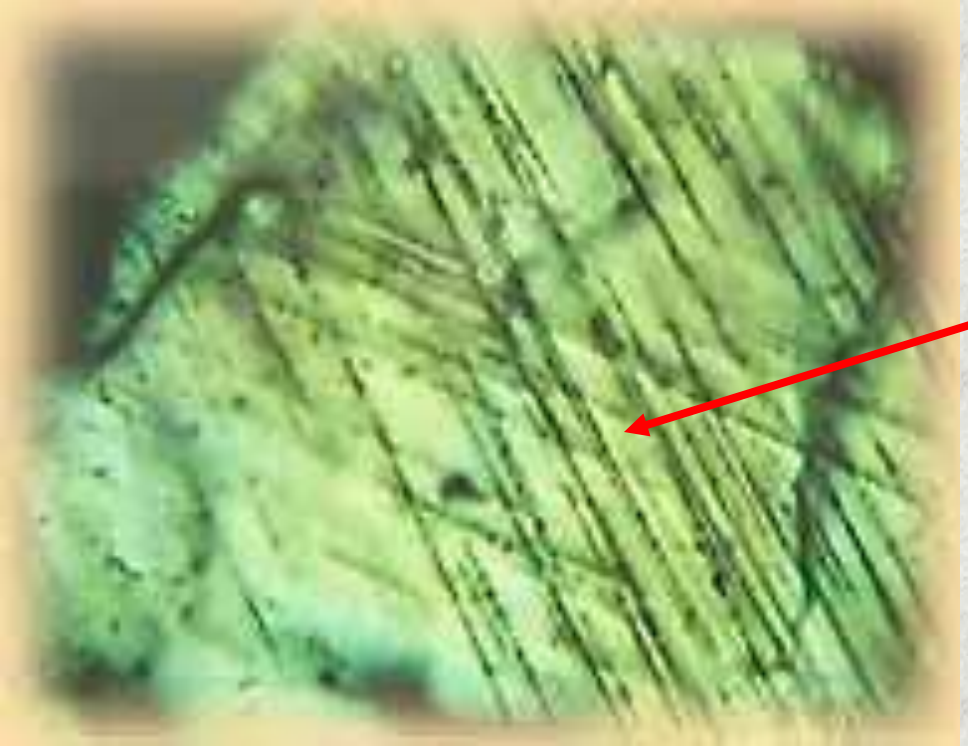
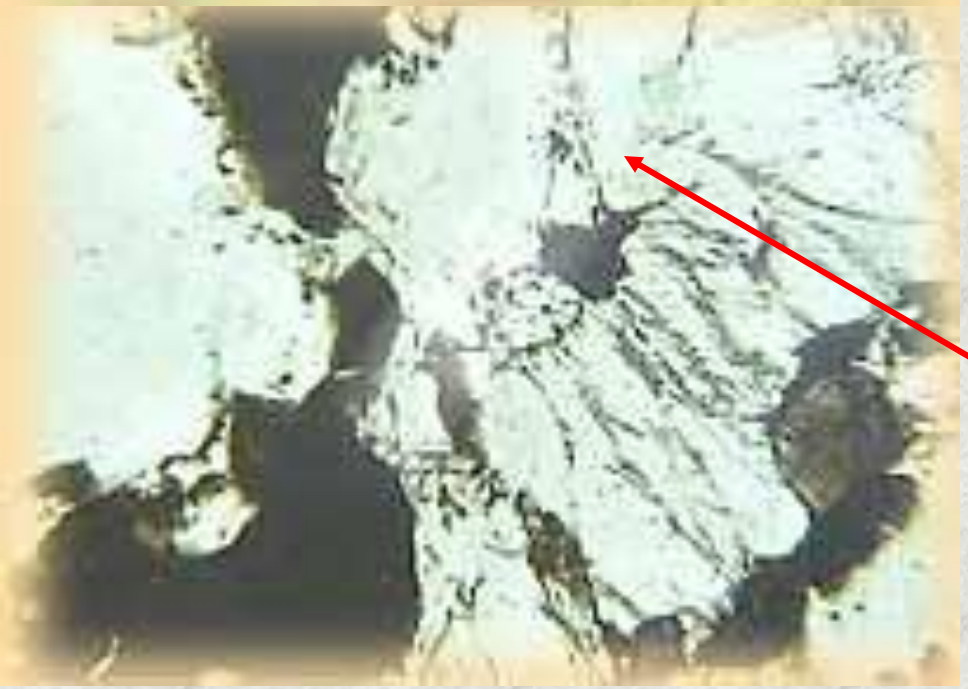
Suevite is a breccia which forms by fragments of rocks which have been erupted by the impact and were later solidified. Besides material of the bedrock it contains glass (from melting process) and high pressure and high temperature minerals, like the high pressure quartz modifications (polymorphs) Stishovite and Coesite. Rests of the meteorite could be also included. Suevite is distinct from the pseudotachylite in an impact structure as the latter is thought to have formed by frictional effects within the crater floor and below the crater during the initial compression phase of the impact and the subsequent formation of the central uplift.

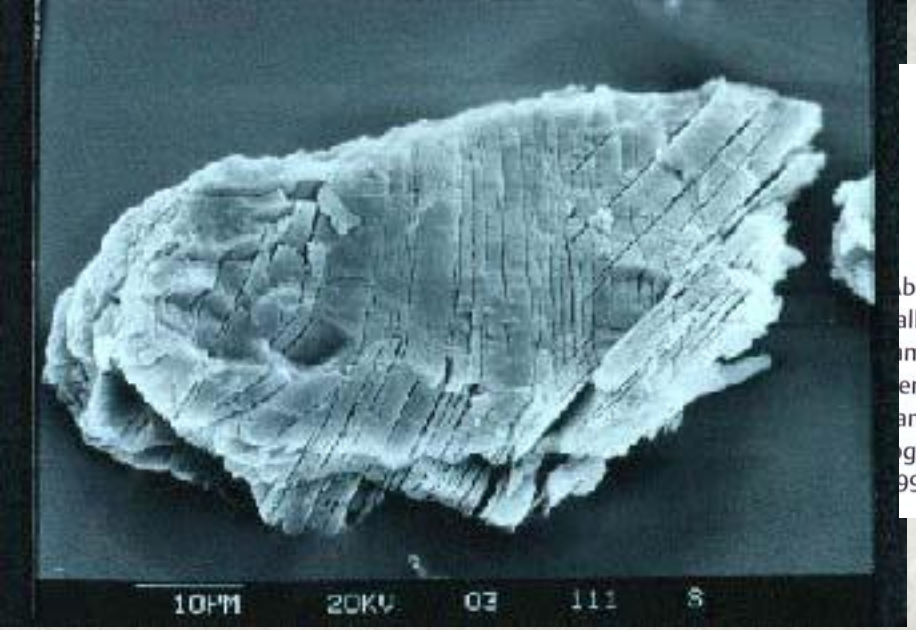


planar elements

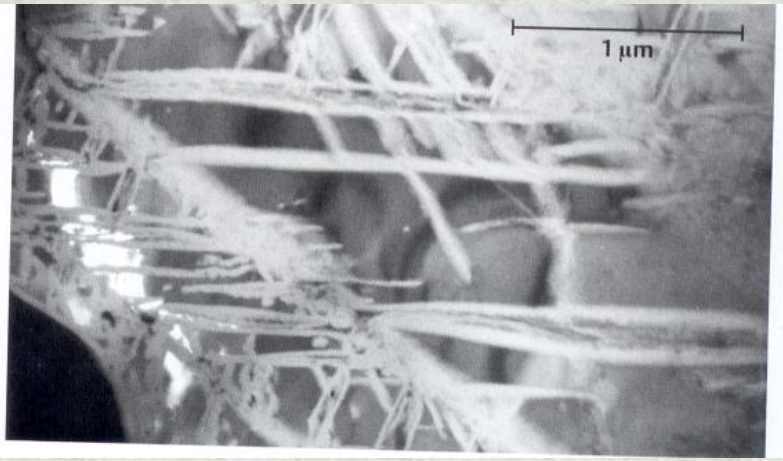
Planar deformation laminae (PDF) in quartz

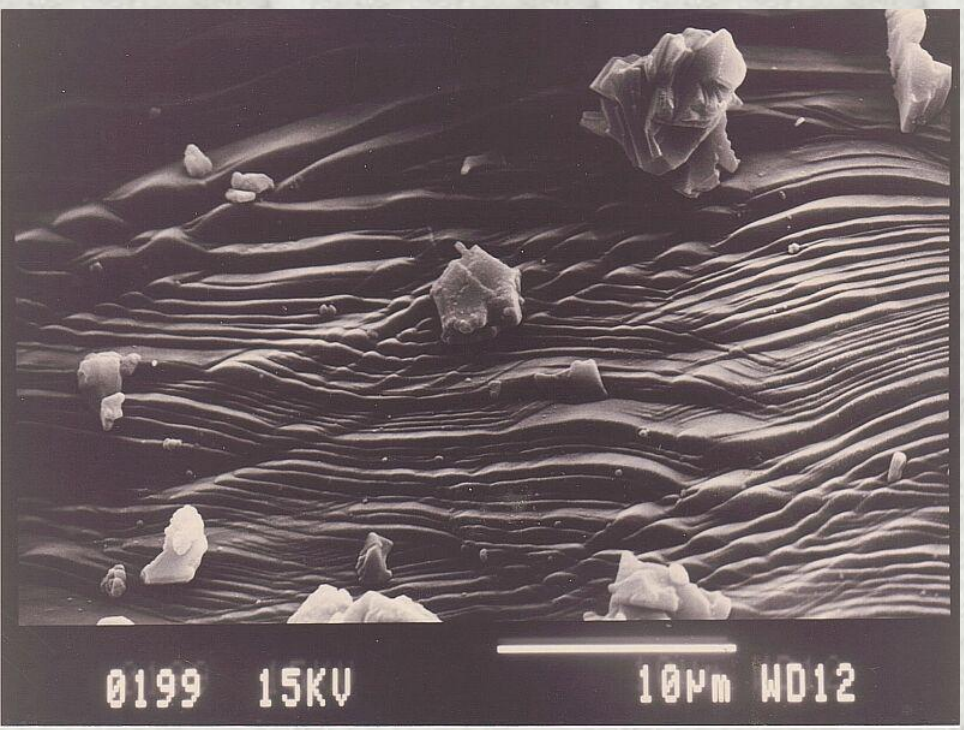


diaplectic glass



bb. 11: Quarz-Kris-
all mit »Schock-
melleN« (helle
ereiche). (Aus:
angenhorst, Geo-
gy 24, 487– 490,
996)

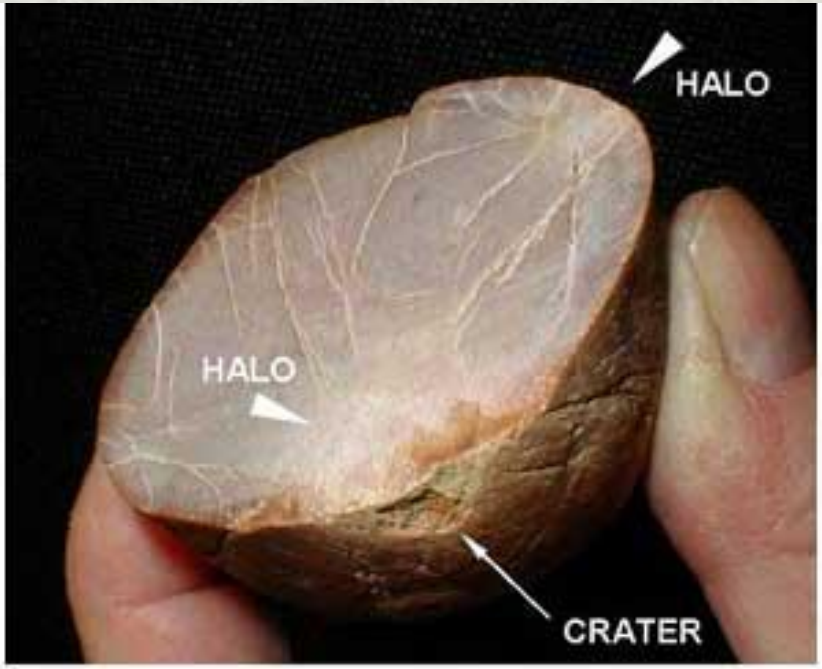




Secondary electron image (SEM), showing crossing PDFs. There is a short distance of less than 1 µm in between the single PDFs.

Surface structures of gravel

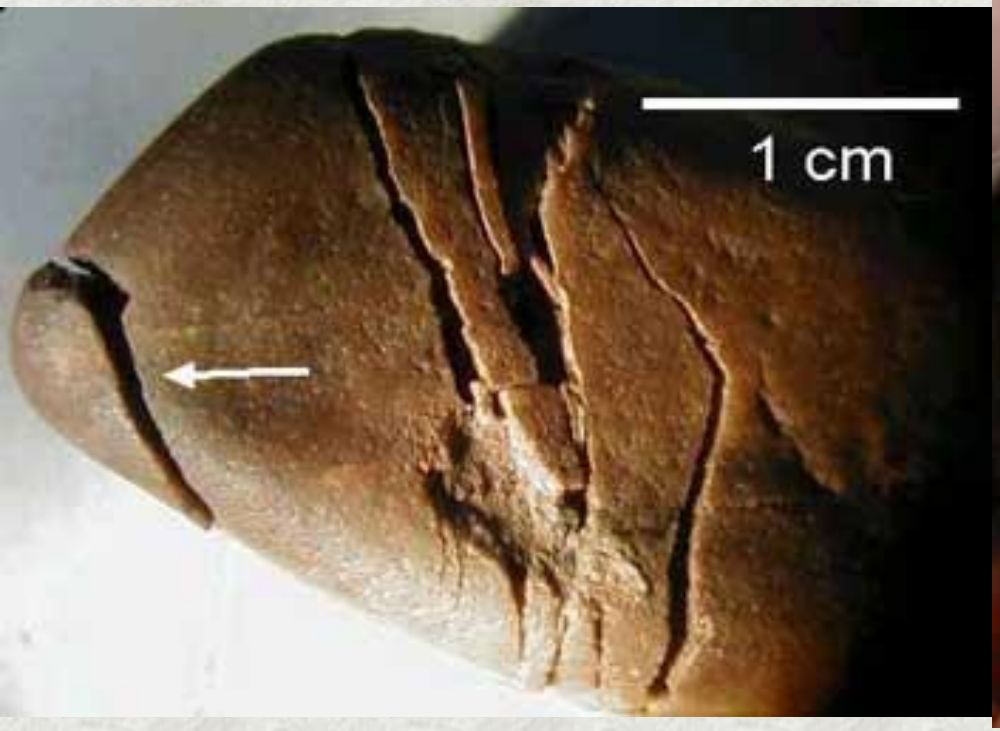
Quartzite gravel with pock marks which have been formed at the contact to other gravels during the impact event which caused micro-brecciation at the contact zone

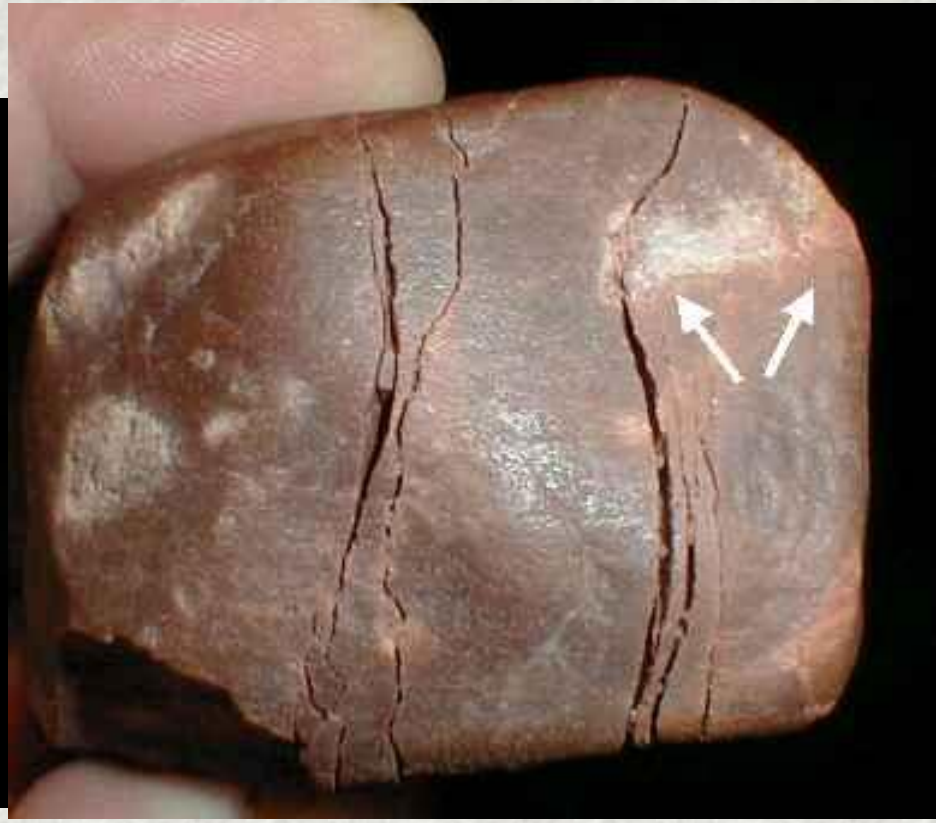


Quartzite gravels cutted across the middle of the superficial mini craters show that the micro fractures spread halo-like from there. The white halos directly below the superficial craters indicate micro fracturing and a plastical deformation.

Spallation

The pressure impulse of the impact causes multiple spallation, especially in quartzite gravels and blocks (see below)





EXPERIMENTAL SHOCK-PRODUCED SPALLATION

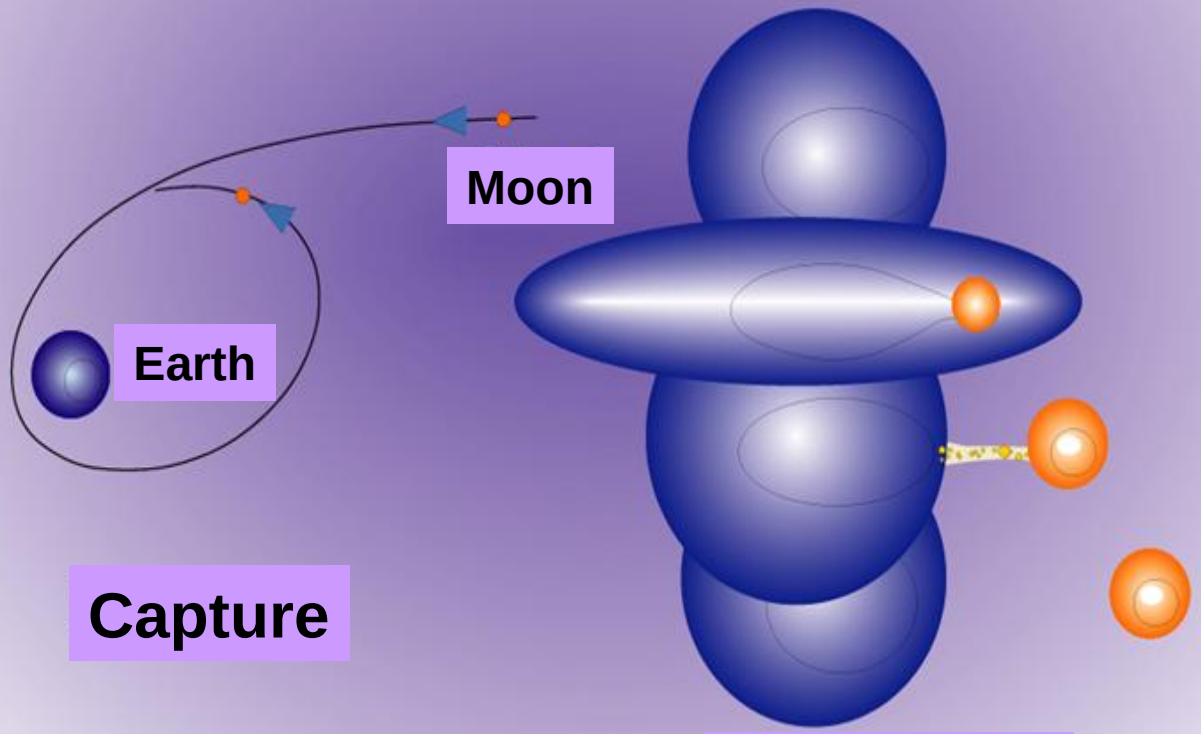
QUARTZ SPHERES ⌀ 14 mm IN EPOXY MATRIX

Shock experiments have been done at Ernst-Mach-Institute of Friburgo. Iron bowls have been accelerated to velocities of 25 to 115 m/s, corresponding impact pressures of 0.55 to 2.5 GPa (5.5 to 25 kbar). The iron projectiles collided with quartz bowls which were embedded in an epoxy resin. The quartz bowls were cutted through the impact craters (see above).

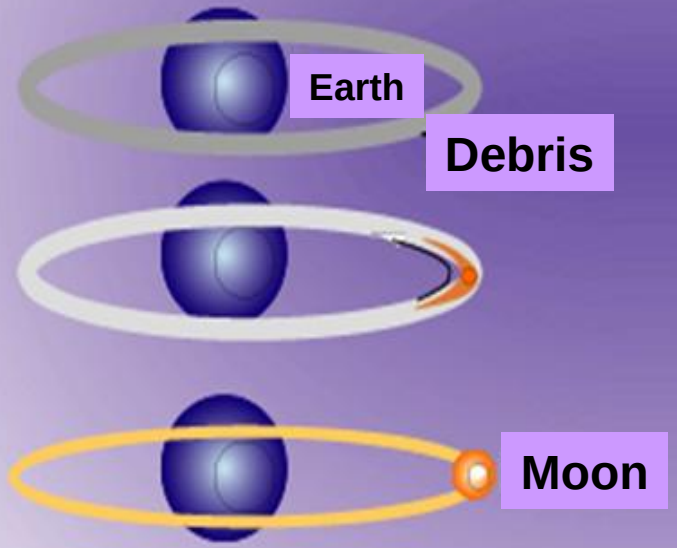
7. Origin of the earth-moon-system?

www.lpi.usra.edu/.../gallery/slide_17.html

Hypothesis about the formation of the Moon

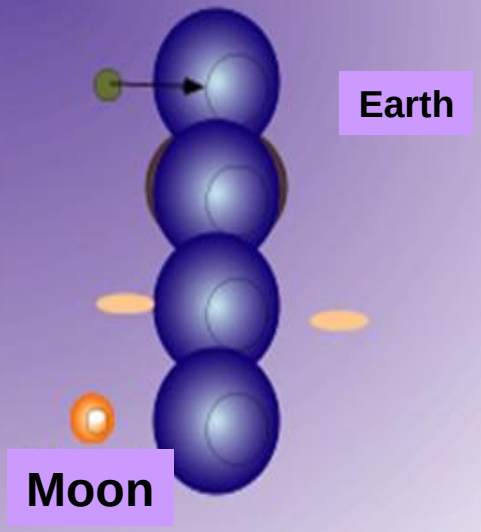


Hypothesis about the formation of the Moon



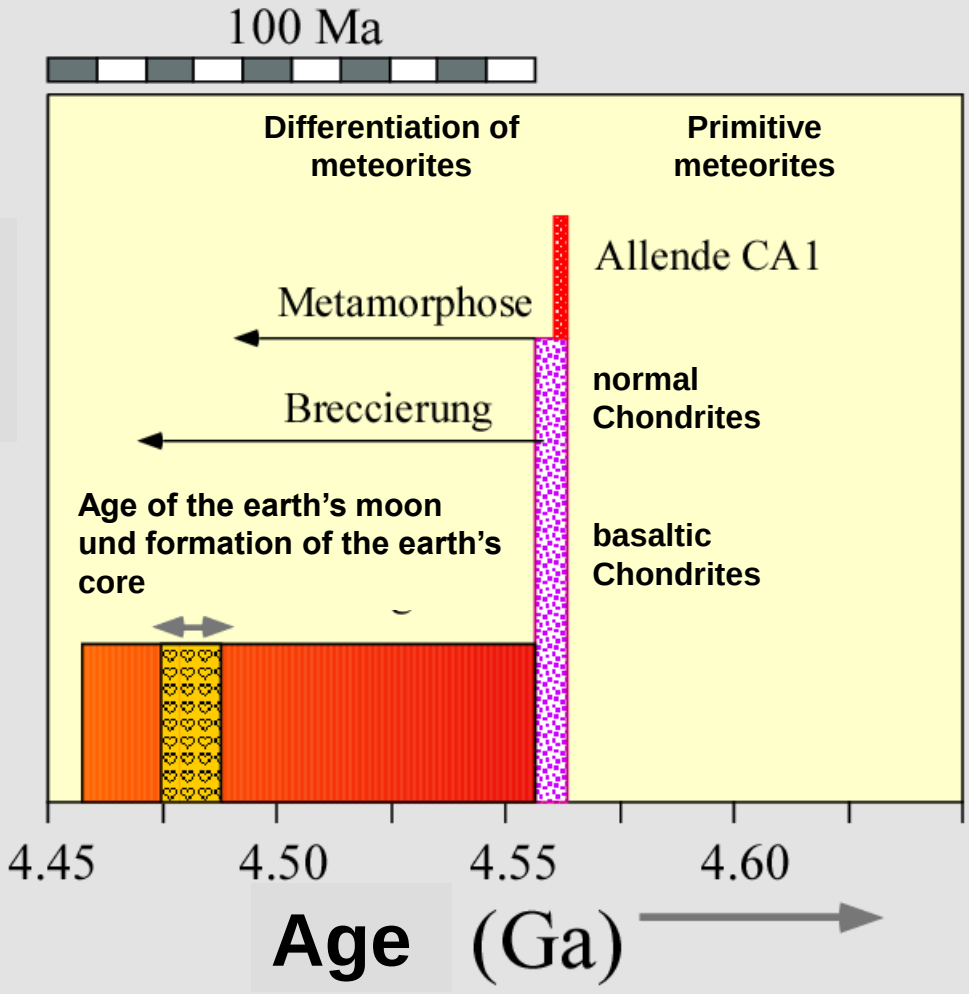
Independently formation

Collision



Changes Age turn and
Allende CA1

Early development of the Earth



Terrestrial Accretion
ca. 80 -100 Ma

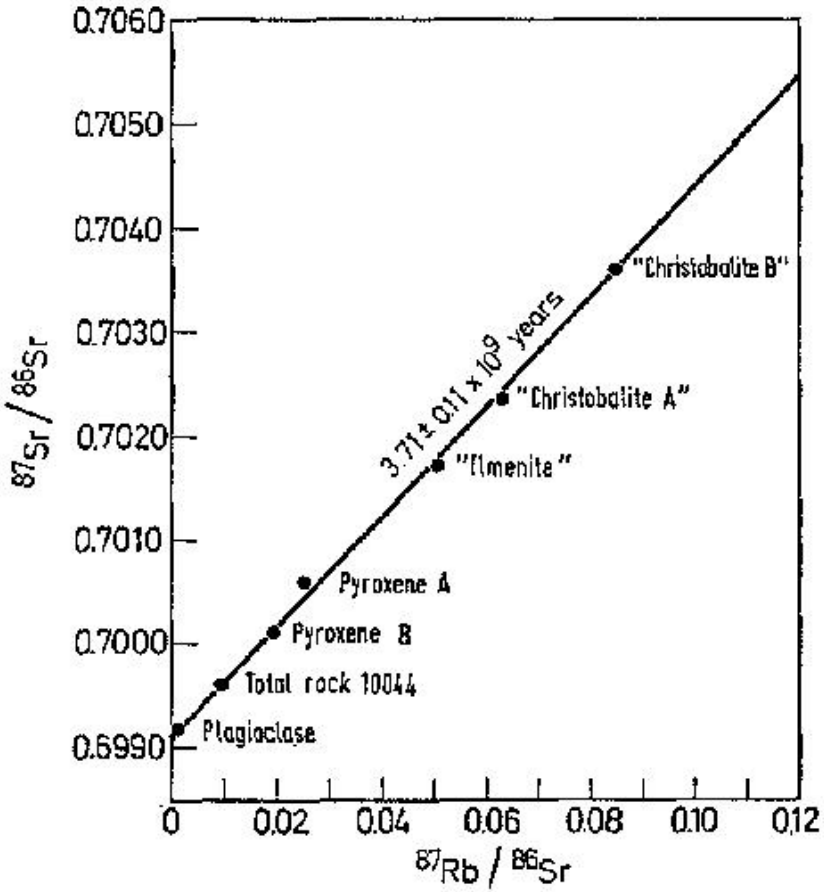
Condensation of solar nebula

Accretion of 8 Ma old meteorites

Nach :
Allegre JC, Manhes G, Goepel C (1995) ***The age of the Earth***.
Geochimica et Cosmochimica Acta. 59; 8, Pages 1445-1456.

Moon age (Rb/Sr isochrone of a rock from the moon)

Mondalter



8. Structure of the Erath

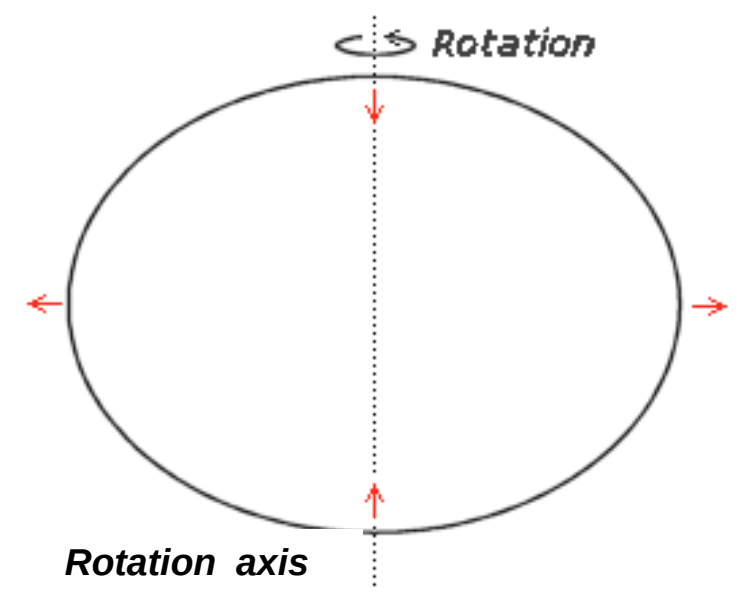
70% oceans
30% continents

Diameter
12 700 km

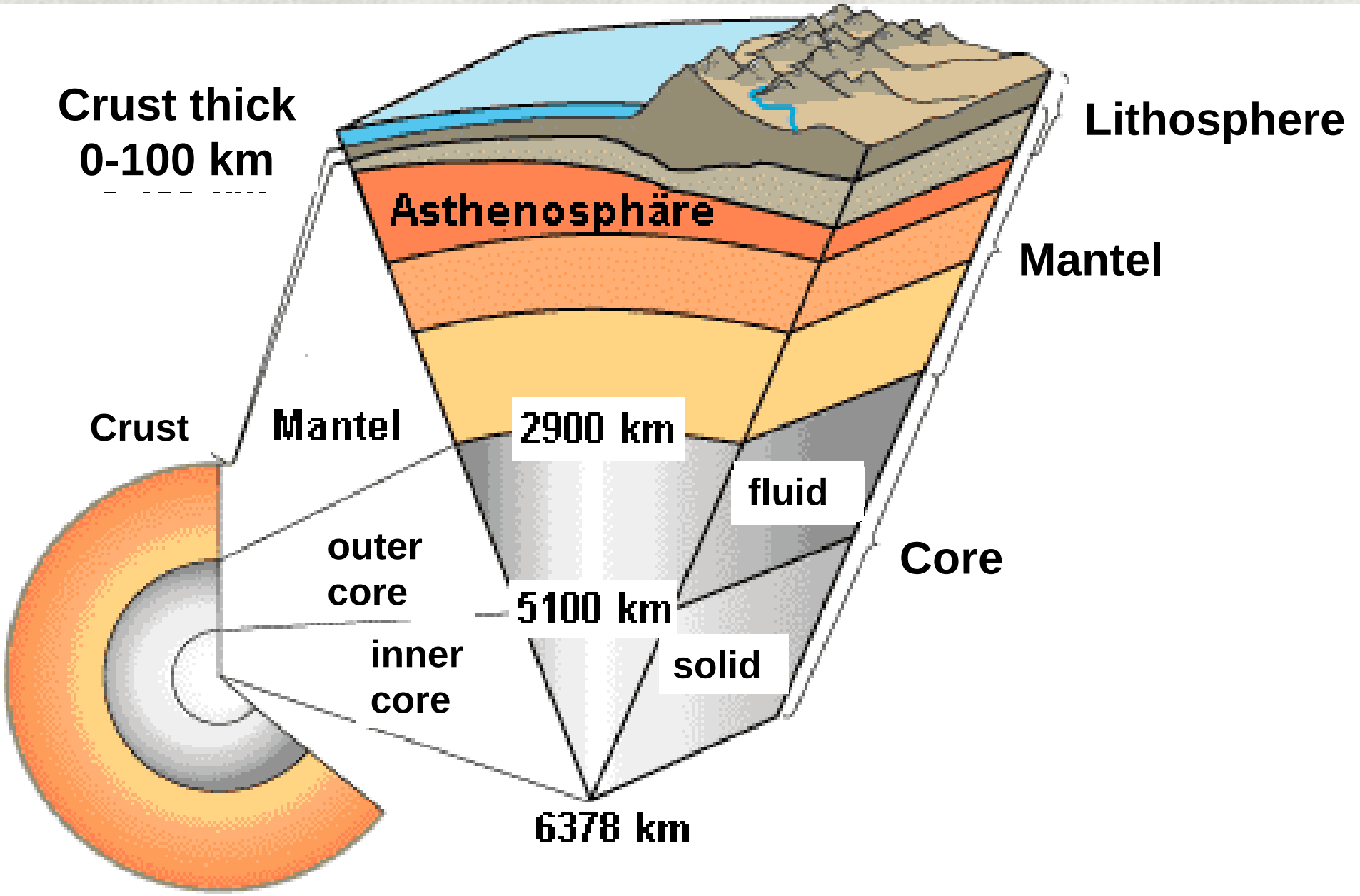
Average density
5.9 g/cm3

Earth's oblateness

The Earth's oblateness result from the centrifugal force of the earth rotation, which is big at Equator and is null at the Poles. Since the interior of the Earth is plastic, accommodates the Earth partially to this force. Thereby the see level adopts too the form of a rotation ellipsoid. The radius of the Earth vary in 21,38 km (a = 6378,137 km, b = 6356,752 km).



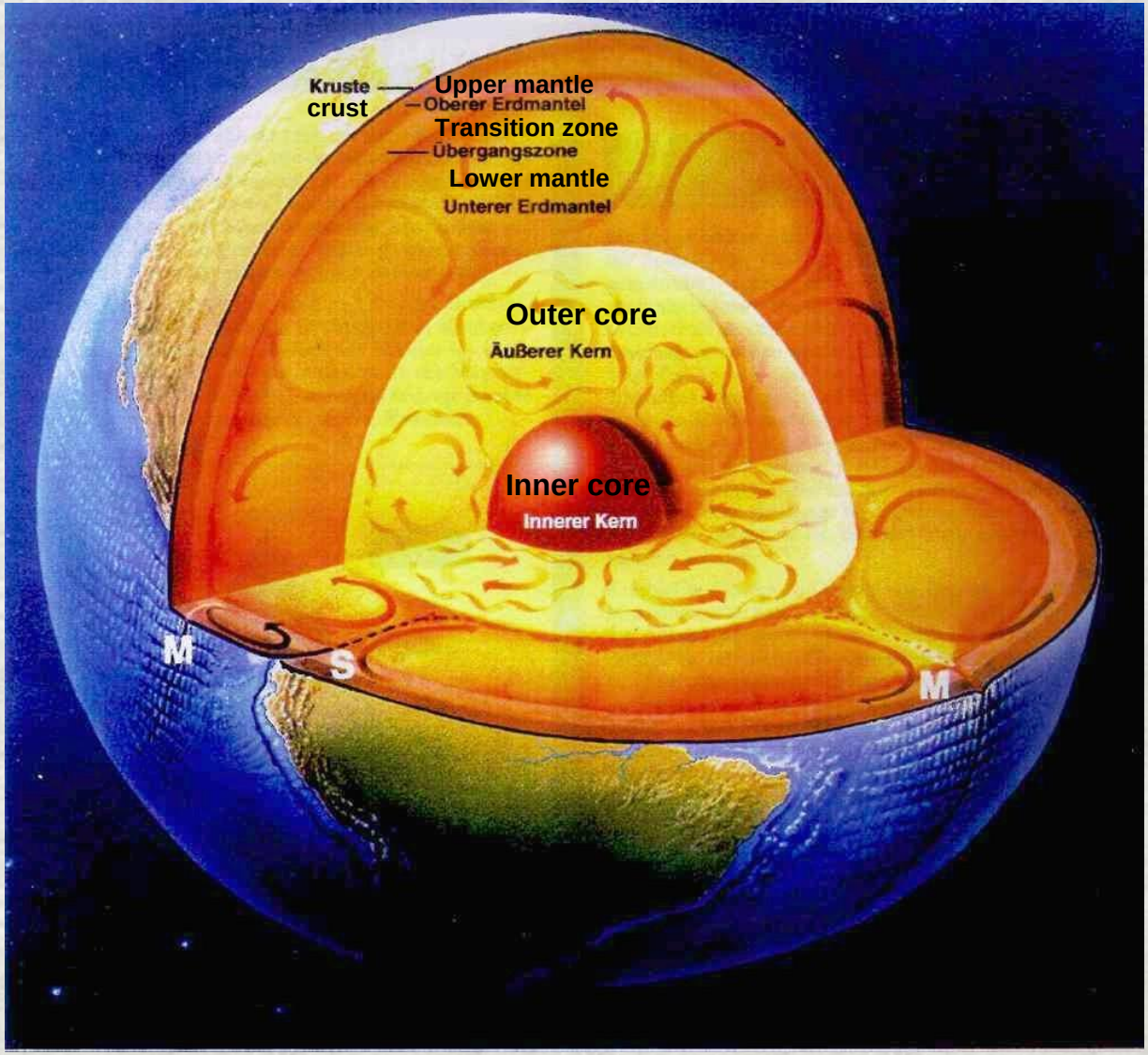
Chimborazo in Ecuador (6310 m): mayor distance from earth's centre


Crust thick
0-100 km
Lithosphere
Asthenosphäre
Mantel
Crust
Mantel
2900 km
fluid
outer
core
Core
5100 km
inner
core
solid
6378 km

Structure of the earth

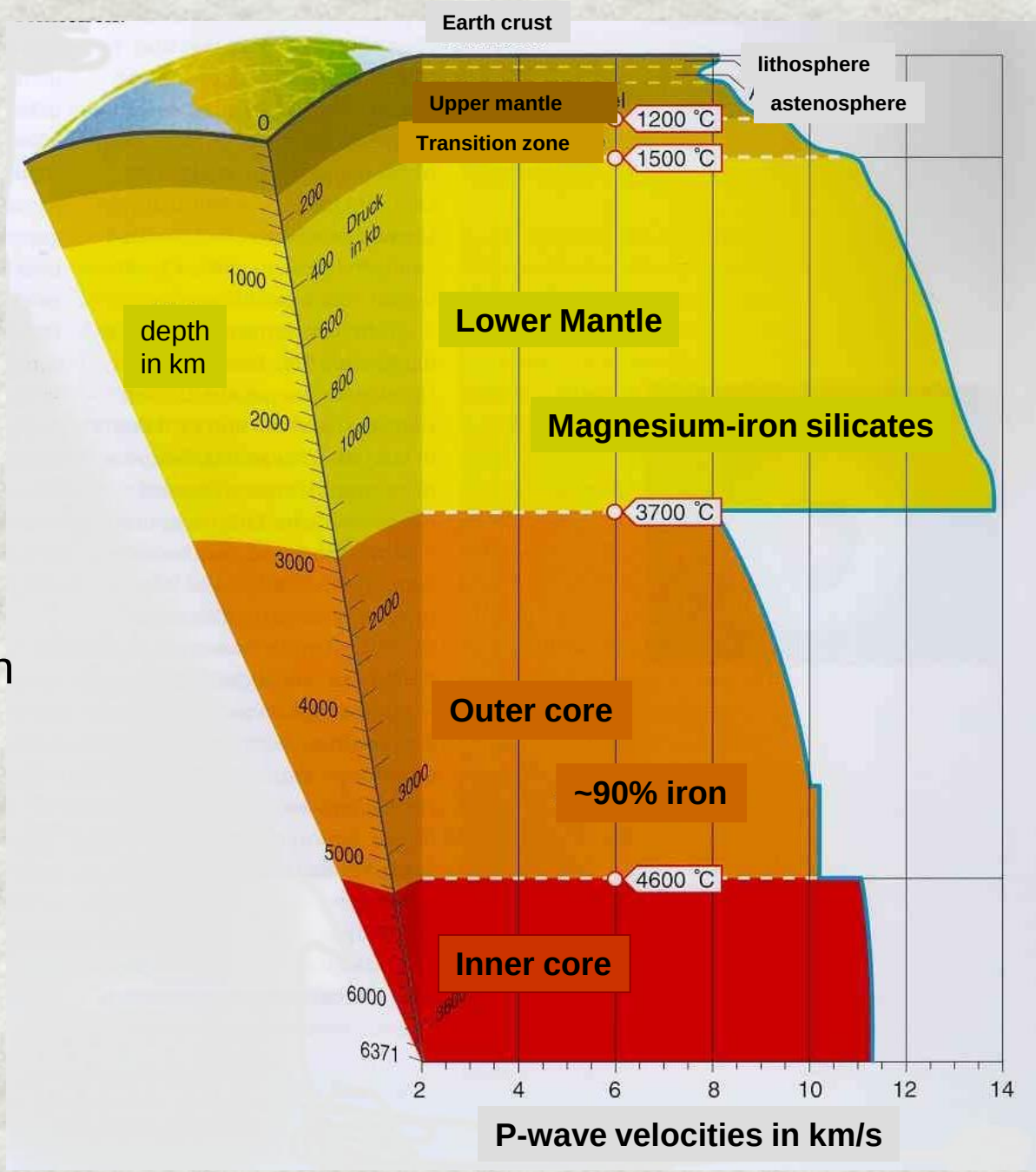
Cross-cut through the earth with its major lithological components and plate tectonic aspects

From: Geo



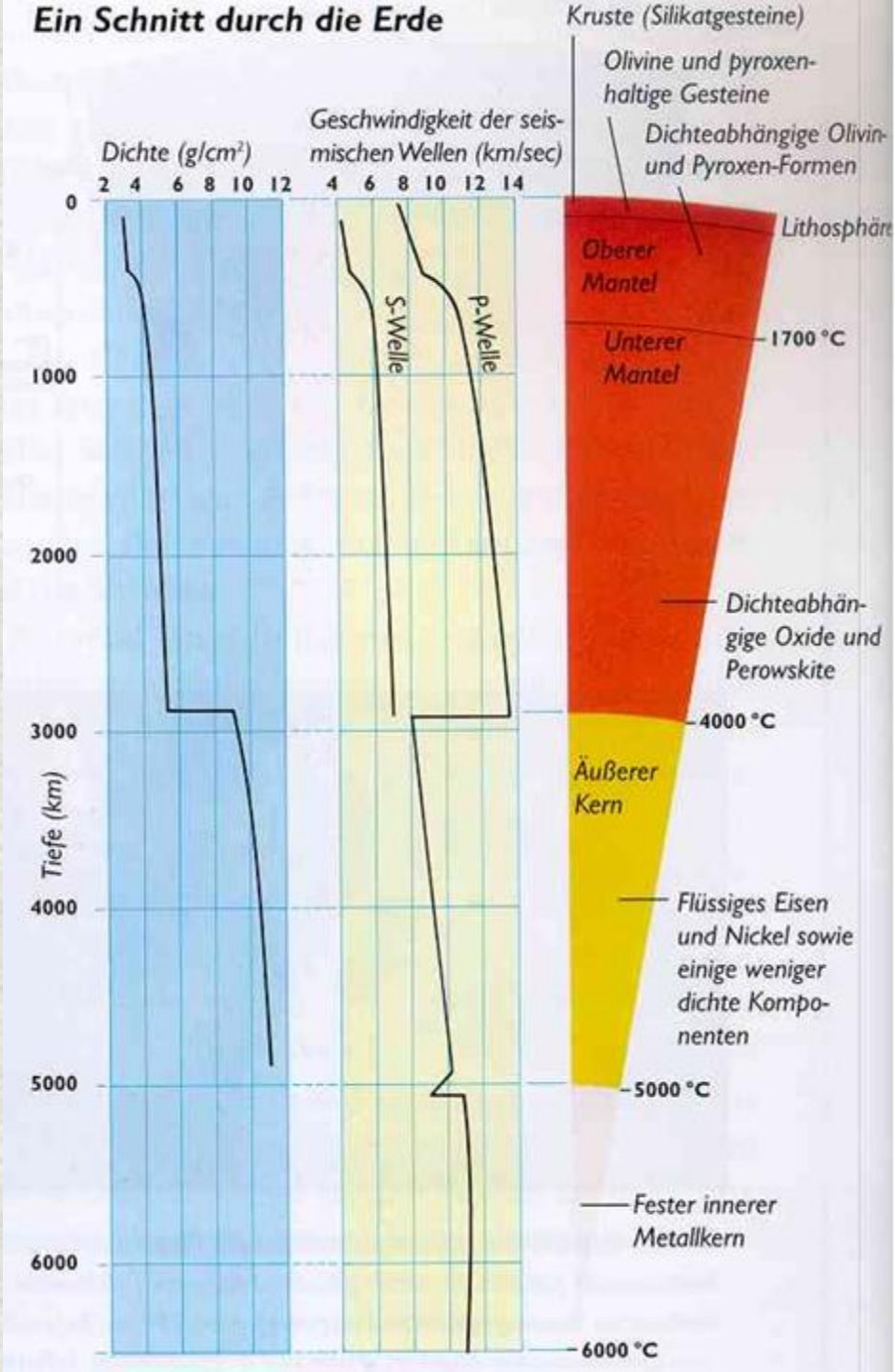
Structure of the earth based on different wave propagation velocities in the earth.

From: Max-Planck-Institut für Chemie (Otto-Hahn-Institut), Mainz. Faszination Forschung



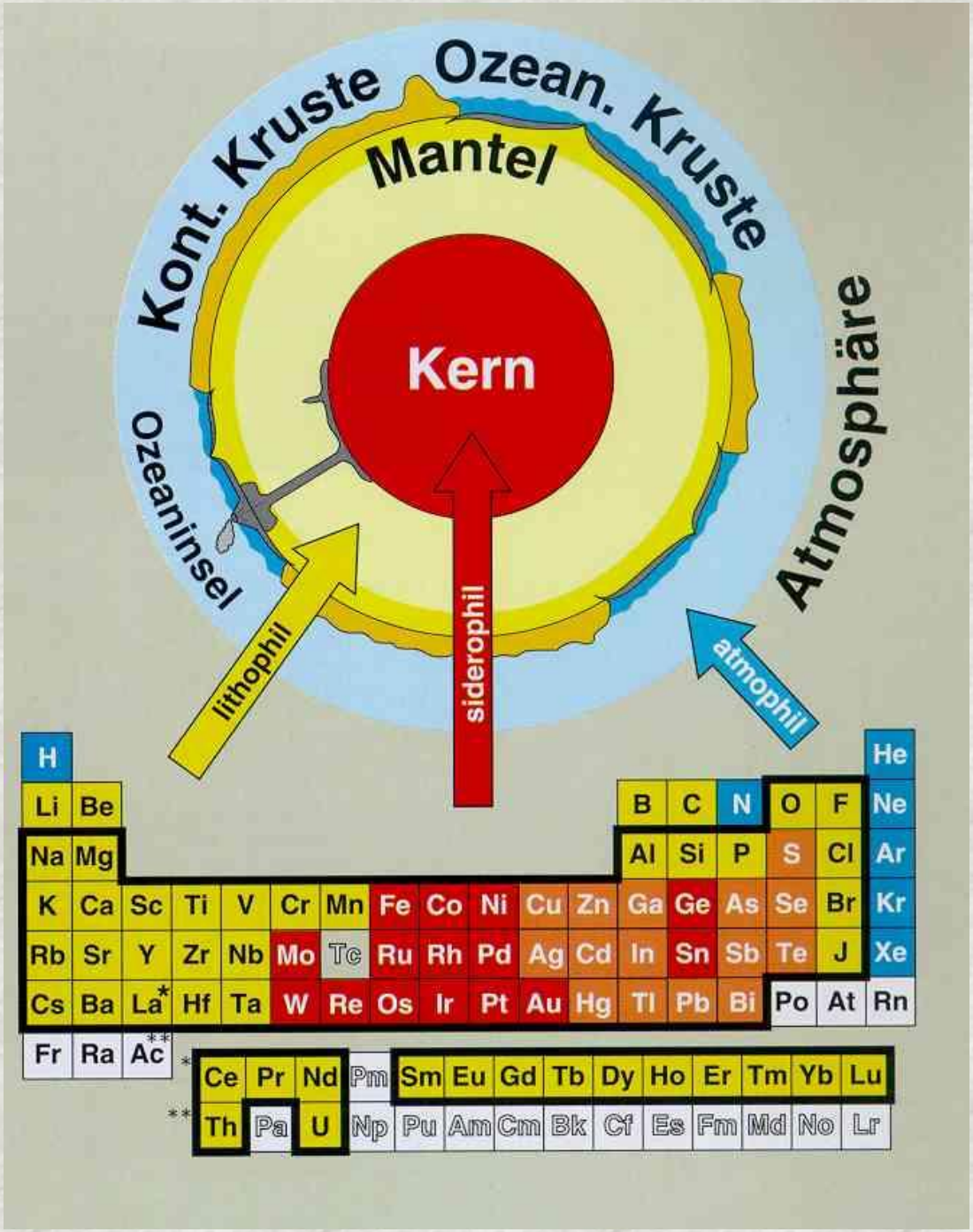
Changes in the propagation velocities of P- and S- waves and the rock densities with increasing depth.

From: Simon Lamb. S. & Sington, D. (2000) Die Erdgeschichte. Eine Spurensuche durch Jahrmillionen. Könemann, Bonn, 240 S.



Crosscut of the earth with the chemical elements and the periodic table. Colors distinguish elements which are concentrated especially in the atmosphere (amophil), in the crust and mantle (lithophil) and in the iron core (siderophil).

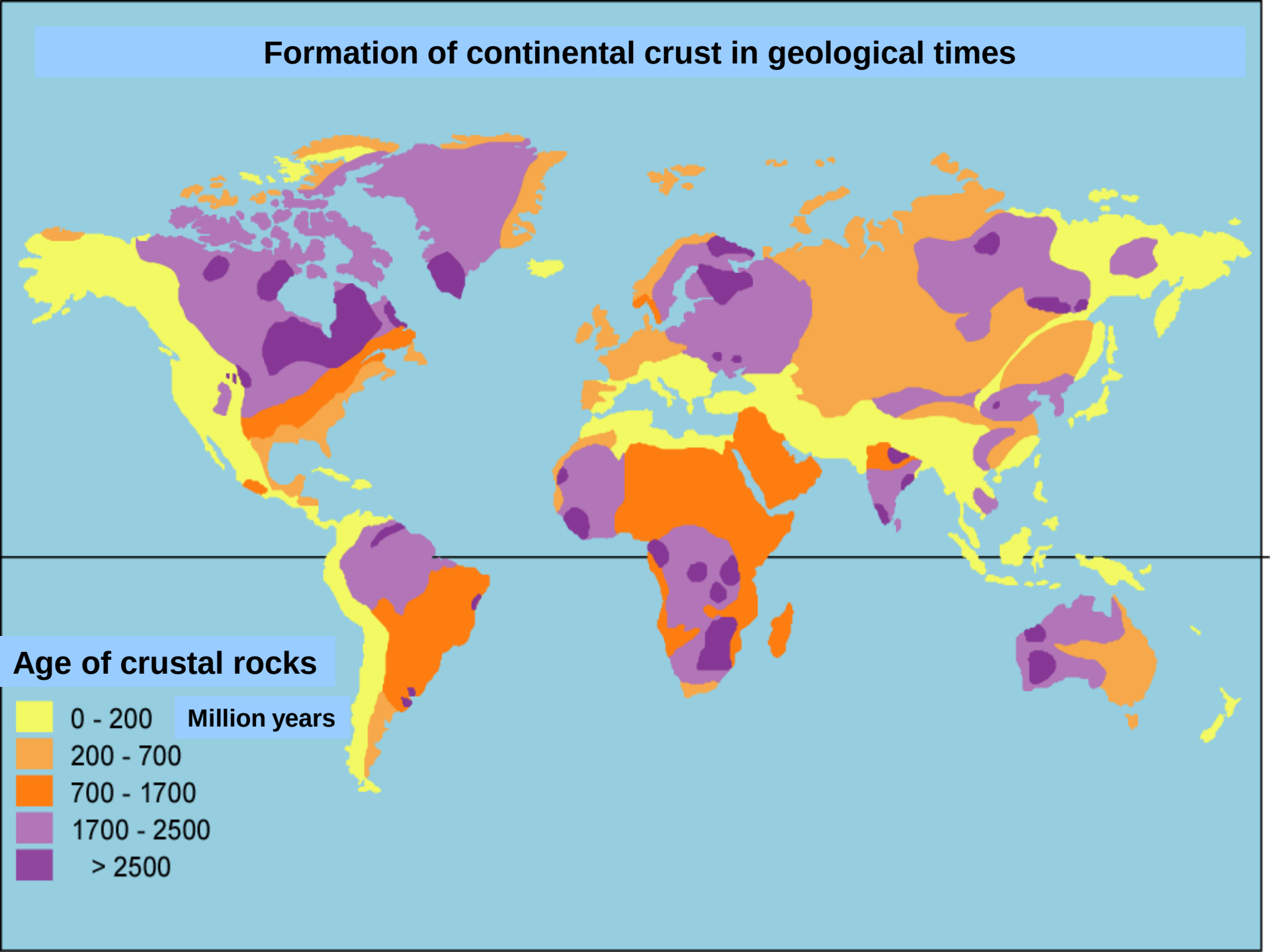
From: Max-Planck-Institut für Chemie (Otto-Hahn-Institut), Mainz. Faszination Forschung



The 8 most common elements in Earth's crust (by mass):

Element	Symbol	Valency	wt.%	vol.%
Oxygen	O	2-	46.6%	93.8%
Silicon	Si	4+	27.7%	0.86%
Aluminum	AL	3+	8.1%	0.47%
Iron	Fe	2+, 3+	5.0%	0.4%
Calcium	Ca	2+	3.6%	1.0%
Sodium	Na	1+	2.8%	1.3%
Potassium	K	1+	2.6%	1.8%
Magnesium	Mg	2+	2.1%	0.3%
	Sum		98.5	98.93

Formation of continental crust in geological times



1. **How do we know about the age and interior of the earth?**

- Rock out crops
- Seismic wave propagation into the earth indicating mineral and rock compositions
- Rock fragments (Xenoliths) which were brought with magma from deeper regions to the earth surface
- High temperature and high pressure experiments in piston cylinder apertures
- Meteorites as examples of broken planets (e.g. iron core)
- Radiogen elements

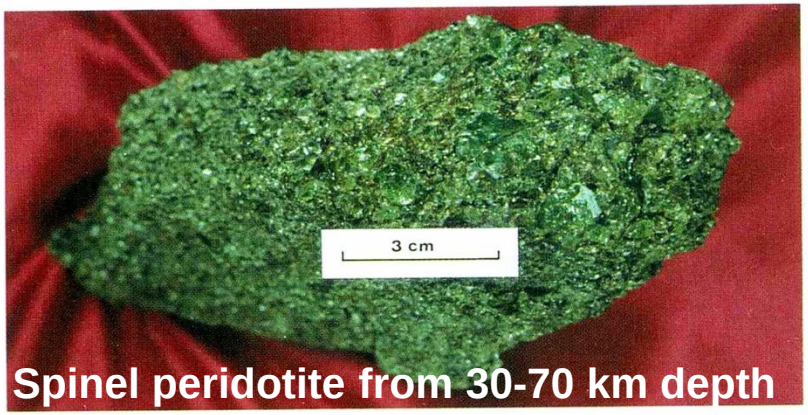
1. Document: Rock out crops (example: Torres del Paine)

2. Document: Xenoliths from different depths

Example: Peridotite xenoliths

Peridotites are the dominant rock type of the upper mantle. Ascending magma are able to bring up mantle fragments of up to 30 cm diameter, which enable a direct window to rocks of the earths mantle.

A Granatperidotite from>70 km depth



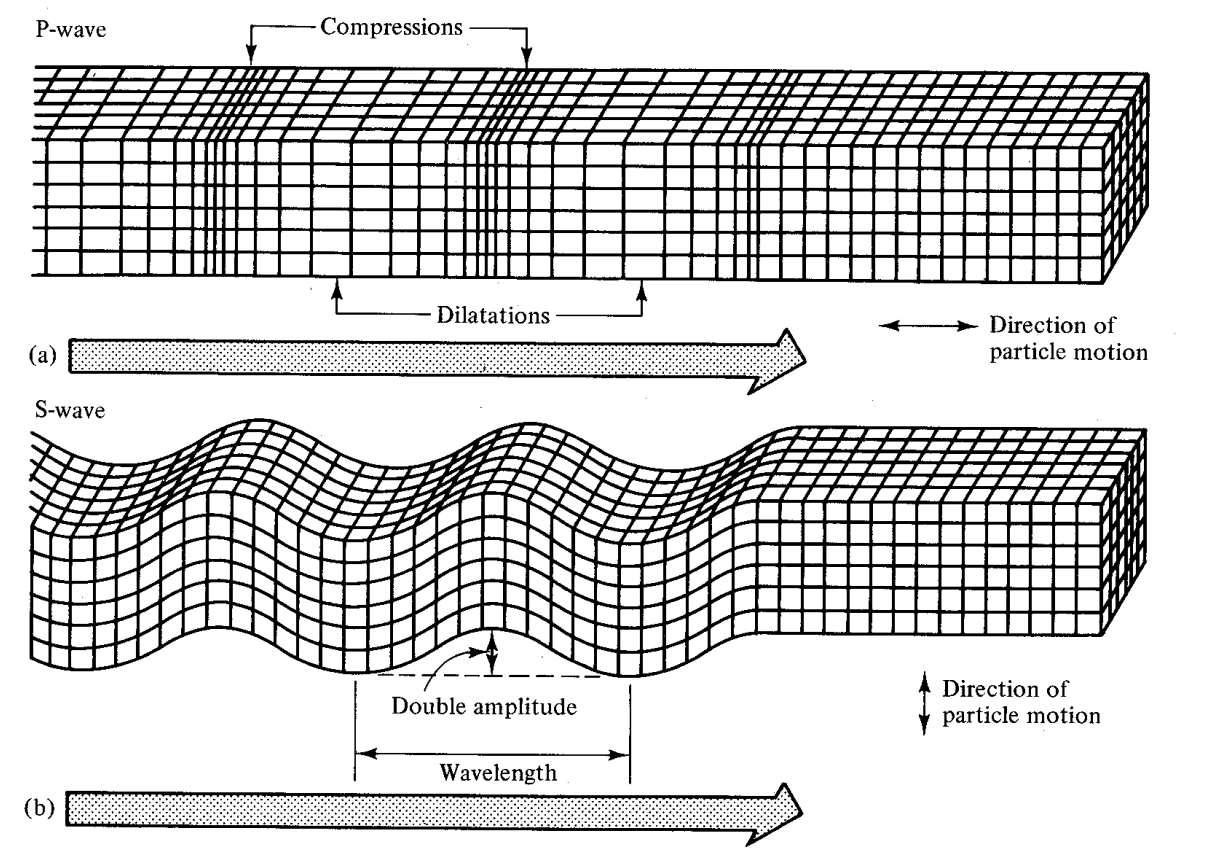
B Spinel peridotite from 30-70 km depth

C Layered spinel peridotite

Eclogite xenolith from the Roberst Victor Mine, Südafrika. Eklogites consist especially of garnet (orange-red, Almandin-Pyrop) and a sodium-rich Clinopyroxene (green). Eklogites can be formed during high pressure metamorphism from basalts (Metamorphism is a recrystallisation of minerals in a solid rocks, which adapt to the changed P-T conditions). Besides peridotites, eclogites represent also an important source of diamonds in the upper mantle.

From Nixon, P.H. (Hrsg.) (1987): Mantle Xenoliths. John Wiley & Sons, Chichester, 844 S.

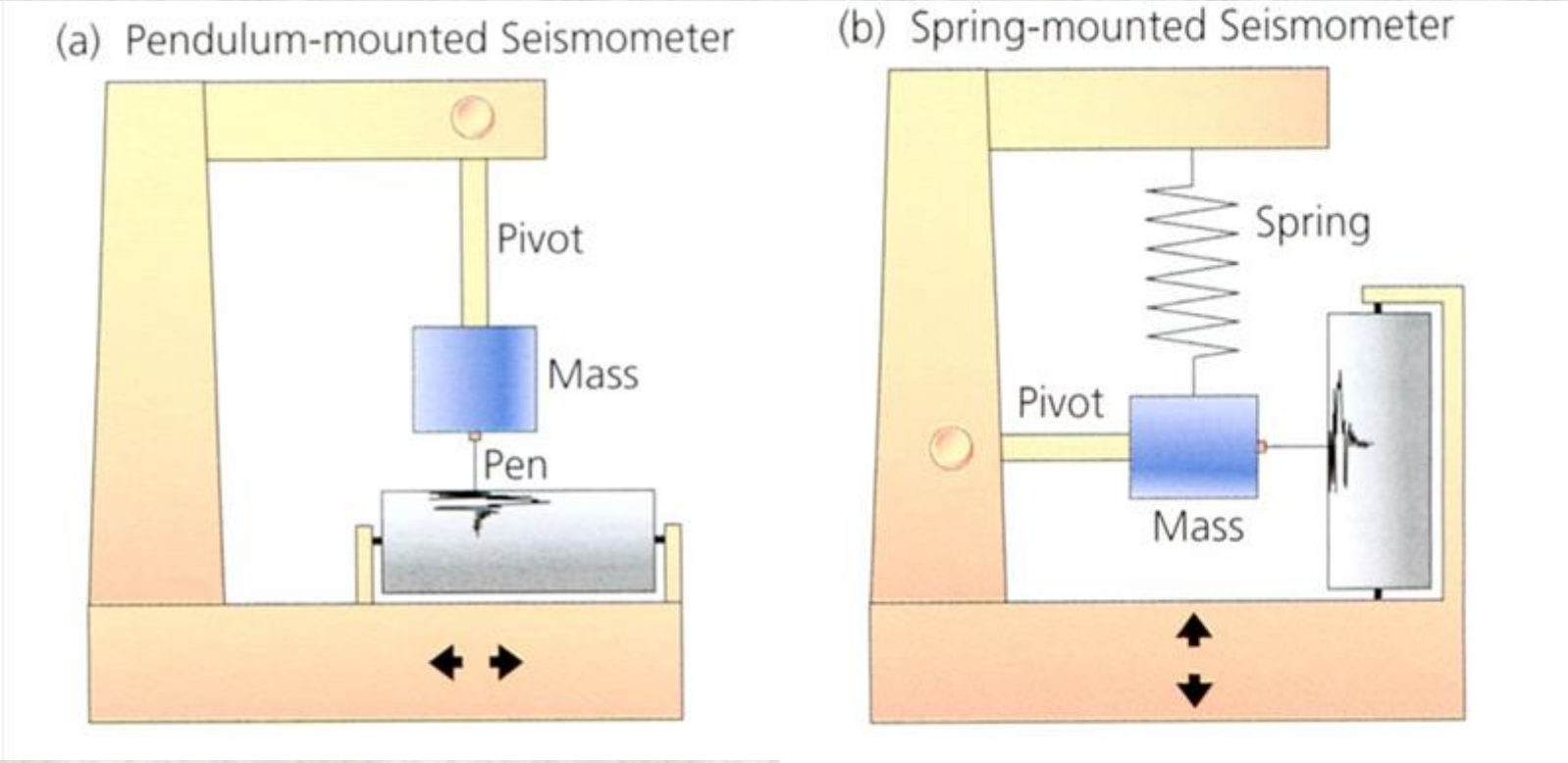
3. Document: Propagation velocities of the waves in the basement rocks depend on mineral and rock composition



Propagation of compression (P-) and Shear waves (S-Waves)

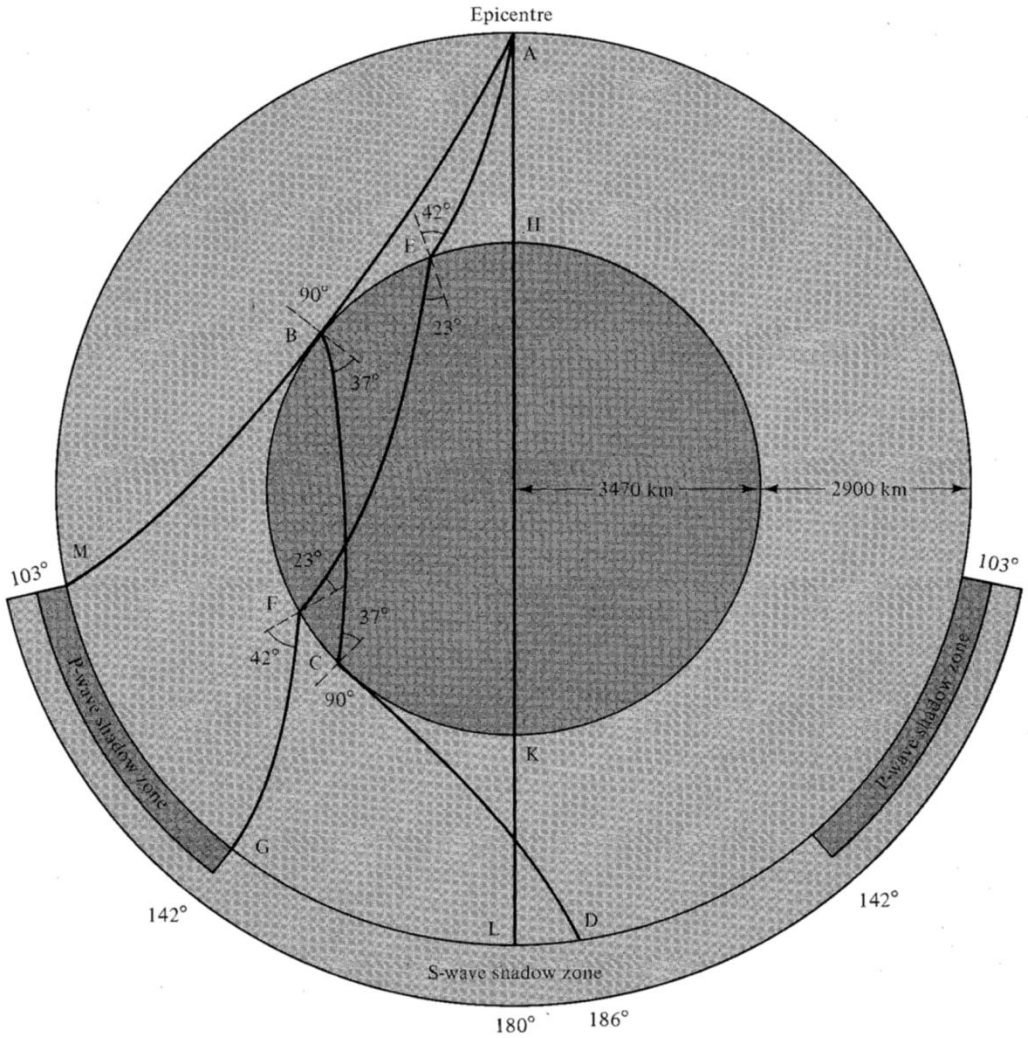
Aus: Brown, G.C., Hawkesworth, C.J. & Wilson, R.C.L. (1992): Understanding the Earth. Cambridge University Press, Cambridge, 551 S.

Two different types of seismometers. Depending on the type of hanging of the weight, horizontal or vertical movements can be registered.



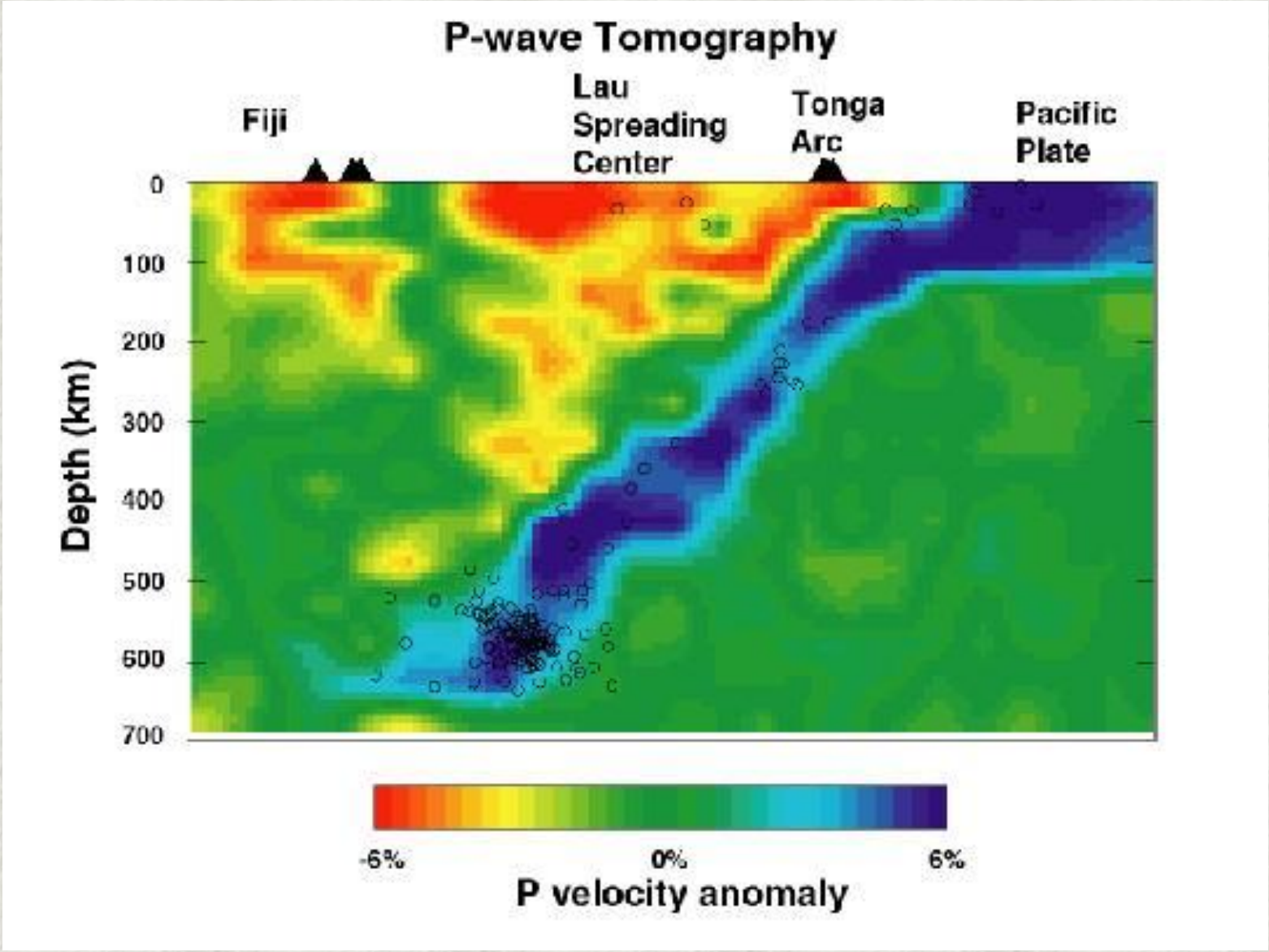
From: Cattermole, P. (2000): Building Planet Earth. Cambridge University Press, 283 S.

The liquid outer core of the earth include a shadow zone for shear waves (S-wave shadow zone). This waves could not propagate due to the missing shear stress resistivity of liquids Earth's side. P-waves are partly refracted at the mantle- core transition, what cause a ring-link shadow compressional waves (P-wave shadow zone).

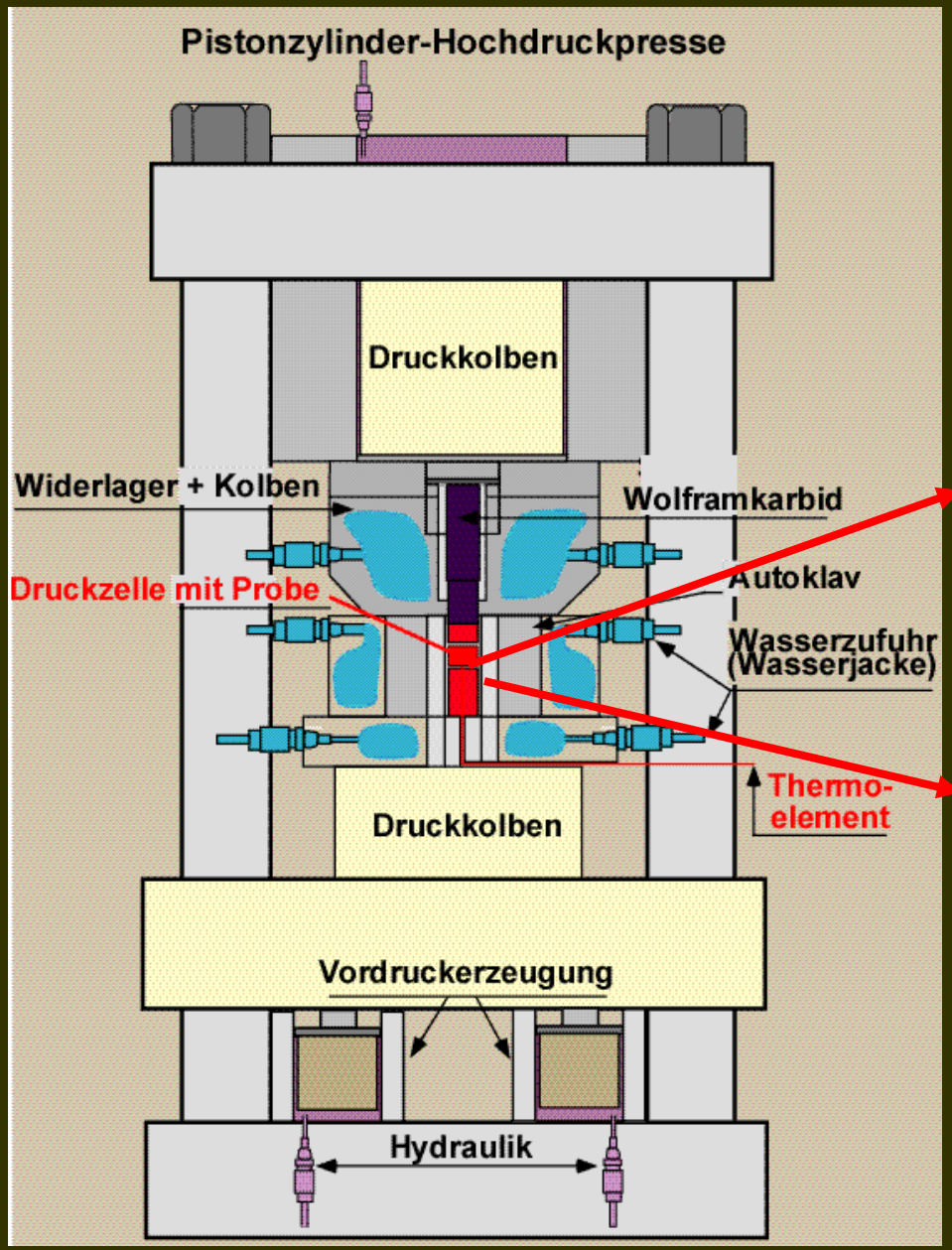


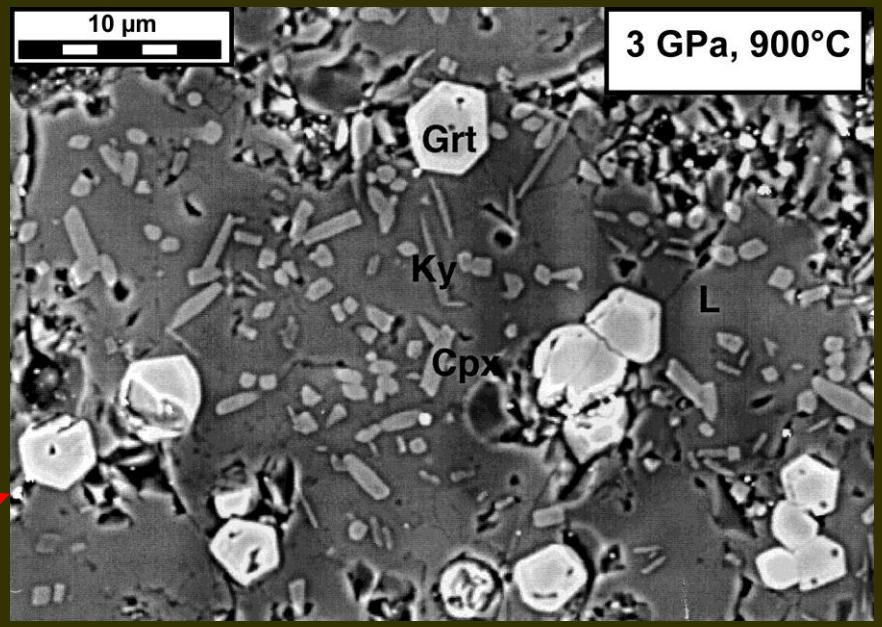
From: Brown, G.C., Hawkesworth, C.J. & Wilson, R.C.L. (1992): Understanding the Earth. Cambridge University Press, Cambridge, 551 S.

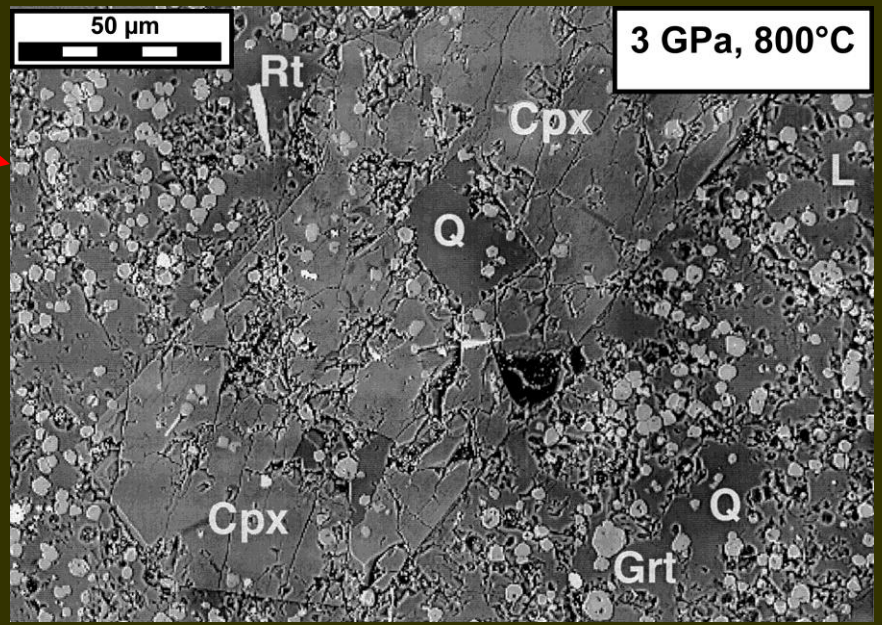
Tomography of a subduction zone



Piston cylinder press

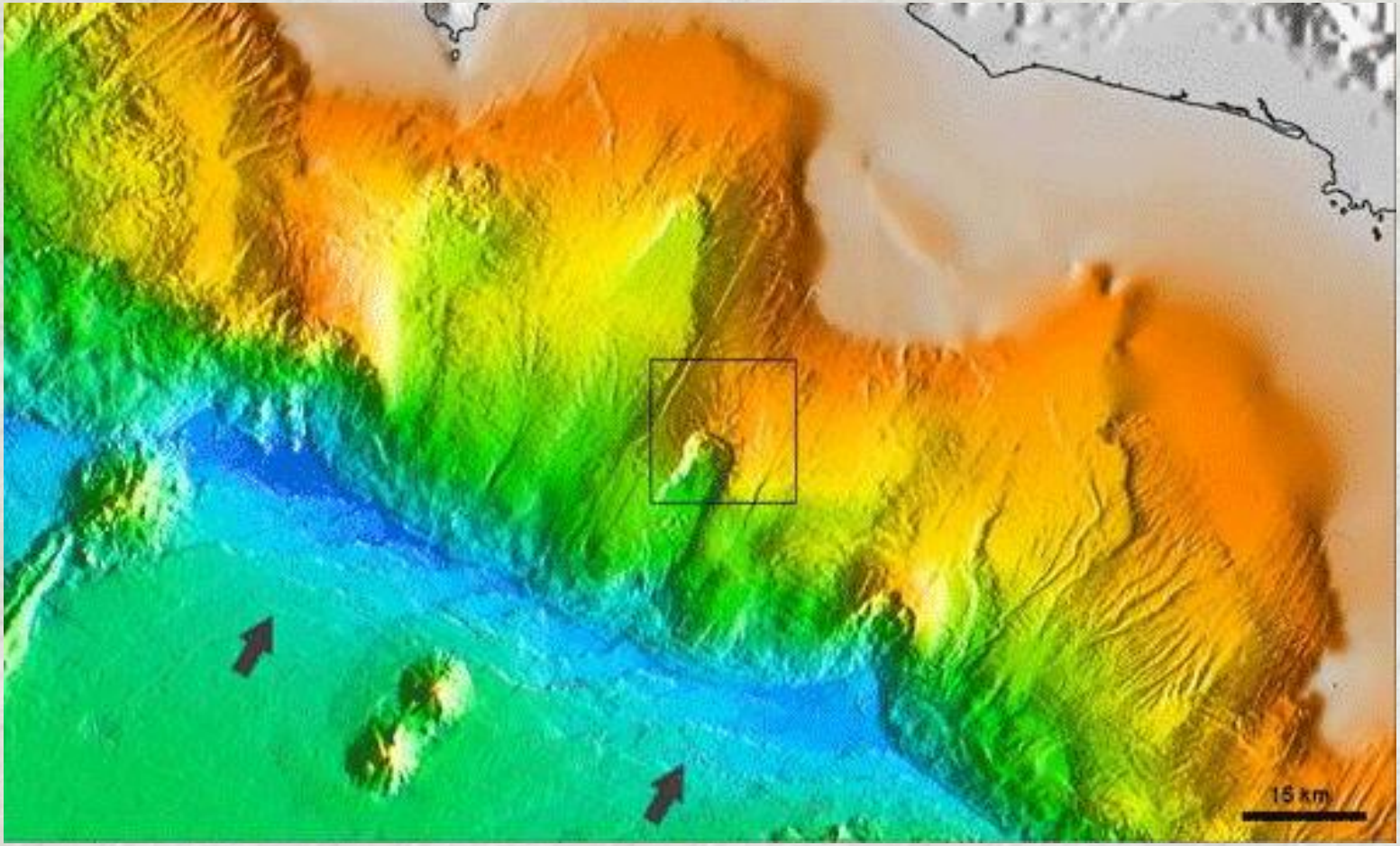






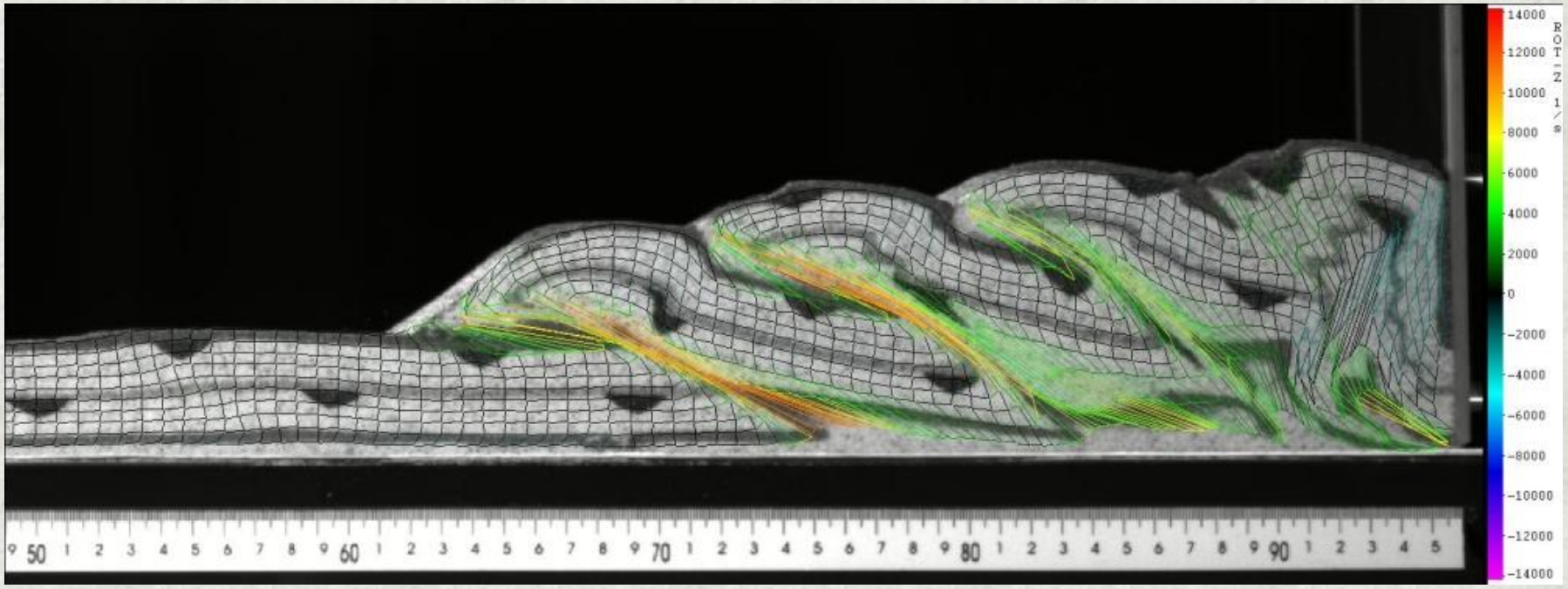
Deformation experiments

Analogue sandbox experiments, simulation the deformation in an accretionary wedge (Ryan Laracy)



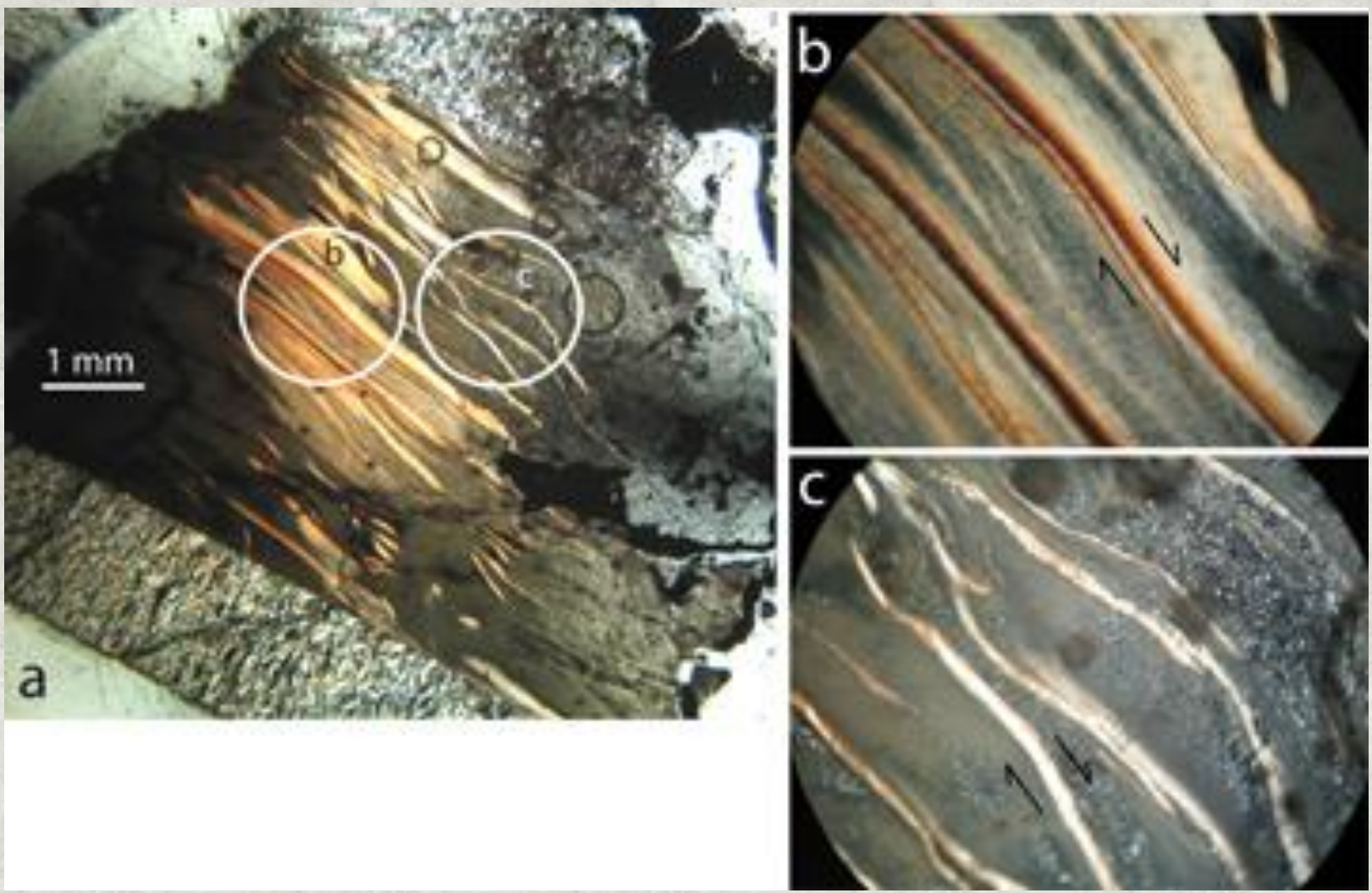
Deformation experiments

- **Simulation of Surface Deformations During Subduction Earthquakes (Onno Oncken, GFZ)**
- Quantitative process understanding between seisomotectonic deformation at the plate boundaries and their impact to deformations at the earth's surface



Deformation experiments

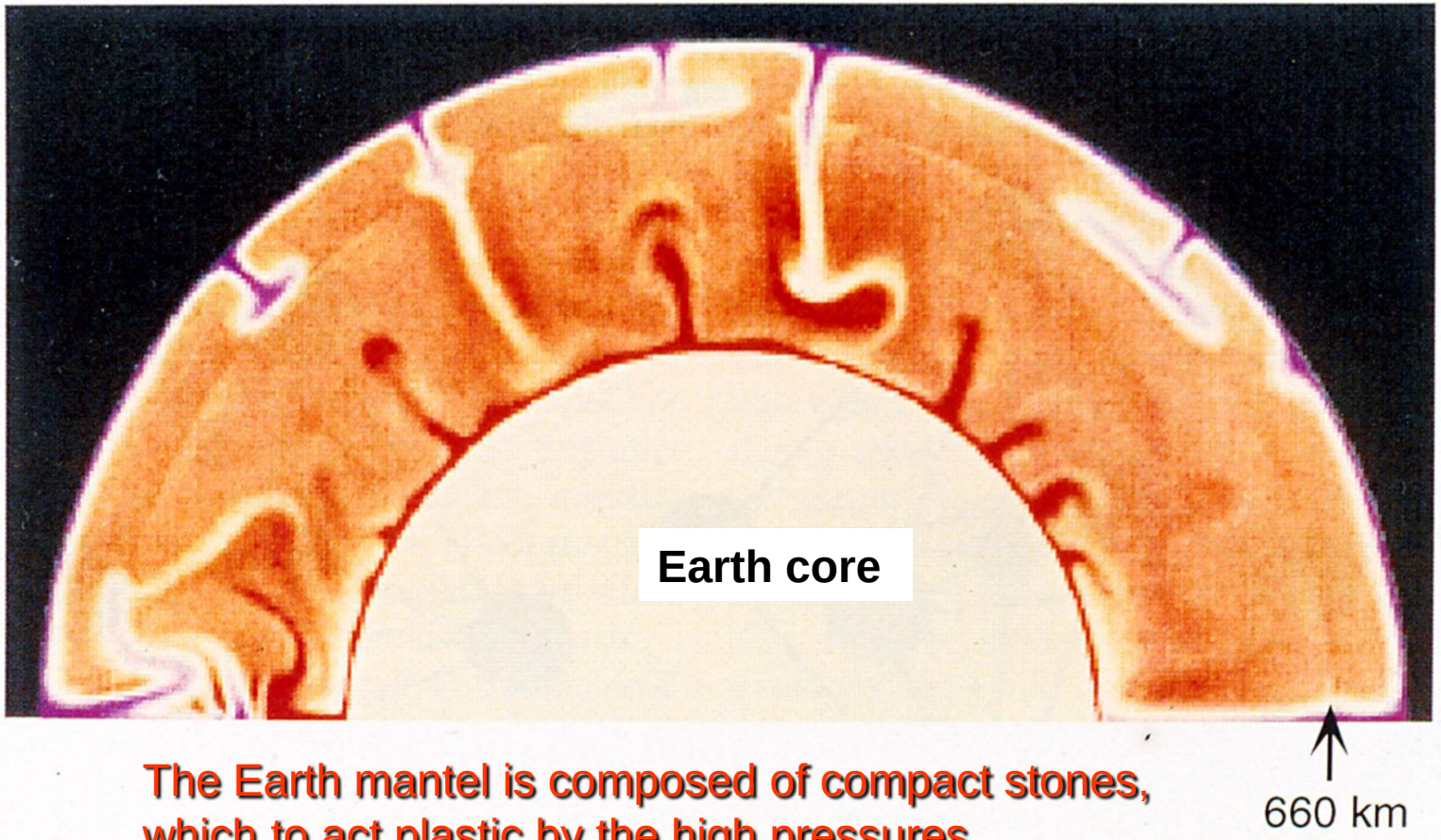
Andalusite Torsion experiments (Dr. Take Hiraga)



Computer simulation:

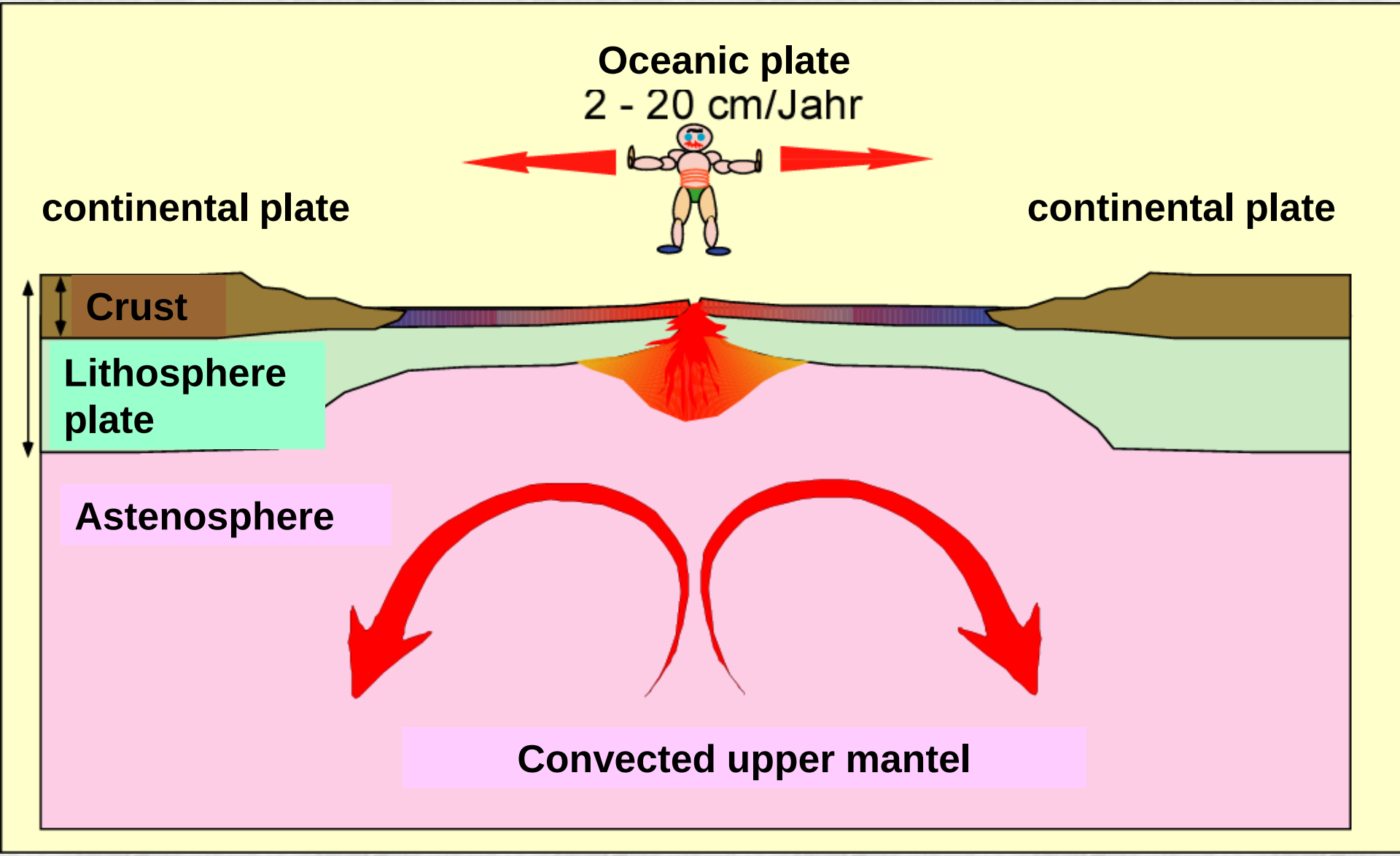
Gradual mixing of the Earth mantel by bipartite and in-depth convection

(Computermodell)

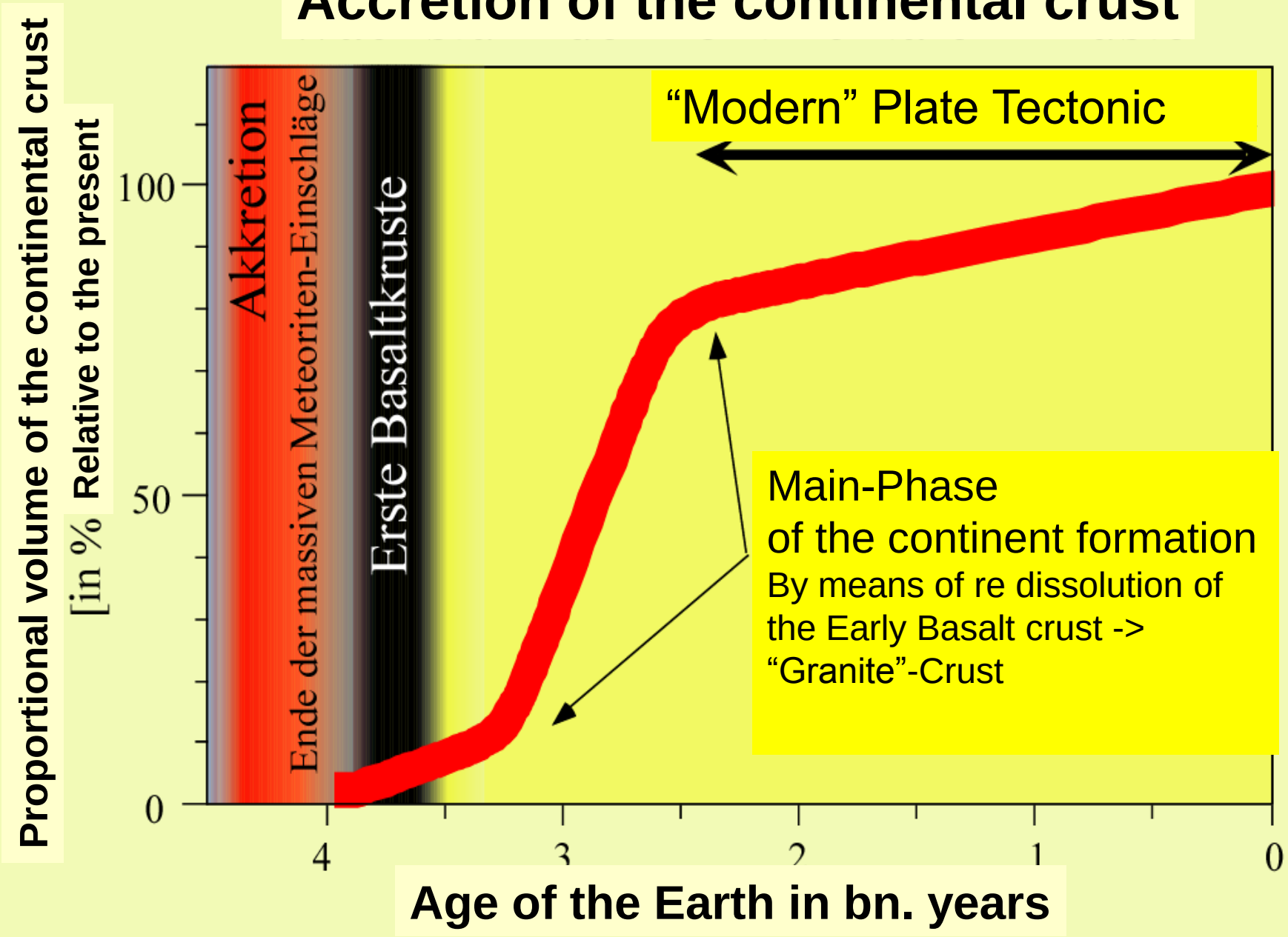


The Earth mantel is composed of compact stones, which to act plastic by the high pressures.

Asthenosphere and Lithosphere



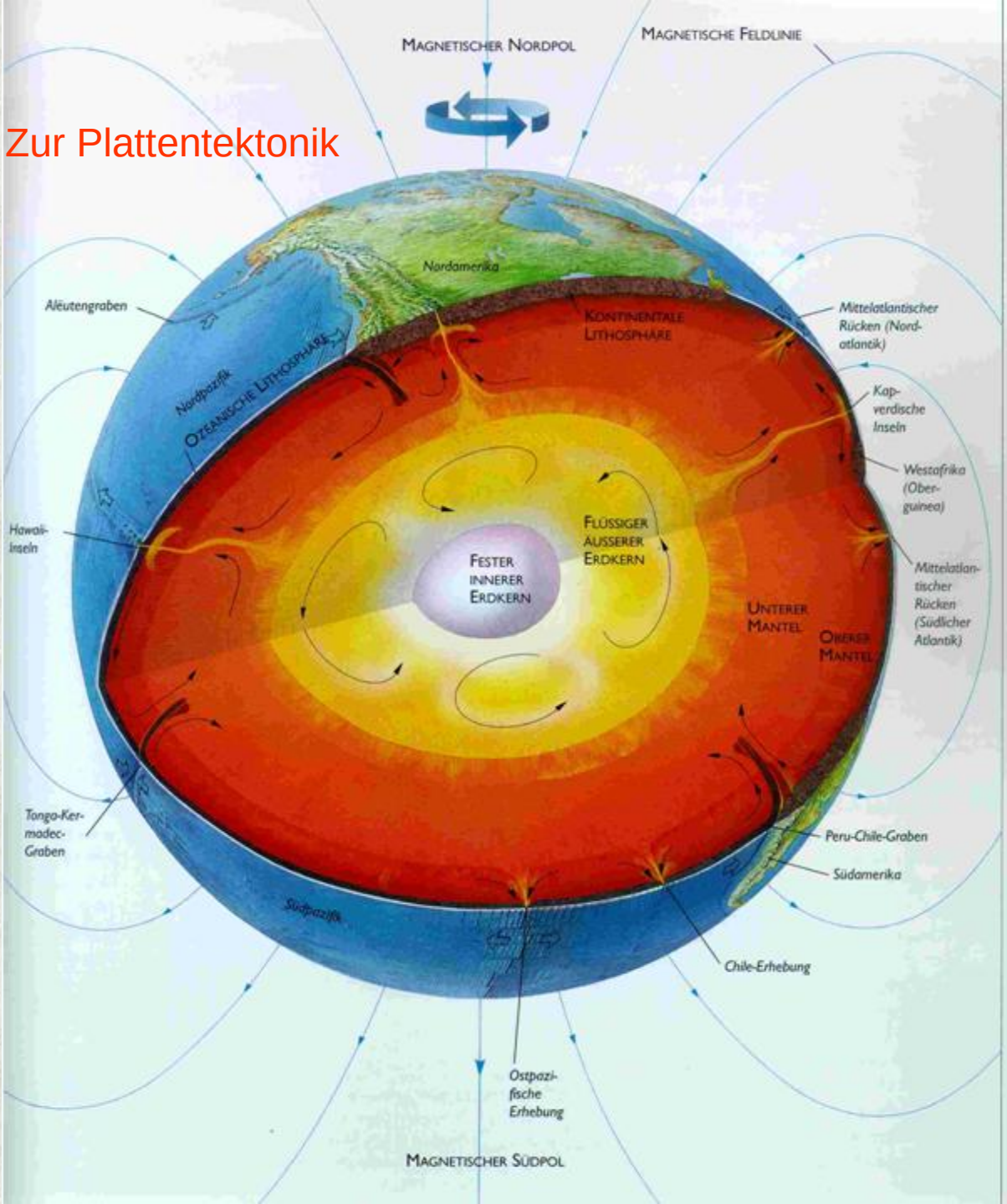
Accretion of the continental crust



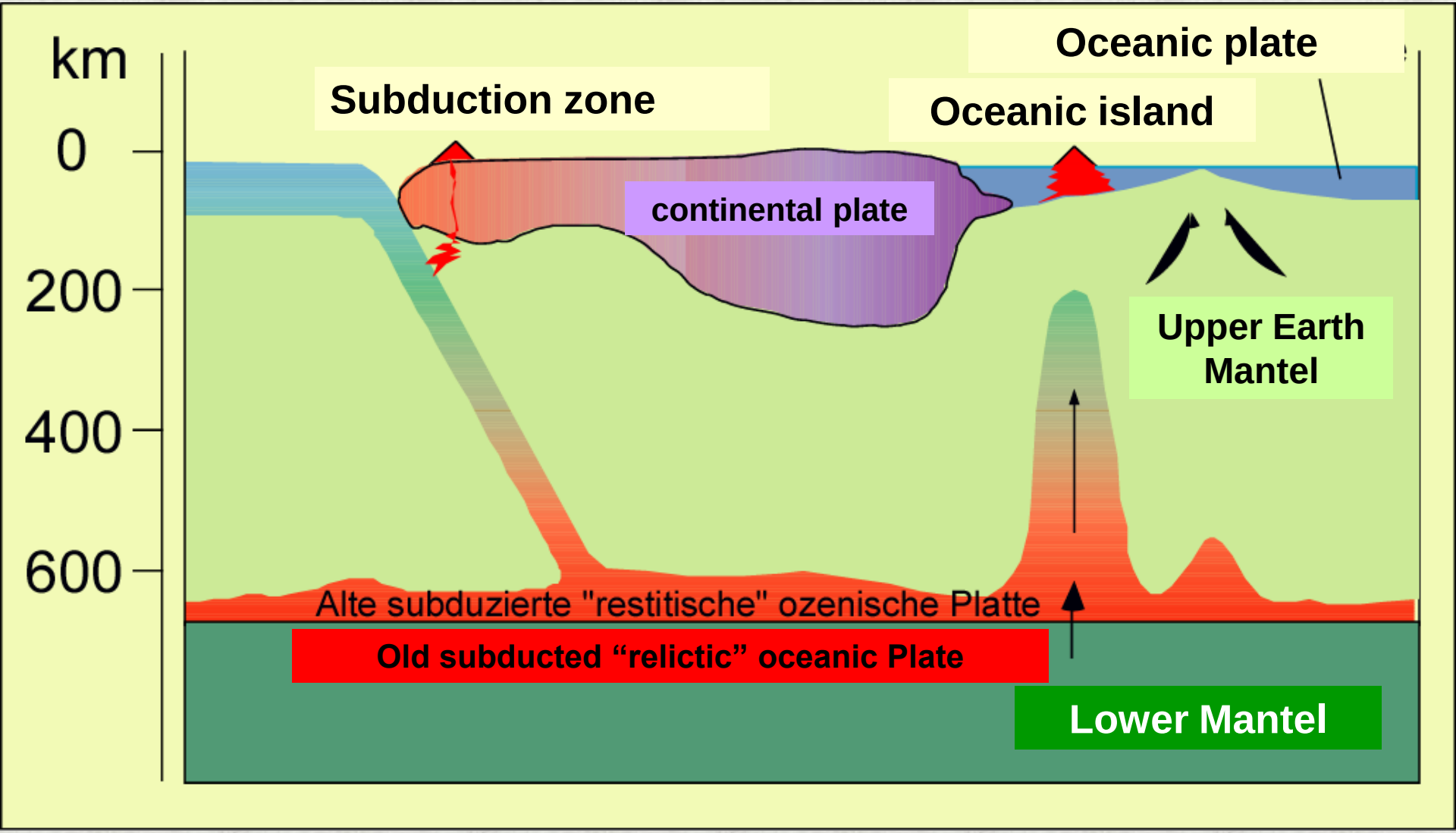
Section through the earth with the main elements of the plate tectonics (Mid-ocean ridge with subduction zones).

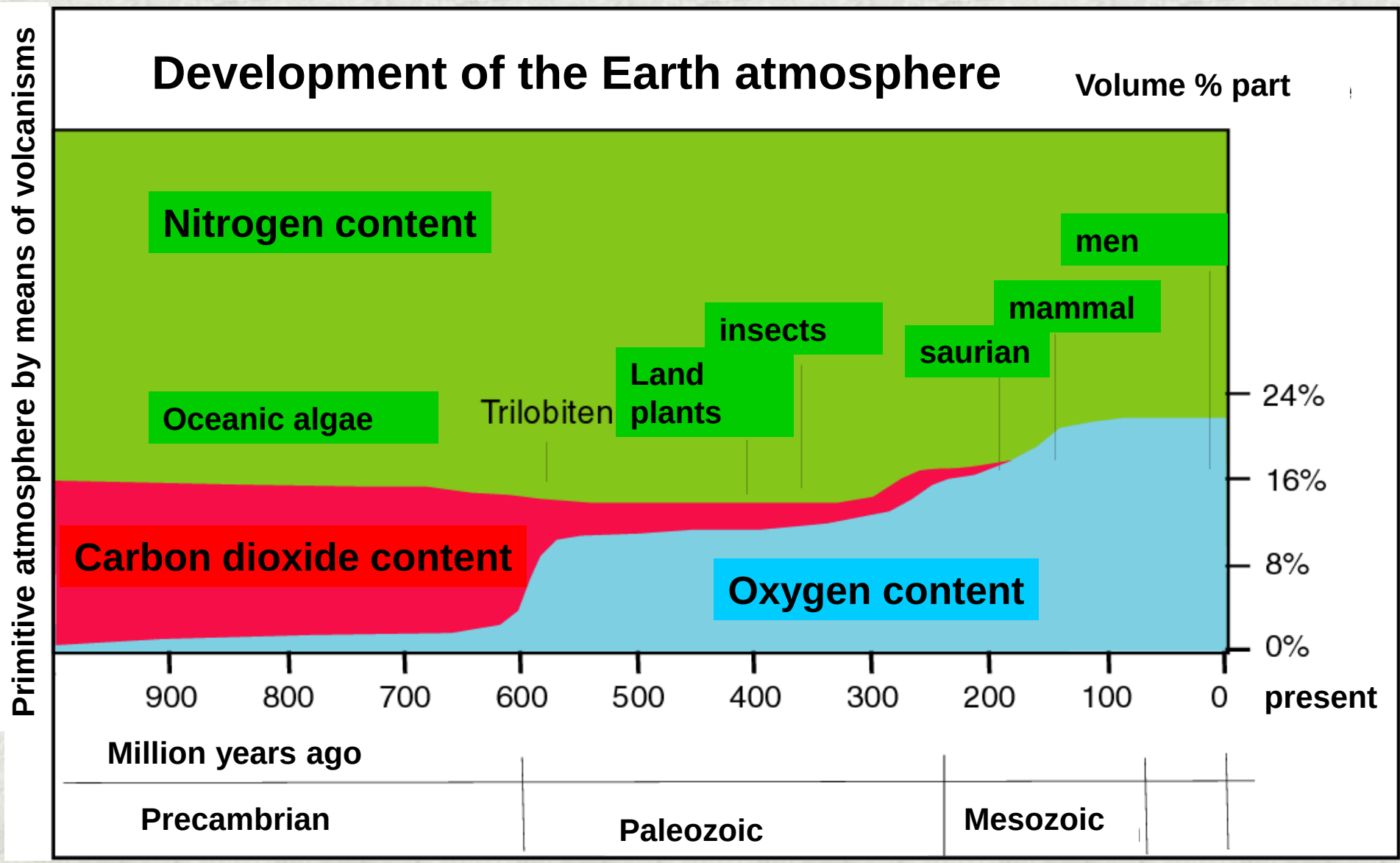
from: Simon Lamb. S. & Sington, D. (2000) Die Erdgeschichte. Eine Spurensuche durch Jahrmillionen. Könemann, Bonn, 240 S.

Zur Plattentektonik



Model for the geochemical development of the Earth Mantel




Development of the Earth atmosphere
Volume % part
Primitive atmosphere by means of volcanisms
Nitrogen content
men
mammal
insects
saurian
Land plants
Oceanic algae
Trilobiten
24%
16%
8%
0%
Carbon dioxide content
Oxygen content
900
800
700
600
500
400
300
200
100
0
present
Million years ago
Precambrian
Paleozoic
Mesozoic

Aufgabe 1: Elementfraktionierung bei Teilschmelzbildung

$$\frac{C_l}{C_o} = \frac{1}{D + F\,(1-D)}$$

F = Aufschmelzgrad eines Gesteines (0-1) wobei dies 0-100% entspricht

D = Verteilungskoeffizient für eine Element zwischen Schmelze und Festphasen

C_l = Elementkonzentration in der Teilschmelze

C_o = Elementkonzentrattion im Ausgangsmaterial

Berechnen Sie, wie hoch die Kaliumkonzentrationen in einer Teilschmelze sind, wenn der Teilschmelzanteil (a) 5% und (b) 30% beträgt (F= 0.05 bzw 0.30).
Der Gesamtverteilungskoeffizient ziwschen einer Teilschmelze und Erdmantelmineralen (C_l/C_o) beträgt 0.1.
Die Ausgangskonzentration im Erdmantel beträgt 1500 ppm (Parts per Million)