

Tatort Plattengrenze 2015 - Themen

1 *5. November*

Trailer

Einführung

Entstehung der Erde

4 *26. November*

Plattenrundgang

Tatort: Nepal 2015

Tatort: Izmir 1999

2 *12. November **

Geologische Zeiträume

Plattentektonik

Platten und Plattengrenzen

5 *3. Dezember*

Alles über Erdbeben

Magnitude

Intensitäten

3 *19. November*

+ Nachtrag

konstruktive Plattengrenzen

destruktive Plattengrenzen

konservative Plattengrenzen

6 *10. Dezember*

Berühmte Fälle

San Francisco

Tohoku

* *im Bernoullianum Hörsaal 223*

... Zusammenfassung bis hierher

Lithosphärenplatten:

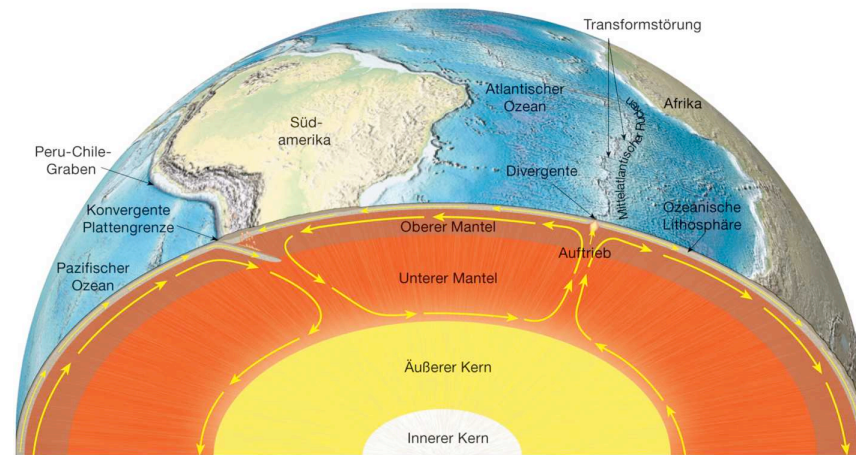
- schwimmen auf Asthenosphäre
- Kruste + oberer Mantel
- ozeanisch 5-100 km dick
- kontinental 50-250 km dick

Plattengrenzen:

- Seafloor Spreading
- Subduktionszonen
- Transformstörungen

Mantelkonvektion:

- Motor der Plattentektonik



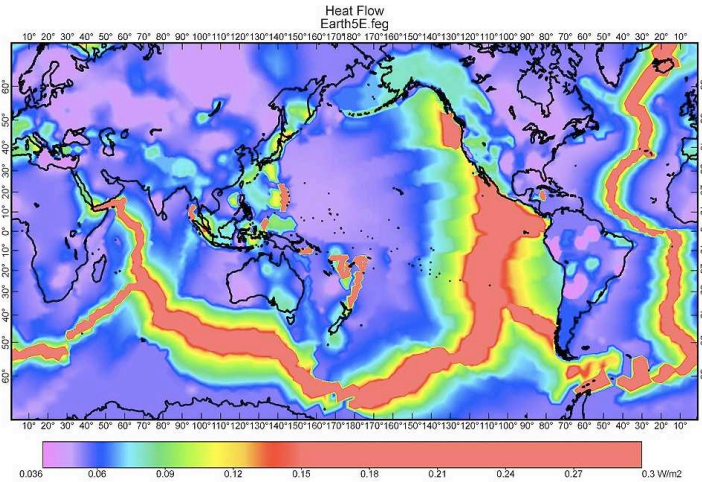
Datenblatt Erde:

Radius:	~ 6500 km	~ $6.5 \cdot 10^6$ m	
Masse:		~ $6 \cdot 10^{24}$ kg	~ 6000 Yg
Alter (kontinentale Kruste):	~ 4'5 Mrd. a	~ $4.5 \cdot 10^9$ a	~ 4.5 Ga
Alter ozeanische Kruste:	~ 200 Mio. a	~ $200 \cdot 10^6$ a	~ 200 Ma

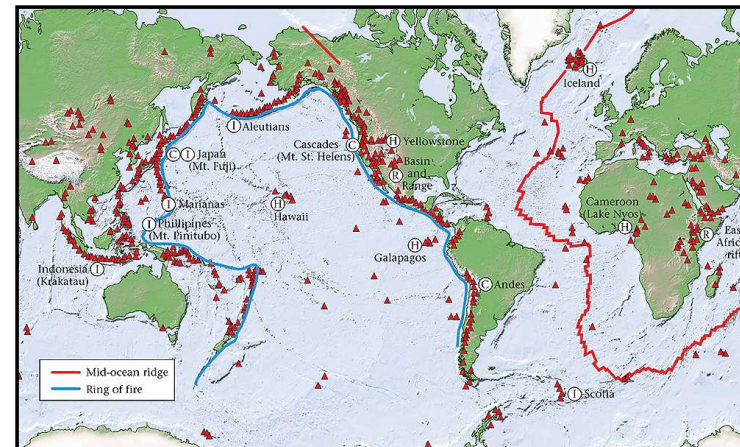
Spurensicherung an Plattengrenzen

wie sich Plattengrenzen verraten

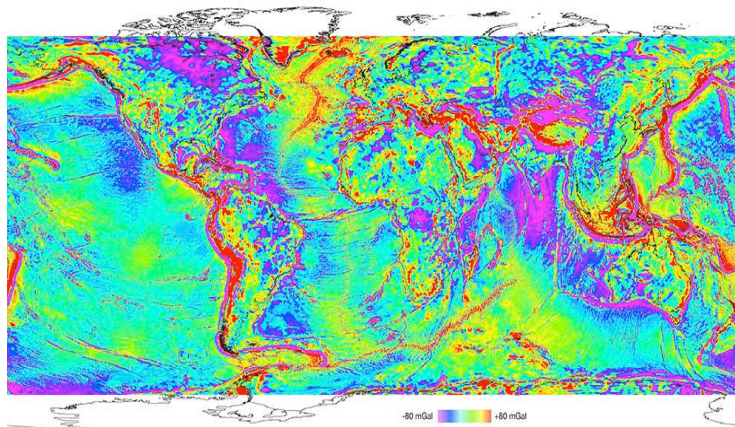
1- Wärmefluss → konstruktive



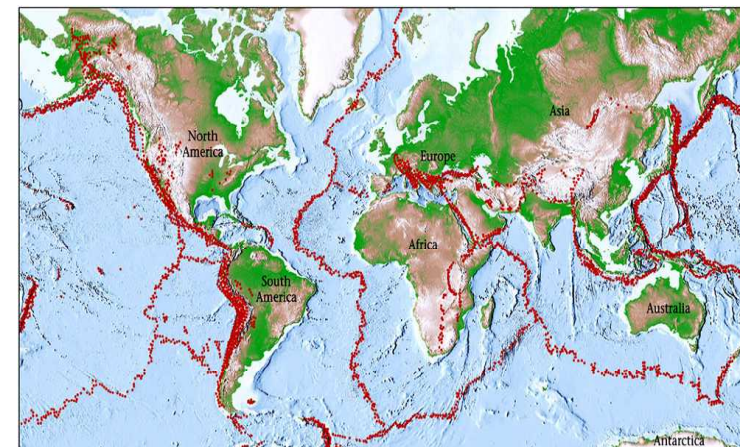
2- Vulkanismus → alle



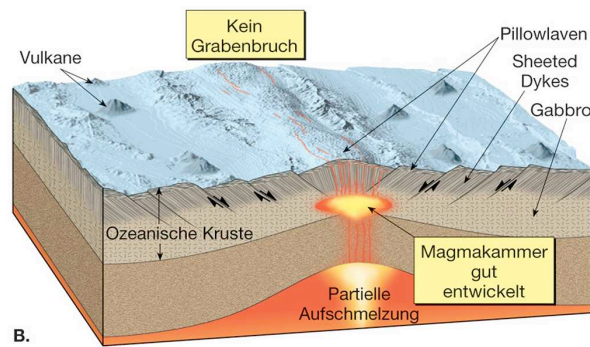
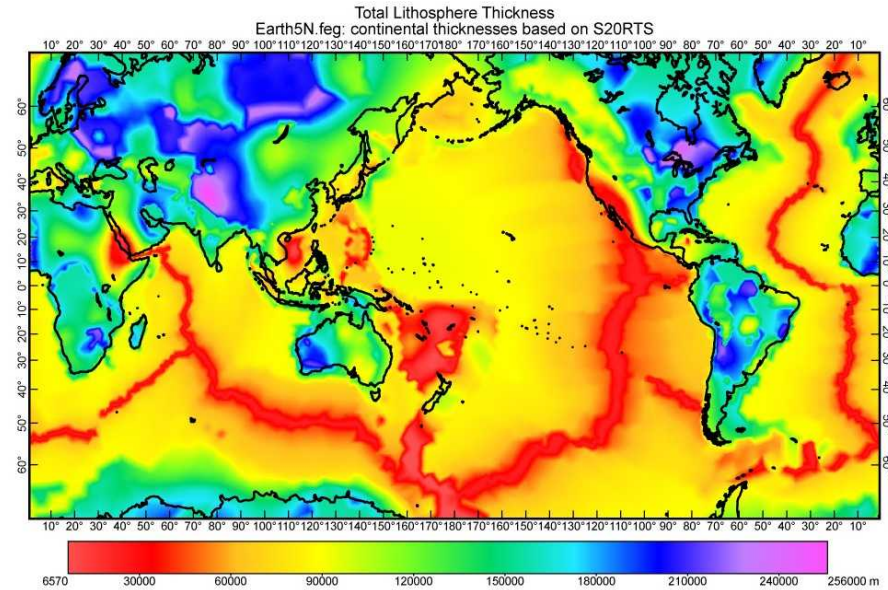
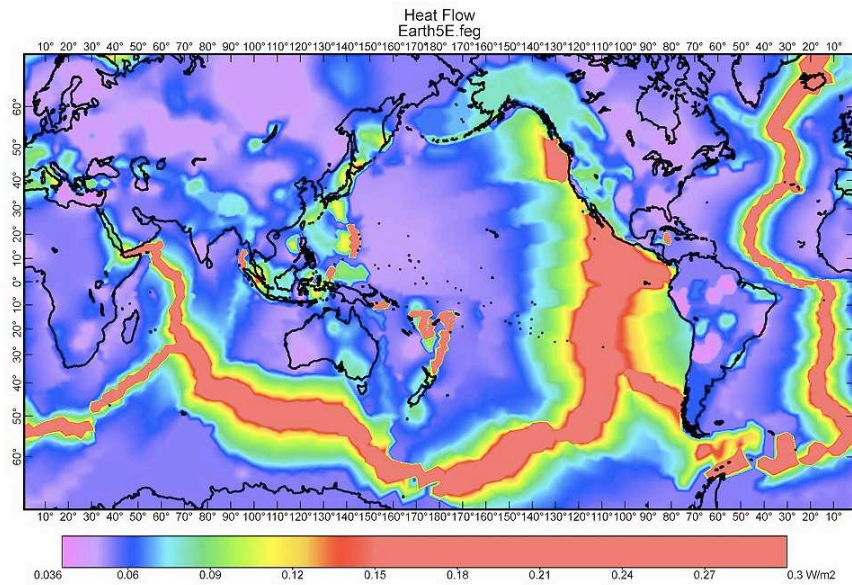
3- Schwereanomalien → destruktive



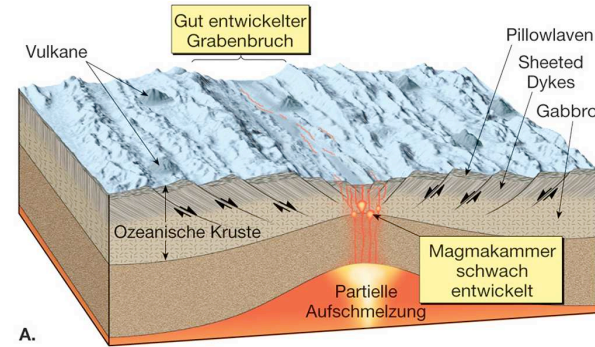
4- Erdbeben → alle



I - Wärmefluss: Seafloor Spreading

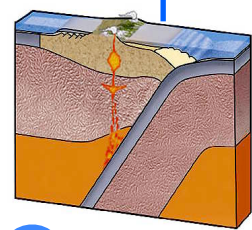
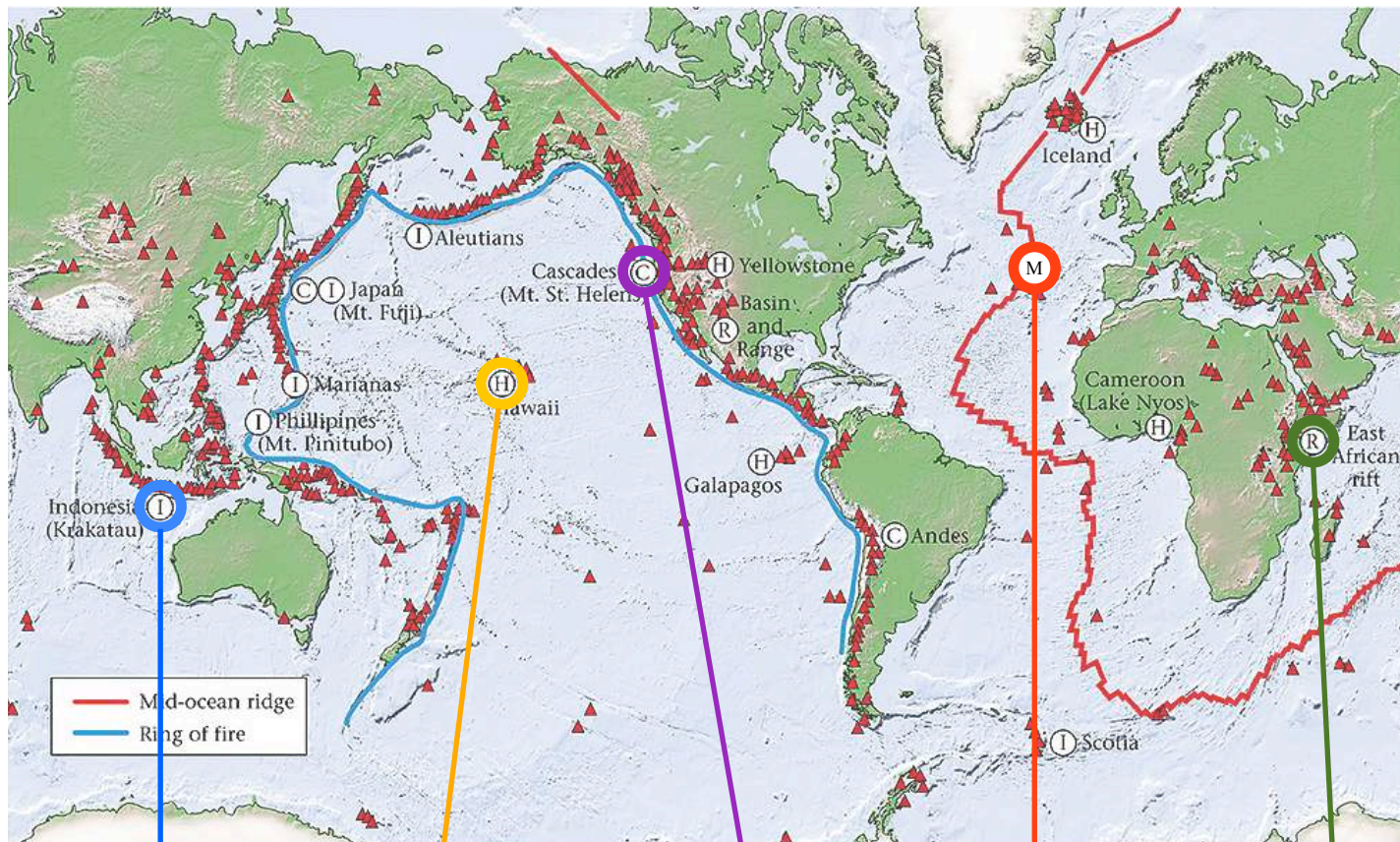


schnelle Öffnung
(Ostpazifischer Rücken)

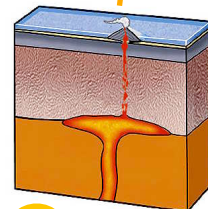


langsame Öffnung
(Mittelatlantischer Rücken)

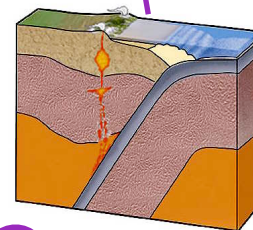
2- Vulkanismus an Plattengrenzen



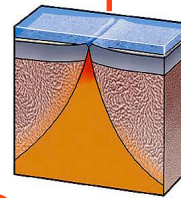
I = Island arc
destruktiv



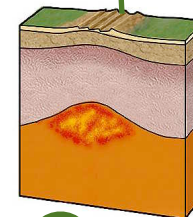
H = Hot spot
(-)



C = Continental arc
destruktiv

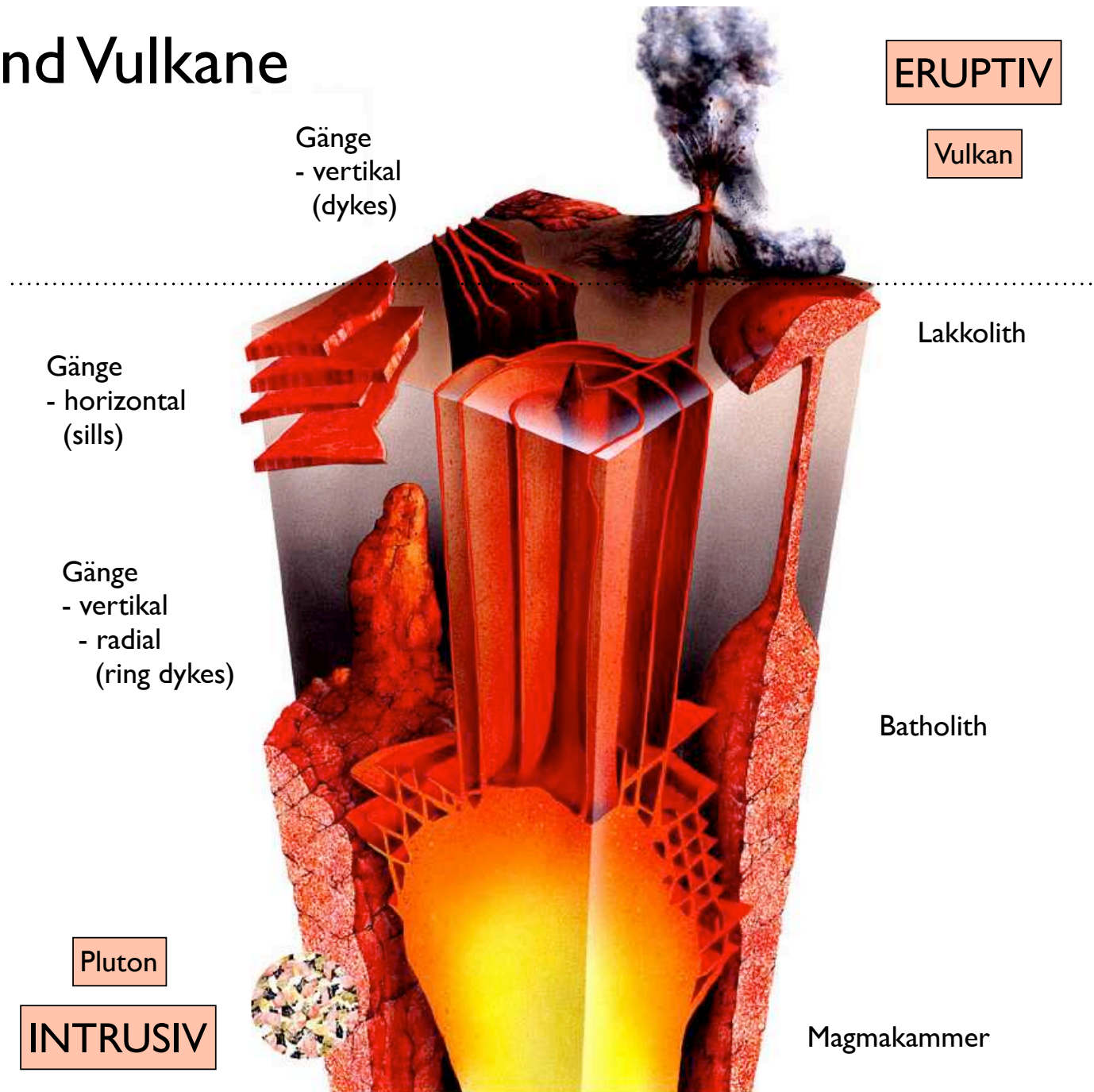


M = Mid-ocean ridge
konstruktiv

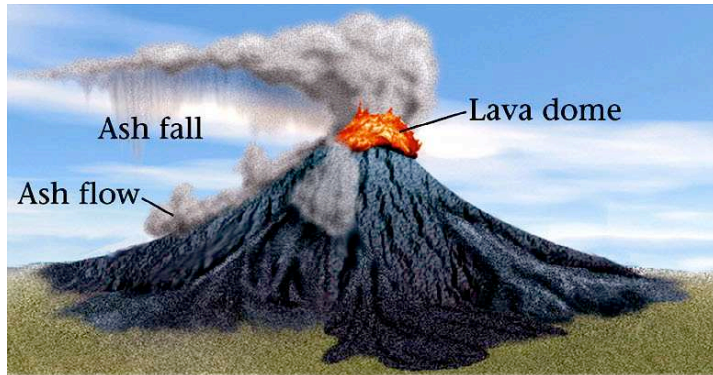


R = Rift
konstruktiv

2- Plutone und Vulkane



2- will it flow or will it blow?



Felsisch = blow

Felsische Gesteinsschmelze (Magma)
→ Rhyolitische Lava

Zähflüssig, wenig fließfähig
(hochviskös)
→ Gefährliche Explosionen

Beispiel: Mount St Helens



Mafisch = flow

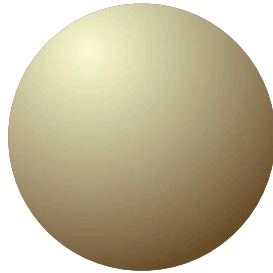
Mafische Gesteinsschmelze (Magma)
→ Basaltische Lava

Dünflüssig, leicht fließfähig
(niederviskös)
→ Ungefährliches Ausfließen

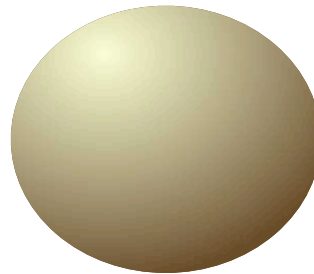
Beispiel: Hawaii

3- welche Form hat die Erde ?

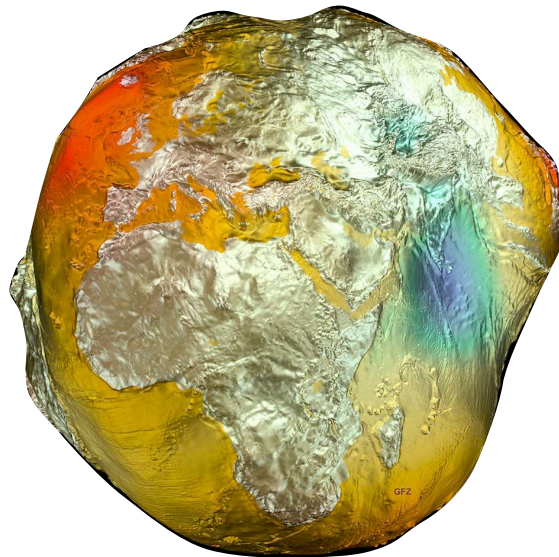
Ist die Erde ...



... eine Kugel ?

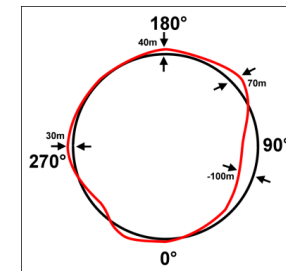
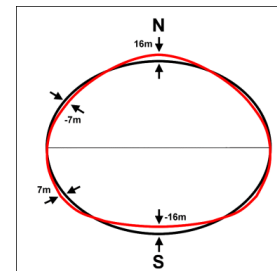
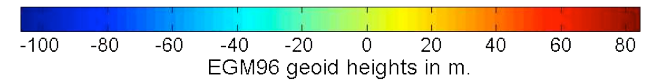
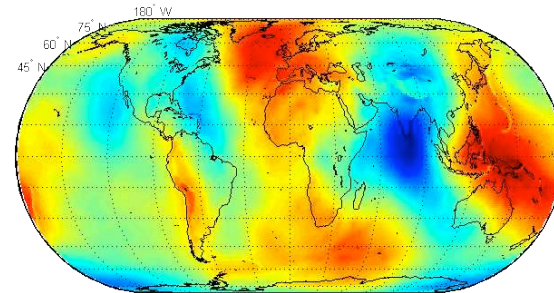


... ein Rotationsellipsoid ?



... und seit 2011 eine Kartoffel !

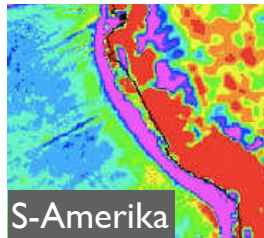
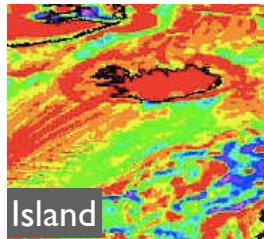
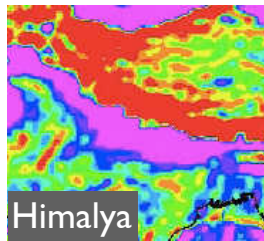
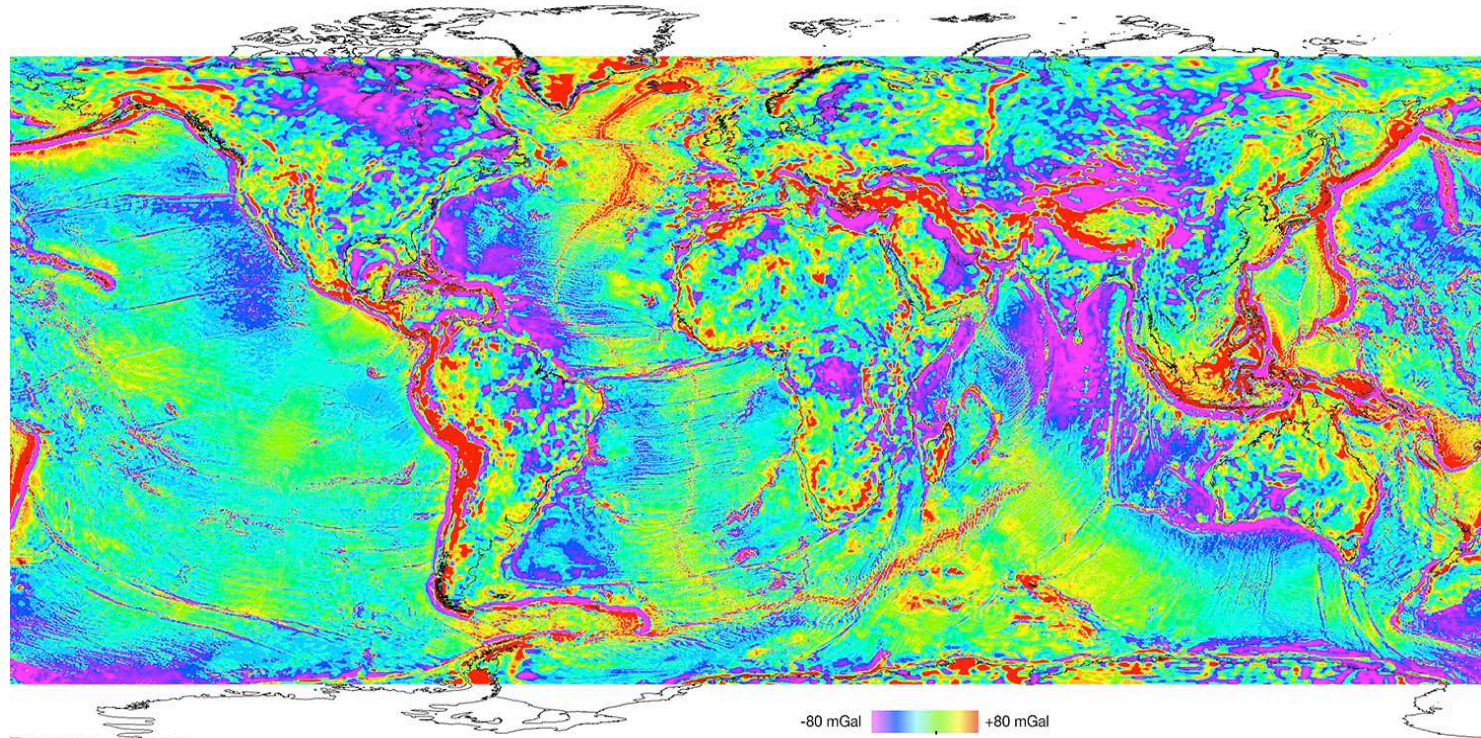
Seit 1828 (Carl Friedrich Gauss) ist die physikalische Form der Erde das sogenannte Geoid ...



... seit 1996 ist ein Birne...

3- Welt - Schwerekarte

<http://www.ngu.no/geodynamics/gplates/> --- Free Air Gravity Anomaly Map



der Höhenlage entsprechende Erdanziehung: zu tief ← → zu hoch

Kontinentalbereich bedeutet:

$\Delta g_F > 0$ zusätzliche Gesteinsmasse

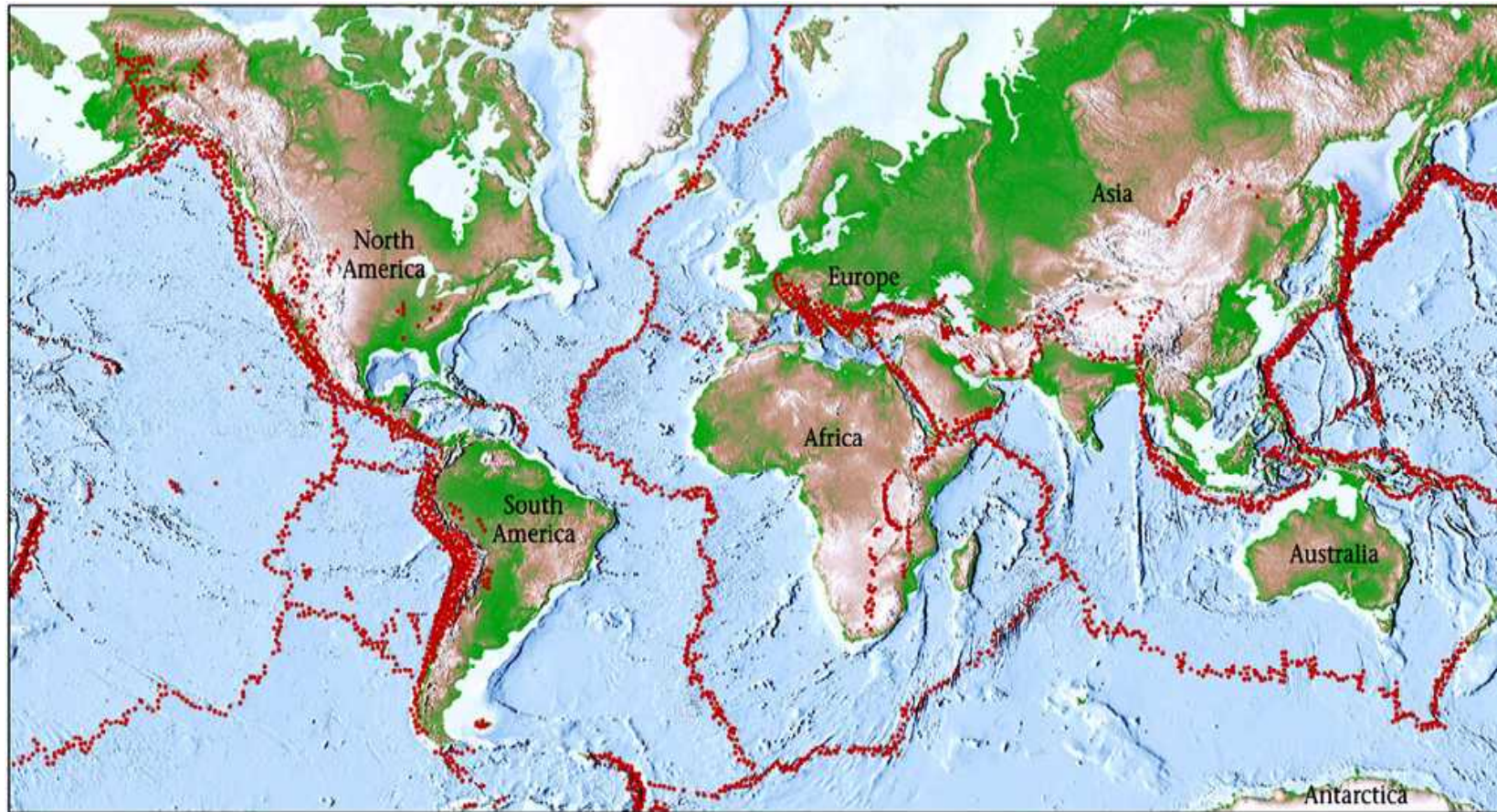
$\Delta g_F < 0$ sehr geringe Dichte - Sedimente

Im Ozeanbereich bedeutet

$\Delta g_F > 0$ dichtes (Mantel-) material - Ozeanrücken

$\Delta g_F < 0$ fehlende Anziehung - grosse Wassertiefe - Graben

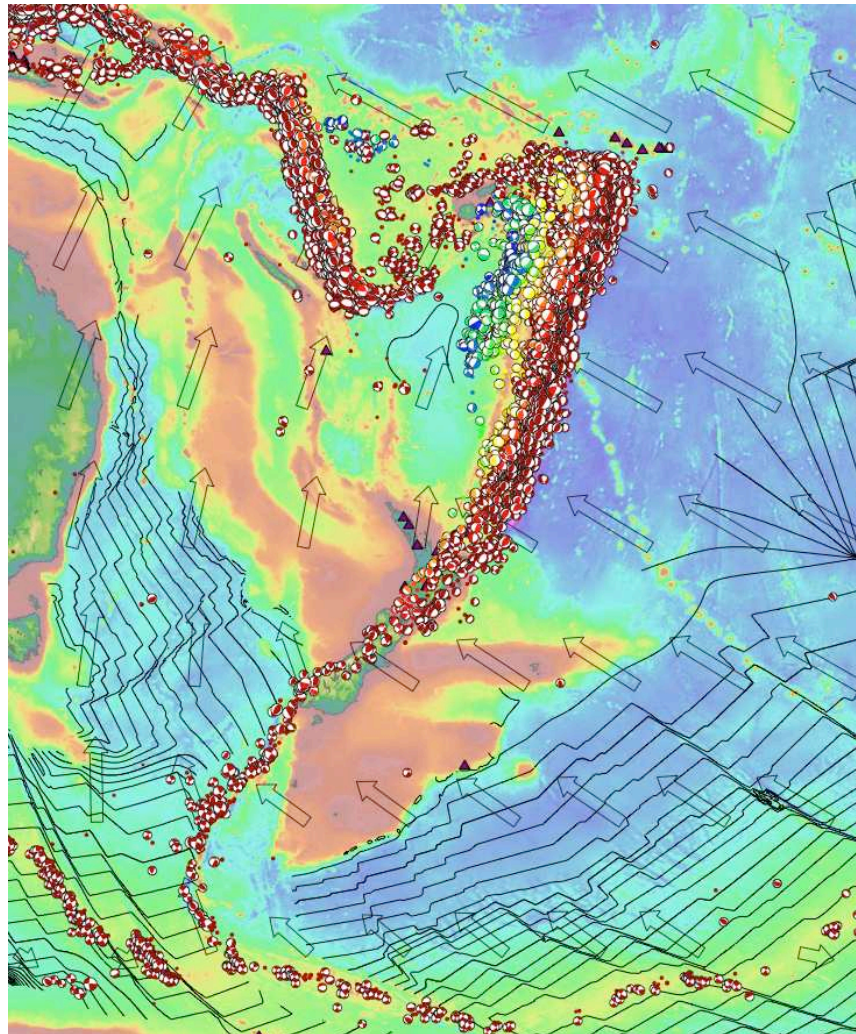
4- Erdbeben an Plattengrenzen



Epizentren definieren Plattengrenzen
Pro memoria: Plattengrenzen \neq Kontentalrand

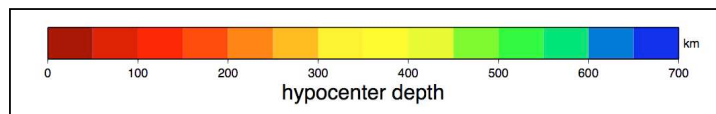
Epizentrum:	Erdoberfläche
Hypozentrum:	Erdbebenherd (in der Tiefe)

4- Erdbeben an Platten grenzen



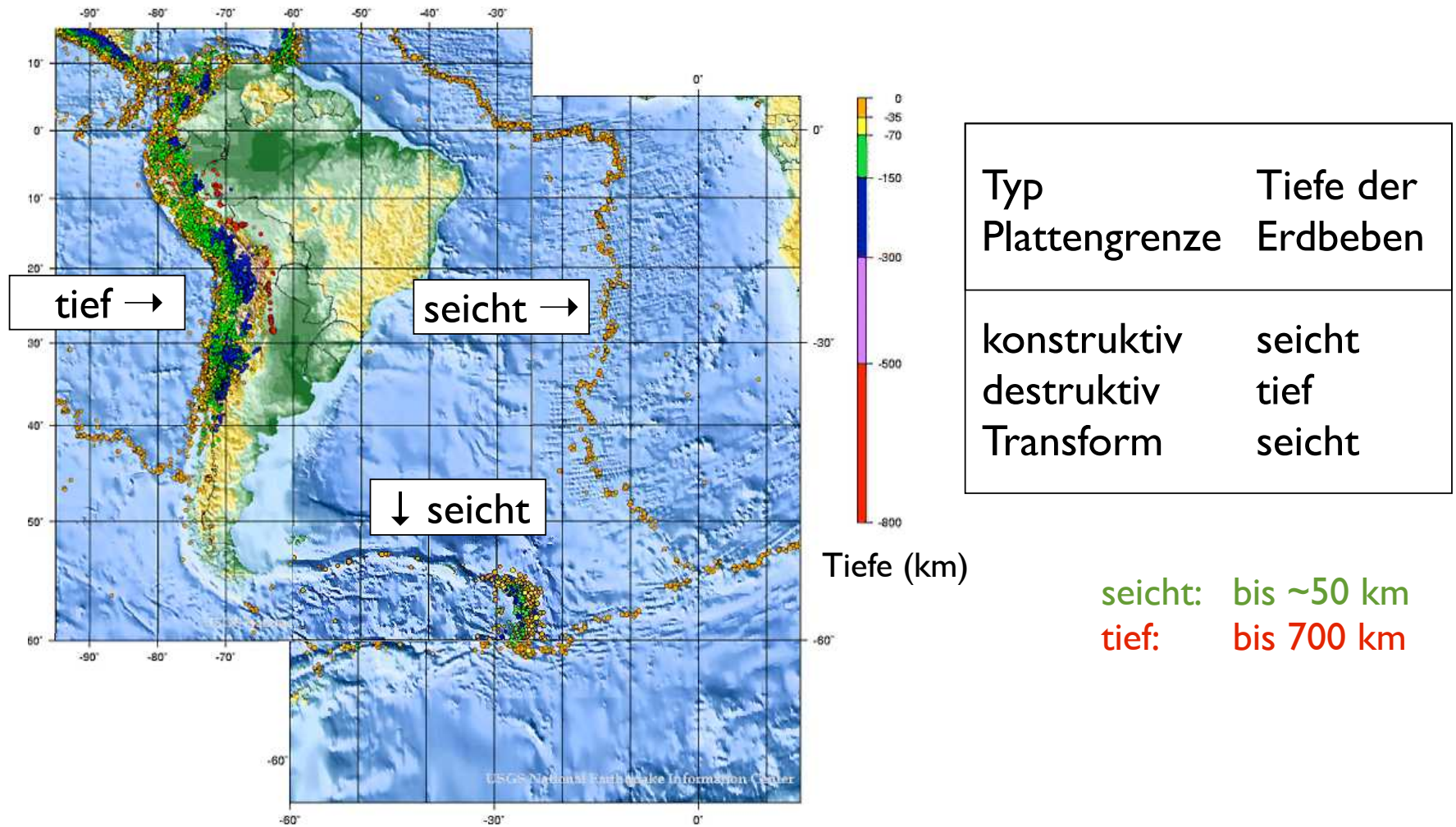
Typ Plattengrenze	Tiefe der Erdbeben
konstruktiv	seicht
destruktiv	tief
Transform	seicht

seicht: bis 50 km
tief: bis 700 km



⊗ ⊙ Erdbeben Hypozentren

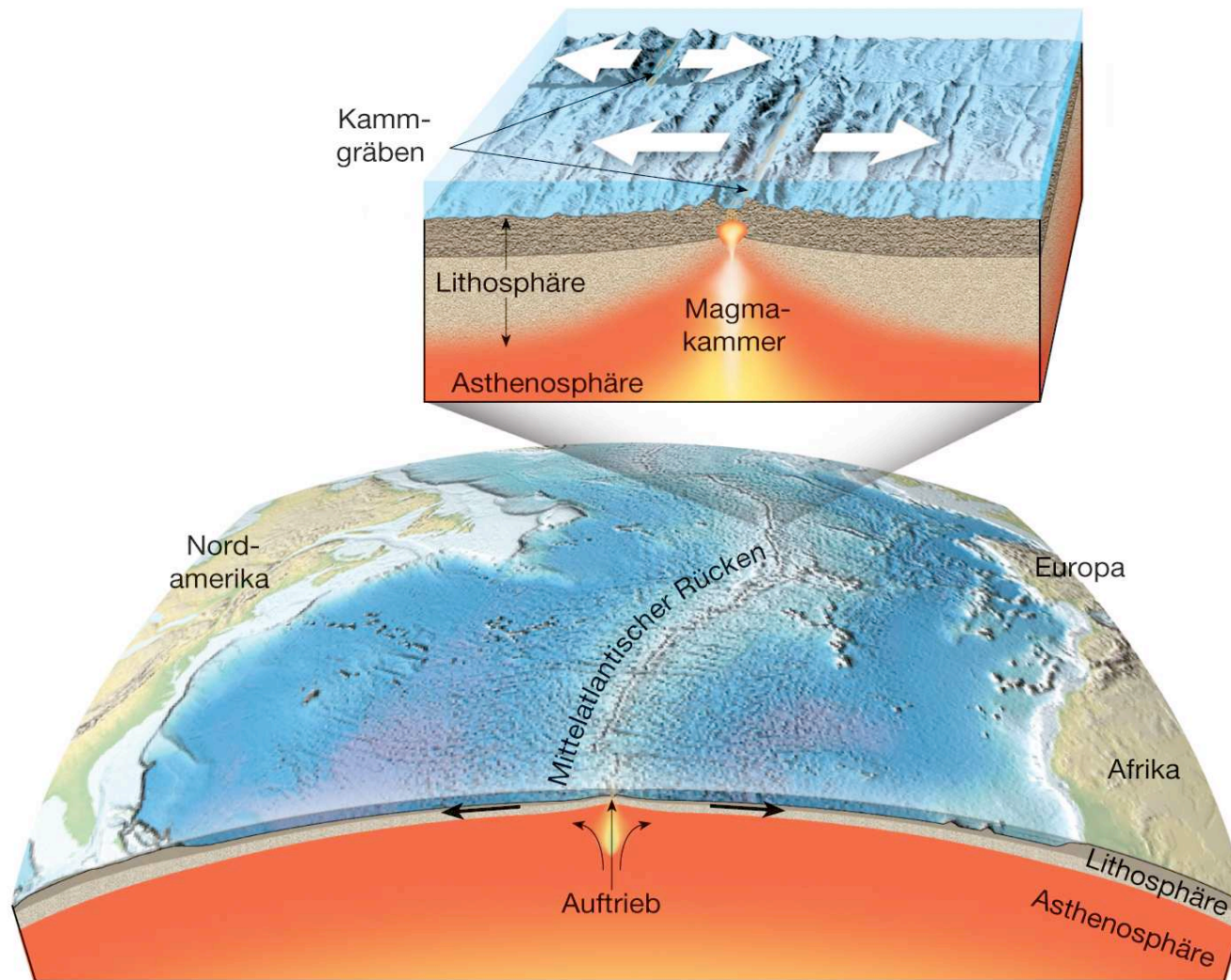
4- Charakteristische Tiefe der Erdbeben



<http://earthquake.usgs.gov/regional/world/seismicity/>

**Steckbrief:
konstruktive
Plattengrenzen**

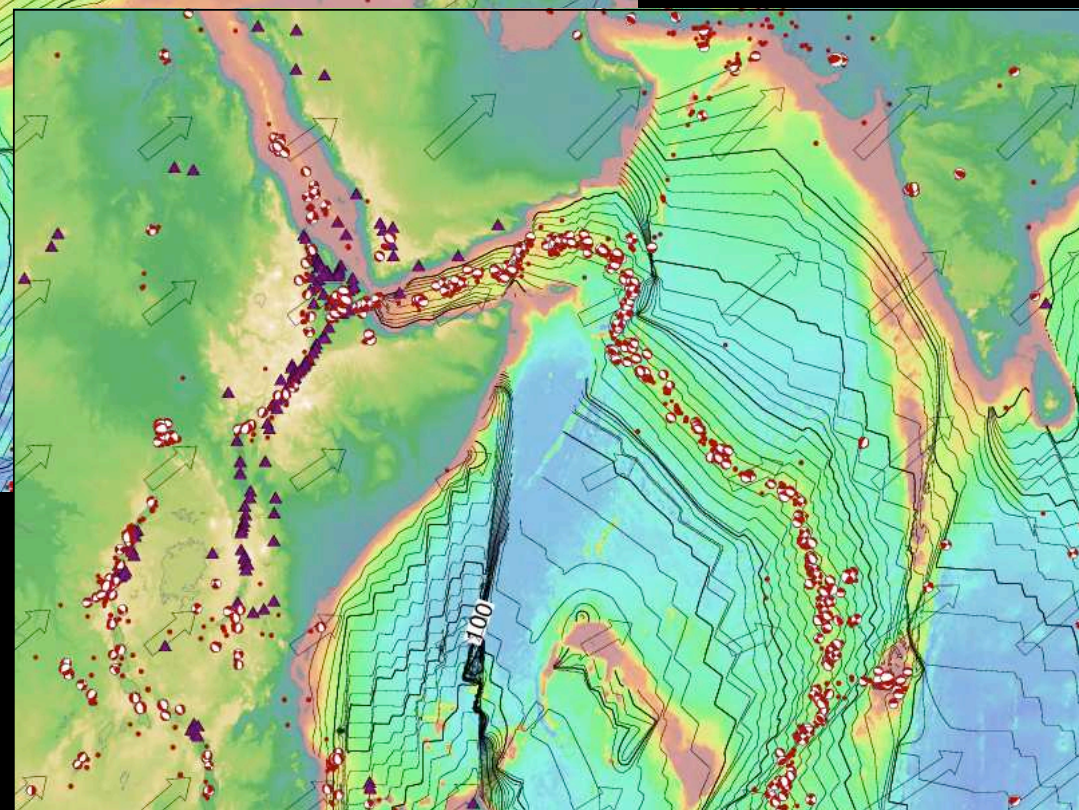
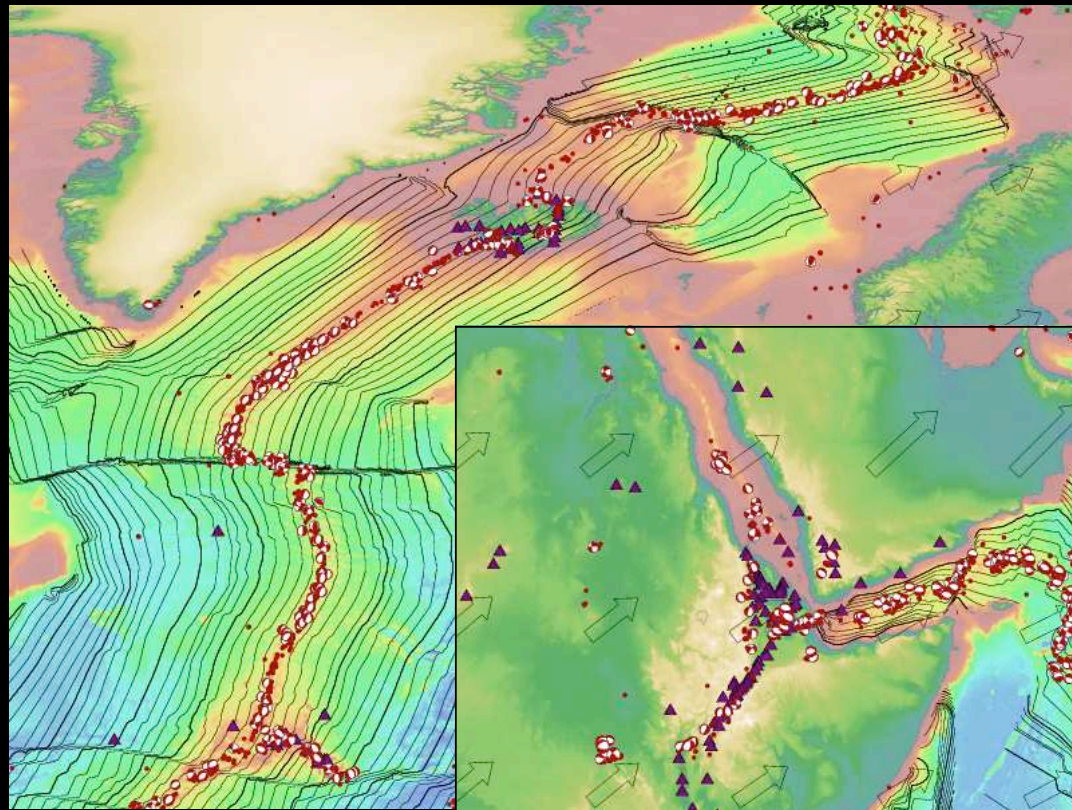
Konstruktive Plattengrenzen



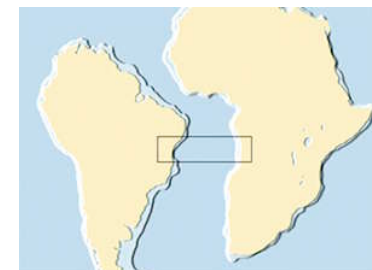
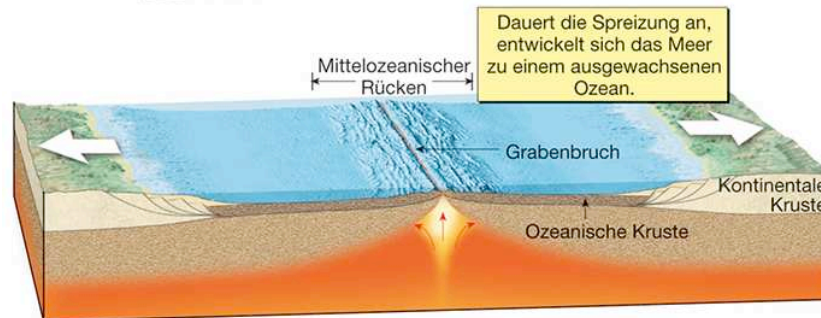
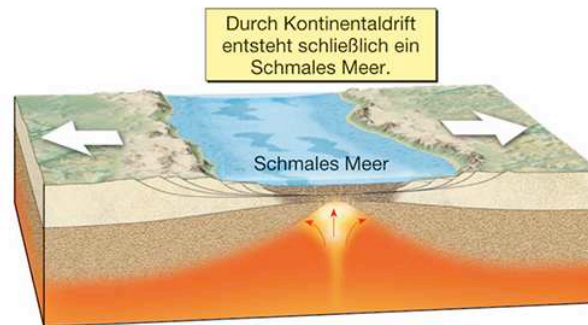
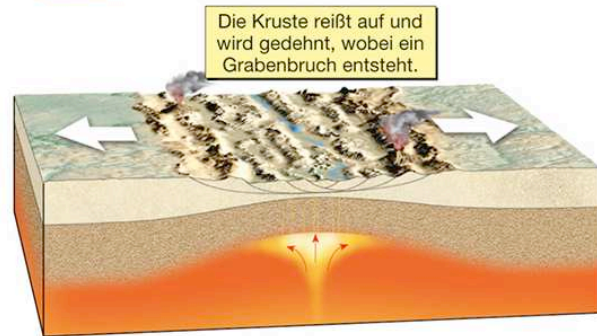
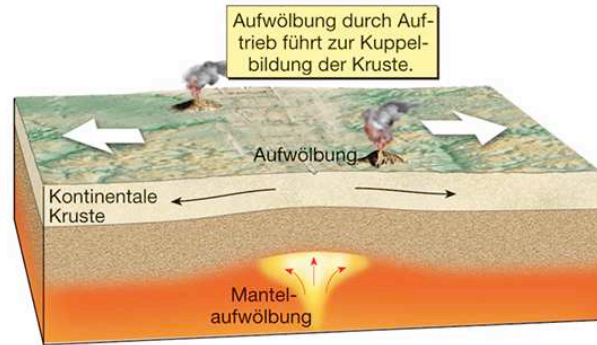
(physikalisch)
konstruktiv
=
(kinematisch)
divergent
=
(geometrisch)
distensiv

Abbildung 2.21: Die meisten divergenten Plattengrenzen befinden sich an den Kämmen der Ozeanischen Rücken.

Seichte Beben - Konstruktive Plattengrenzen

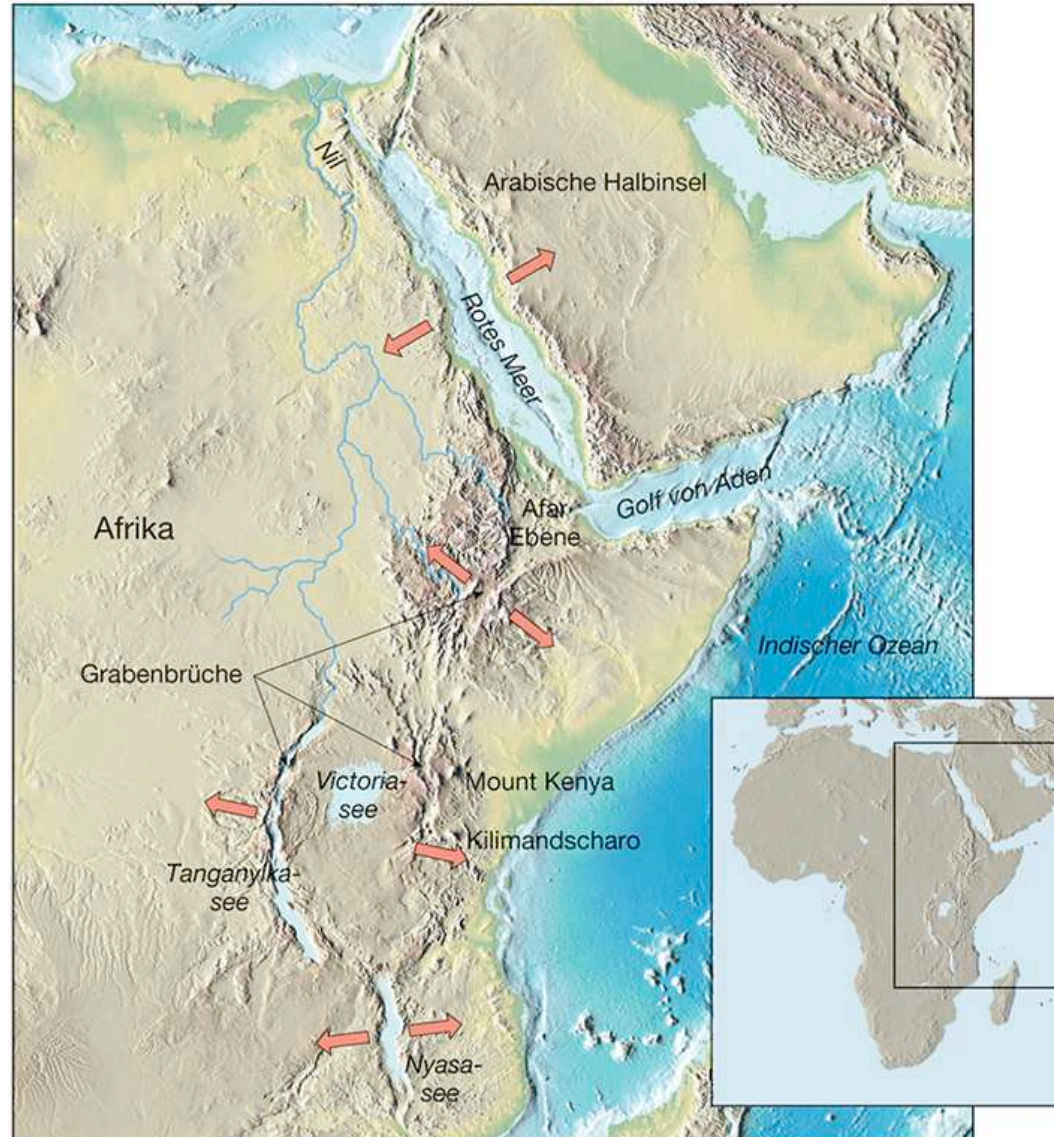


vom kontinentalen Grabenbruch zum Ozean



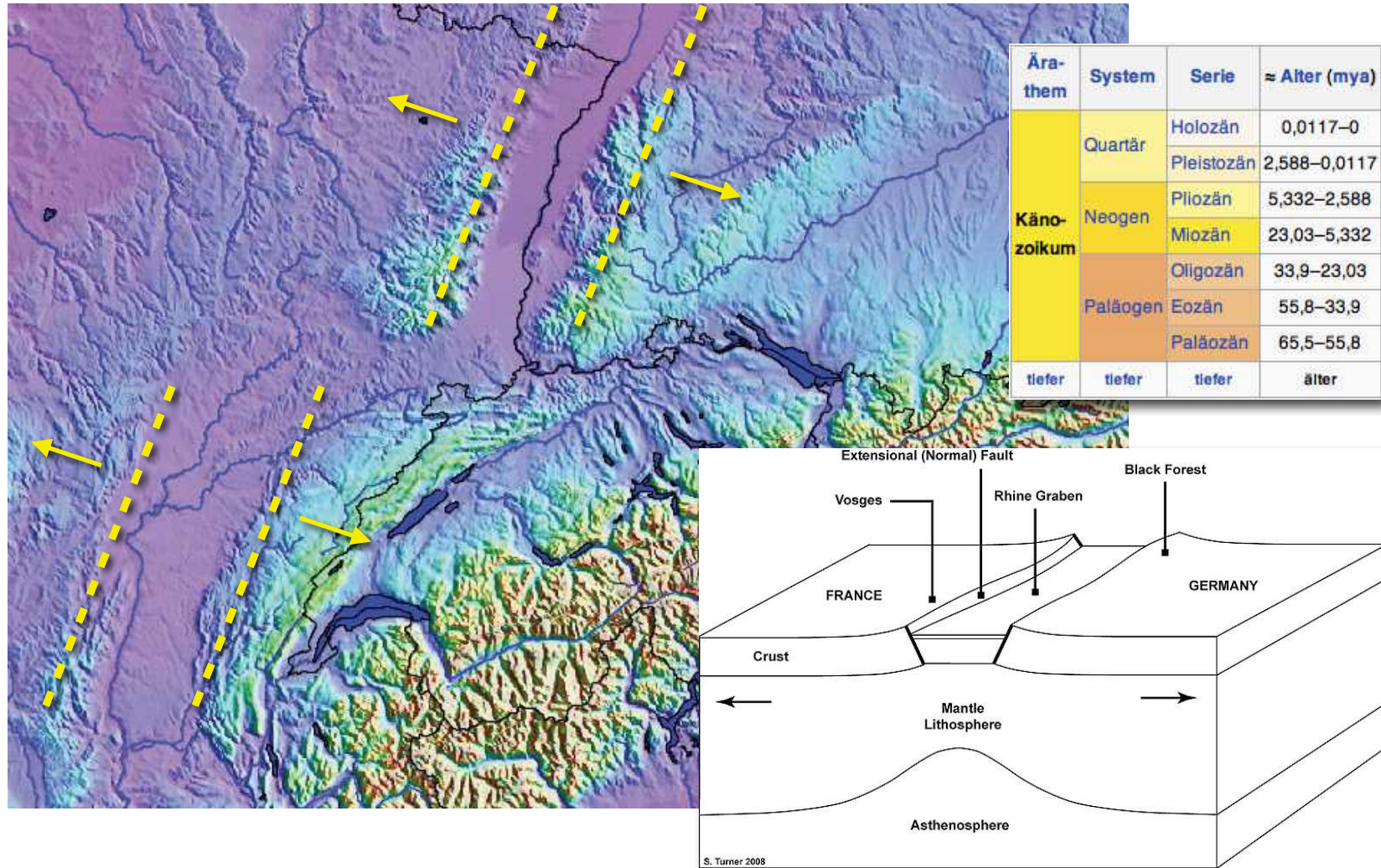
Beispiel: Ostafrikanischer Grabenbruch

aktuell
aktiv



Beispiel: Rheingraben Bressegraben

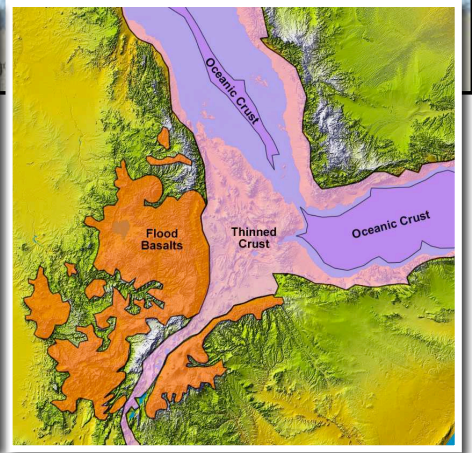
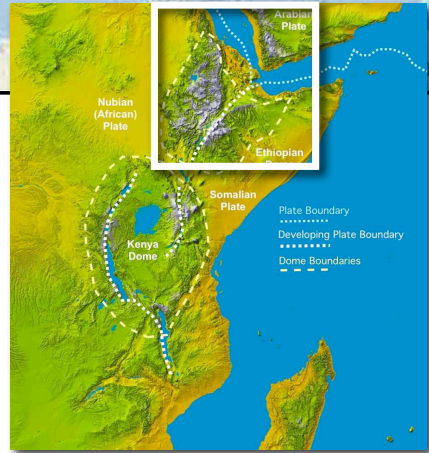
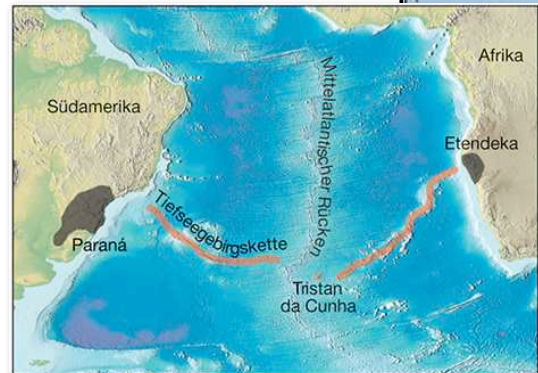
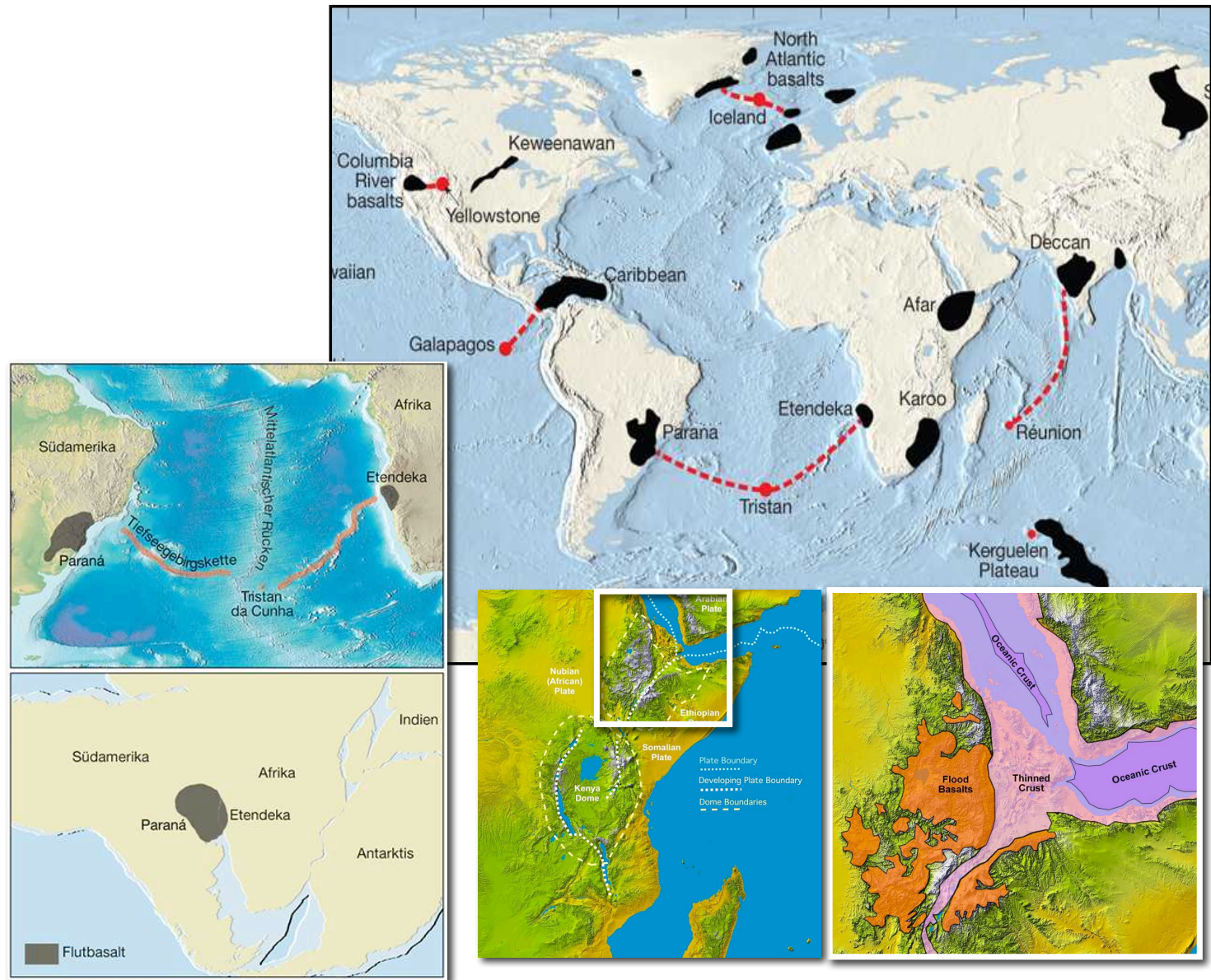
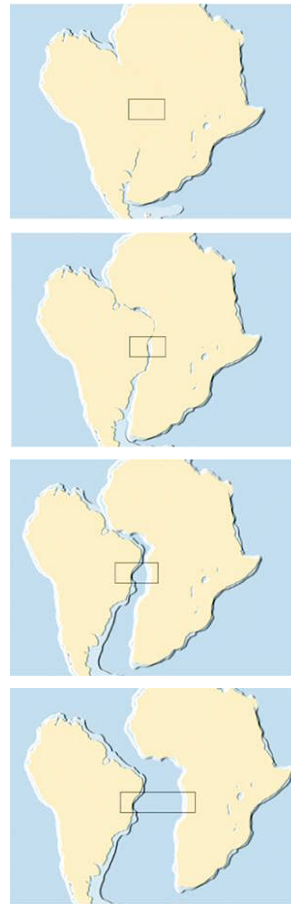
Eozän - Miozän



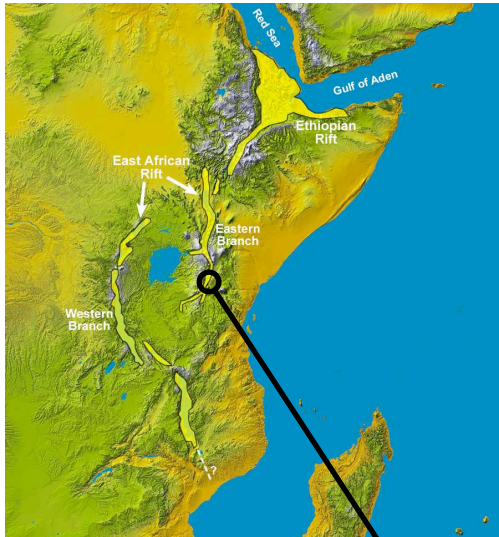
<http://en.wikipedia.org/wiki/File:Rhinegrabencross.jpg>

vom Hotspot zum Ozean

Plateaubasalte und Hotspot Trails



Ost-Afrikanisches Rift: Ein Kontinent zerbricht



Oldoinyo Lengai



Oldoinyo Lengai Lava, ca. 2 Tage alt



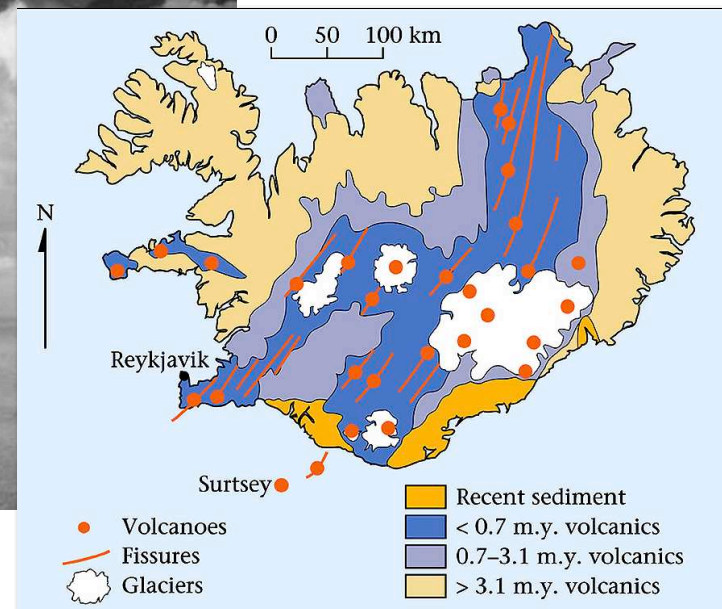
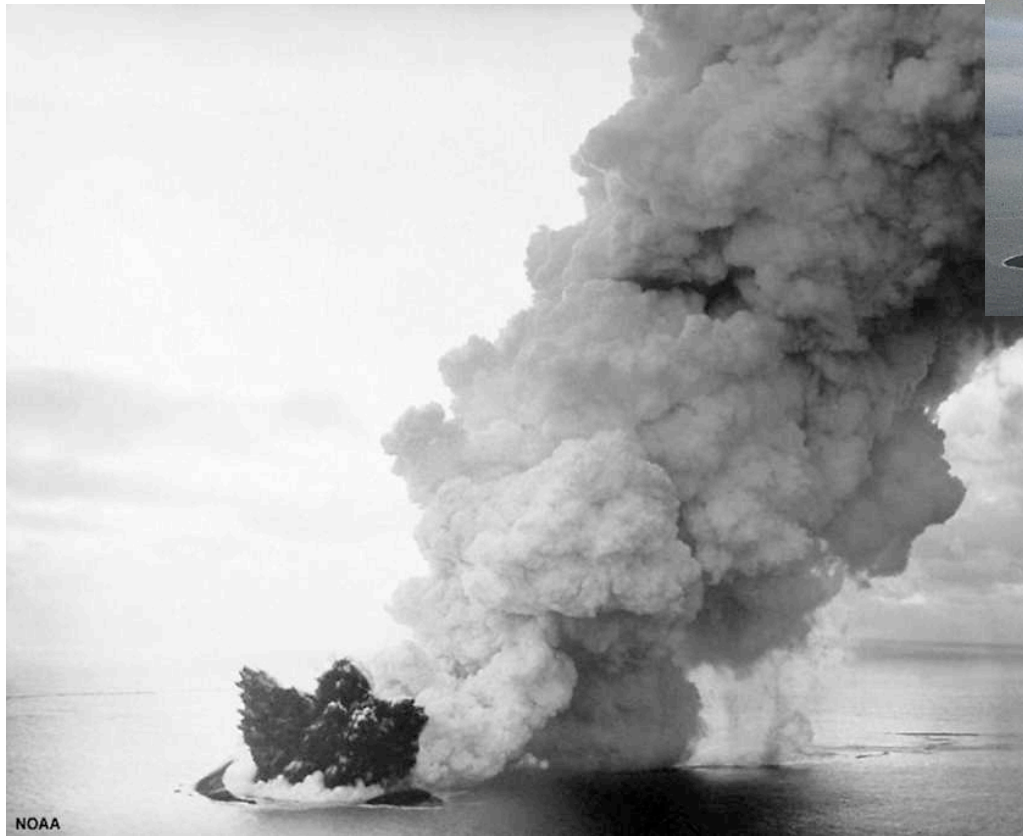
Probennahme (B. Marty and T. Fischer)

Einzigster aktiver Karbonatit Vulkan der Welt

- Zusammensetzung:
typisch Ozeanrücken-Mantel mit $\geq 30\%$ CO_2
- Sehr niedrige Viskosität:
dünnflüssig, sprudelt fast wie Wasser
fließt aus bei $\sim 540^\circ\text{C}$
- An der Oberfläche wird das CO_2 - nach Erkalten - fest

Island: auf dem Mittelozeanischen Rücken

Surtsey Eruption 1963



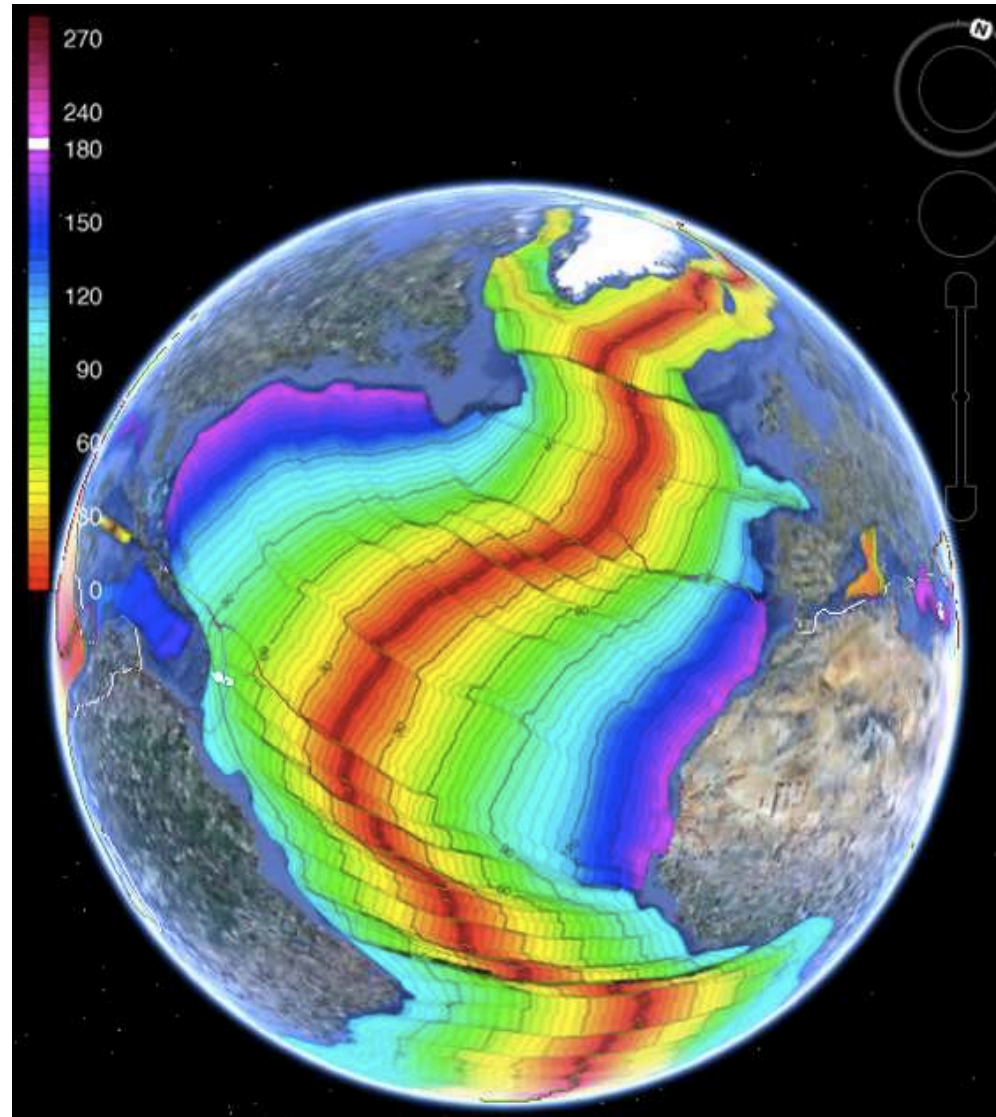
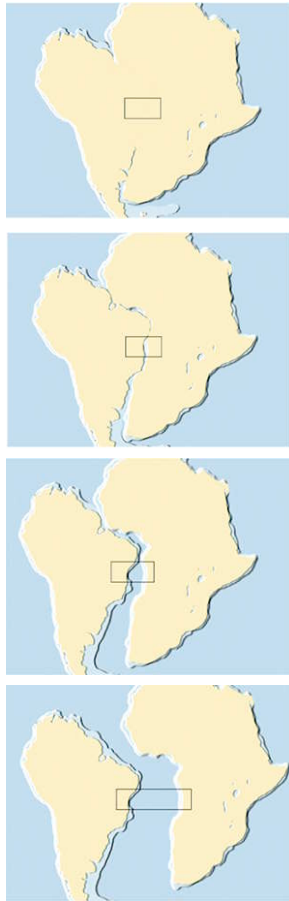
Der Mittelatlantische Rücken

Alter des Ozeanbodens

180 Ma

90 Ma

0 Ma

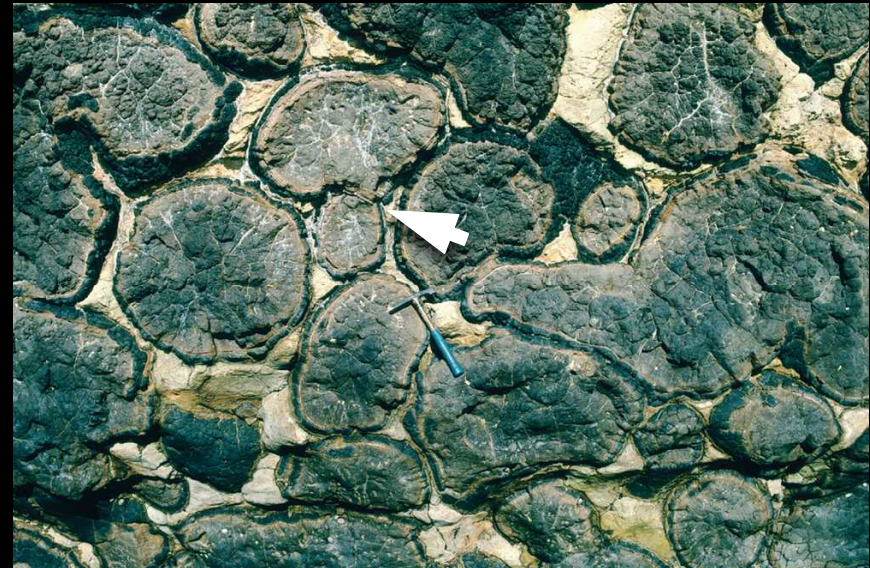
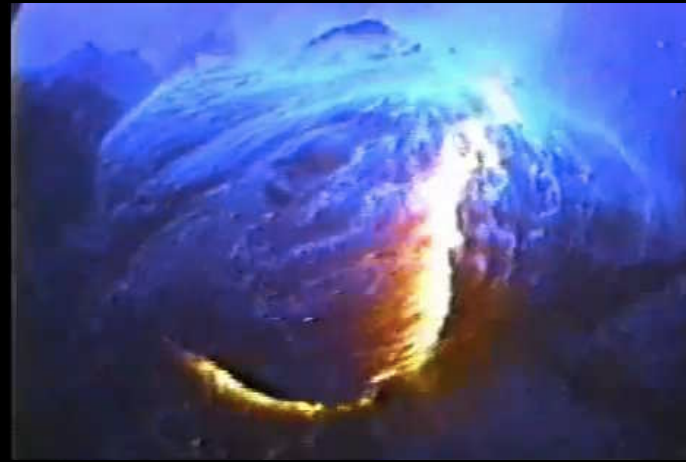


Leben am mittelozeanischen Rücken

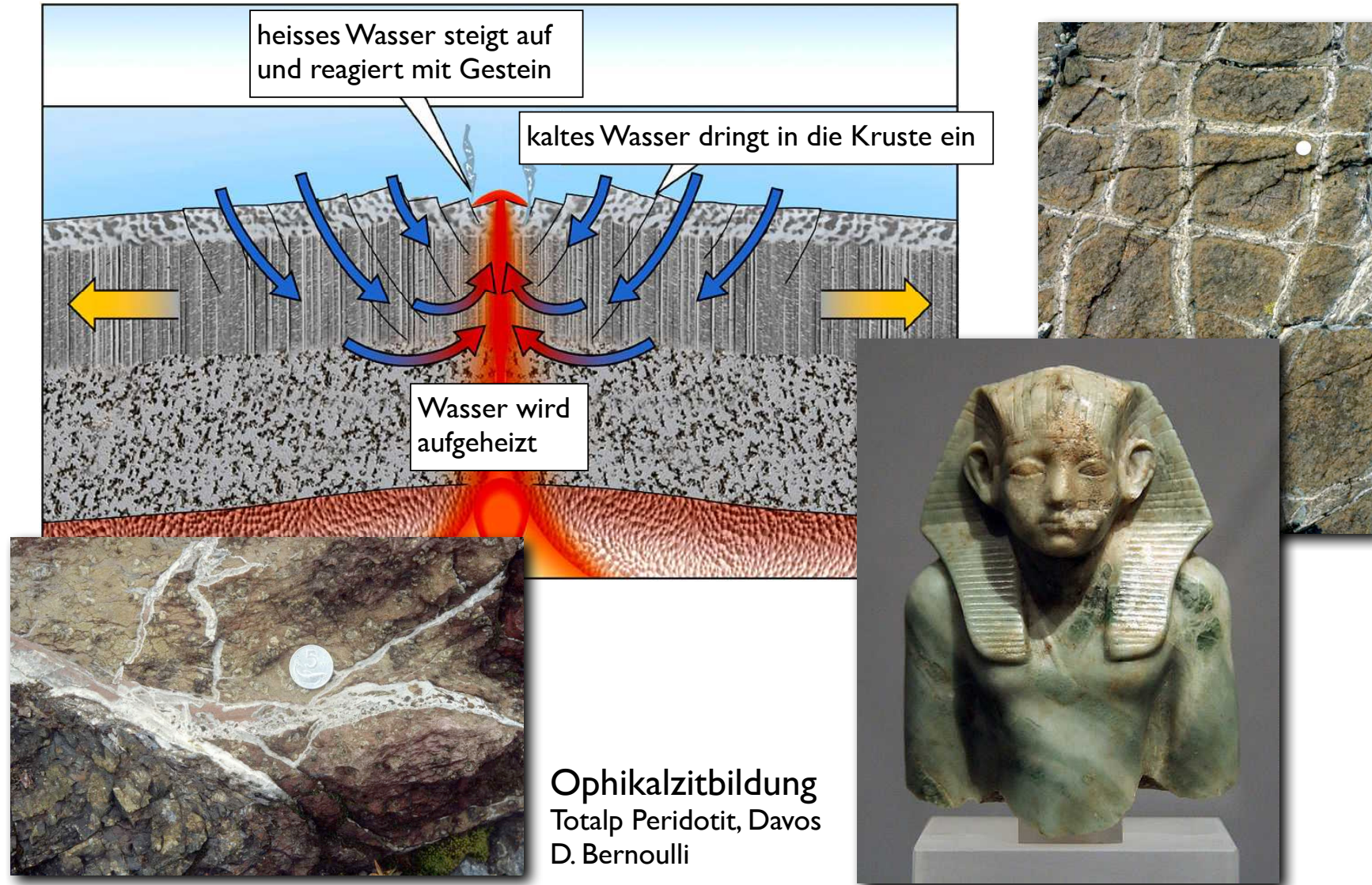
Bildung von Kissenlava (pillow lava)



<https://www.youtube.com/watch?v=DdIUuUY0L9c>



Interaktion Meerwasser - Kruste

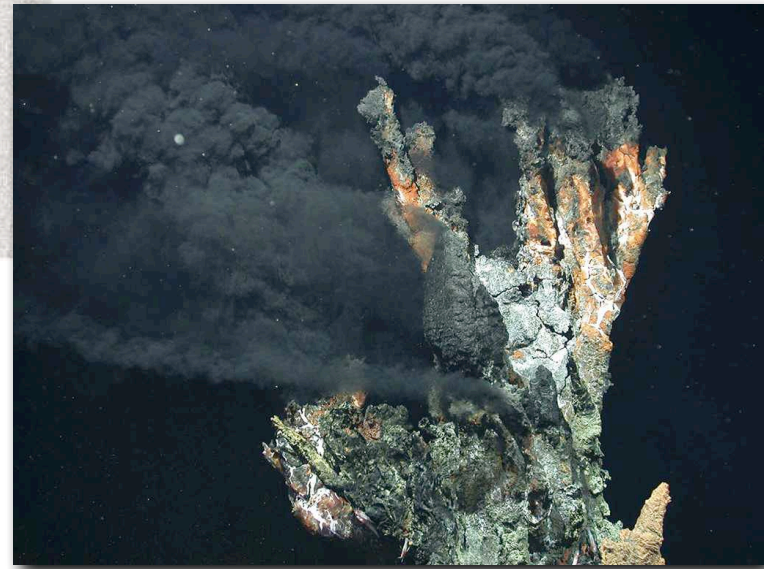
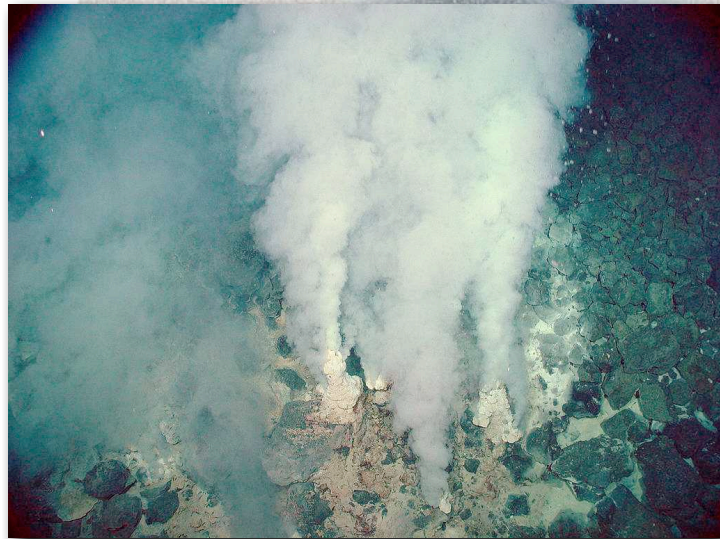
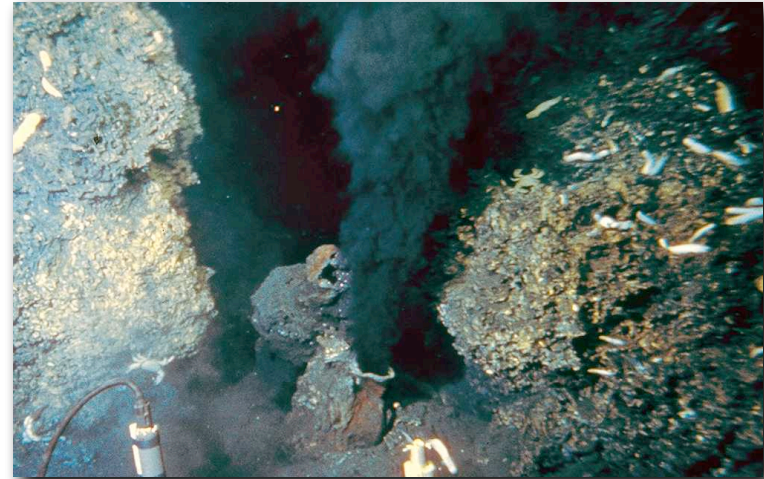
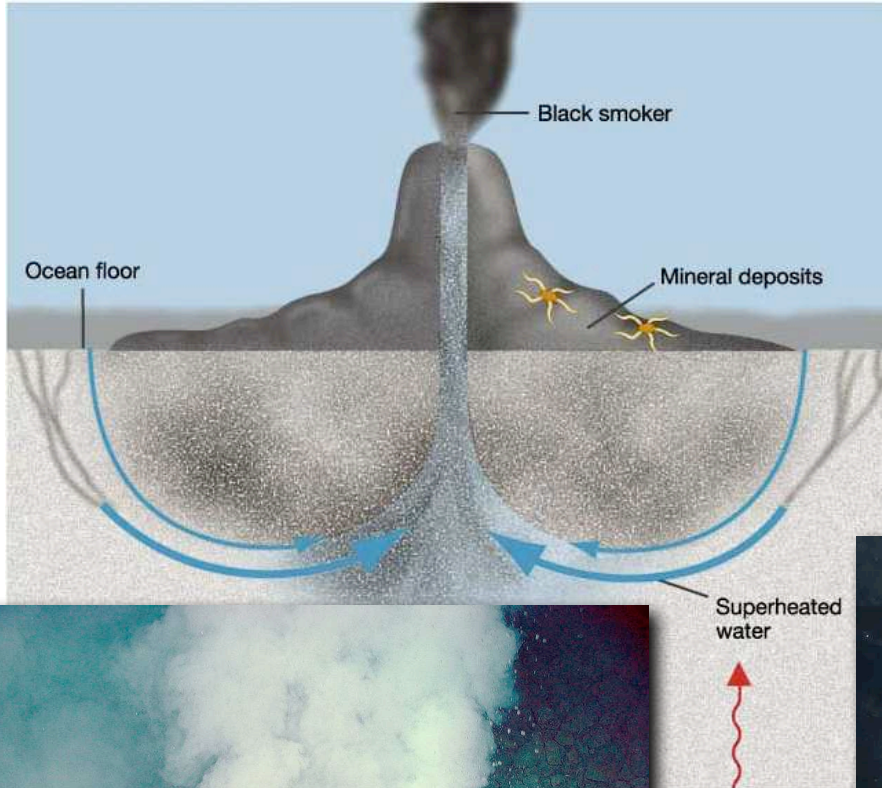


Ophikalzitbildung
Totalp Peridotit, Davos
D. Bernoulli

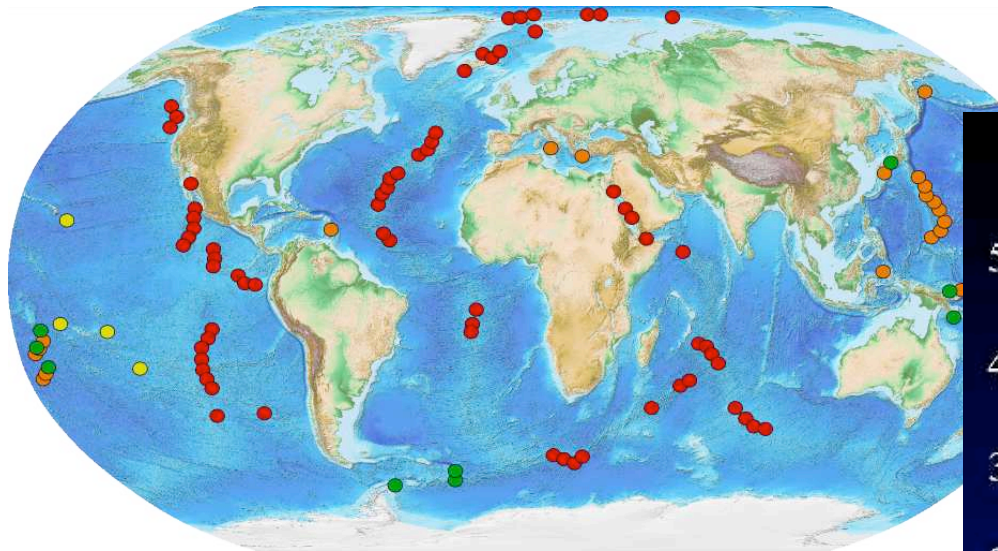


Amenemhet III.

Schwarze und weisse Raucher

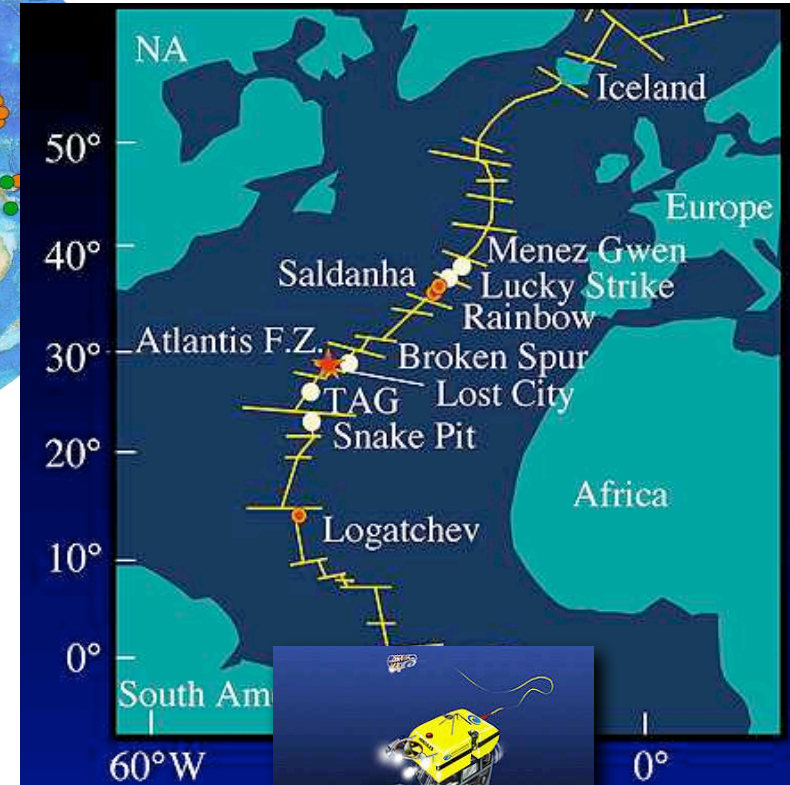


Hydrothermale Felder



gelb = Hotspot
rot = Mittelozeanische Rücken
grün = Back-arc Spreizungsrücken
orange = Vulkanbögen

<http://www.lostcity.washington.edu/>



Gretchen L. Früh-Green
Petrologist and Geochemist
Department of Earth Sciences
ETH-Zurich, Switzerland
shore-based

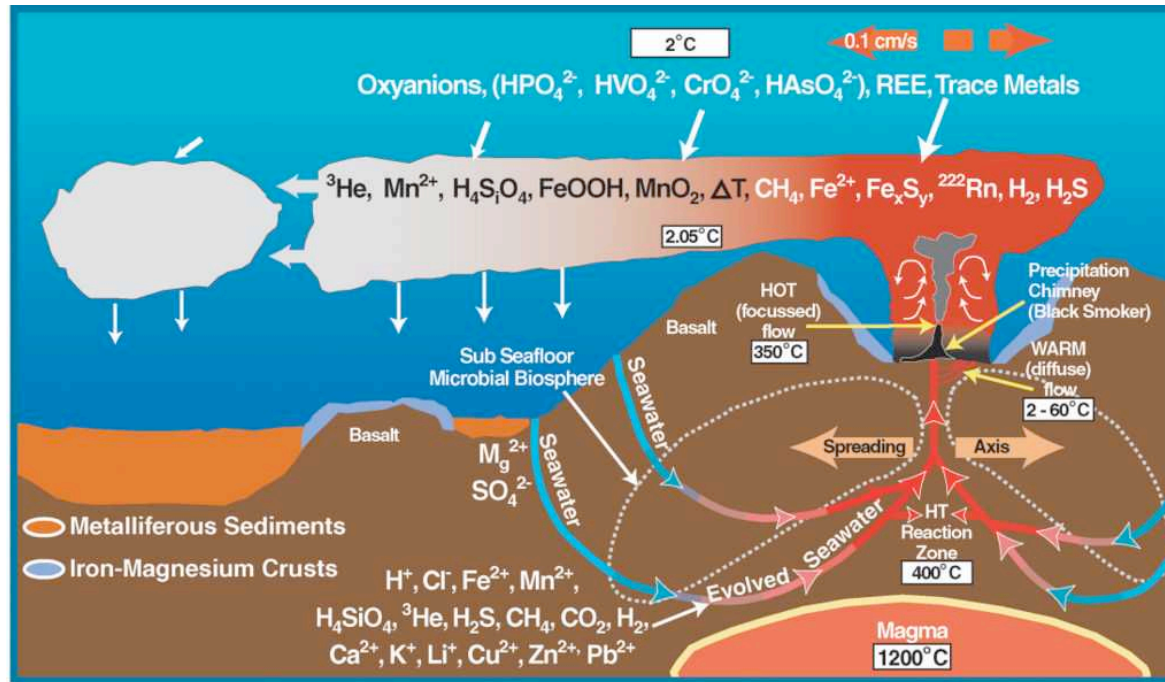


ROV Kiel nach Twin Sisters



<http://www.geomar.de/entdecken/videos/schwarze-raucher-erzfabriken-der-tiefsee/>

Chemosynthese versus Photosynthese



Riftia pachyptila (Bartwurm)
bis zu 3m lang (nur im Pazifik)
Symbiose mit Schwefelbakterium
Filamente (rot=Hämoglobin)

Lebensbasis für Tiere =
chemosynthetisch aktive Bakterien und Archäen

Bartwürmer, Venus-/Miesmuscheln, Spinnenkrabben, ...etc.
haben kein Verdauungssystem sondern Symbionten



**Steckbrief:
destruktive
Plattengrenzen**

wohin mit der Lithosphäre ?

Produzierte Fläche pro Jahr:

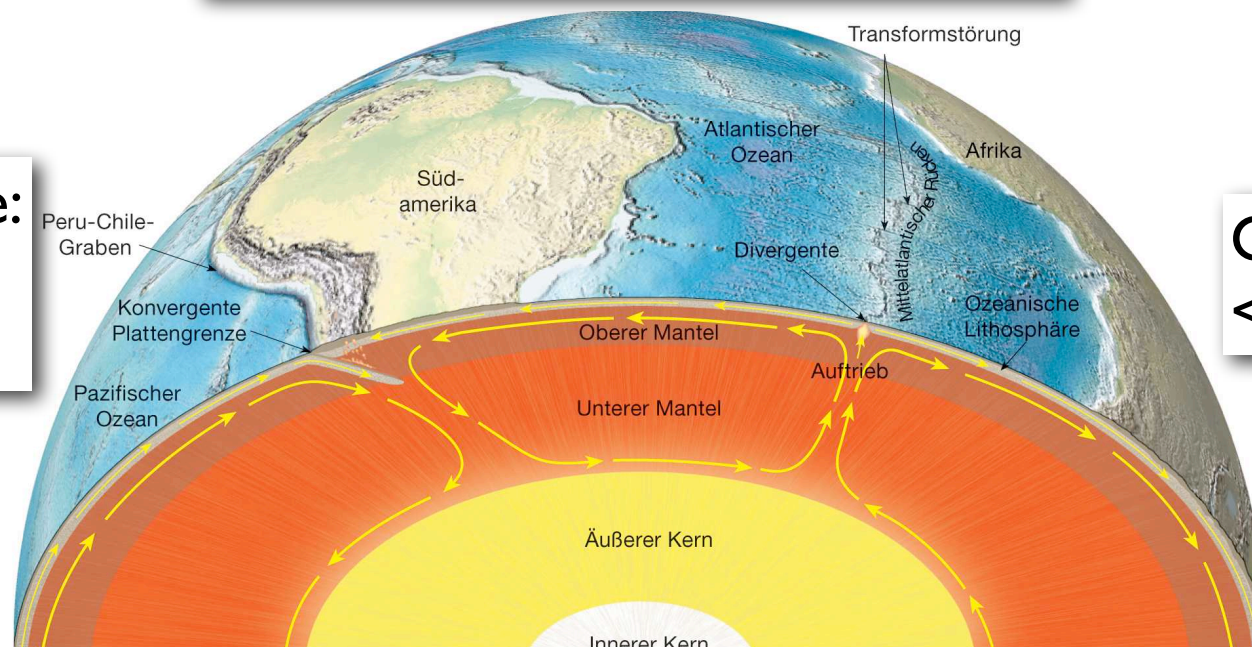
70 000 km ozeanische Rücken, 7cm / a spreading

$70 \cdot 10^6 \cdot 0.07 \approx 5 \cdot 10^6 \text{ m}^2 (\approx 5 \text{ km}^2)$

= 10^{-8} Erdoberfläche

Verdoppelung in 100 Ma !!

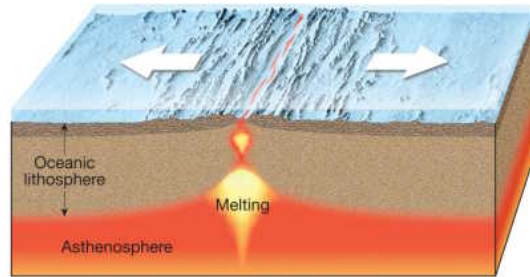
**Kontinente:
4.5 Ga
konstant**



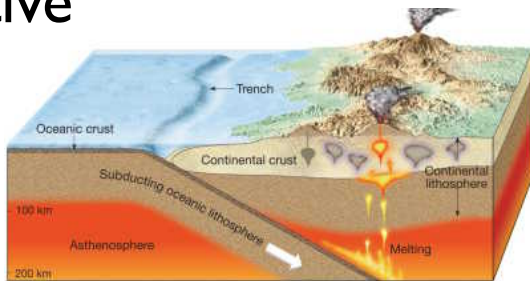
**Ozeane :
< 180 Ma**

destruktive Plattengrenzen: 3 Typen

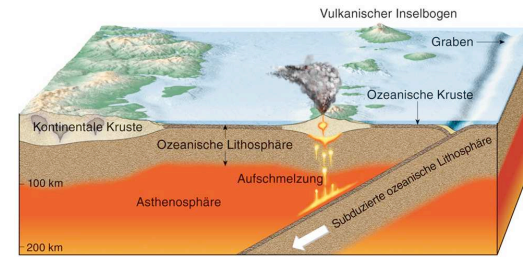
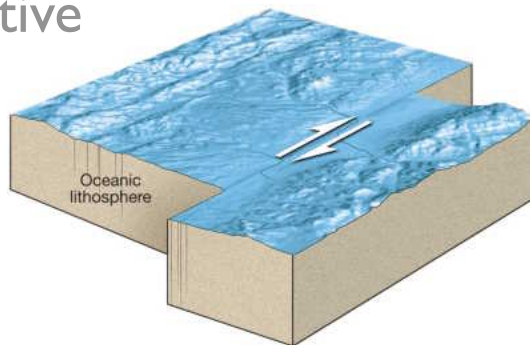
konstruktive



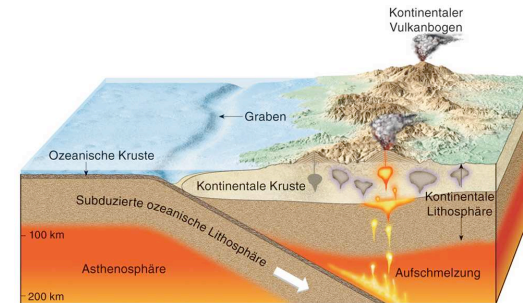
destruktive



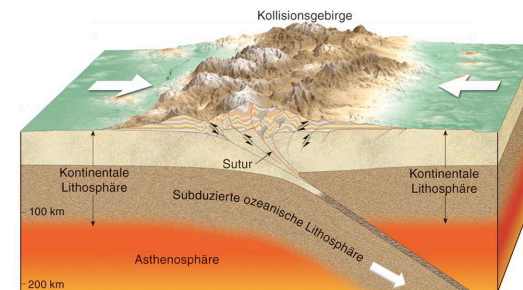
konservative



Ozean - Ozean



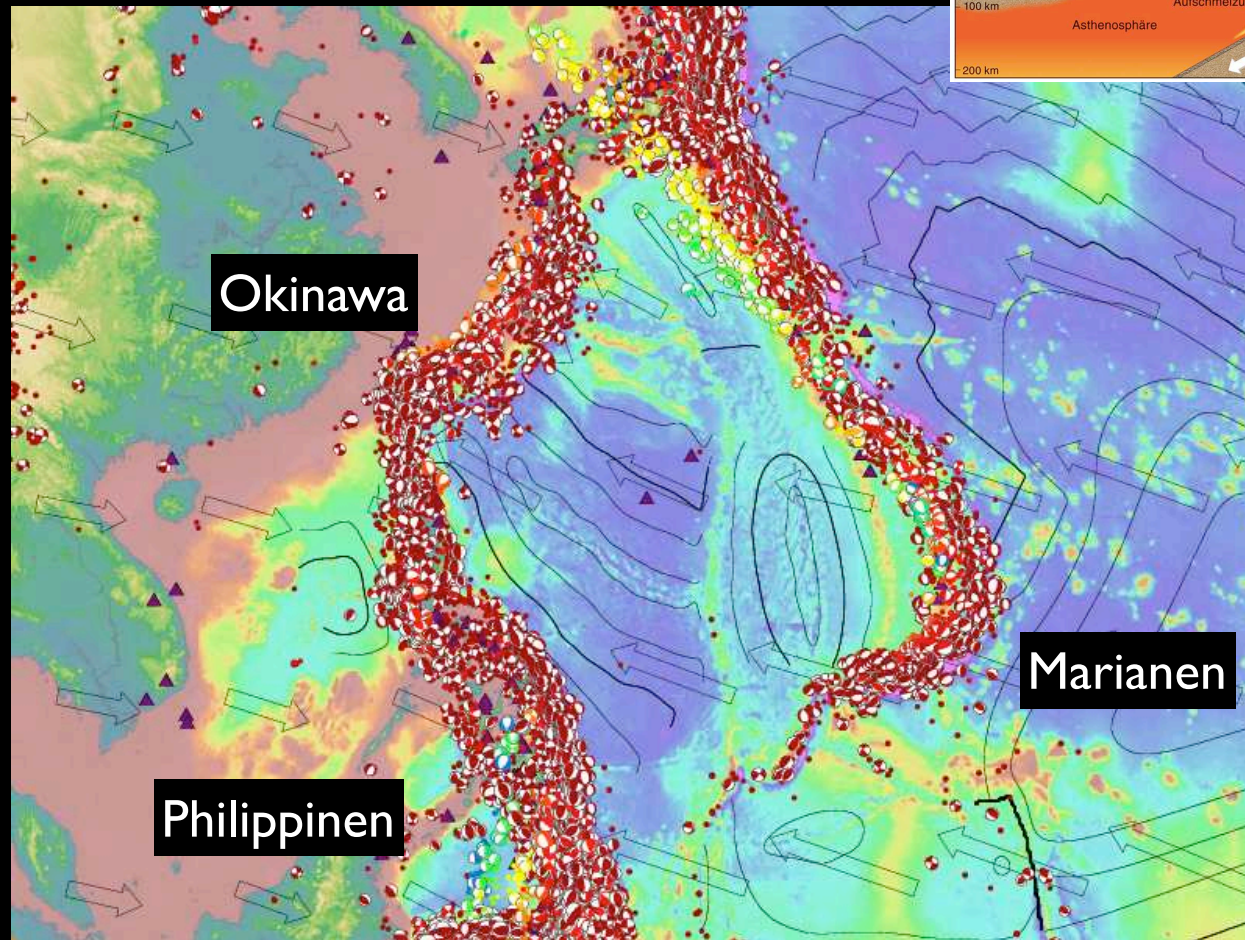
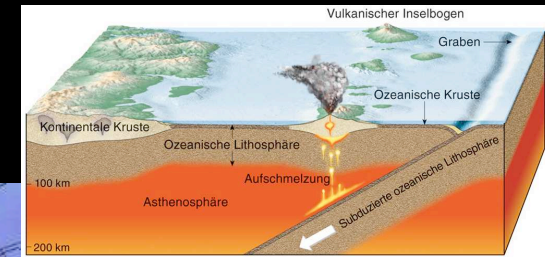
Ozean - Kontinent



Kontinent - Kontinent

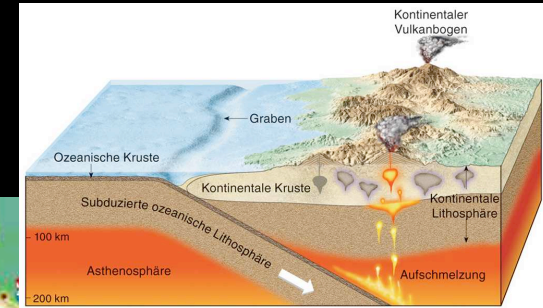
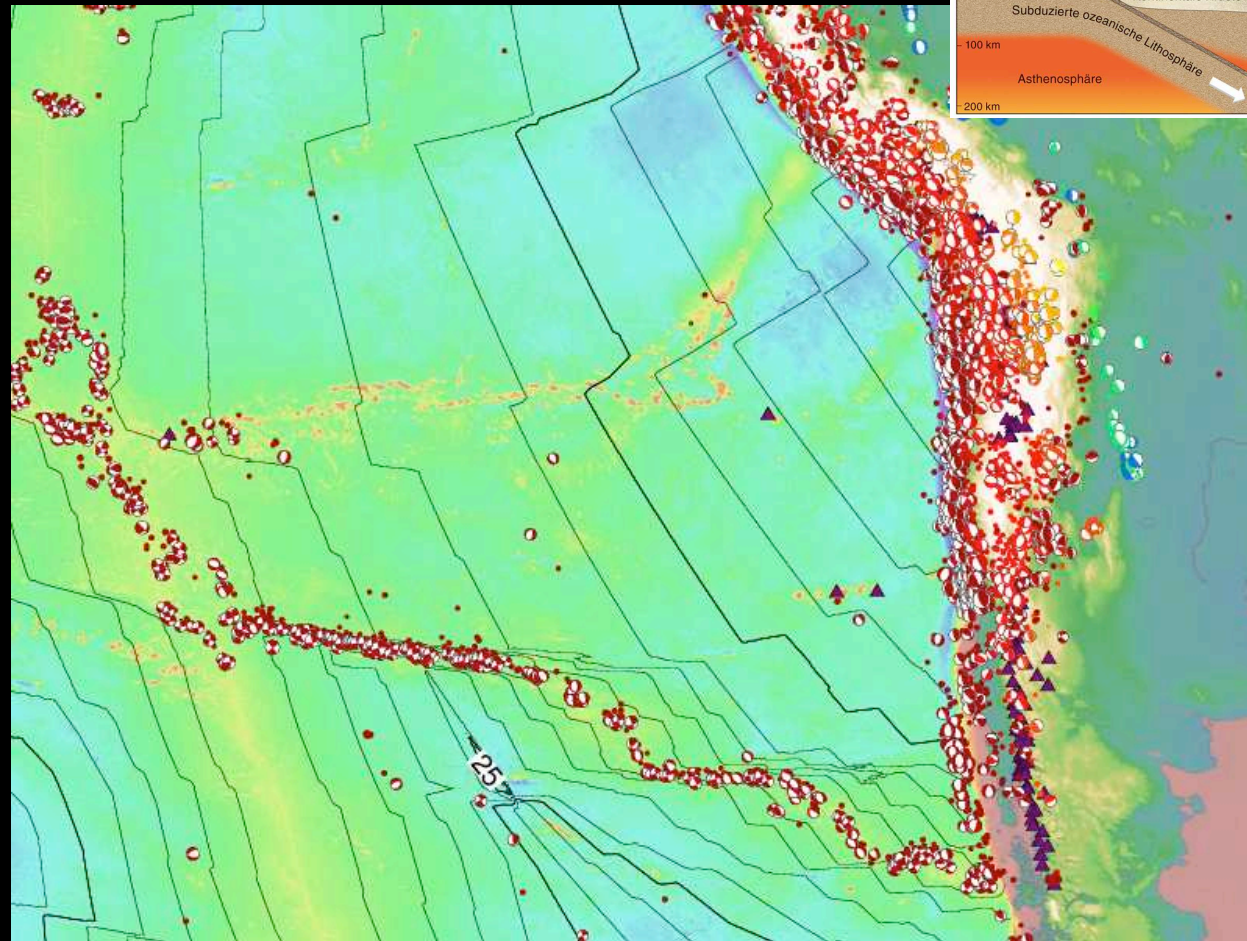
Ozean - Ozean

Mt Fuji



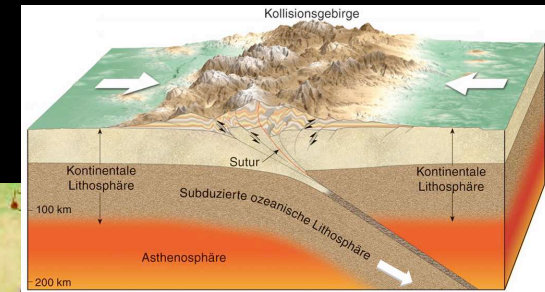
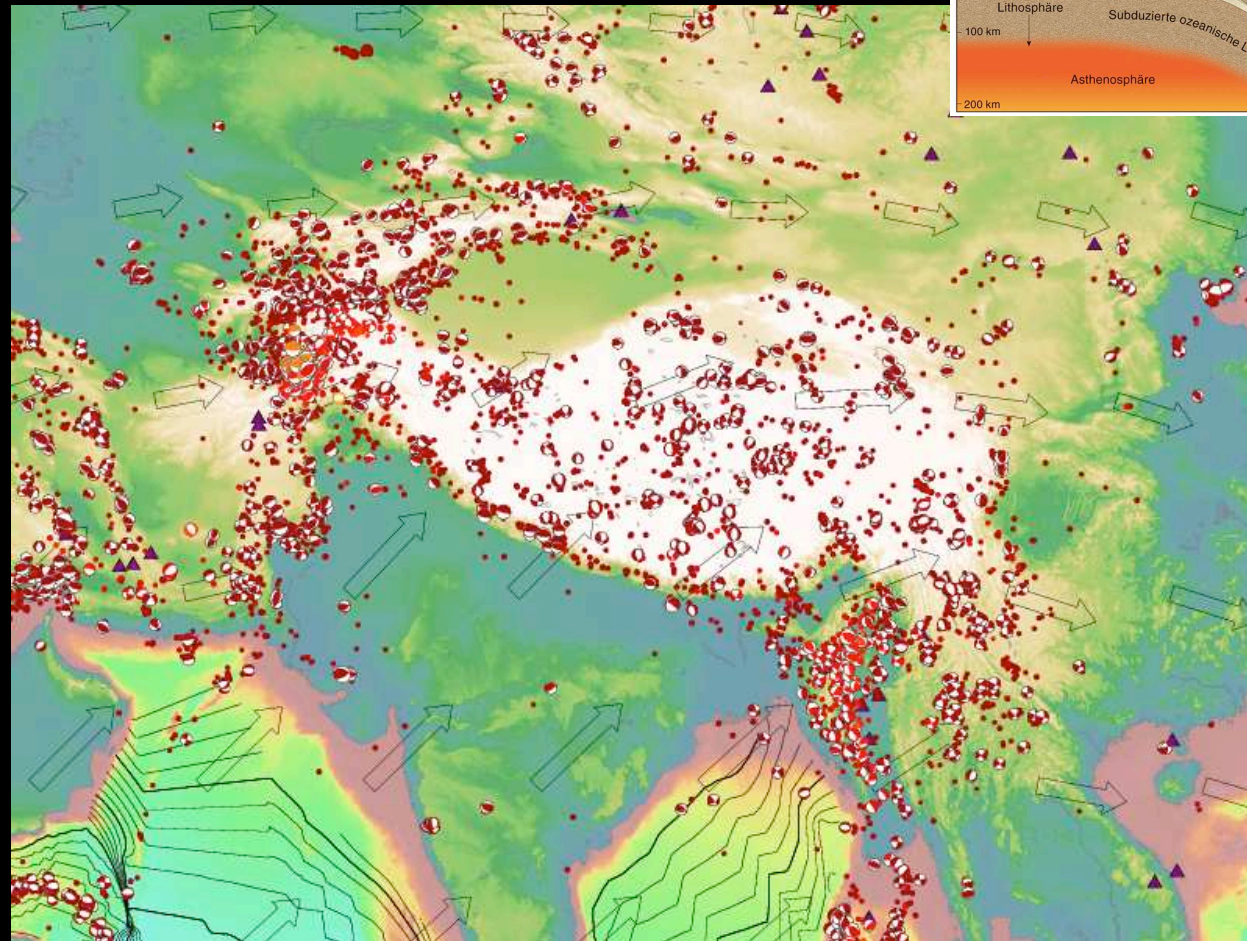
vulkanischer Inselbogen

Ozean - Kontinent



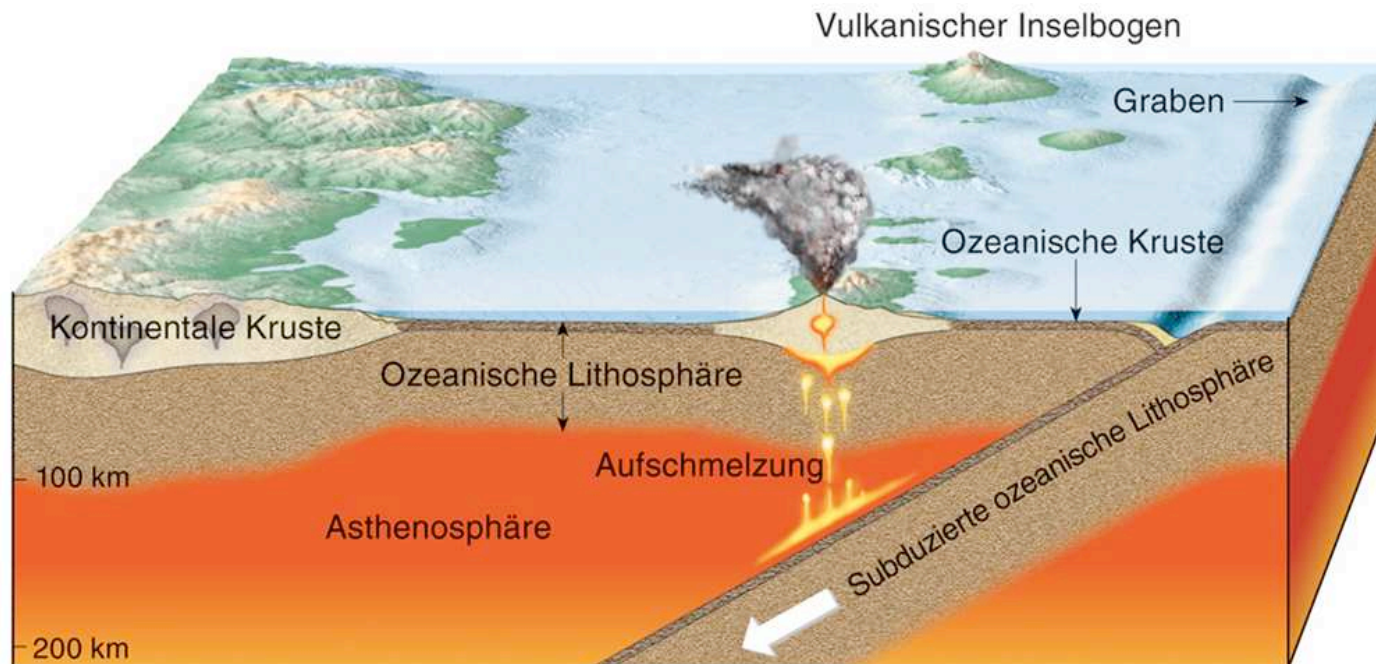
kontinentaler Vulkanbogen

Kontinent - Kontinent



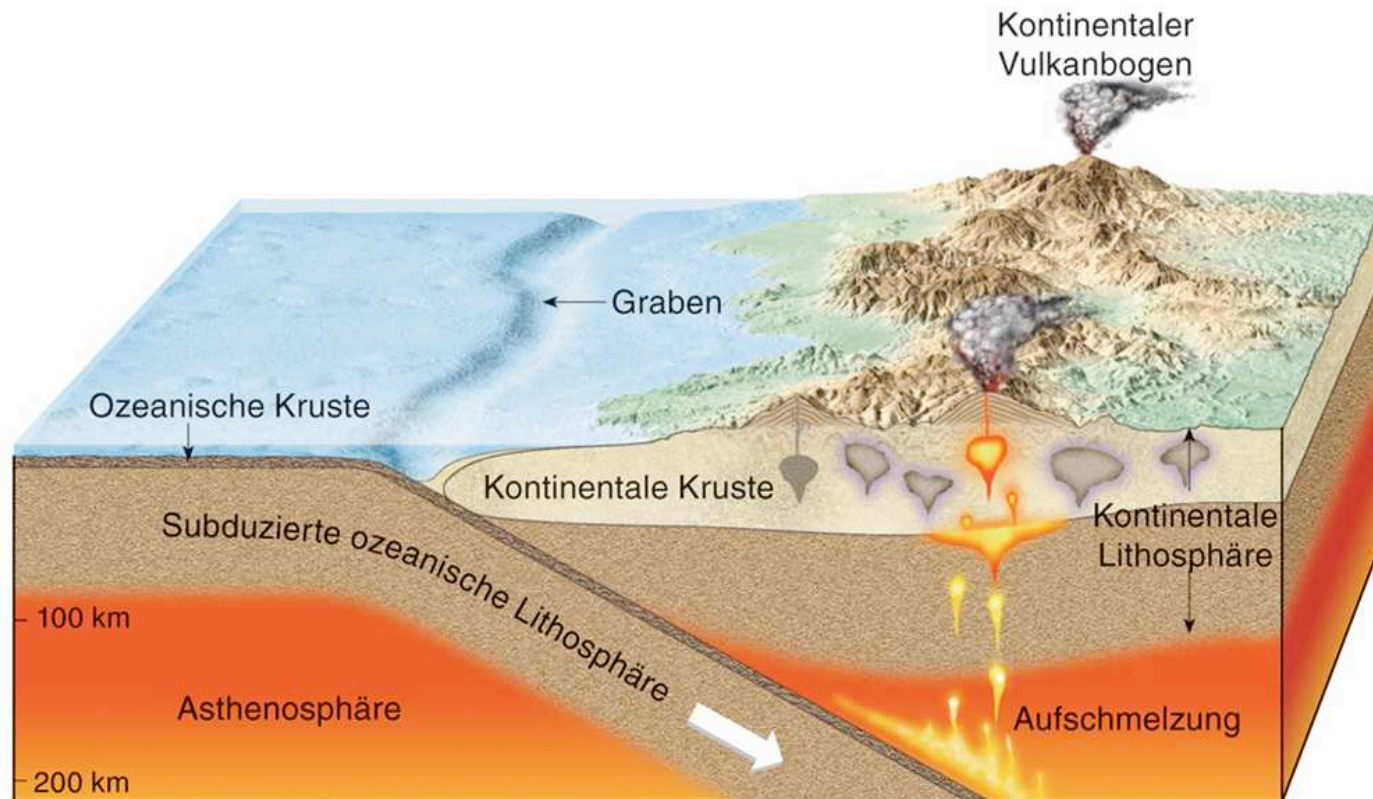
Kontinent-Kontinent Kollision

Ozean - Ozean



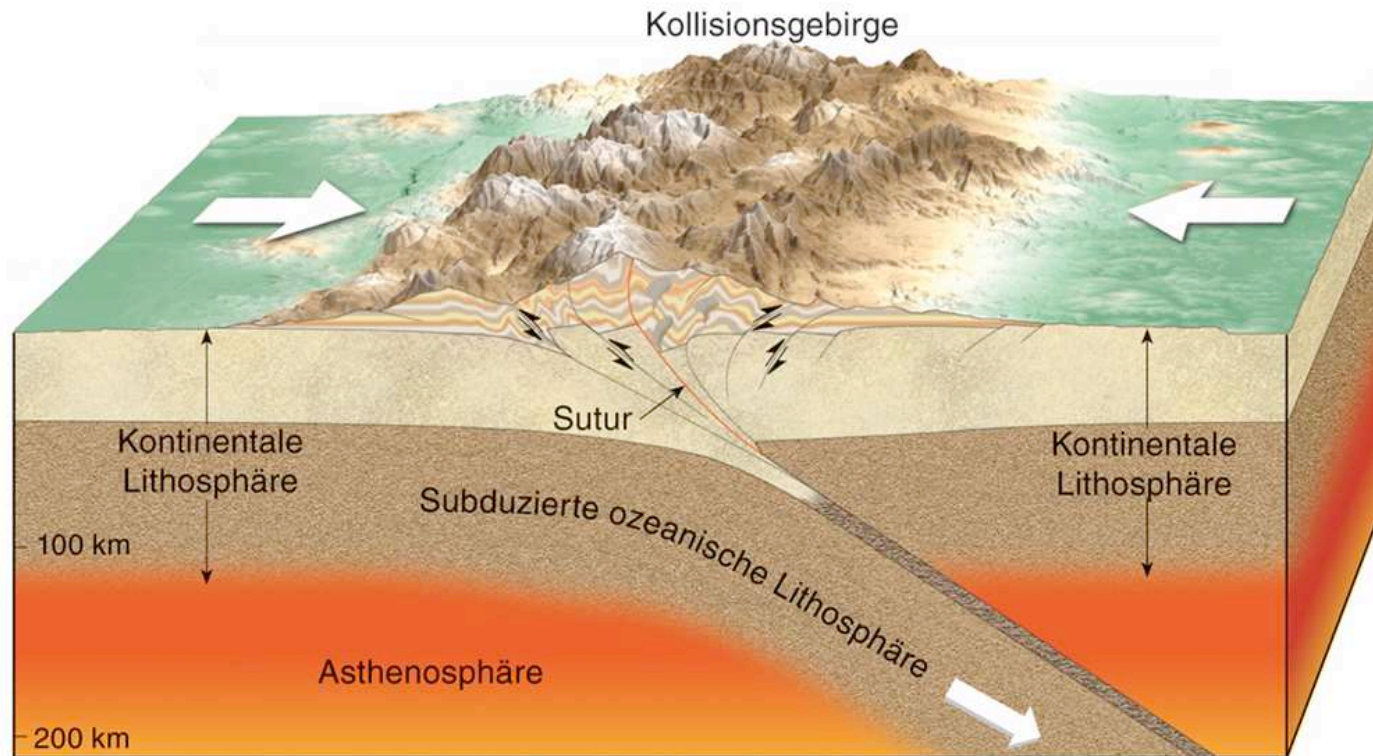
dichtere Platte sinkt hinunter
Vulkanismus am Ozeanboden
Vulkanische Inselbögen: Japan, Aleuten, Tonga

Ozean - Kontinent



dichtere Platte (= ozeanische) sinkt hinunter
Aufschmelzung in überschobener Platte
Kontinentale Vulkanbögen: Anden, Cascades (USA)

Kontinent - Kontinent

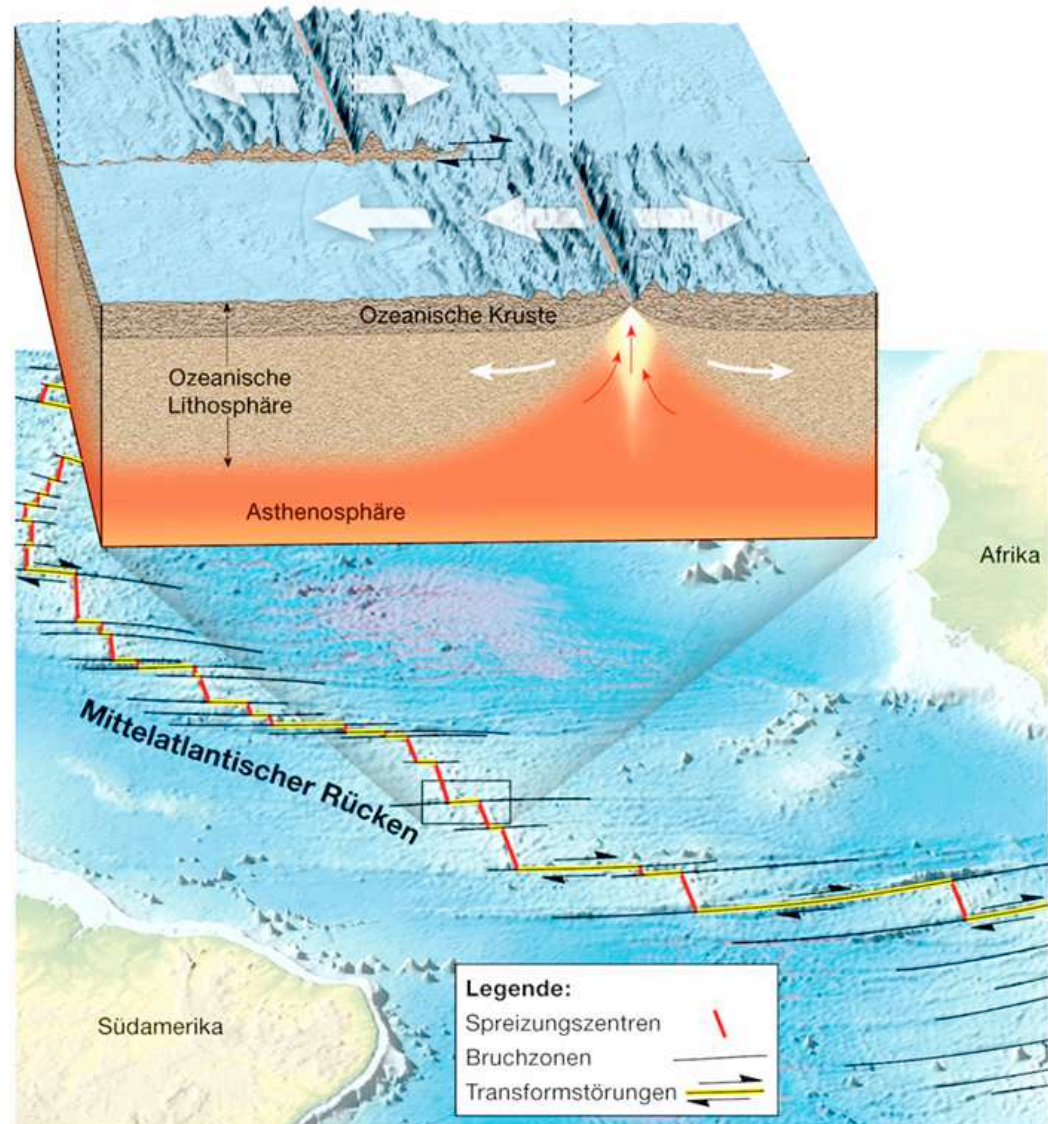


Fortgesetzte Subduktion → kontinentale Kollision
dichtere Platte wird subduziert
Kollisionsgebirge: Himalaya, Alpen, Appalachen

**Steckbrief:
konservative
(Transform-)
Plattengrenzen**

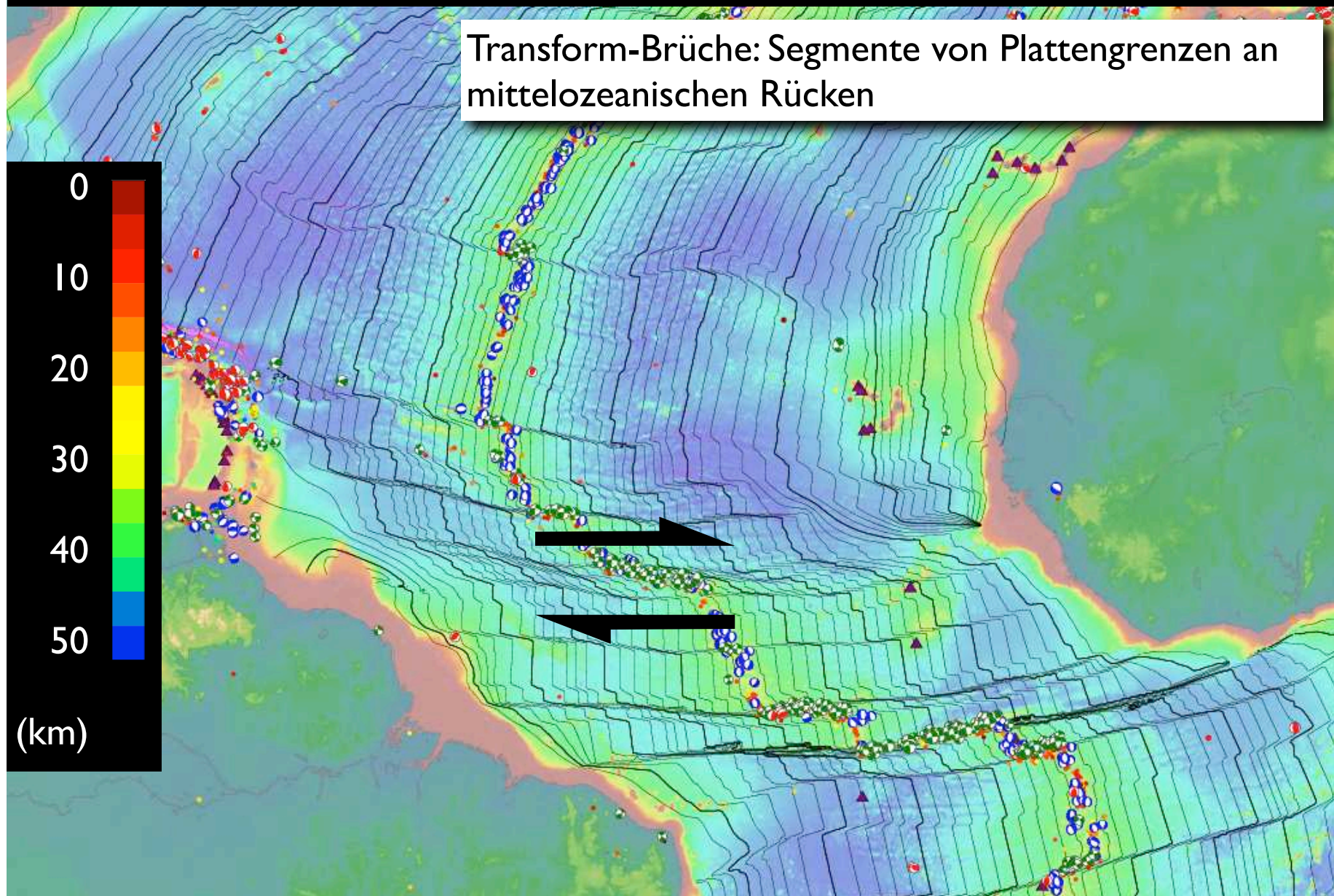
Konservative Plattengrenzen

Transformbrüche
Transformstörungen

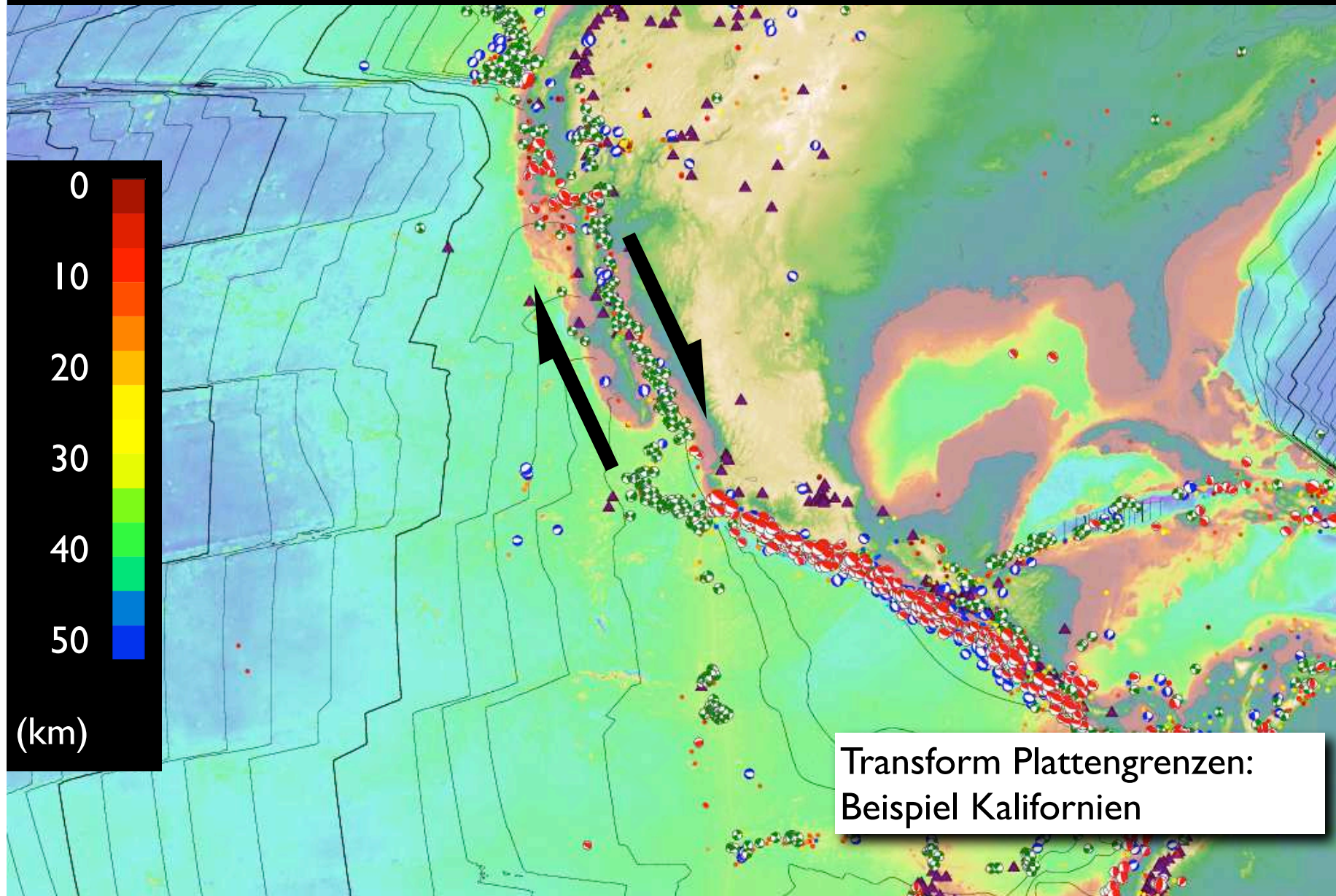


Konservative Plattengrenze

Transform-Brüche: Segmente von Plattengrenzen an mittelozeanischen Rücken



Konservative Plattengrenze



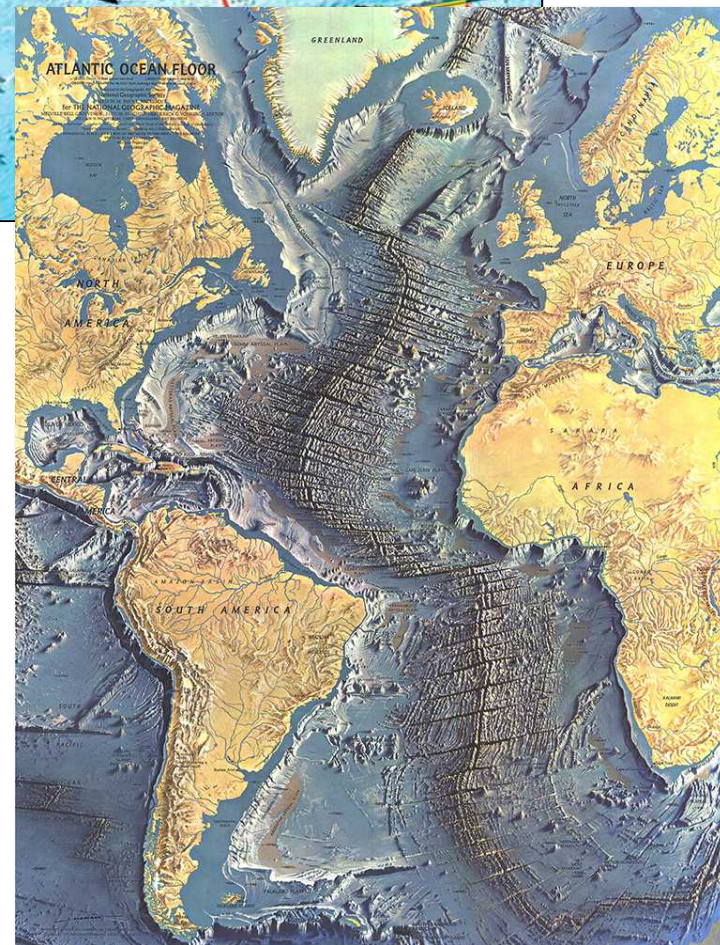
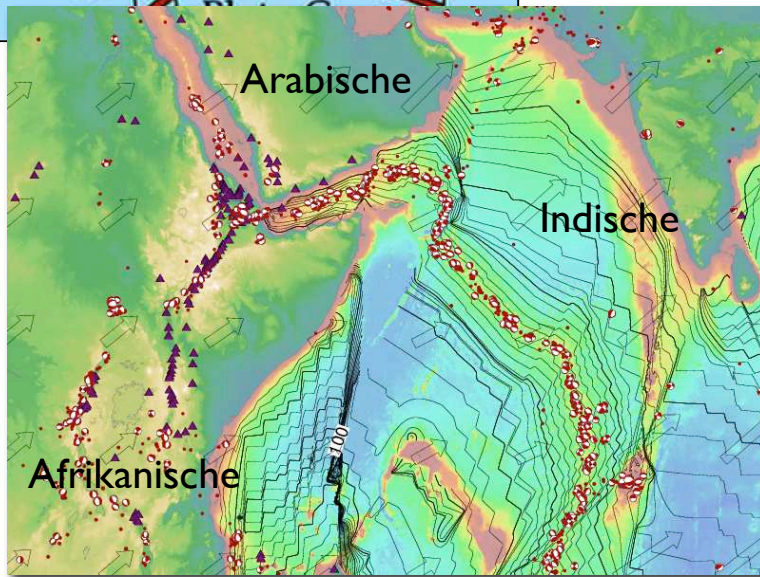
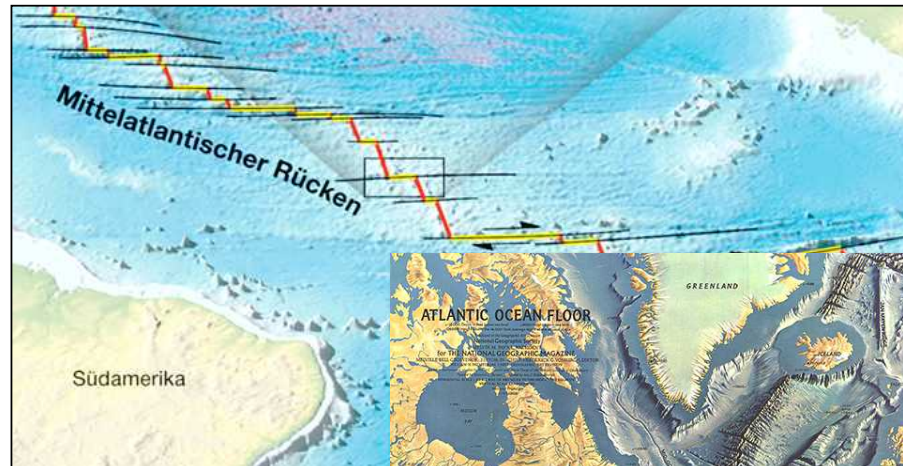
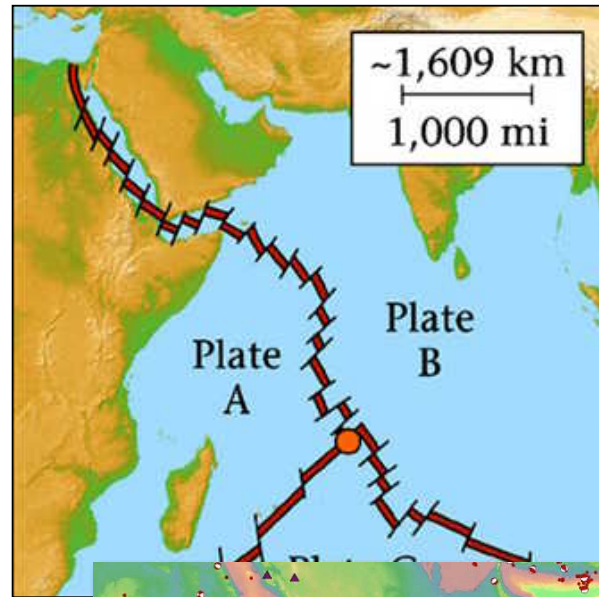
Transform - Plattengrenzen

Transpression

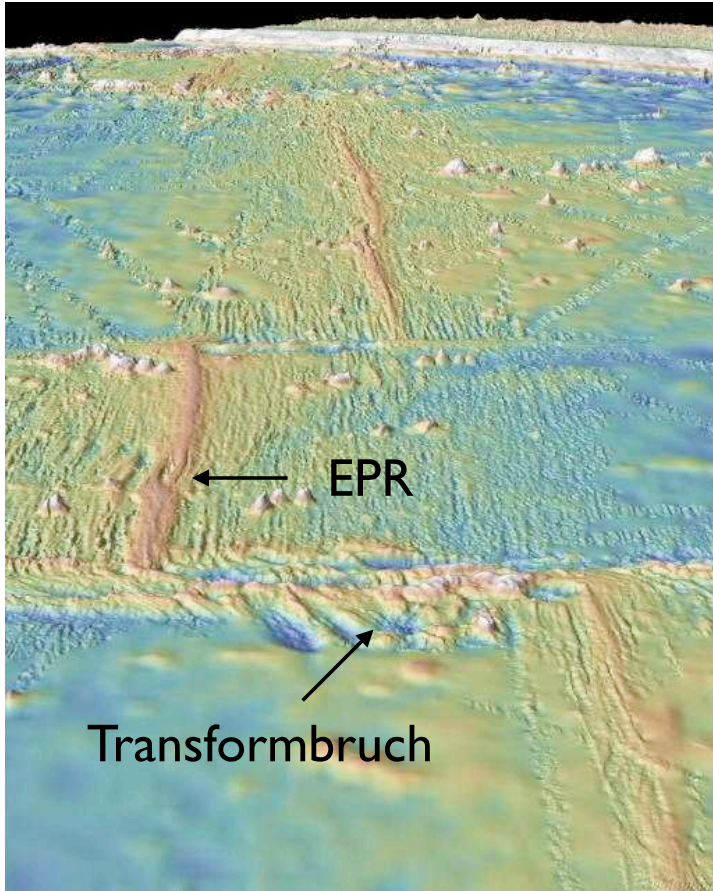


Transtension

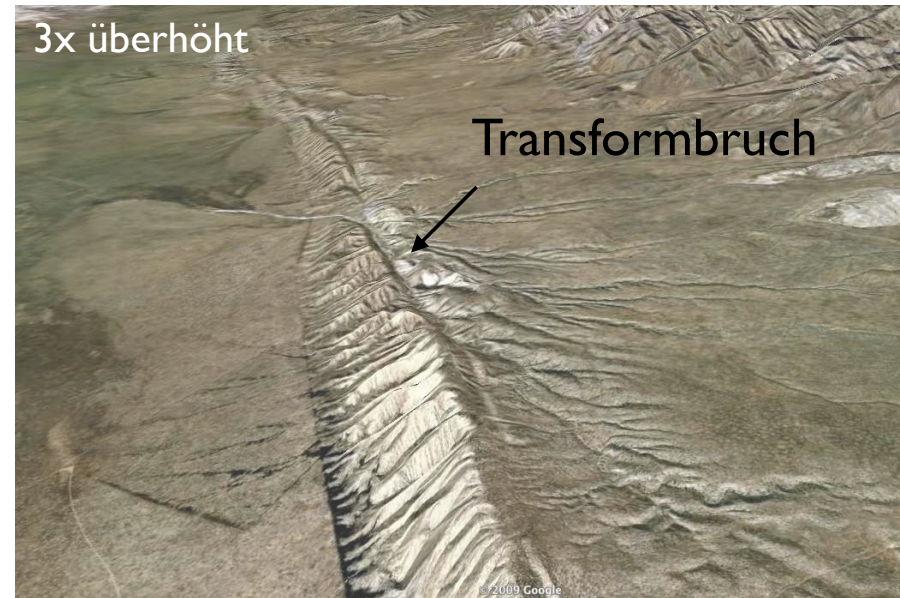
Transform - Plattengrenzen



Transformbrüche



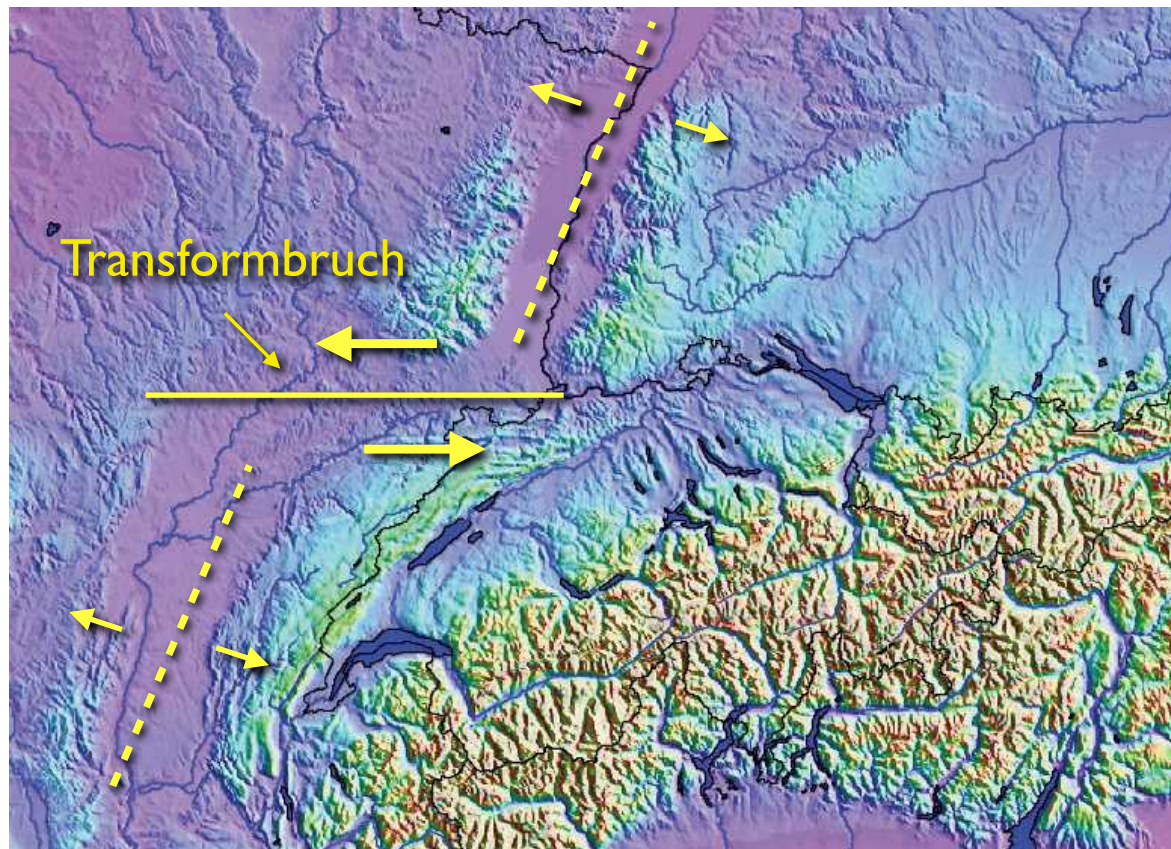
im Ozean: am East Pacific Rise (EPR)



kontinental: San Andreas Fault

fossile Transform - Störung

Rhein - Graben



Bresse- Graben