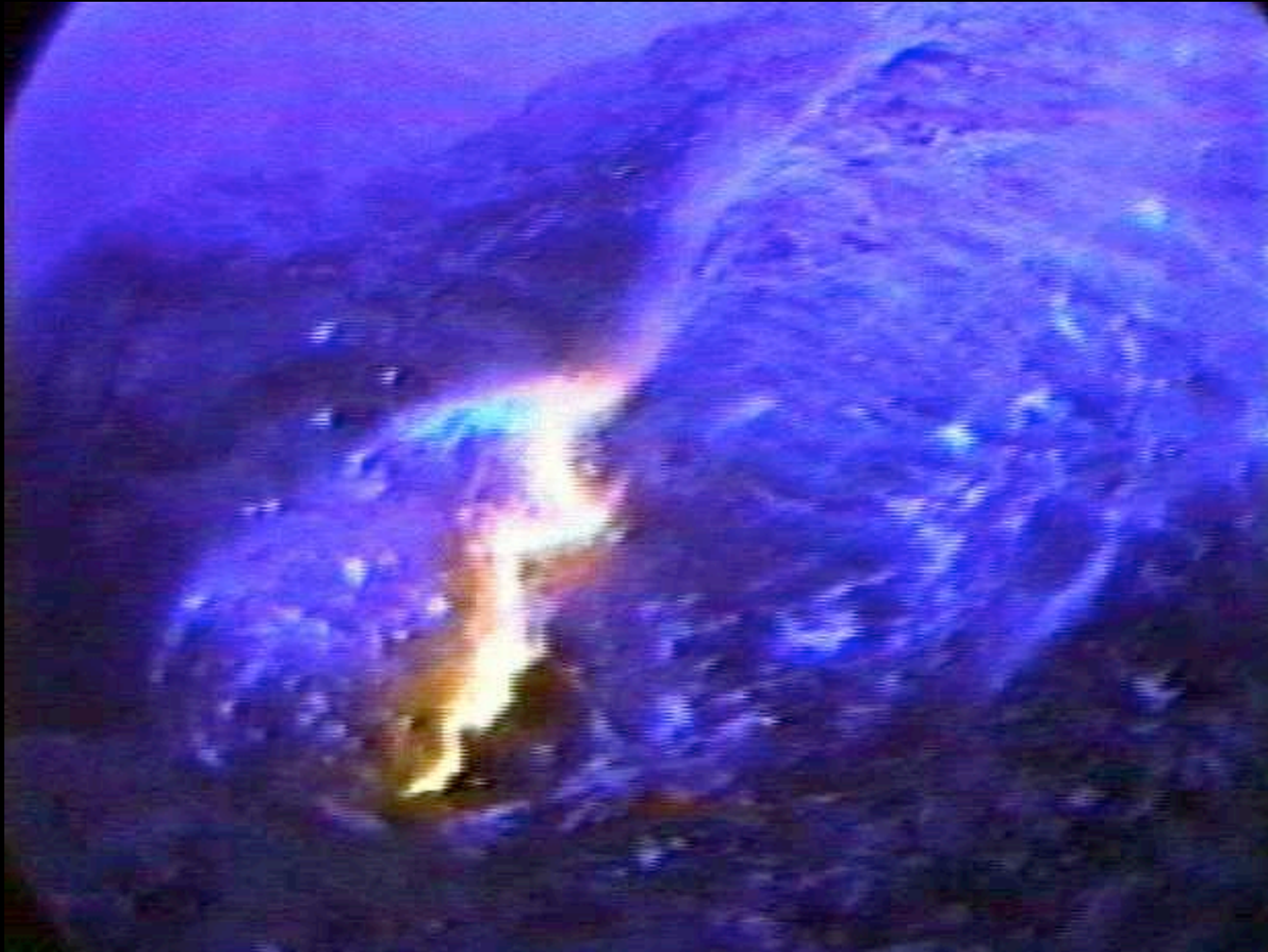
Ozeanische Kruste

- 1- Unverfestigte Sedimente
- 2- Kissenlava
- 3- Sheeted Dyke Komplex
- 4- Gabbro (Ophiolit Komplex)

Mantel:
Peridotit



Bildung von Kissenlava (pillow lava)



<http://video.yahoo.com/watch/111691/635356>

pillows



pillow lava (New Zealand)



pillows



"Ozean im Gebirge"



Pillow-Lava am Marmorera Staudamm

Tiefsee-Sedimente



verfalteter Radiolarit

Tiefsee-Sedimente

weisser pelagischer Kalk
Majolica (frühe Kreide, Südtessin)

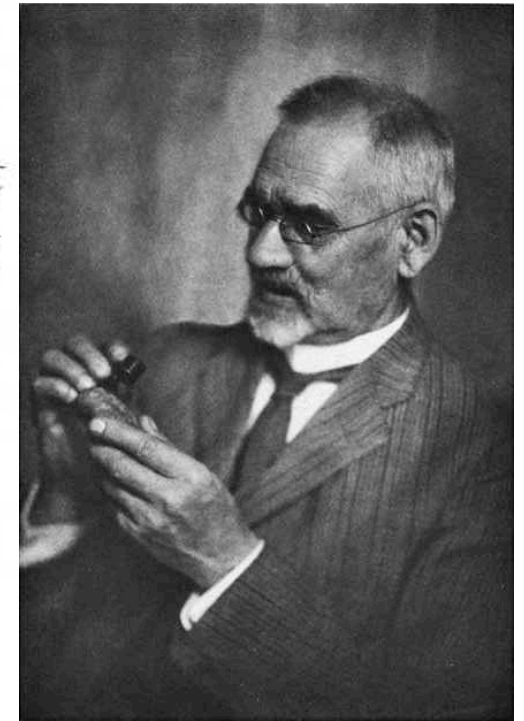
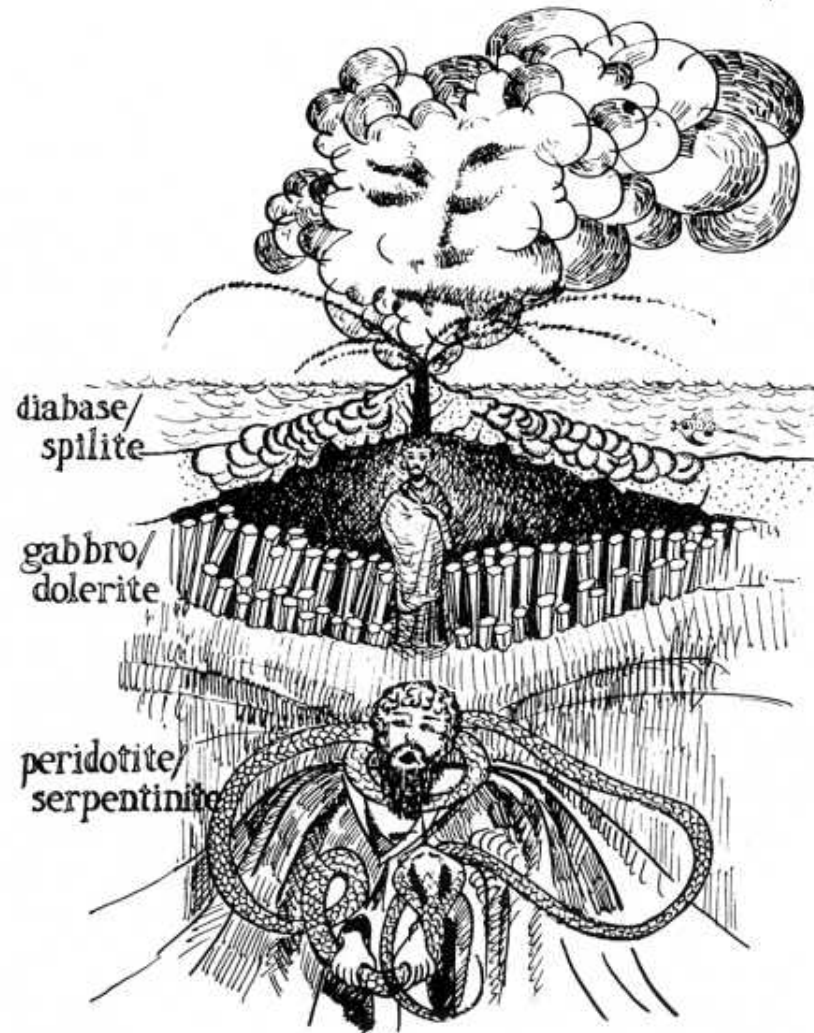


Silex

grün - rot - weiss !

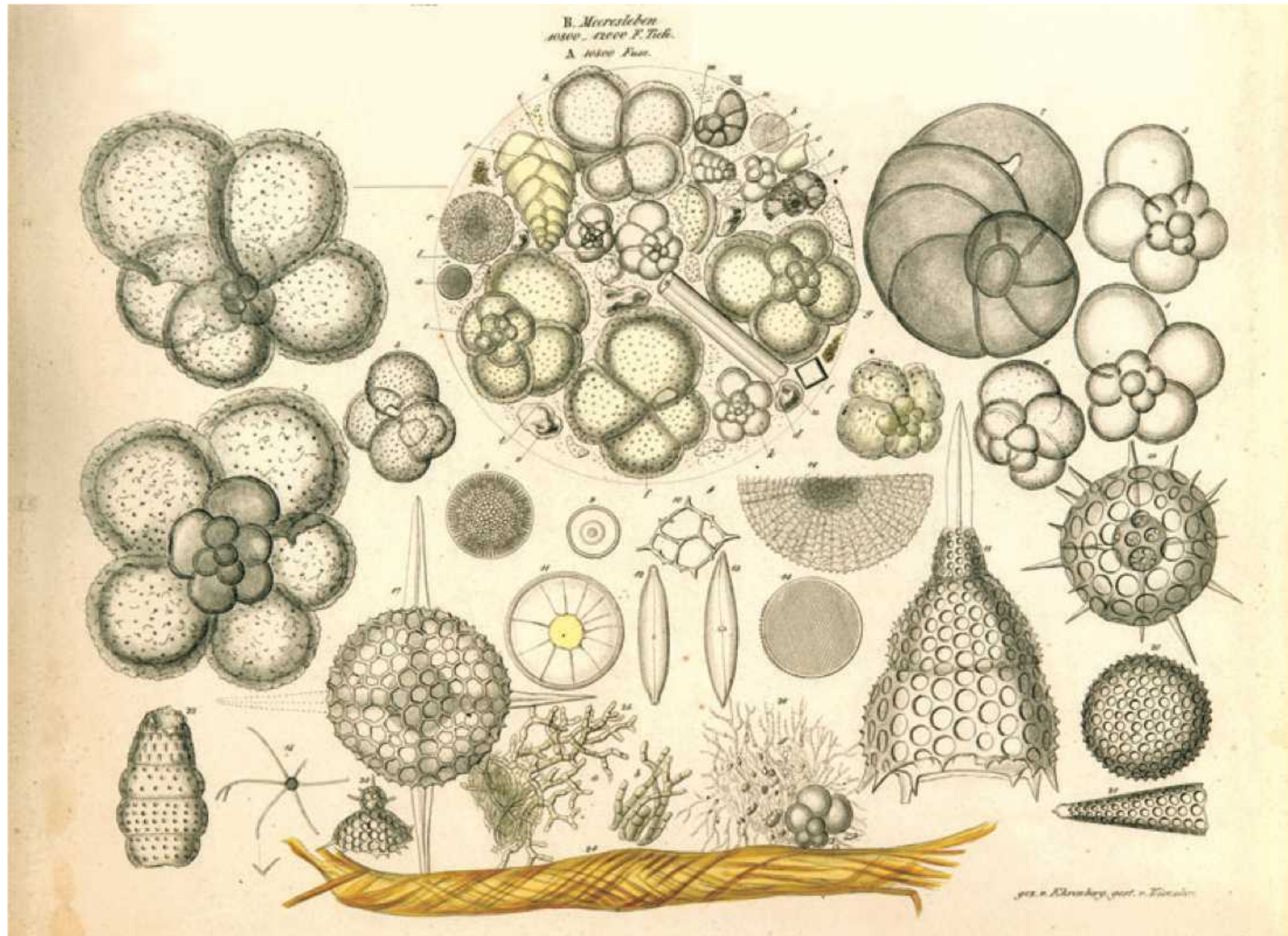


the Steinmann trinity.

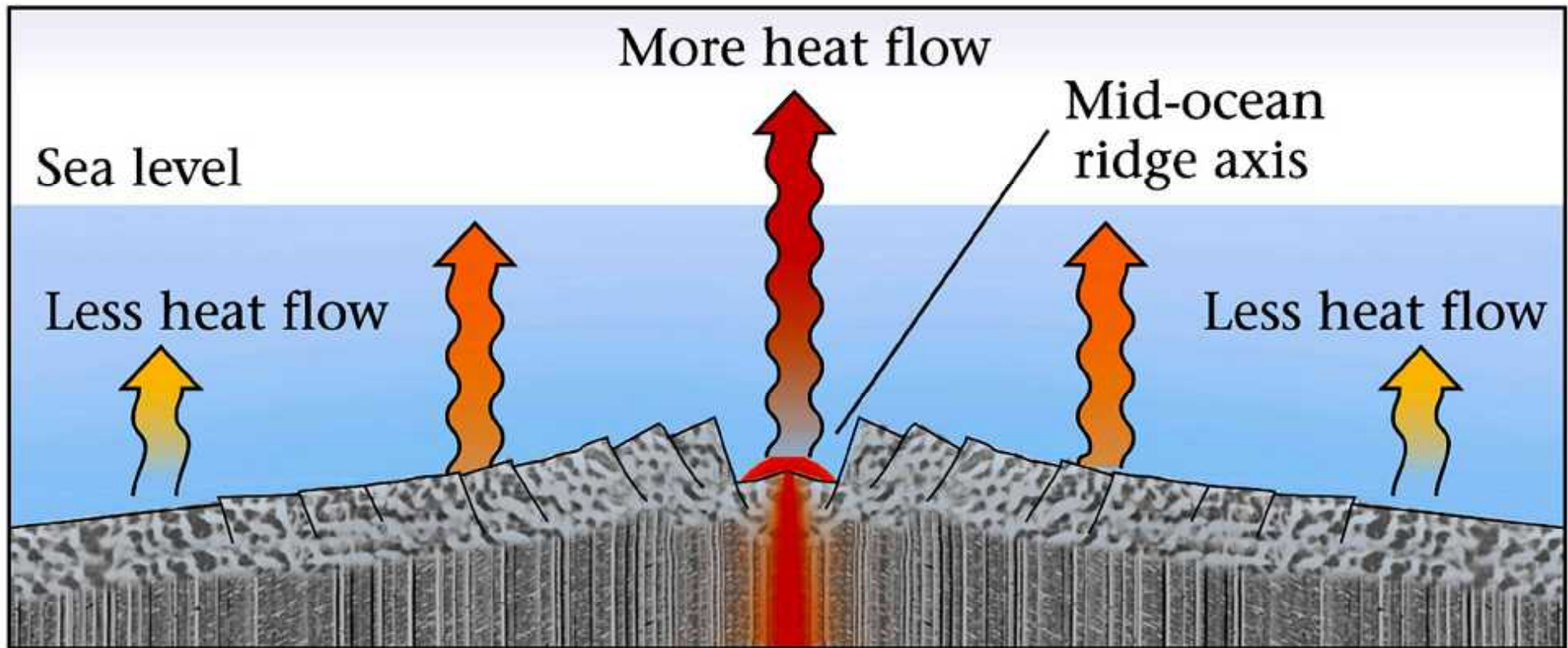


Gustav Steinmann
(1856 - 1929)

Diatomeen ... Meeresleben



Wärmefluss



typische Werte (10^{-3}Wm^{-2})

mid-ocean ridge
old oceanic crust
young mountain belts
old cratons

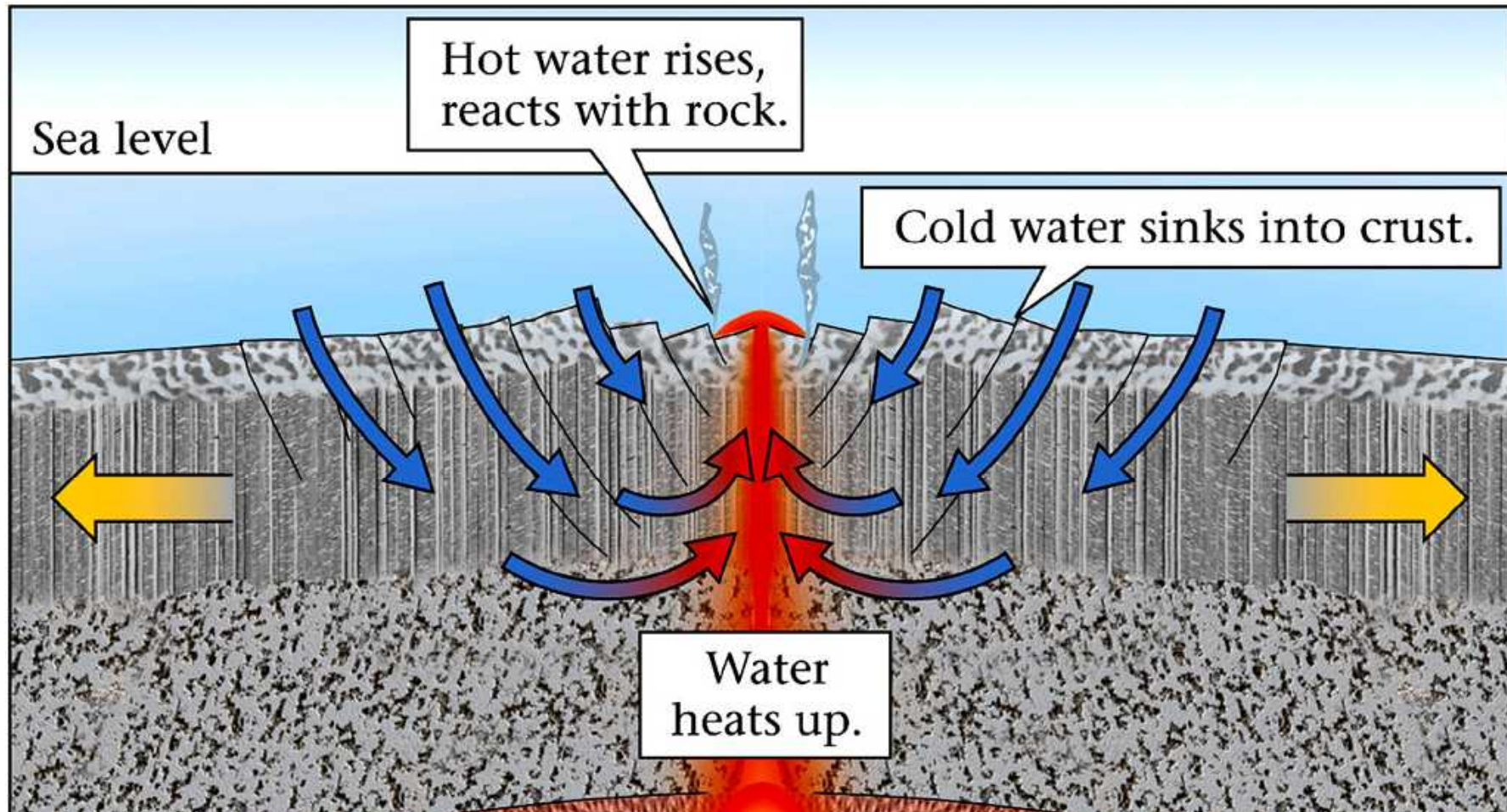
100-200

~ 50

60 - 75

< 40

Interaktion Meerwasser - Kruste

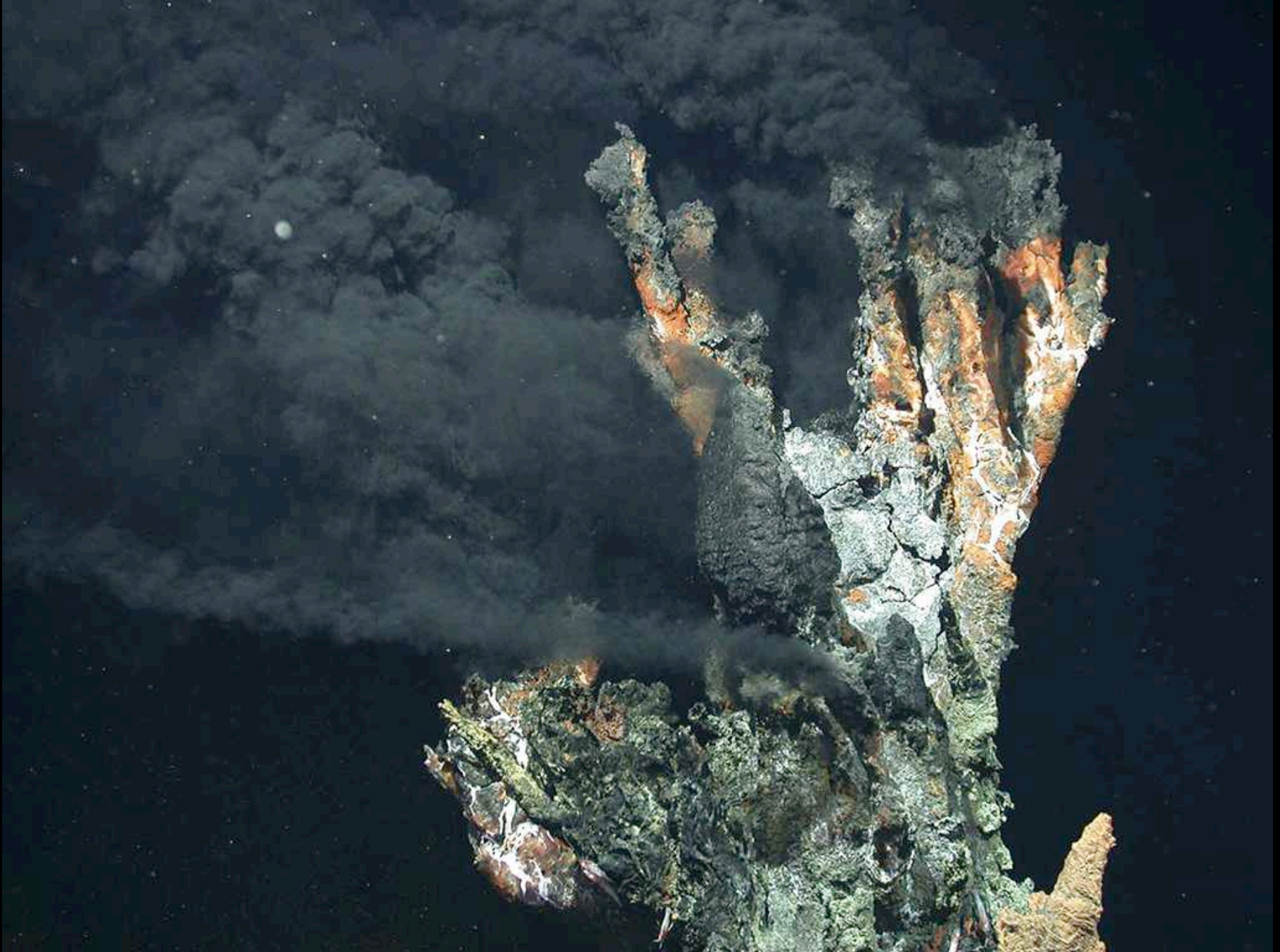


- Meerwasser zirkuliert hinunter in die Kruste
- Basaltisches Gestein erleidet Hydrothermalmetamorphose
- Hydrothermale Fluids lösen Metallionen, die auf dem Meeresboden ausgefällt werden → schwarze Raucher (black smokers)

Ophikalzit



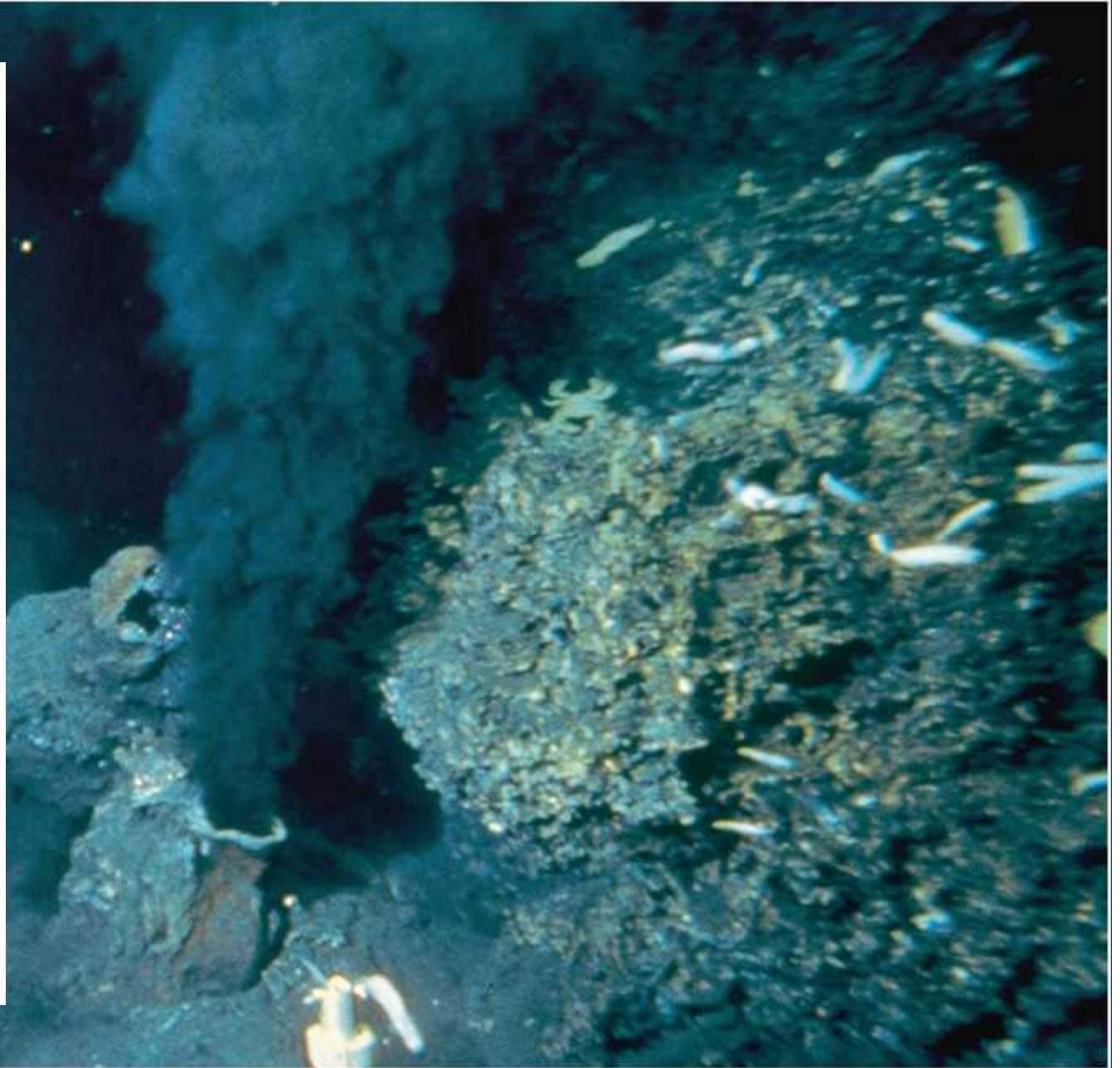
Black smoker



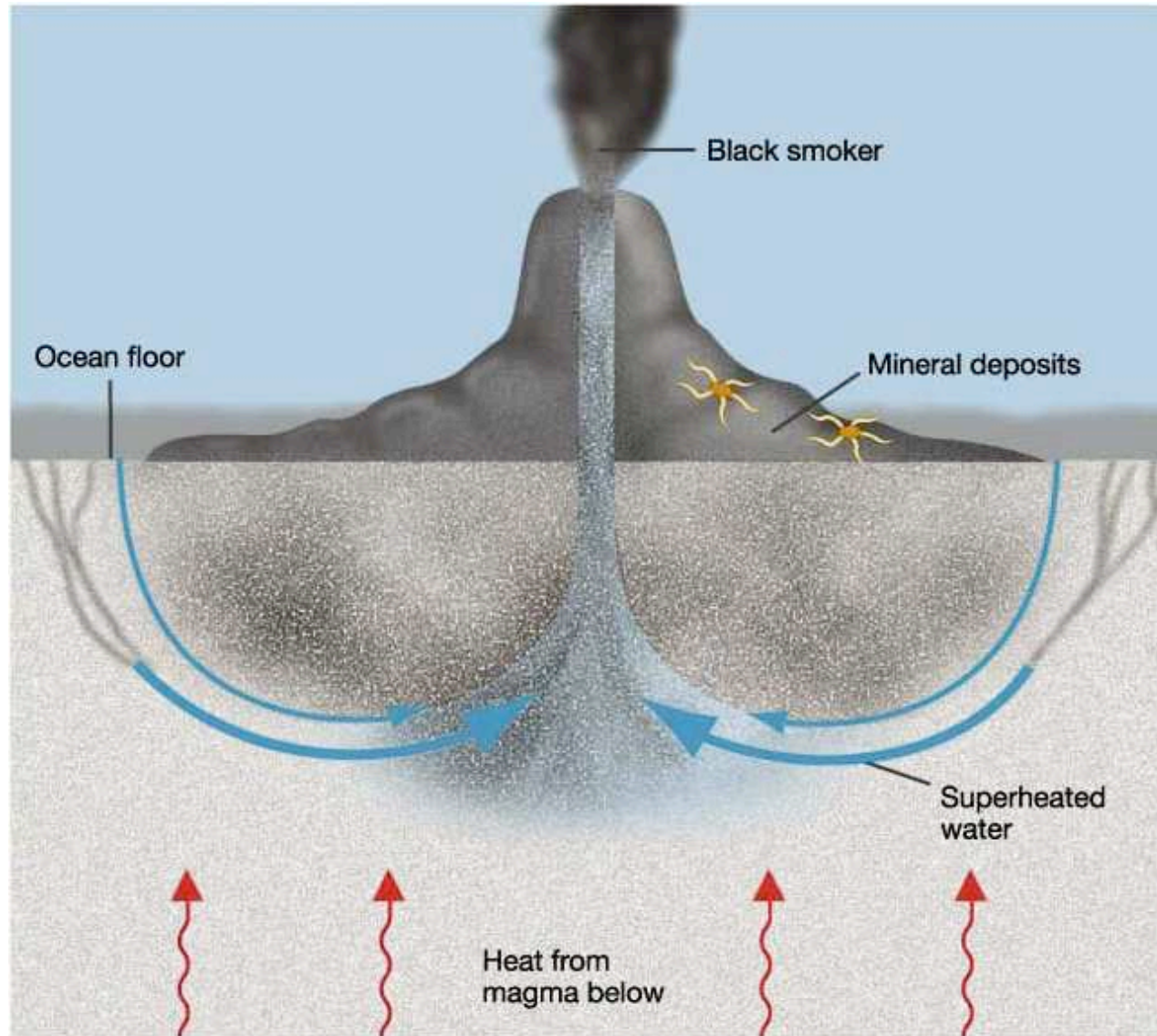
Hydrothermal vent



Black smoker - tube worms



Chemosynthesis versus Photosynthesis



schwarzer Rauch

350°C

metallhaltige Sedimente

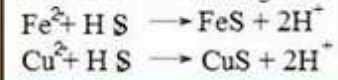
Meerwasser

2°C

CuSO₄

FeS
CuS
ZnS

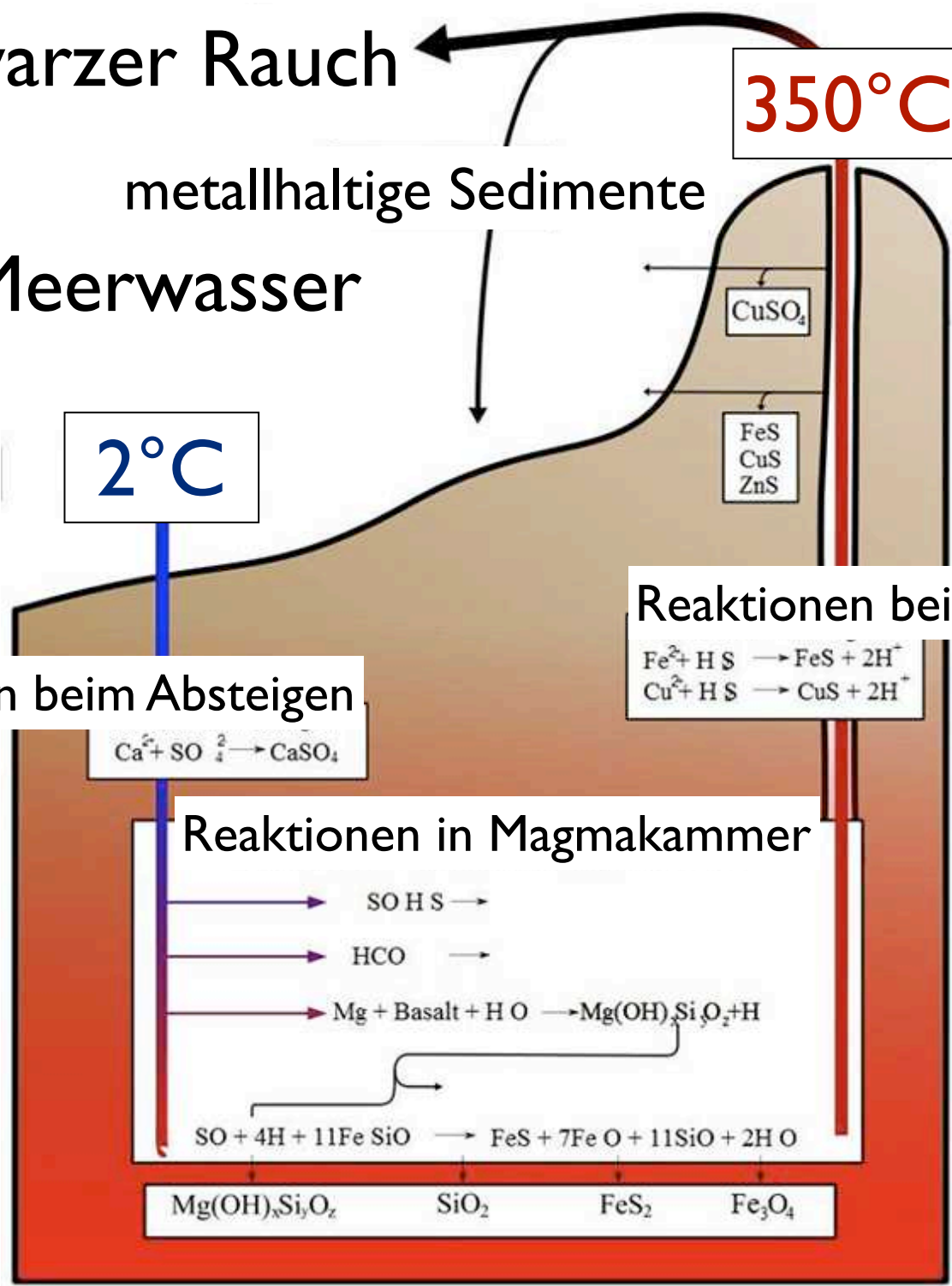
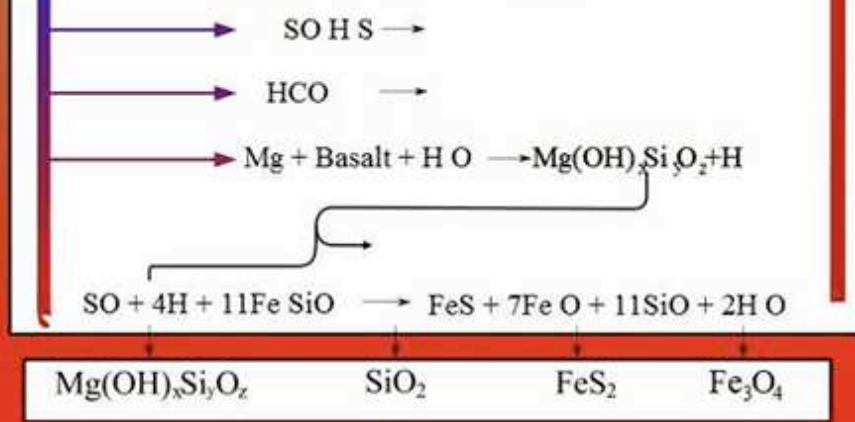
Reaktionen beim Aufsteigen



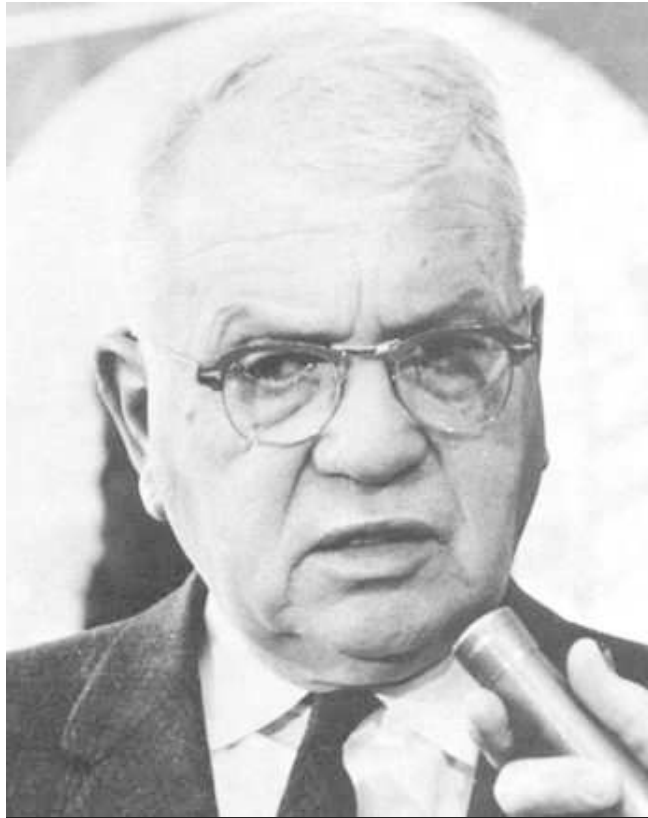
Reaktionen beim Absteigen



Reaktionen in Magmakammer



Exkurs: Entstehung des Lebens

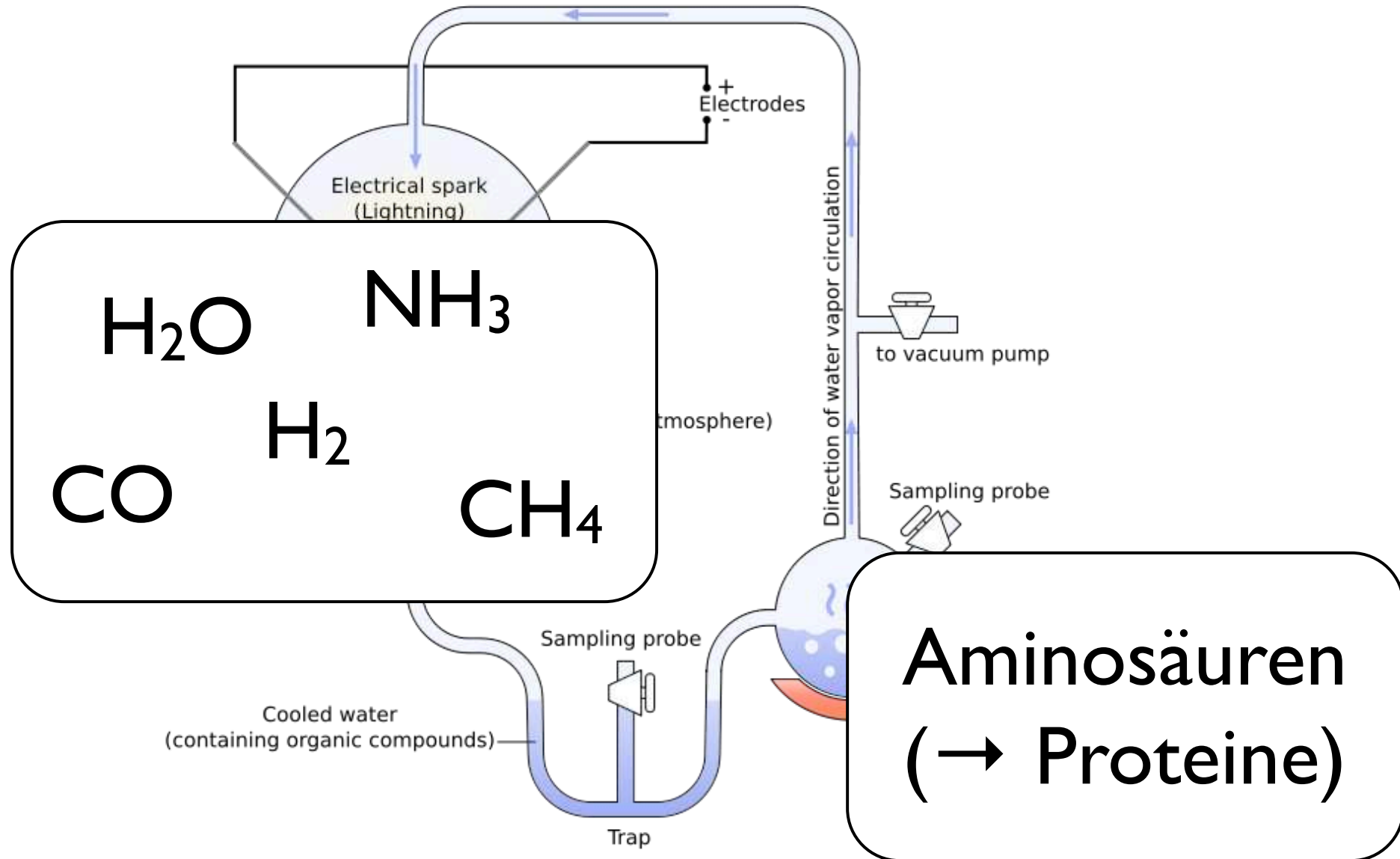


Harold Urey
(1893 - 1981)

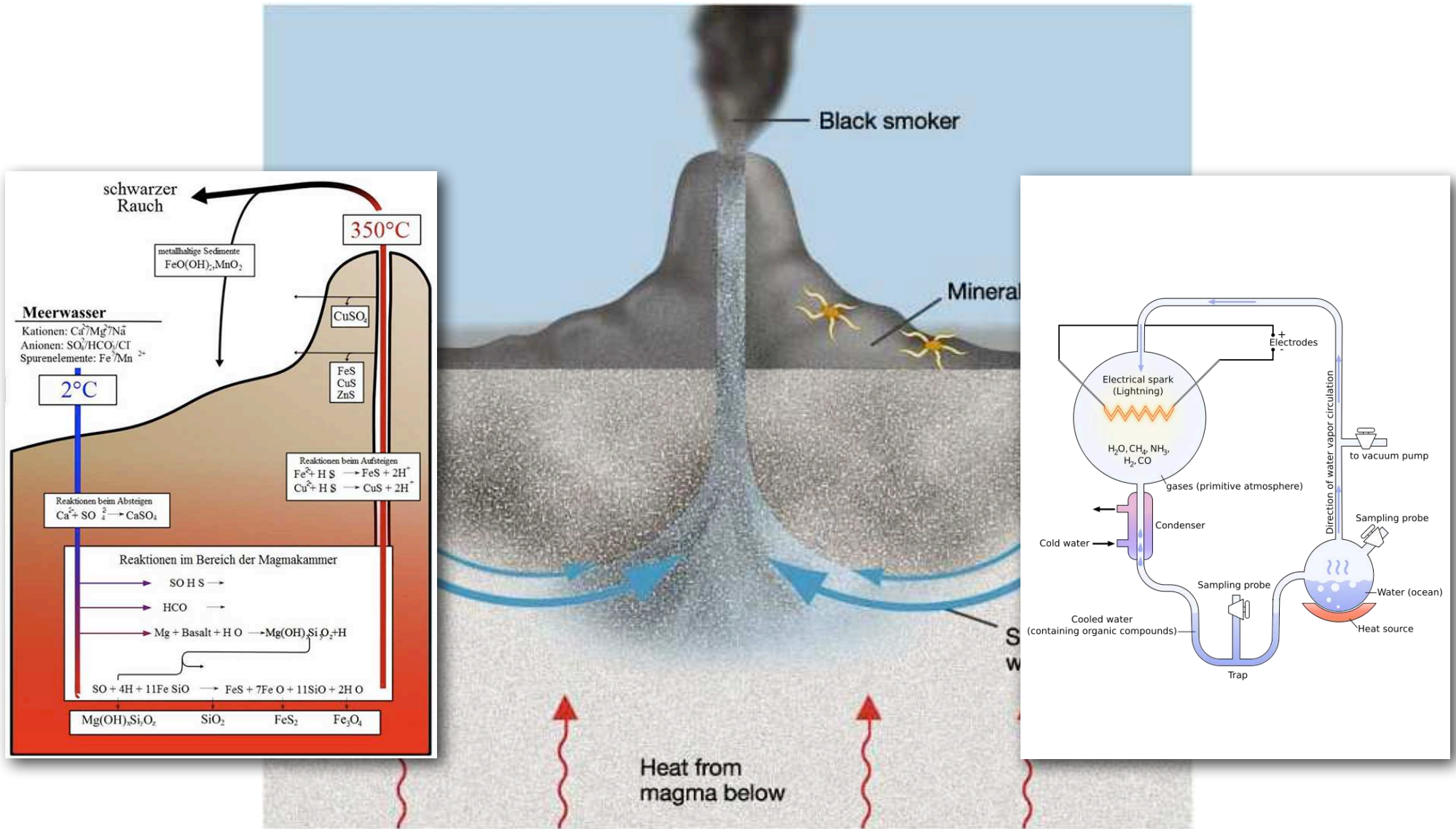


Stanley Lloyd Miller
(1930 - 2007)

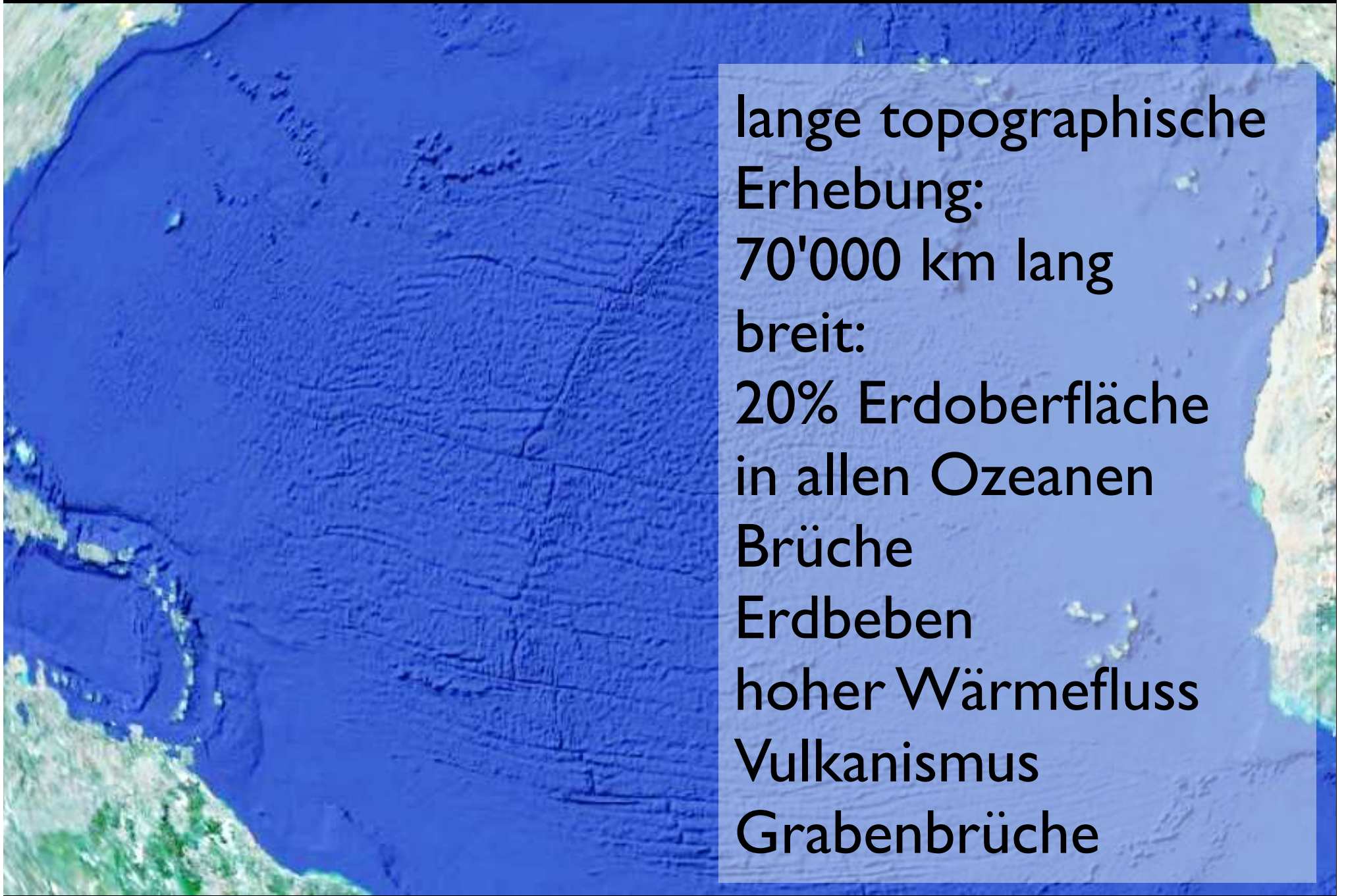
Das Miller - Urey Experiment (1953)



Chemosynthese versus Photosynthese



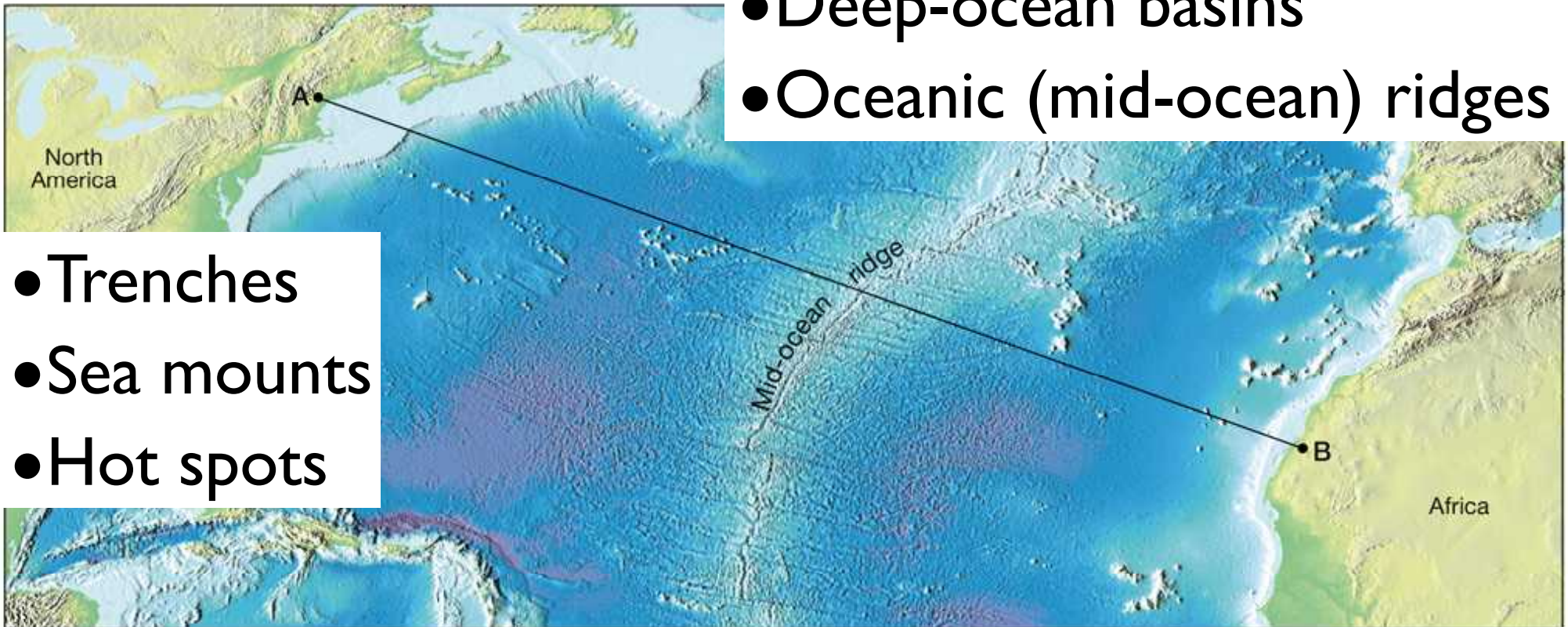
Mittelatlantische Rücken (Google Earth)



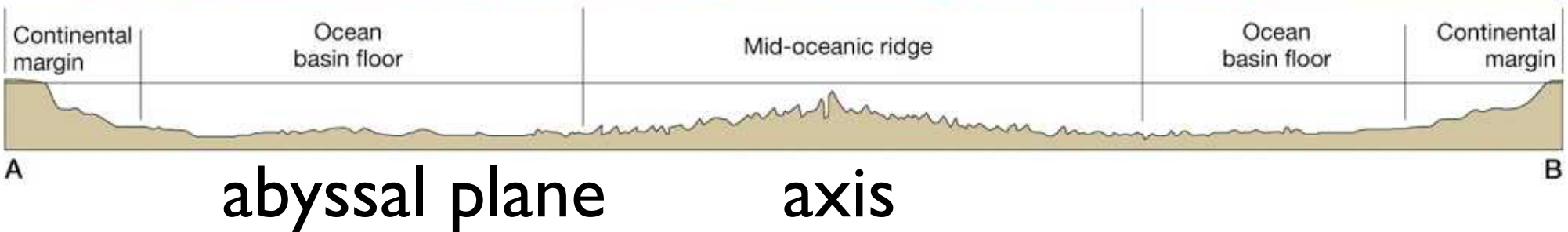
lange topographische
Erhebung:
70'000 km lang
breit:
20% Erdoberfläche
in allen Ozeanen
Brüche
Erdbeben
hoher Wärmefluss
Vulkanismus
Grabenbrüche

Major provinces of the ocean floor

- Continental margins
- Deep-ocean basins
- Oceanic (mid-ocean) ridges

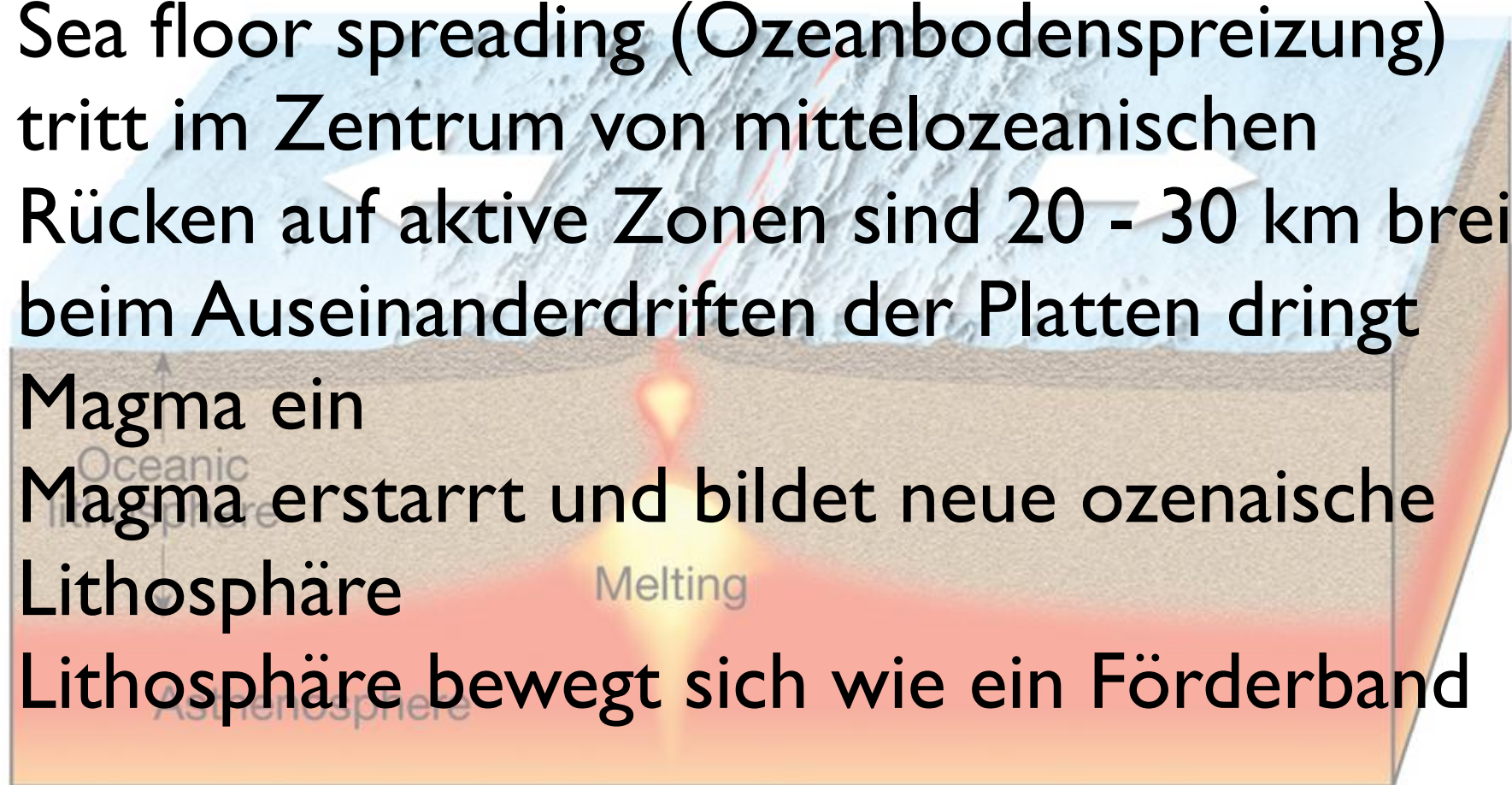


- Trenches
- Sea mounts
- Hot spots

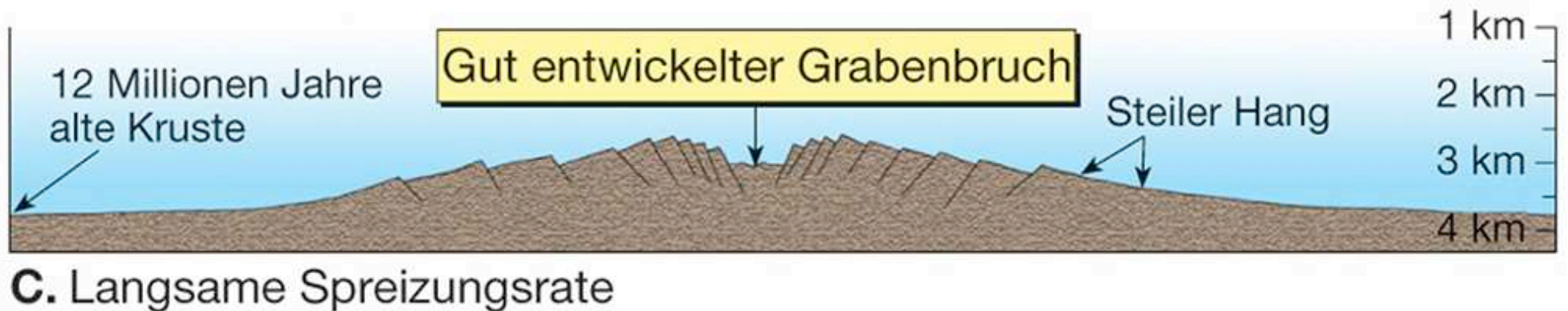
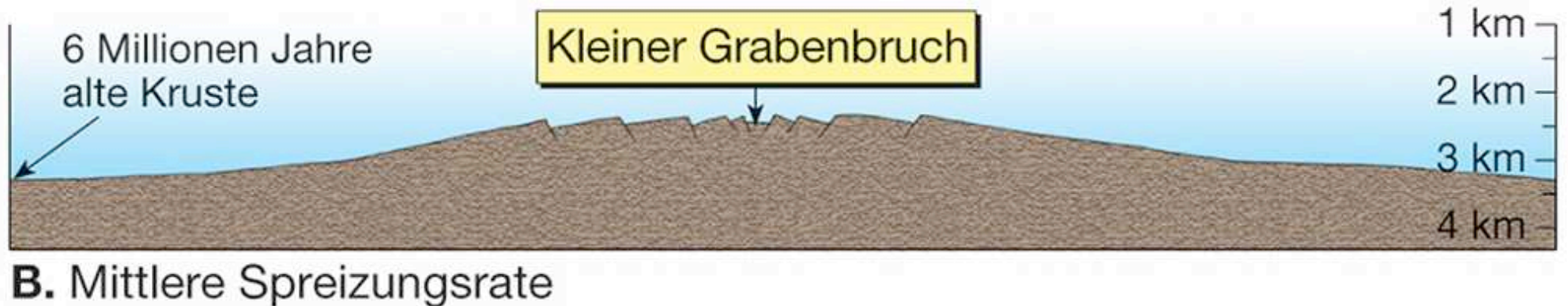
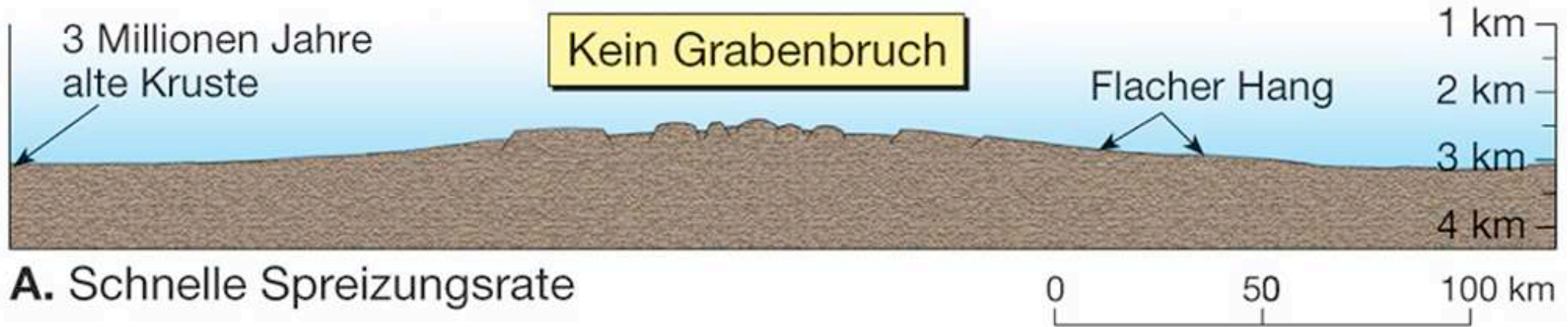


Sea floor spreading

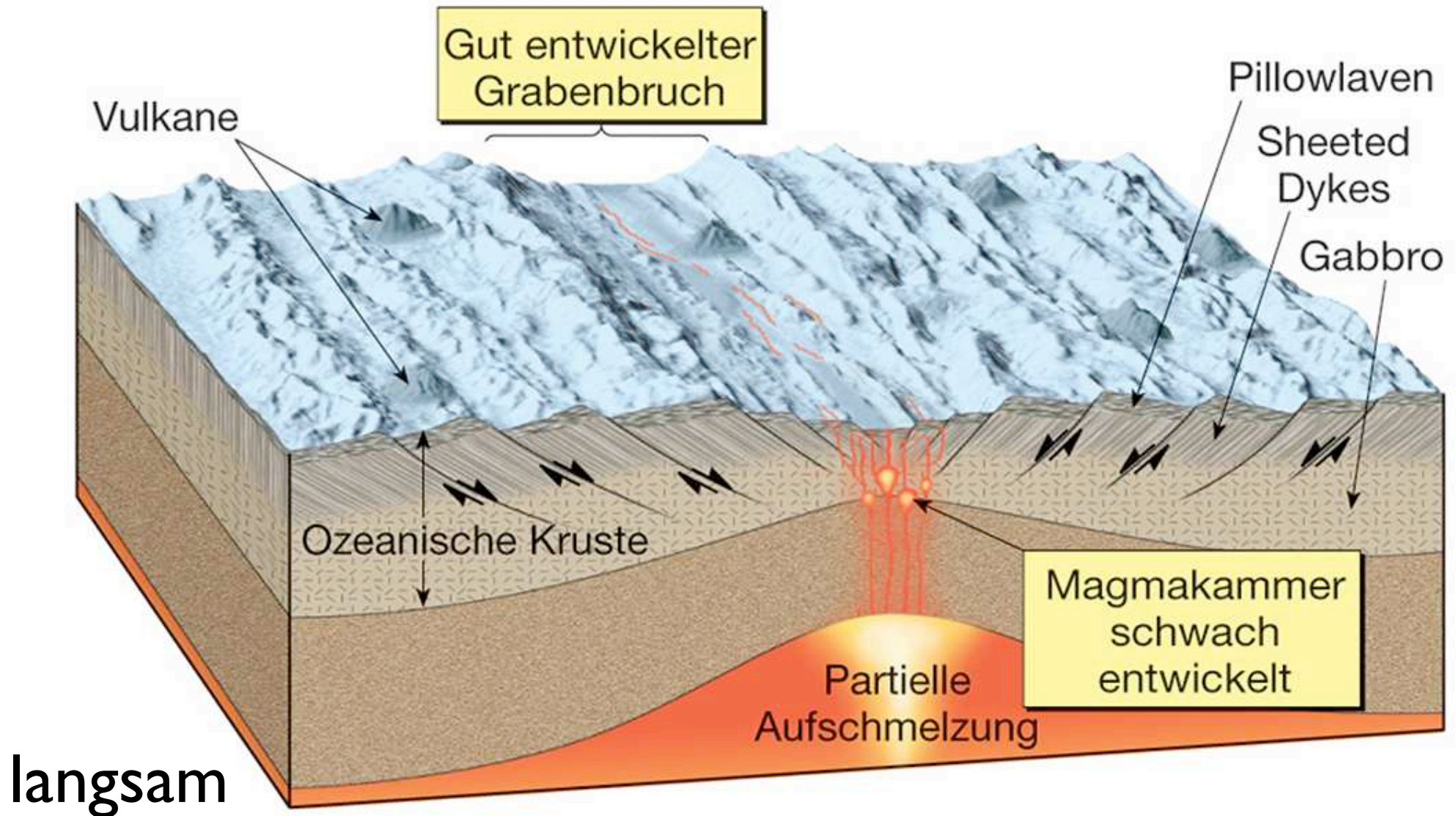
- Idee wurde 1960 von Harry Hess formuliert
- Sea floor spreading (Ozeanbodenspreizung) tritt im Zentrum von mittelozeanischen Rücken auf aktive Zonen sind 20 - 30 km breit
- beim Auseinanderdriften der Platten dringt Magma ein
- Magma erstarrt und bildet neue ozeanische Lithosphäre
- Lithosphäre bewegt sich wie ein Förderband



Spreading rates



Langsame Spreizungsraten



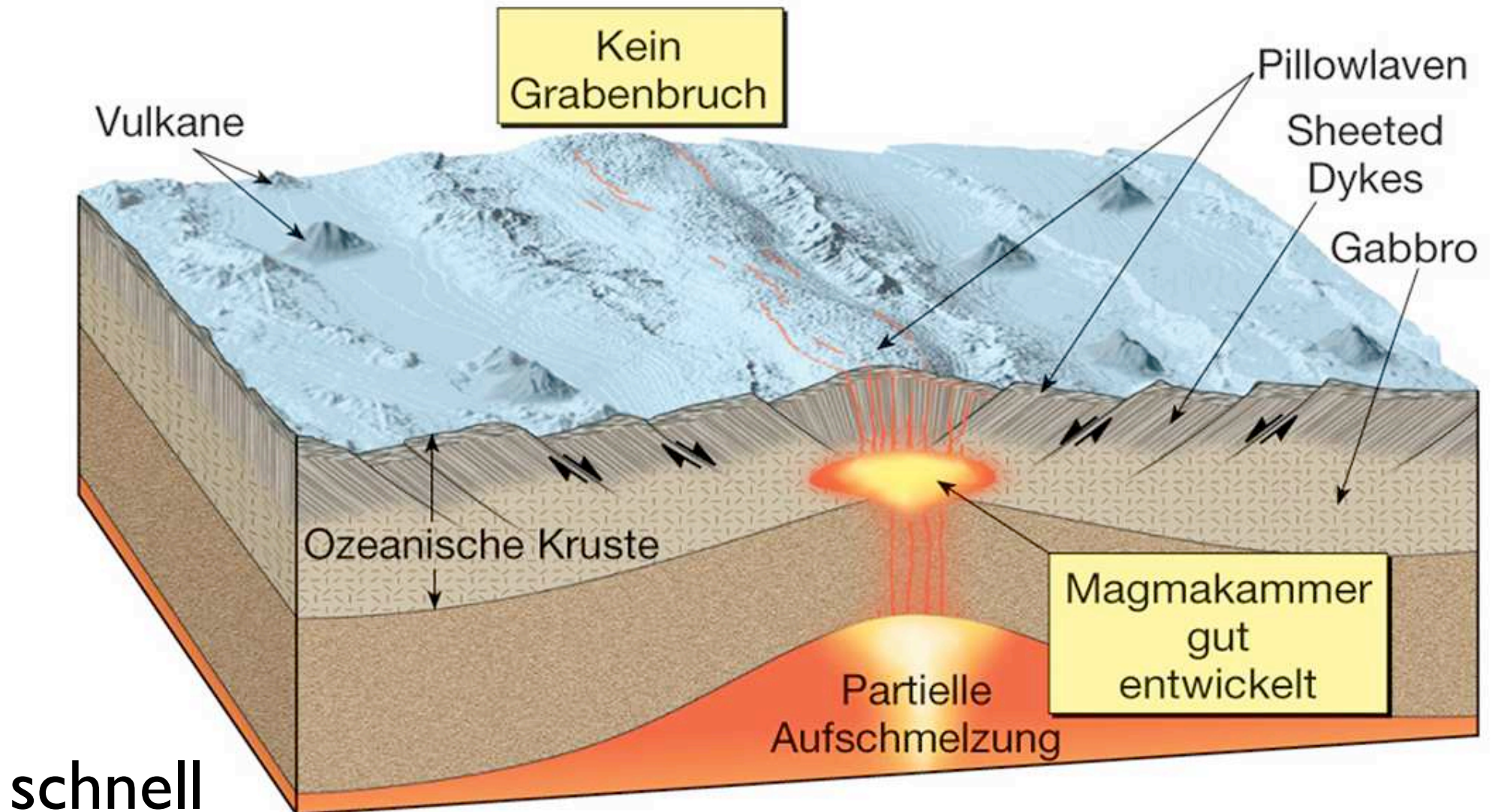
langsam

1-5 cm/a

ausgeprägter Kammgraben:

30 - 50 km breit 1500 - 300 m tief

Schnelle Spreizungsraten



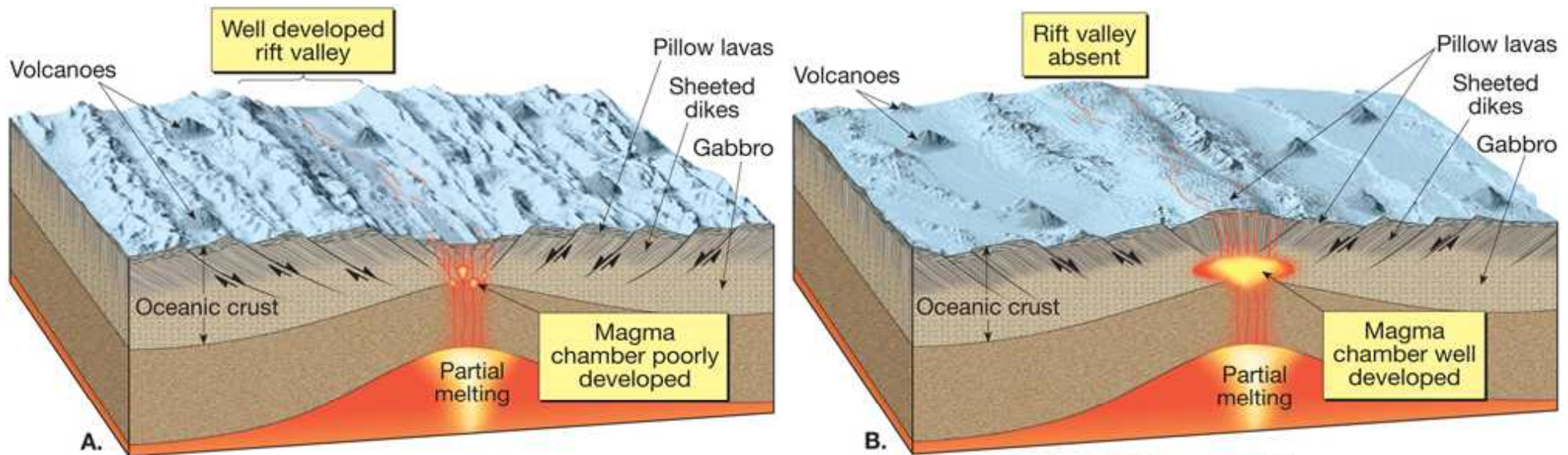
schnell

> 9 cm/a

kein ausgeprägter Kammgraben
enge Zone mit Bruchbildung

Spreading rates and Topography

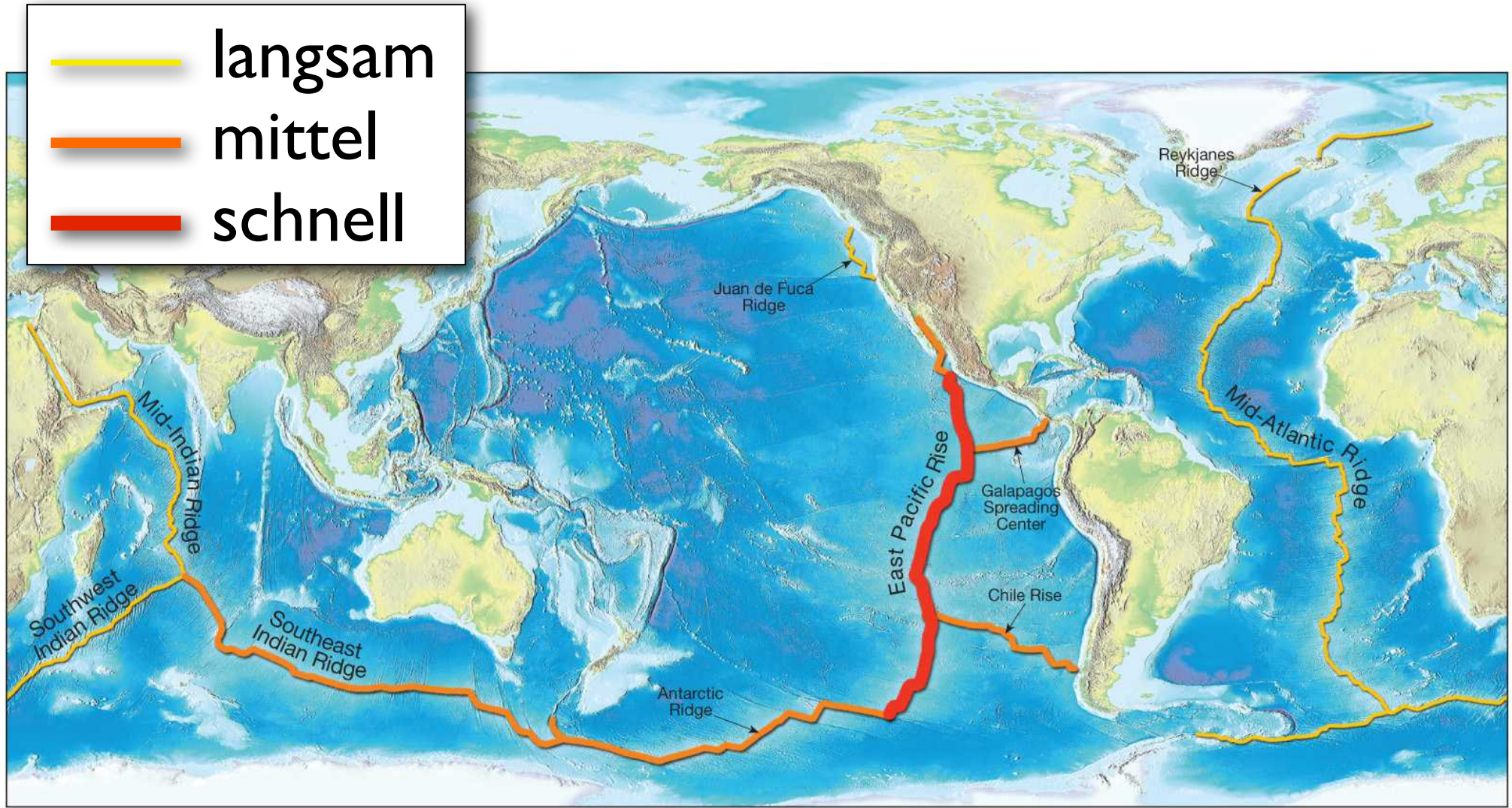
Rifts valleys (Grabenbrüche) with different topography. It is controlled by plate velocity.



langsam

schnell

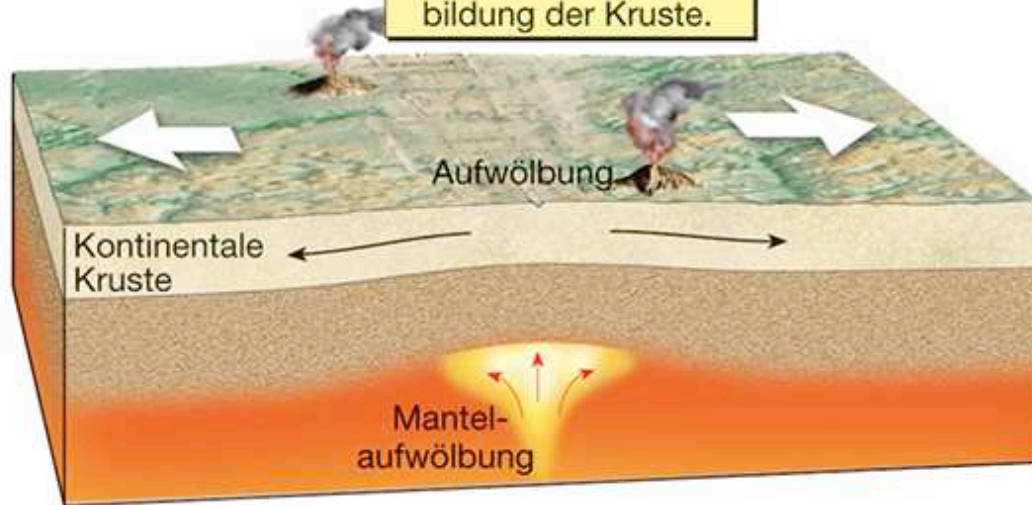
Ozeanisches Rückensystem



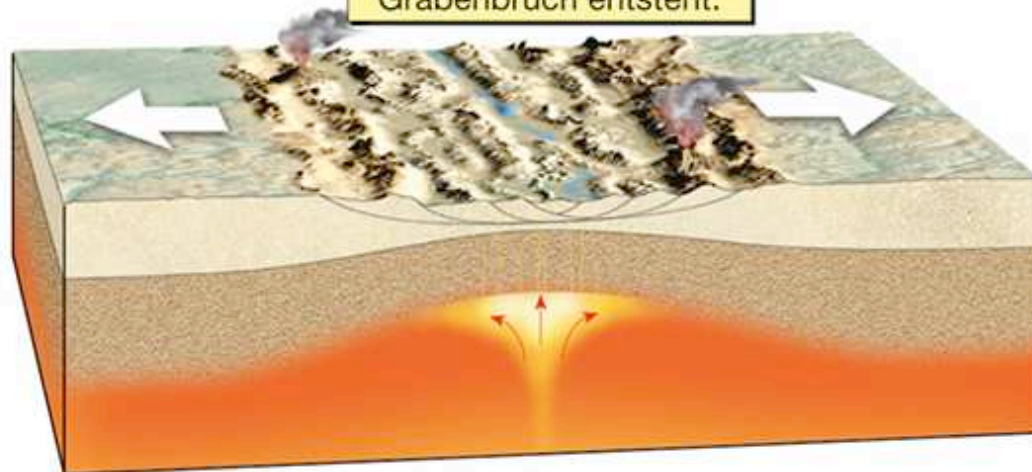
Spreizungsraten

Grabenbruchbildung

Aufwölbung durch Auftrieb führt zur Kuppelbildung der Kruste.

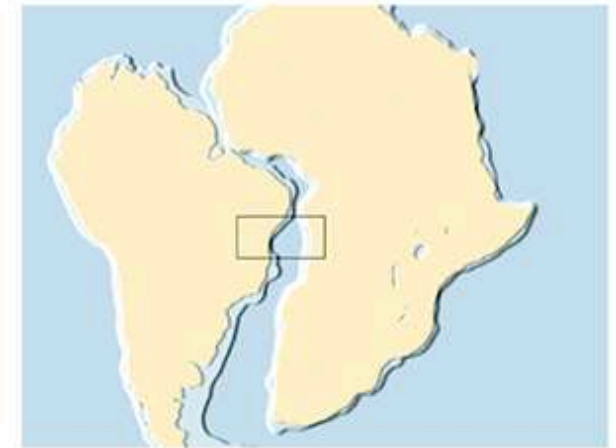
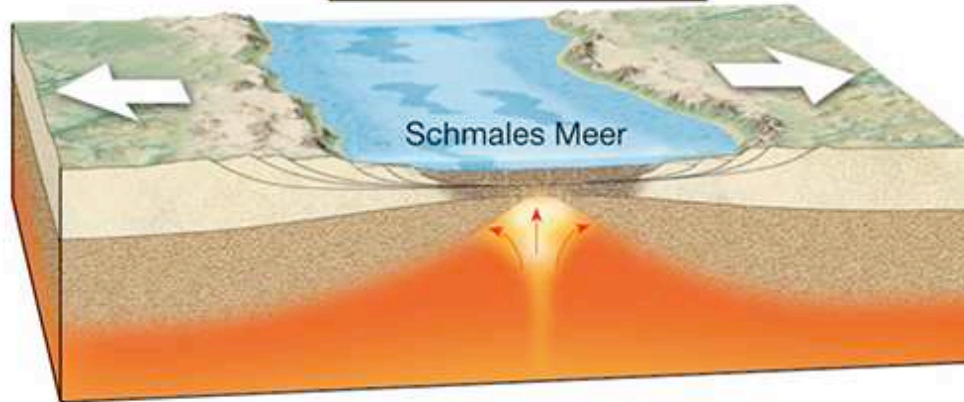


Die Kruste reißt auf und wird gedehnt, wobei ein Grabenbruch entsteht.

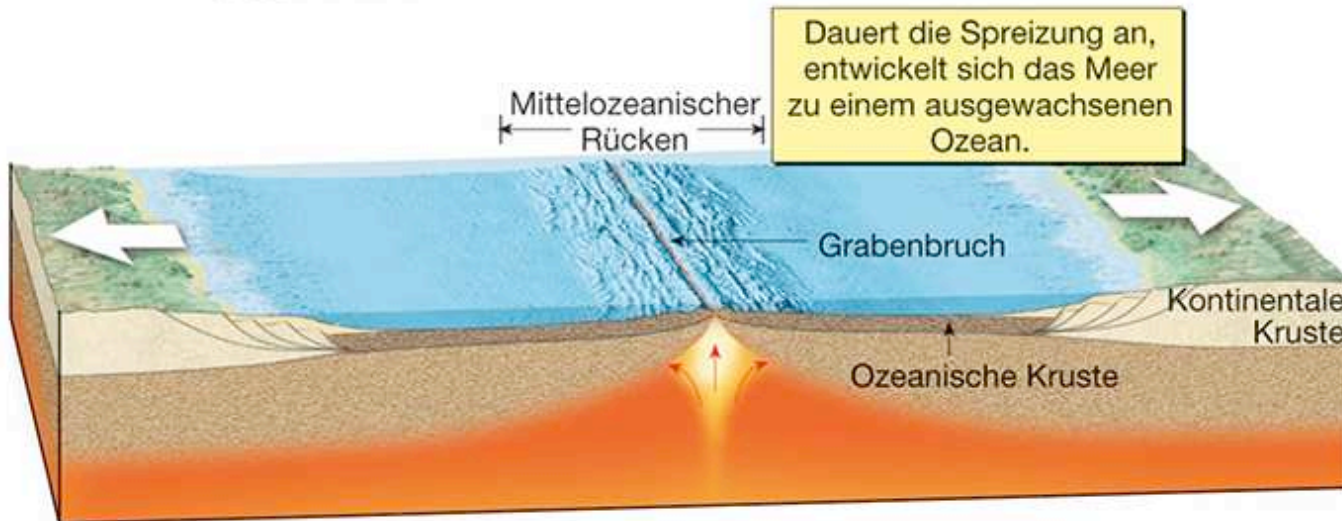


Grabenbruchbildung

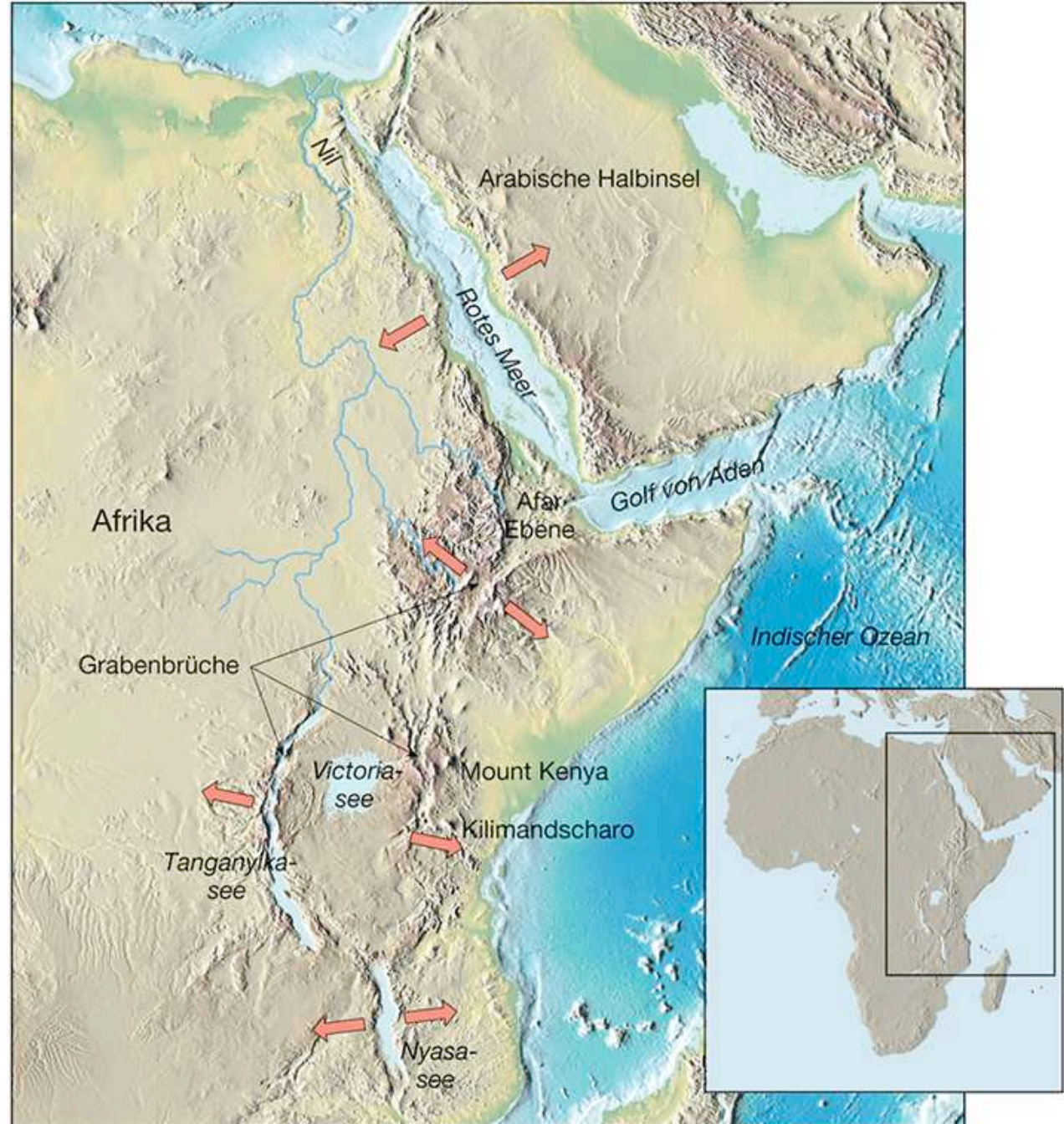
Durch Kontinentaldrift entsteht schließlich ein Schmales Meer.



Dauert die Spreizung an, entwickelt sich das Meer zu einem ausgewachsenen Ozean.



Continental rifting



Ostafrikanischer
Grabenbruch

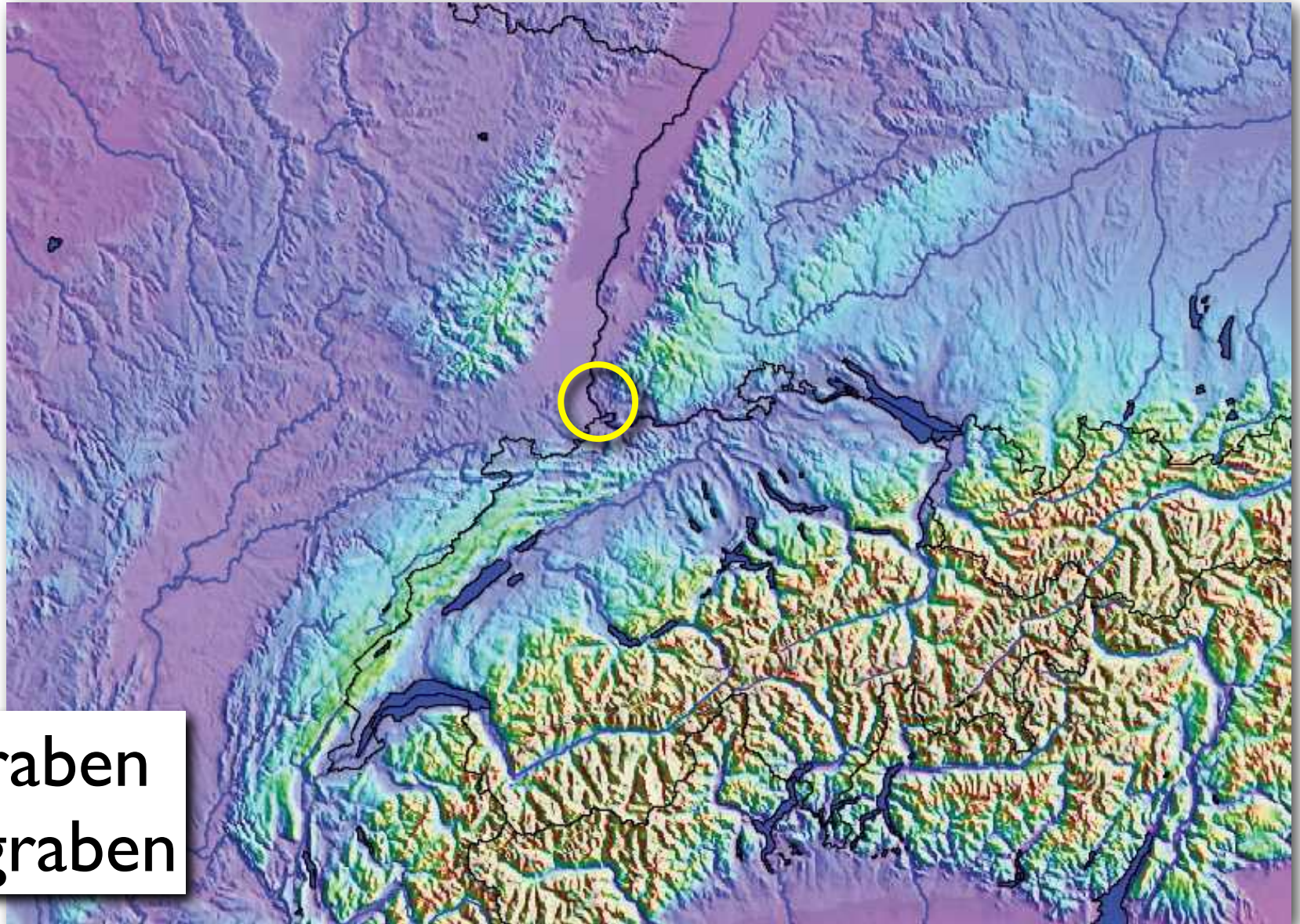
Grabenbruchbildung



Mittelkontinentaler
Grabenbruch
(Keweenawan-
Grabenbruch)

erfolglos
(aborted rift)

Grabenbruchbildung



Rheingraben
Bressegraben

Schwelle von Arzo



Brekzie von Arzo



Plattengeschwindigkeiten

relativ:

Geschwindigkeit, mit der sich zwei Platten voneinander entfernen

absolut:

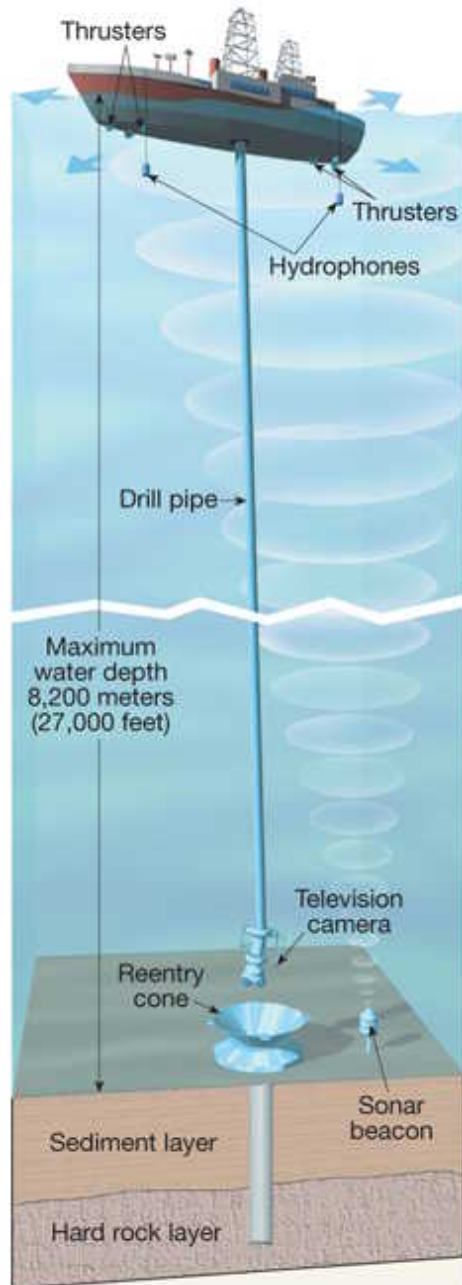
Geschwindigkeit, mit der sich eine Platte an einem Hot Spot vorbeibewegt

ganz absolut:

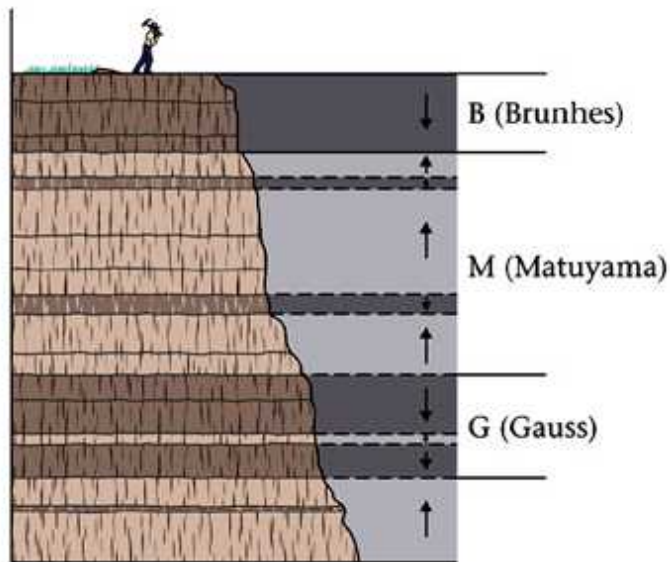
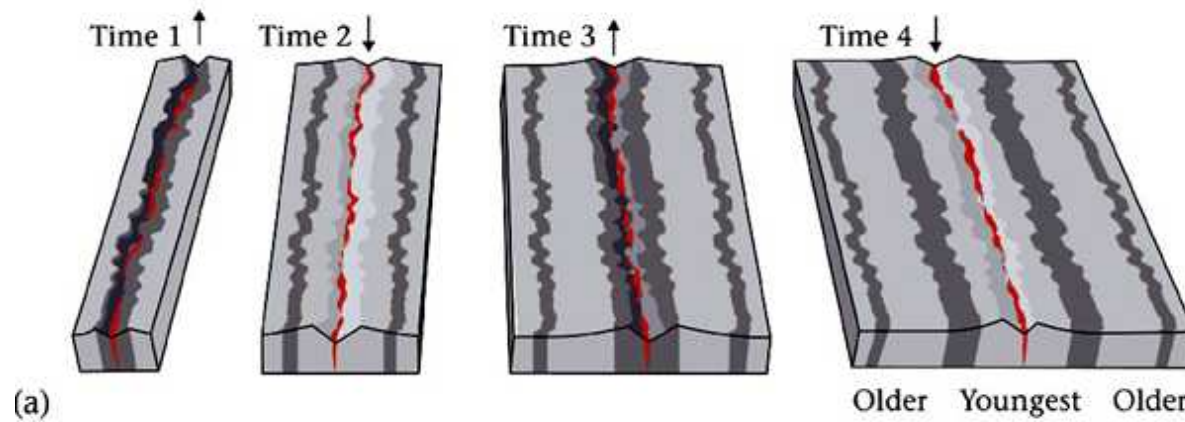
Satellitendaten

Astronomisch

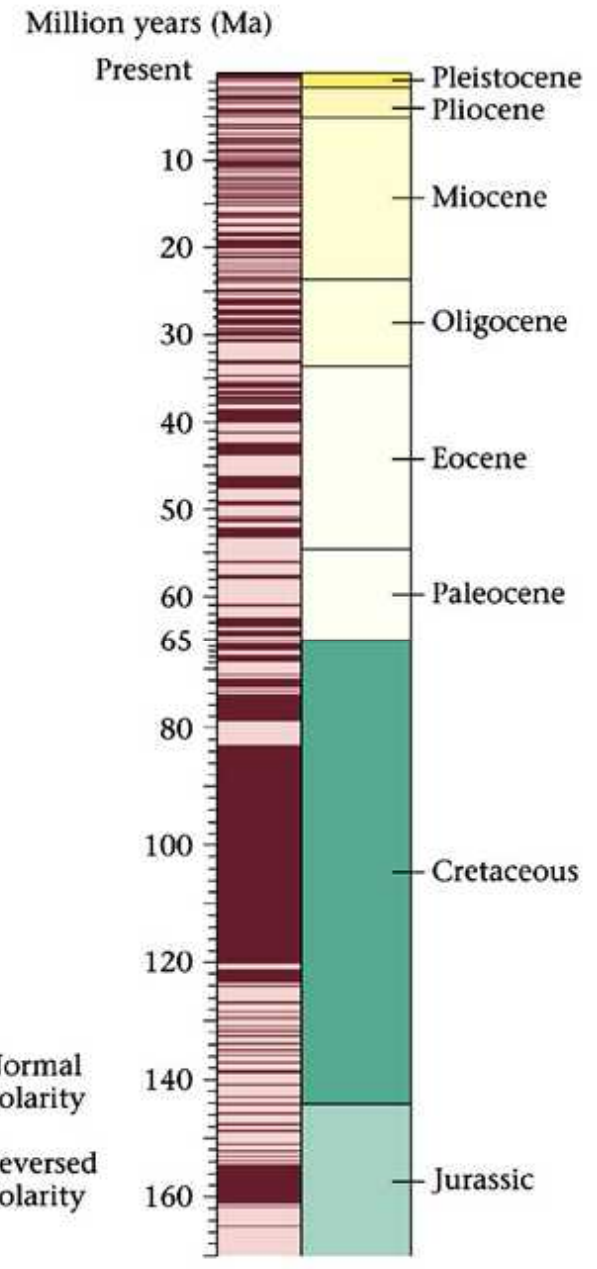
Ocean drilling



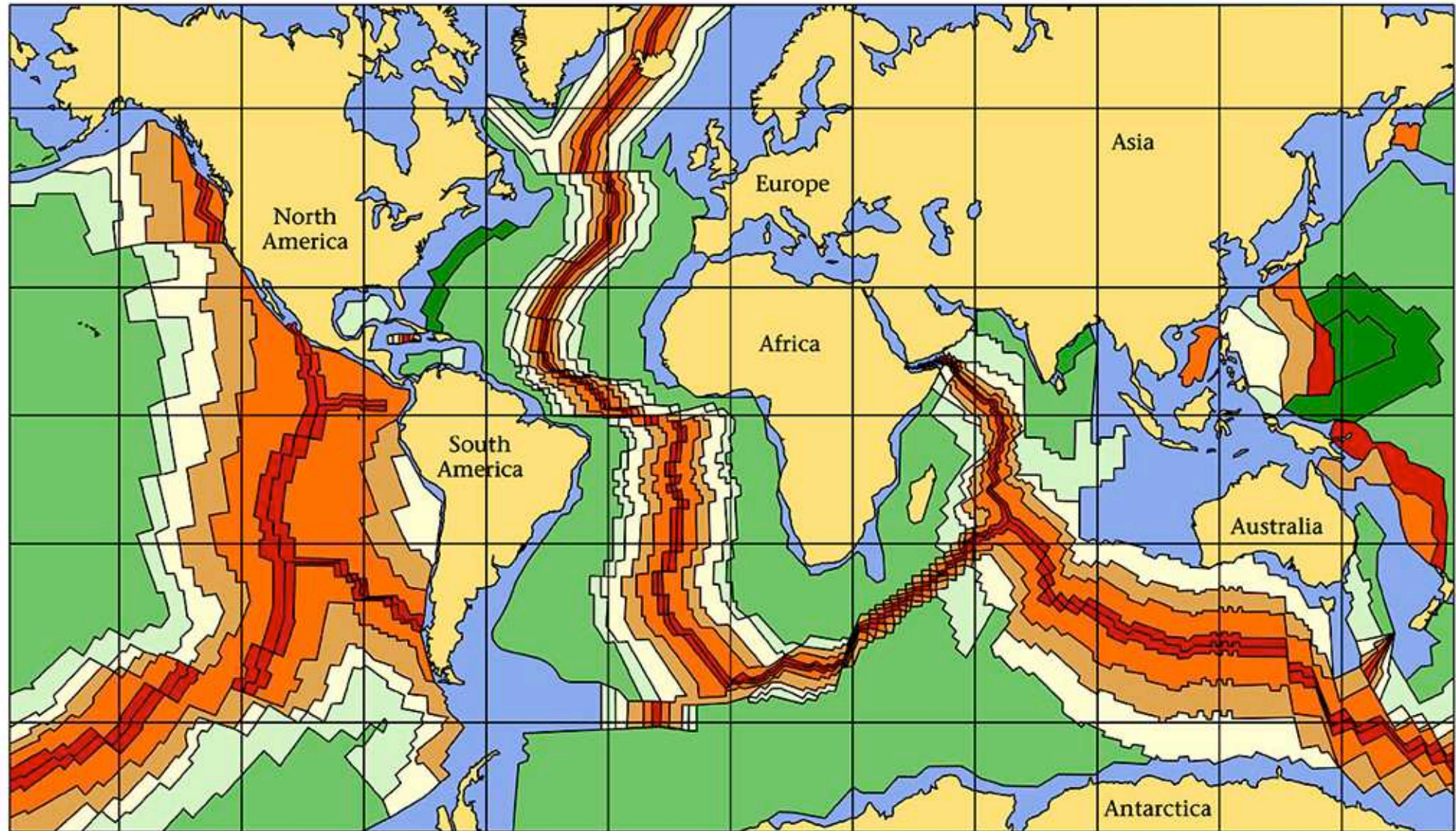
Magnetische Lineationen



(b) Vertical sequence of basalt flows on continent

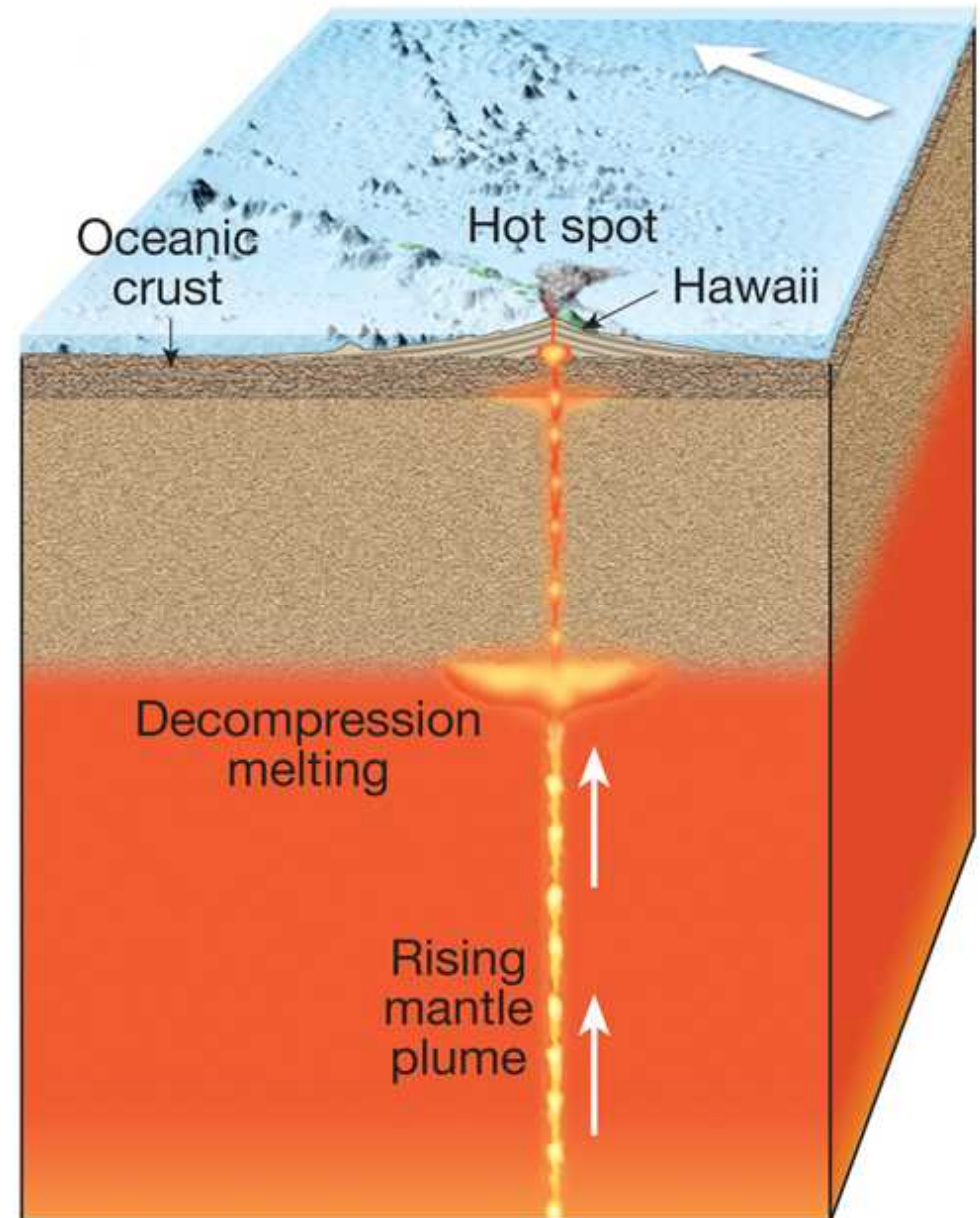
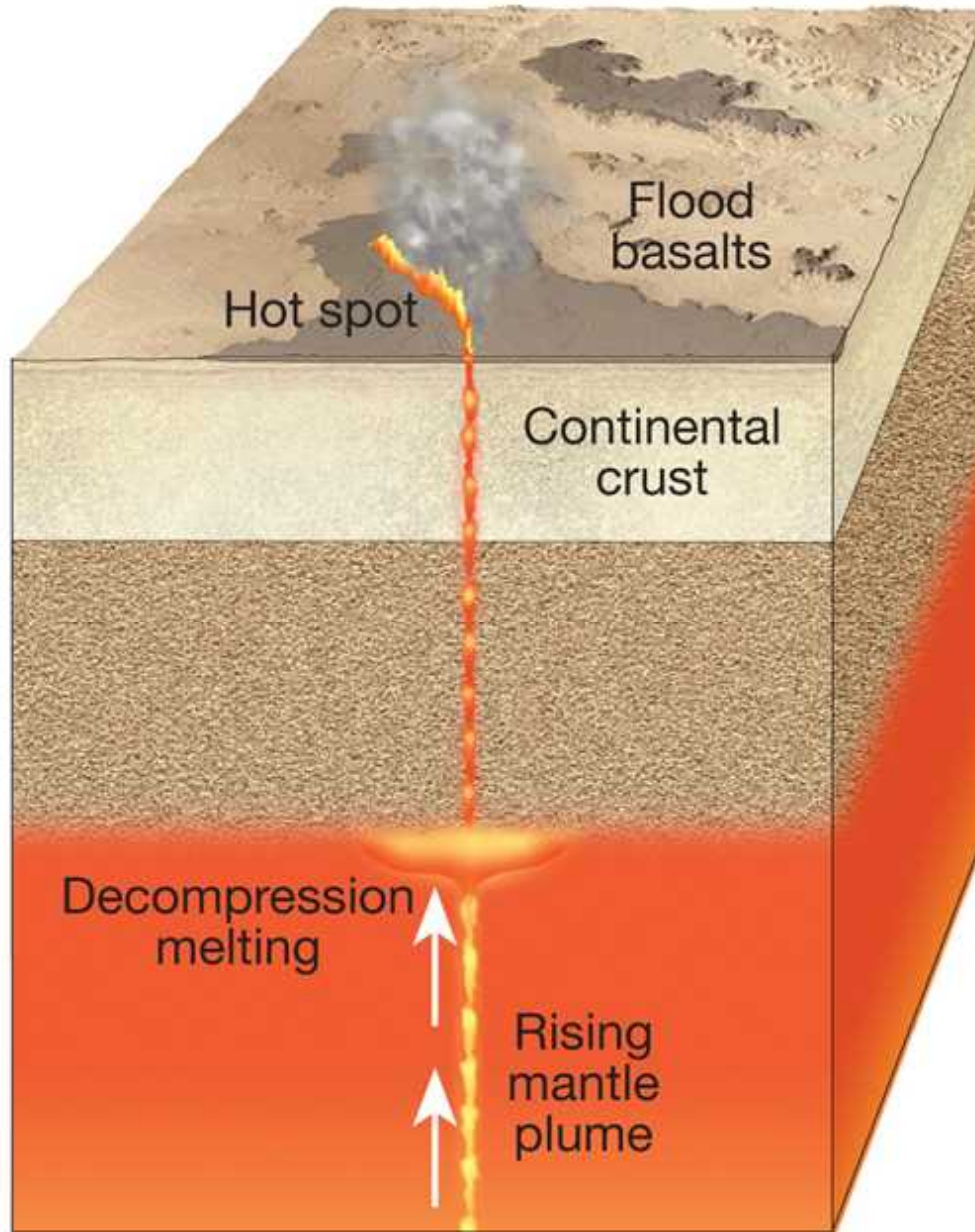


Plattengeschwindigkeiten

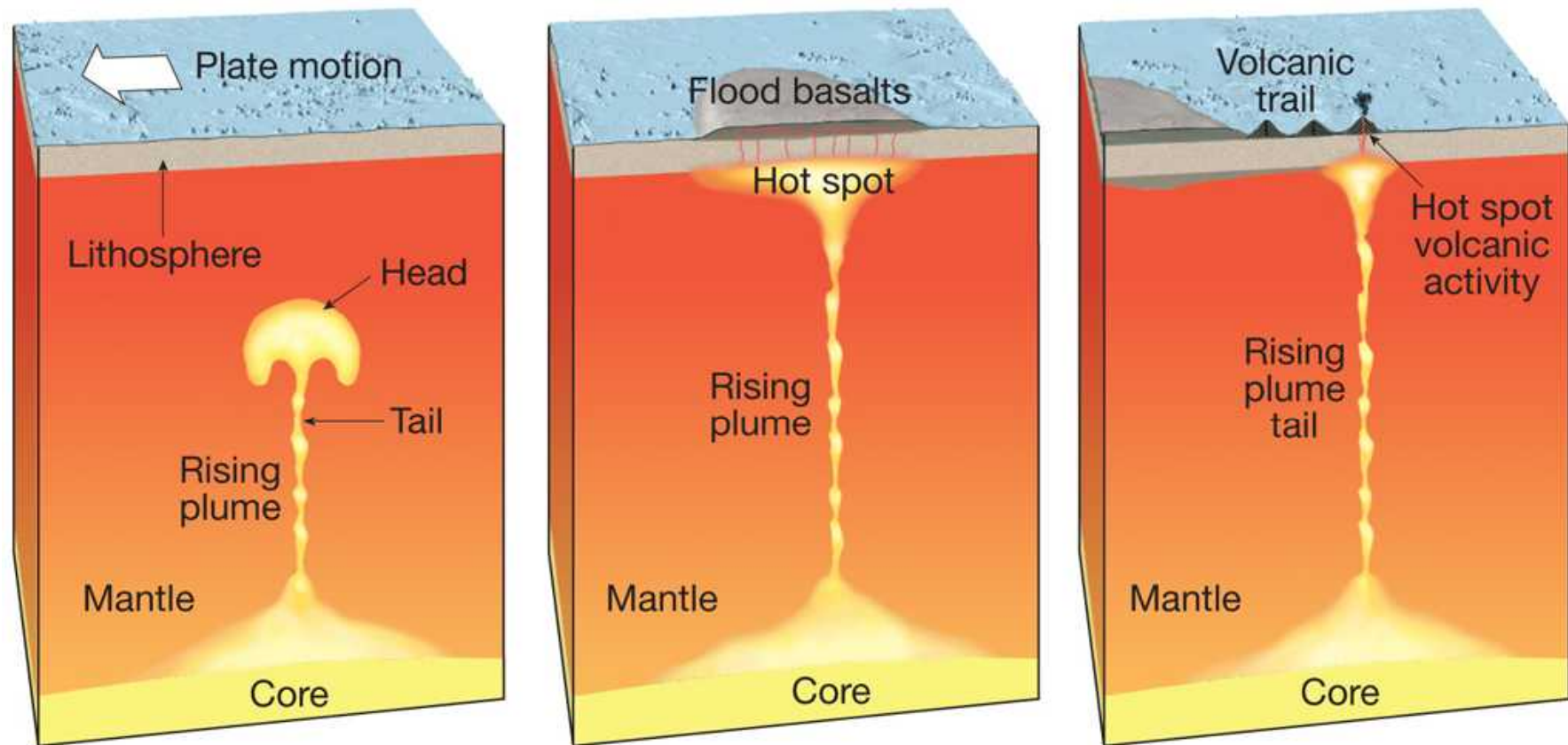


Ma	0-5	5-21	21-38	38-52	52-65	65-145	145-160
Age	Pleistocene to Pliocene	Miocene	Oligocene	Eocene	Paleocene	Cretaceous	Jurassic

Hot spots - flood basalts

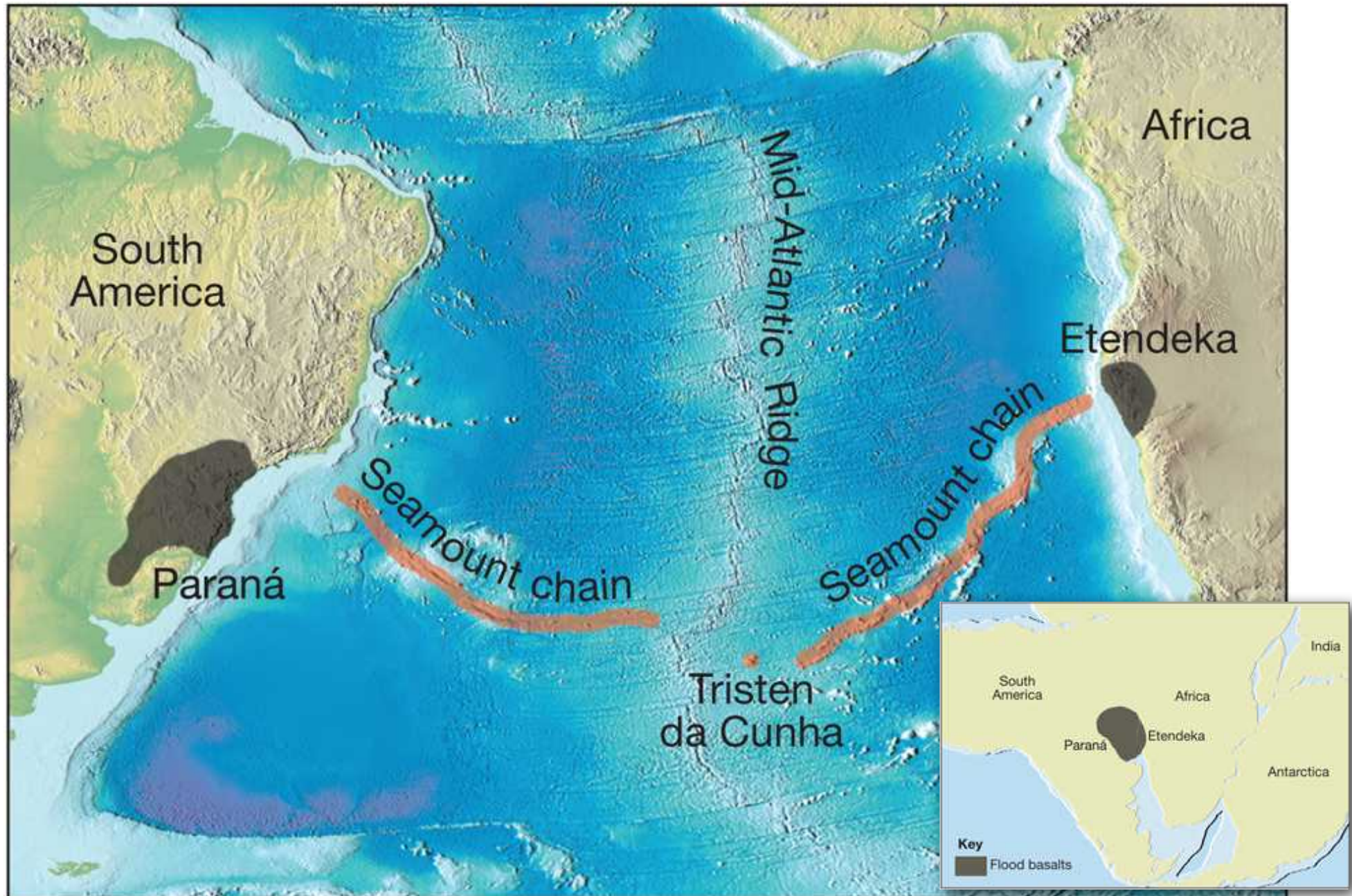


Hot spots & mantle plumes

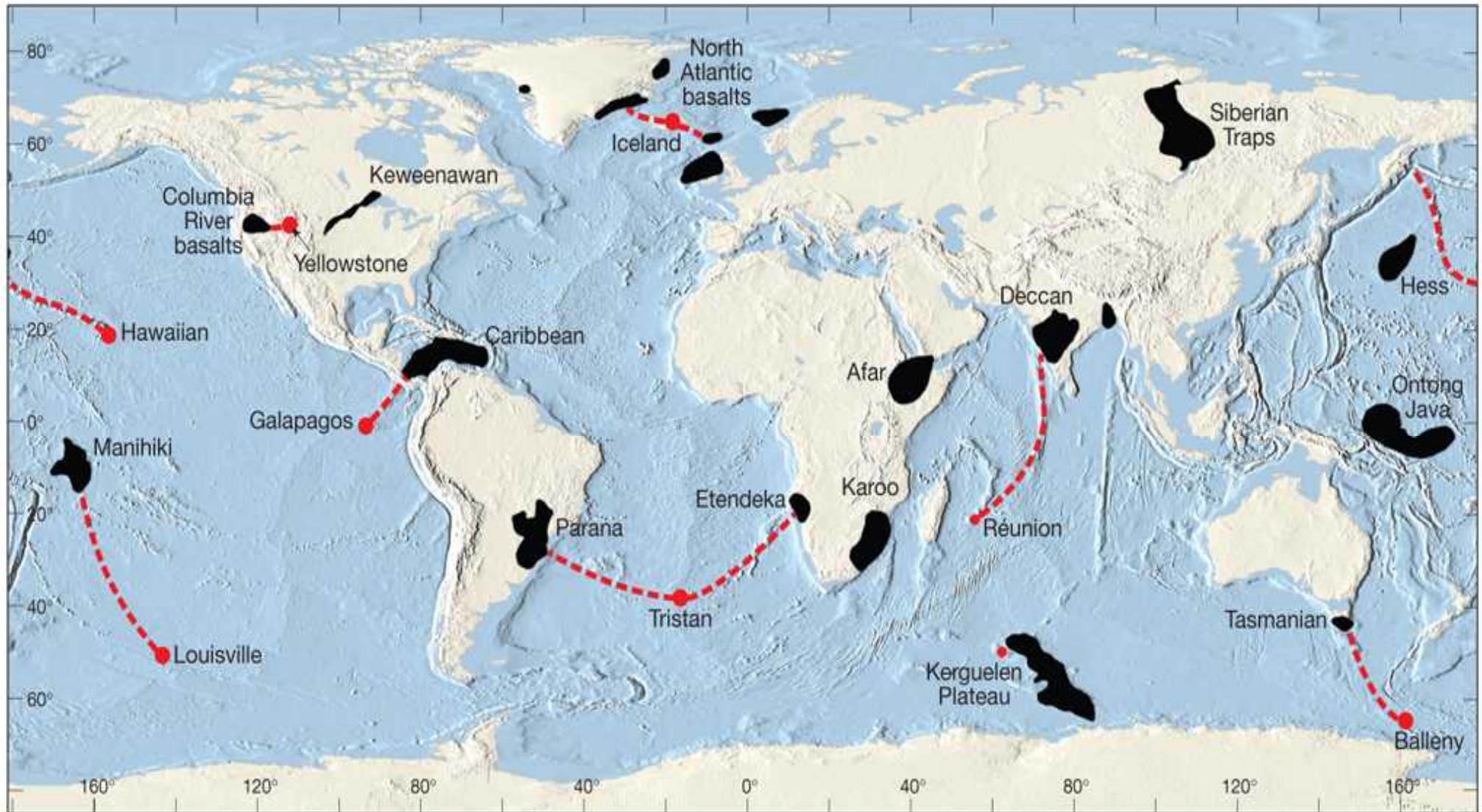


- Caused by rising plumes of mantle material
- Volcanoes can form over them (Hawaiian Island chain)
- Mantle plumes are long-lived structures; some originate at great depth

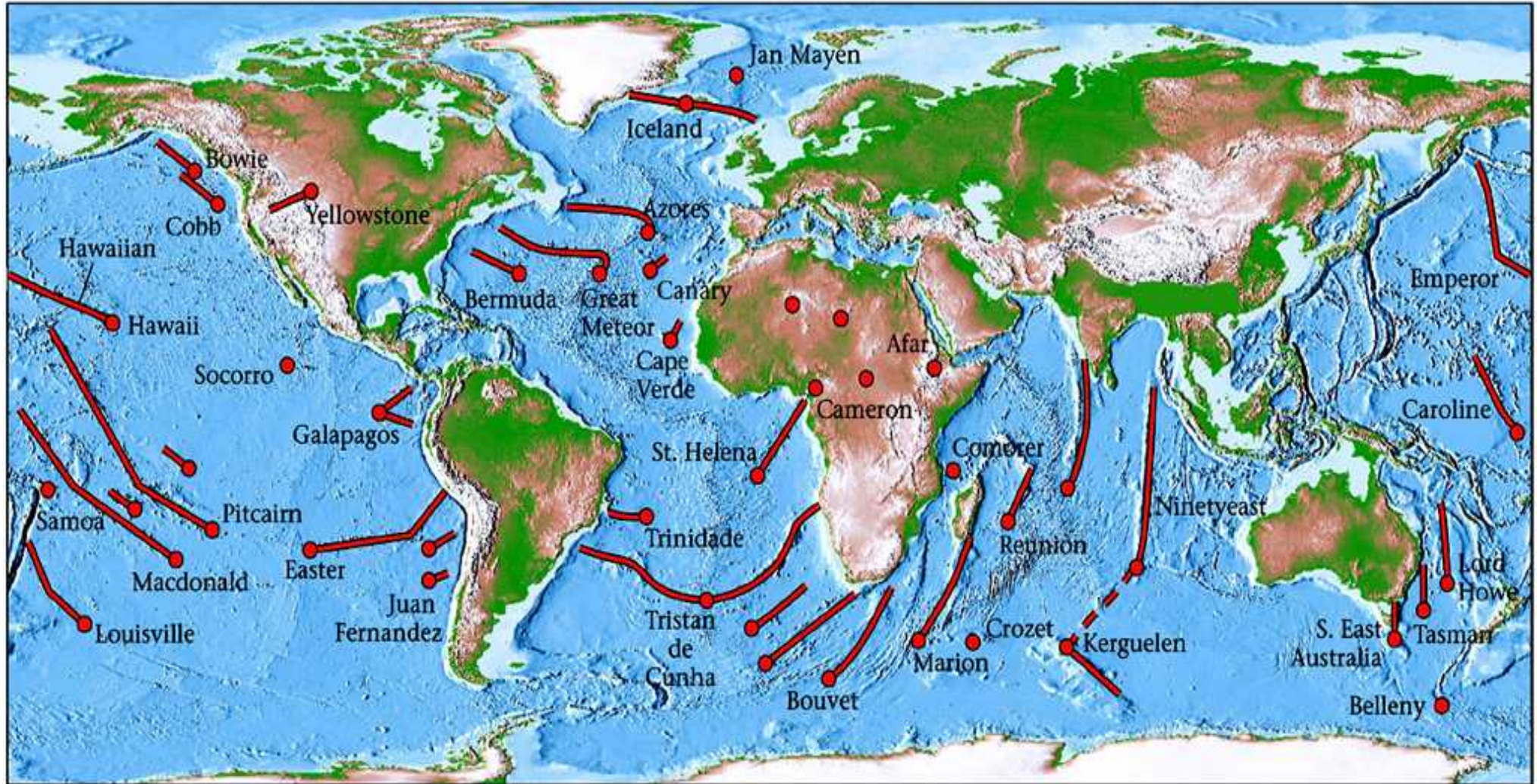
Hot spot am Beginn der Grabenbildung



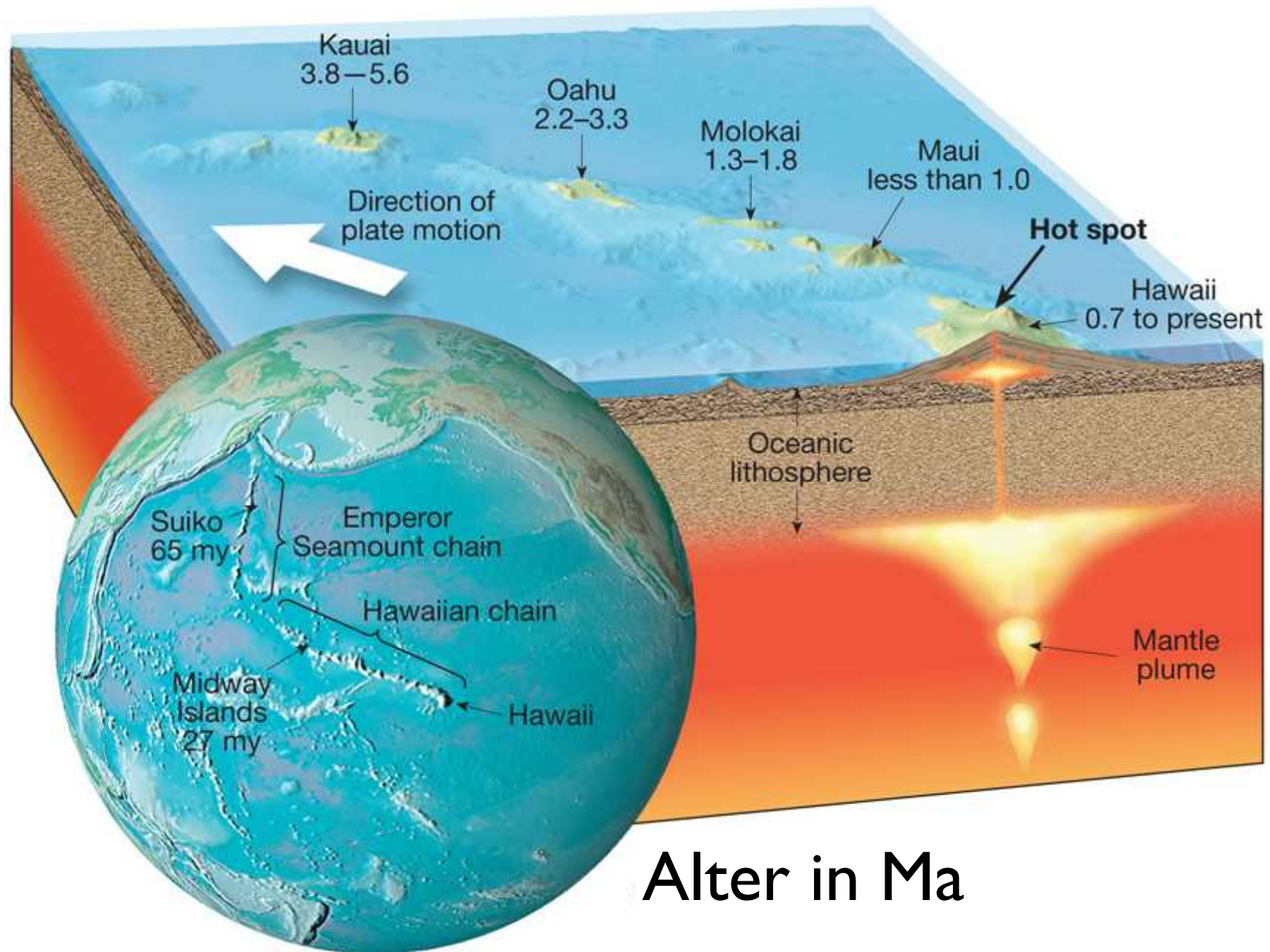
Hot Spots und Plateaubasalte



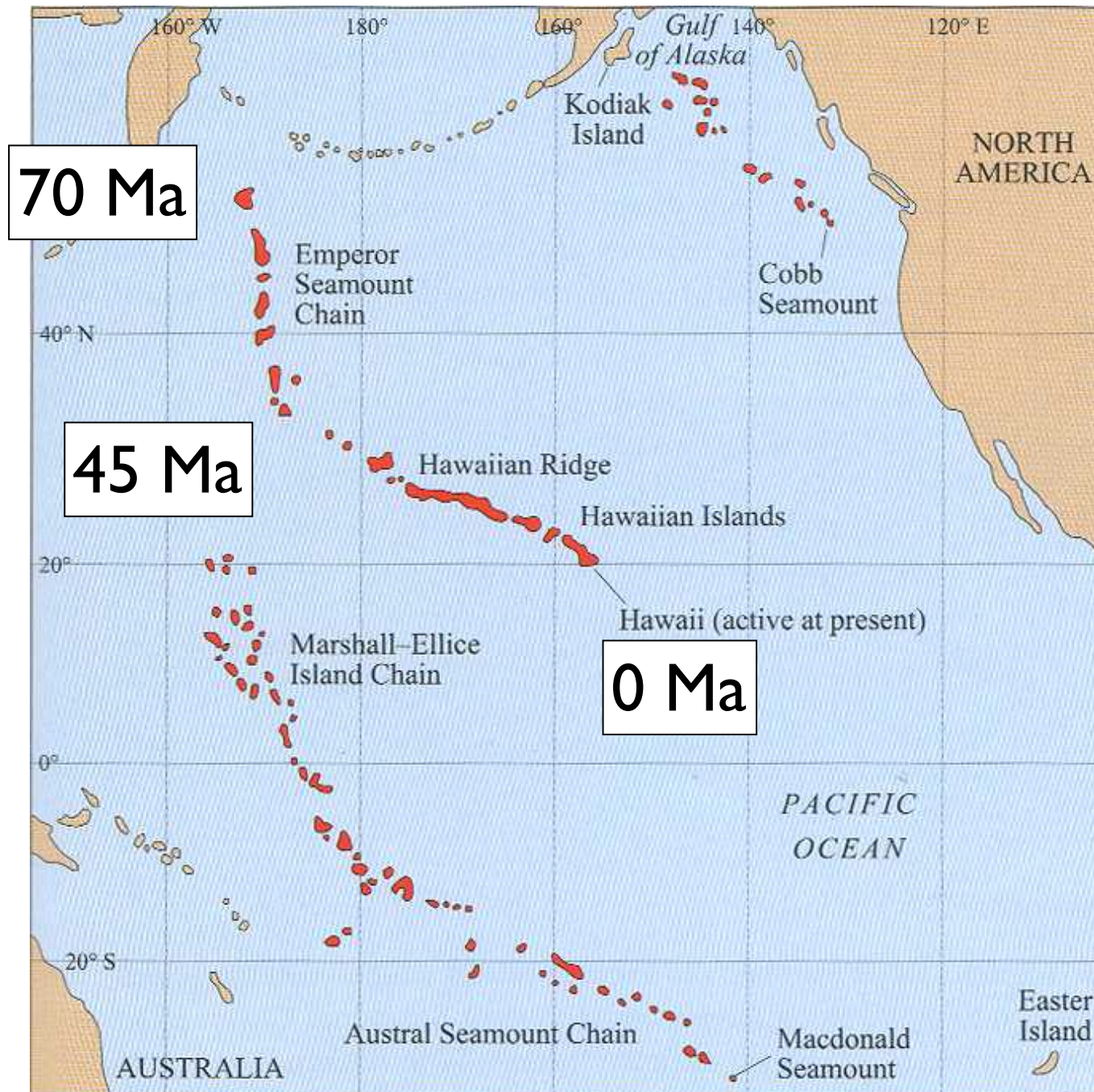
Spuren von Hot Spots



The Hawaiian Islands



Absolute Plattenbewegung



Hawaii -
Emperor chain

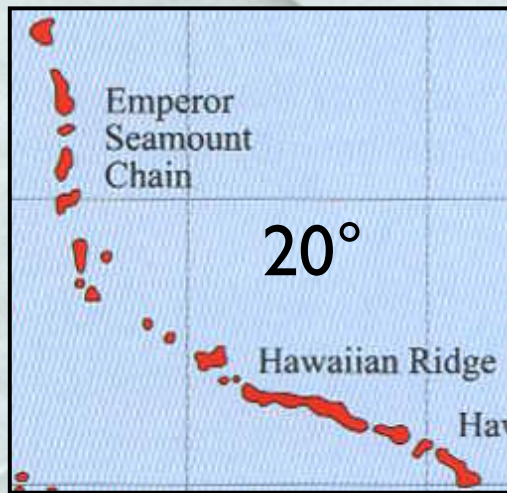
back of the envelope calculation: plate rates

Mit welcher Geschwindigkeit bewegt sich die Pazifische Platte über den hot spot, der heute Hawaii ist ?

Altersdatierung: NW: 70 Ma

SE (Hawaii): 0 Ma

$$\Rightarrow t \approx 7 \cdot 10^7 \text{ a}$$

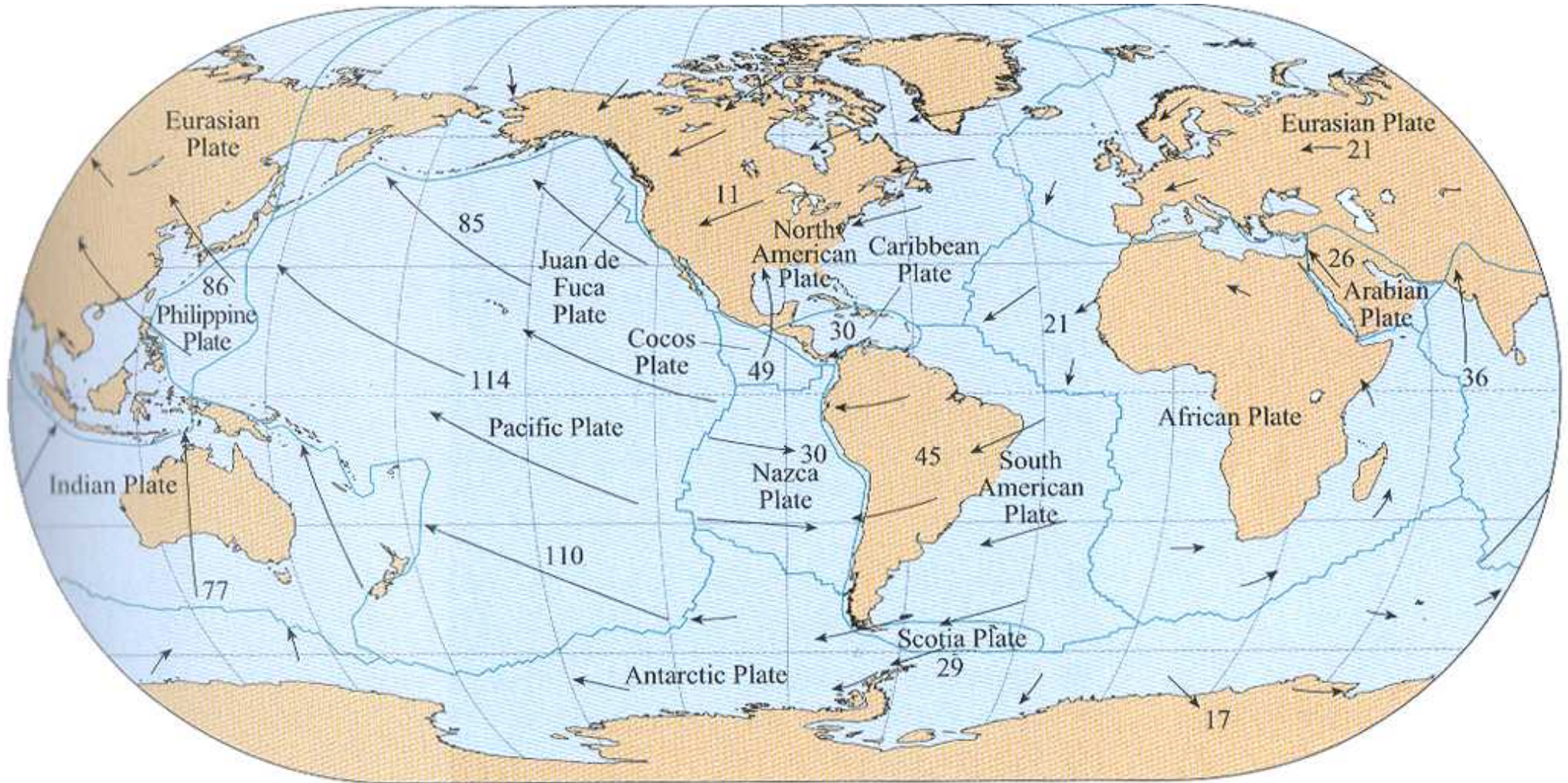


Distanz: 10° am Äquator $\approx 1000 \text{ km}$

$$\Rightarrow d \approx 6 \cdot 10^6 \text{ m}$$

Geschwindigkeit: $\frac{6 \cdot 10^6 \text{ m}}{7 \cdot 10^7 \text{ a}} \approx 9 \text{ cm / Jahr} \approx 10^{-1} \text{ ma}^{-1}$

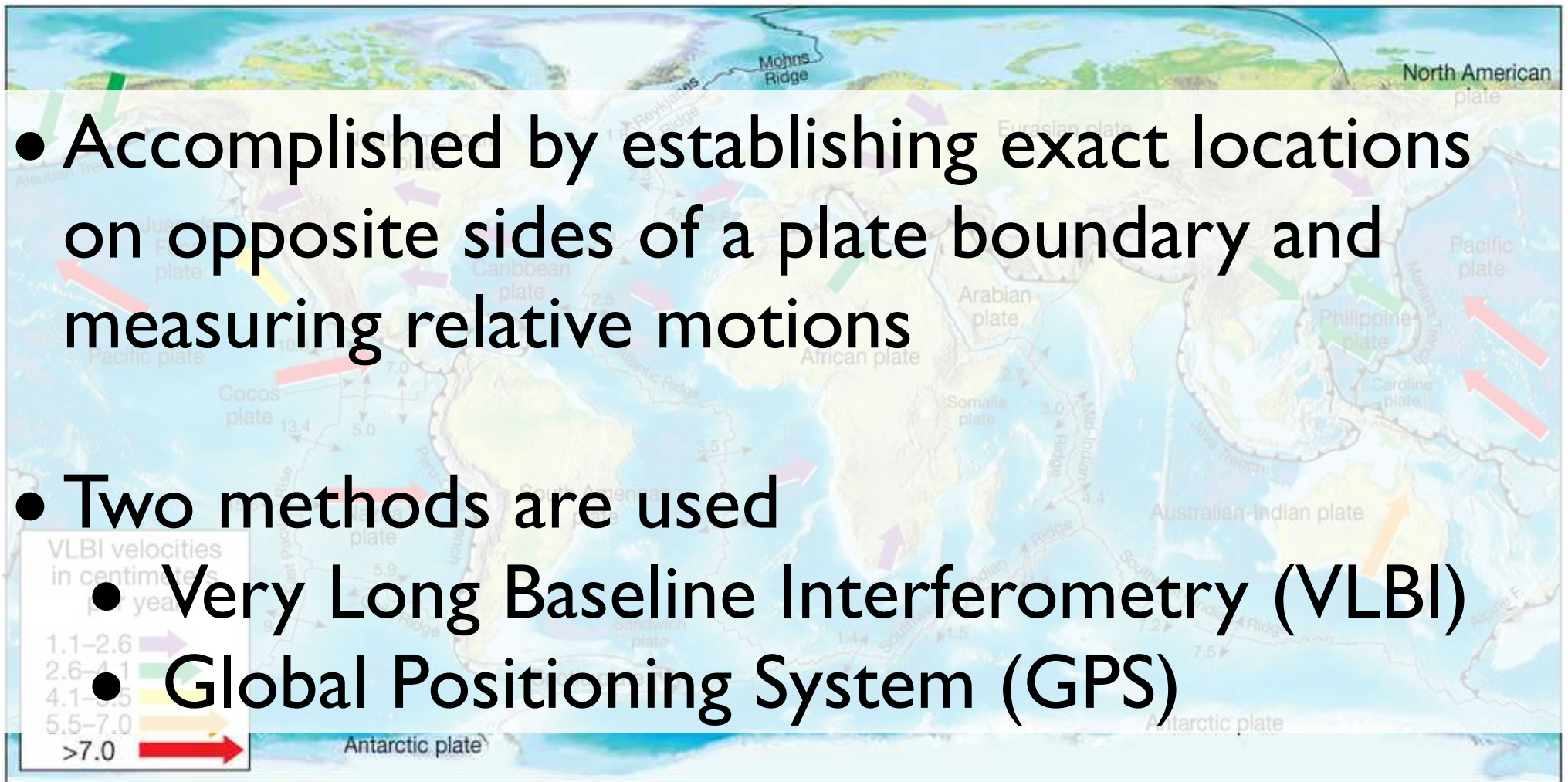
Absolute Plattenbewegung



bezüglich Hot Spots (mm a⁻¹)

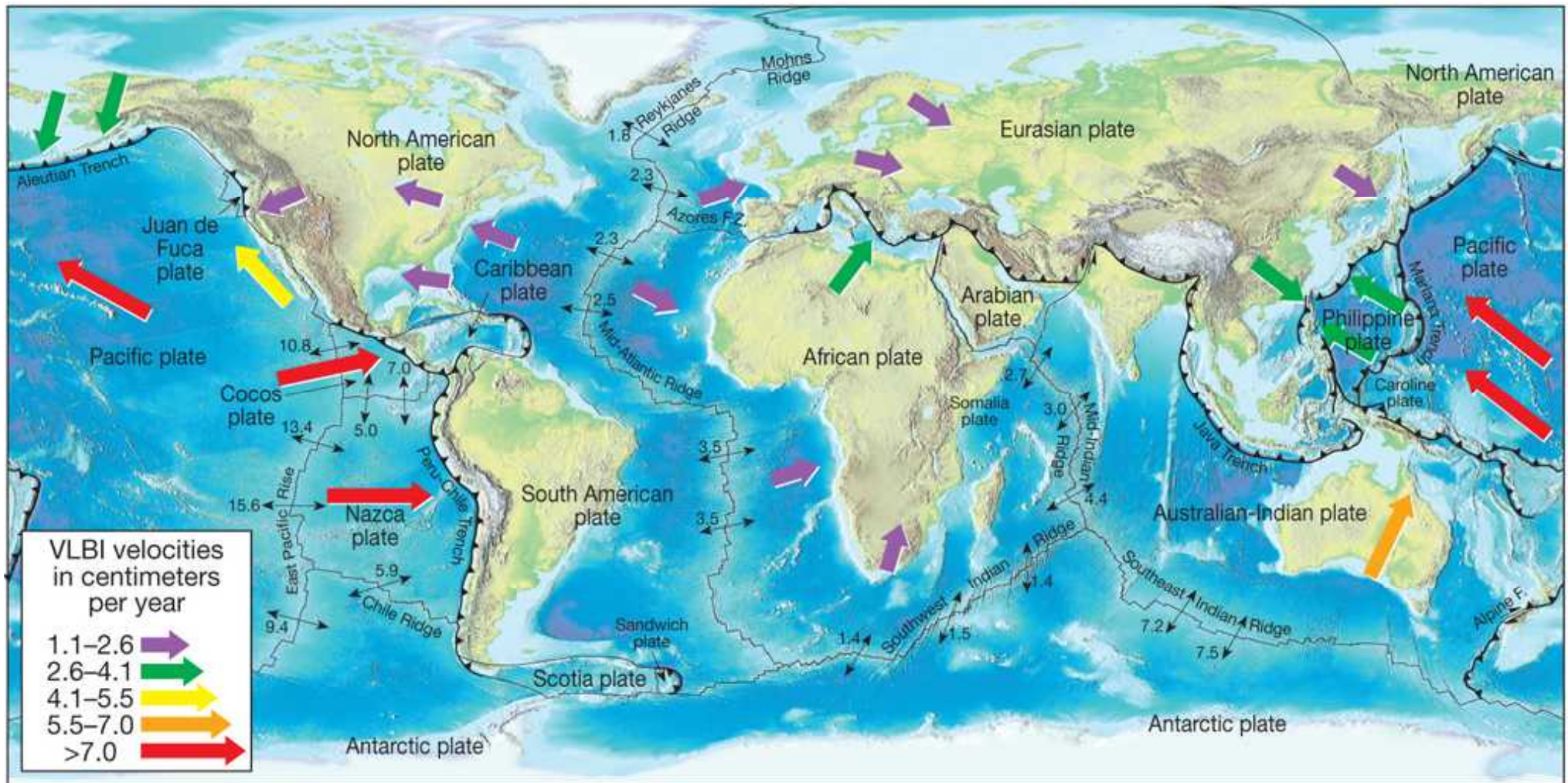
Measuring (absolute) plate motion

- Accomplished by establishing exact locations on opposite sides of a plate boundary and measuring relative motions
- Two methods are used
 - Very Long Baseline Interferometry (VLBI)
 - Global Positioning System (GPS)



Absolute plate motion

very large baseline interferometry (VLBI)



(cm a⁻¹)

A 3D rendering of the Earth, showing continents and oceans, with the text "the end" overlaid in a white, cursive font. The Earth is shown from a perspective that includes North America, South America, and parts of Europe and Africa. The oceans are a deep blue, and the landmasses are colored in shades of green, brown, and tan, representing vegetation and terrain. The text "the end" is written in a white, cursive font across the center of the globe.

the end