Die Lithosphäre:
Creme brûlée oder Jelly Sandwich ?

Abschieds-Vorlesung Renée Heilbronner

Universität Basel

Departement Umweltwissenschaften

DUW-Kolloquien FS 2016
Abschiedsvorlesung

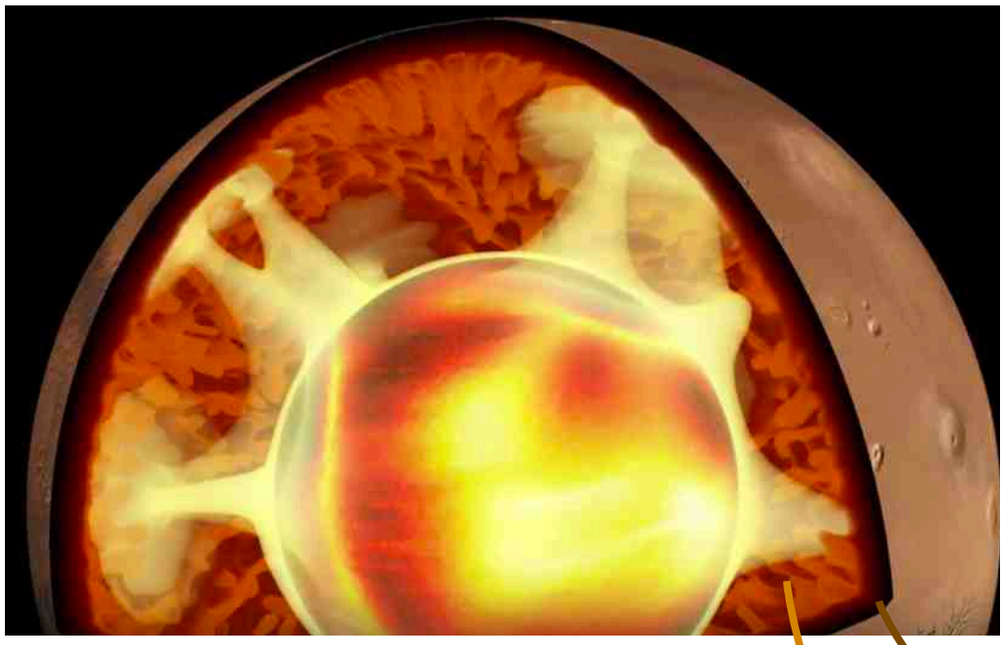
Dienstag, 31. Mai 2016, 16:15 Uhr

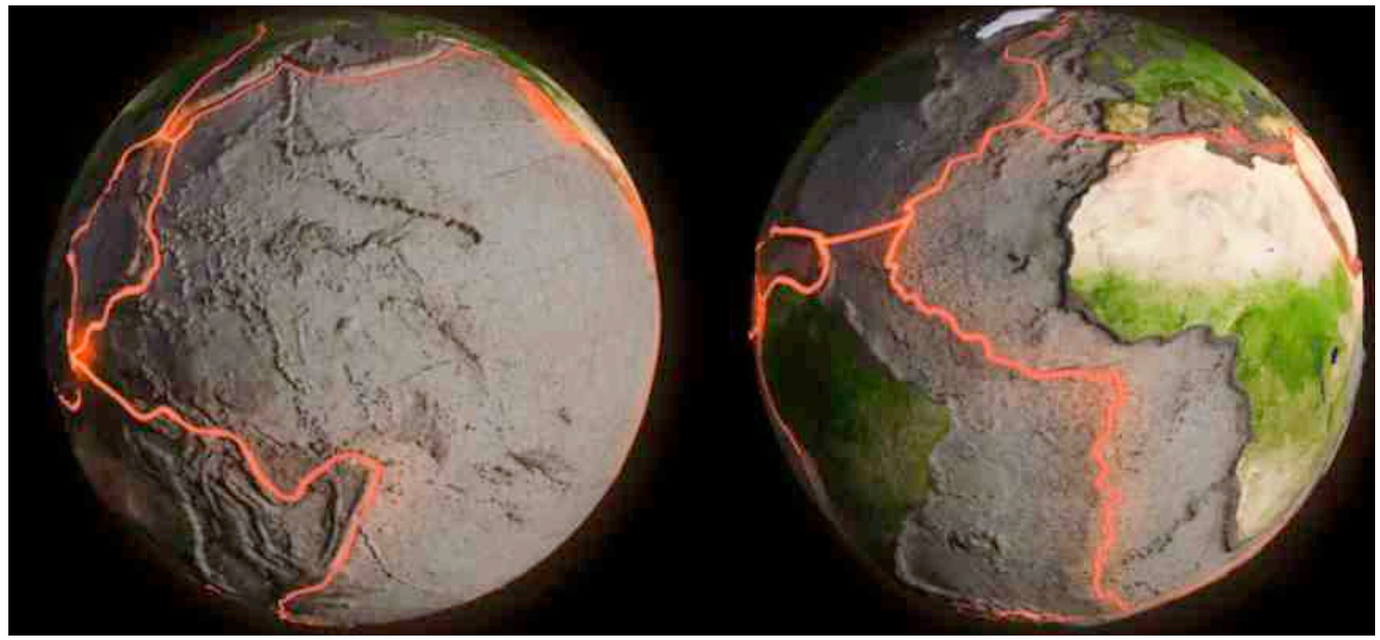
im Hörsaal Botanik, Schönbeinstrasse 6

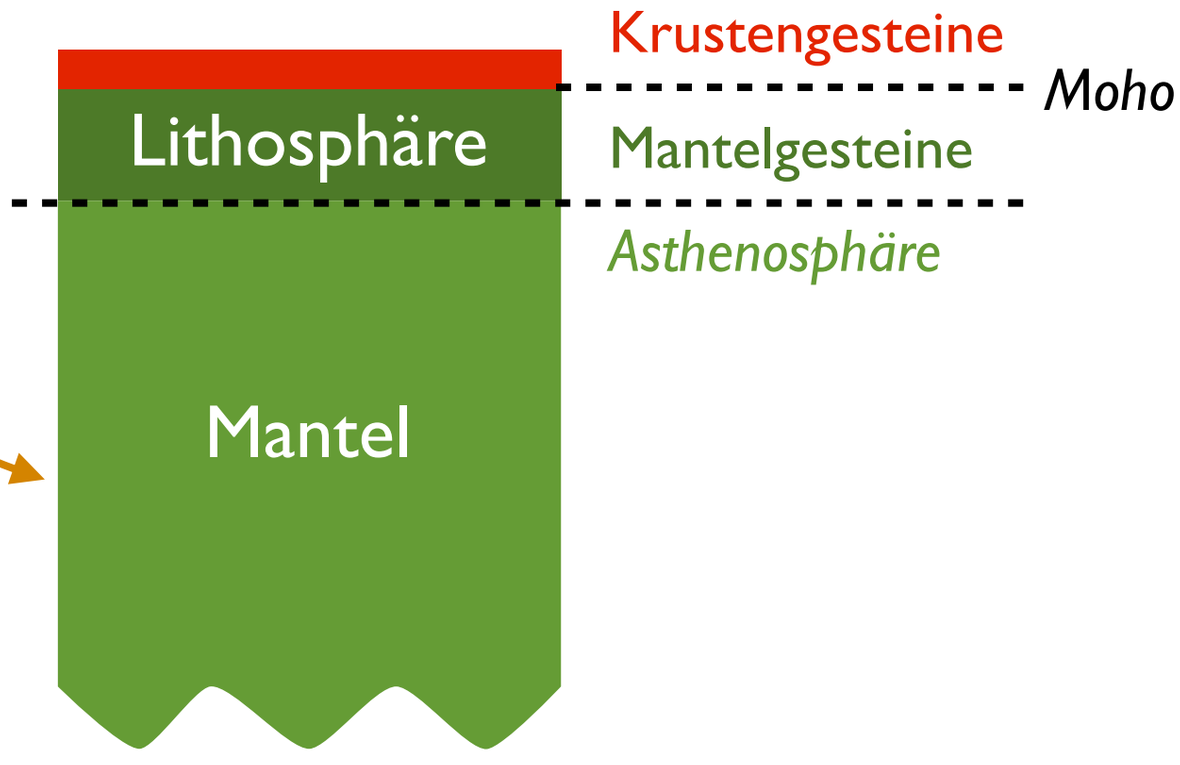
Prof. Dr. Renée Heilbronner

"Die Lithosphäre: Creme Brûlée oder Jelly Sandwich ?"

was ist "die Lithosphäre"



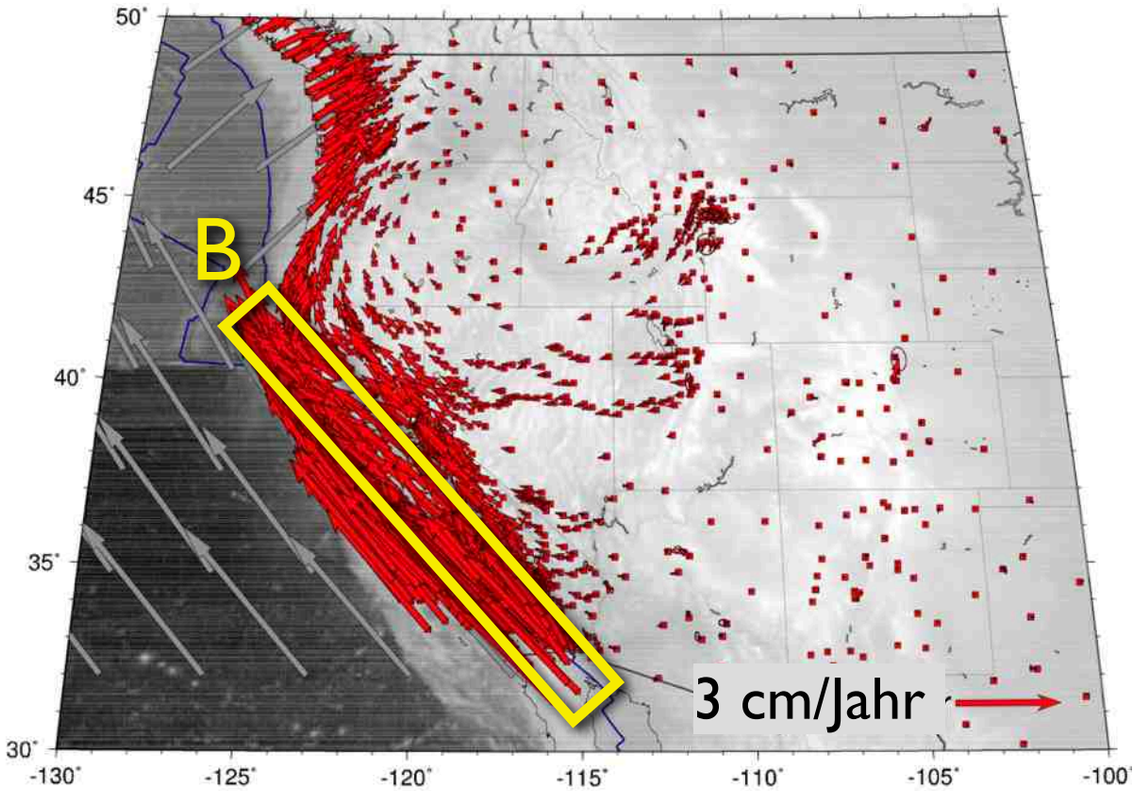




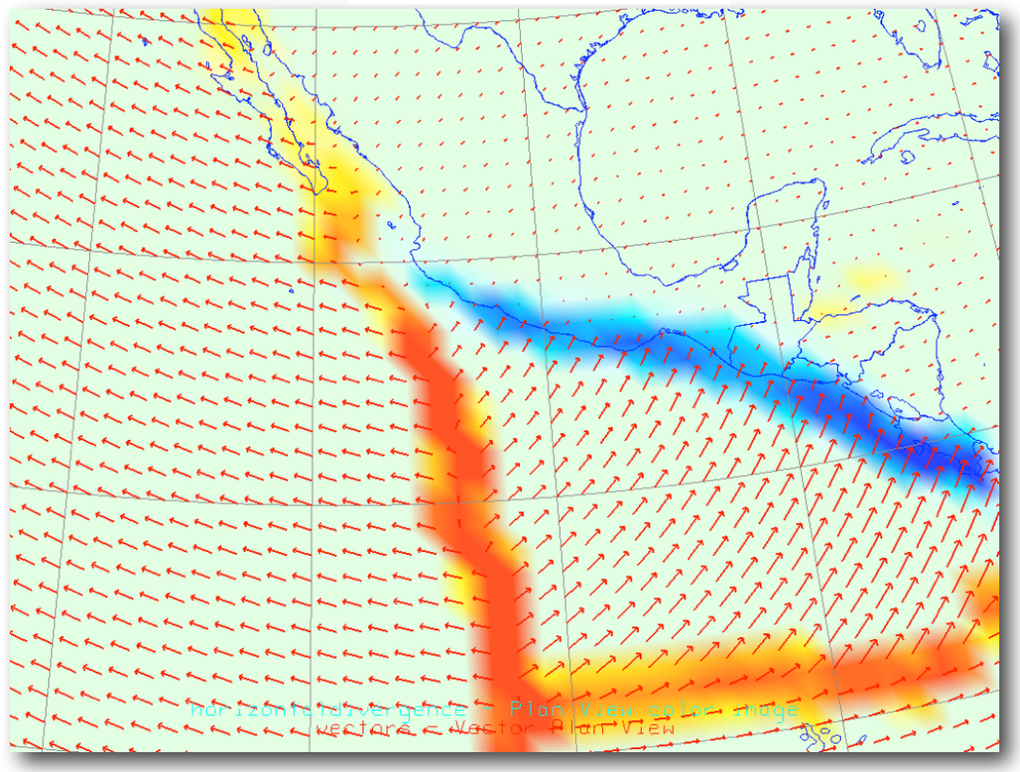
das sind die tektonischen Platten...

... die sich über die Erde bewegen...

GPS Geschwindigkeiten



Verformung



Kontraktion

Extension

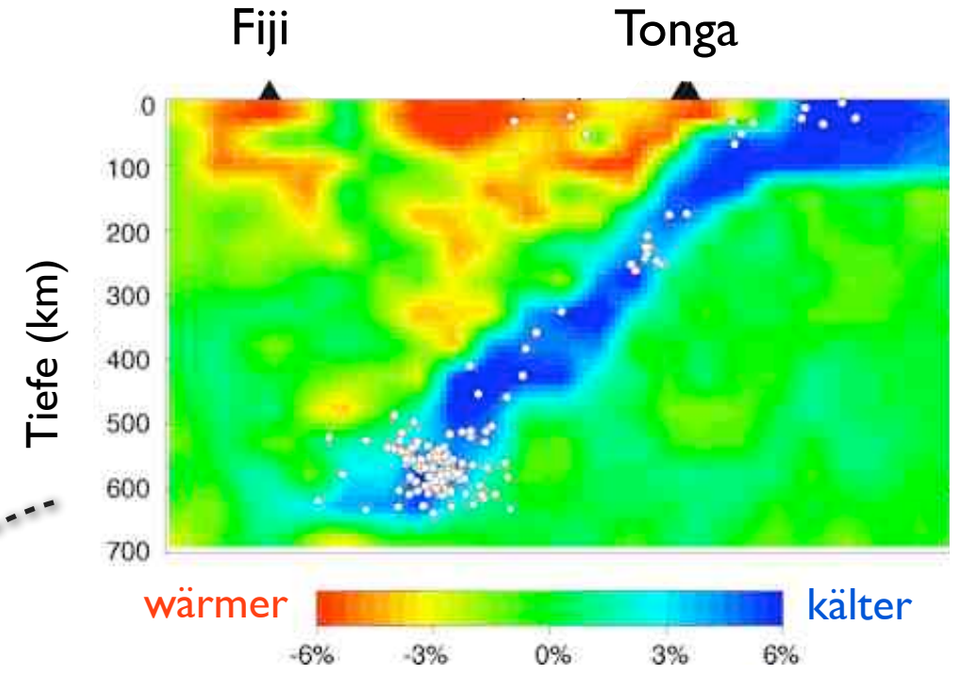
typische Plattengeschwindigkeit $\dot{d} = 3$ cm / Jahr $= 10^{-9}$ ms^{-1}

auf 100 km Breite verteilt: $\dot{d} / B = 10^{-9}$ ms^{-1} / 10^{5} m

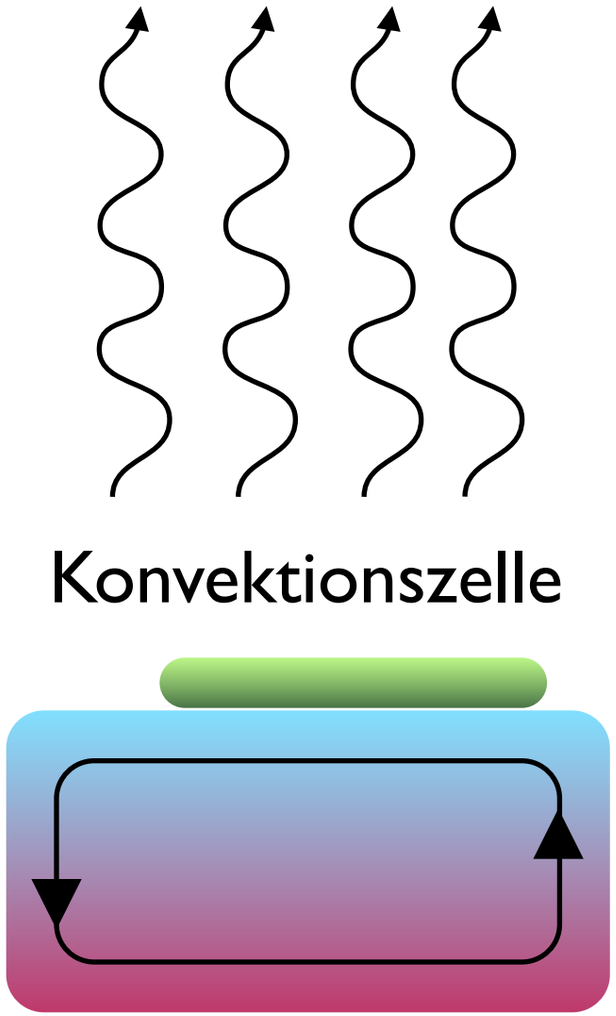
geologische Verformungsrate: $\dot{\varepsilon} = 10^{-14}$ s^{-1}

... und (an den Plattengrenzen) Verformung bewirken

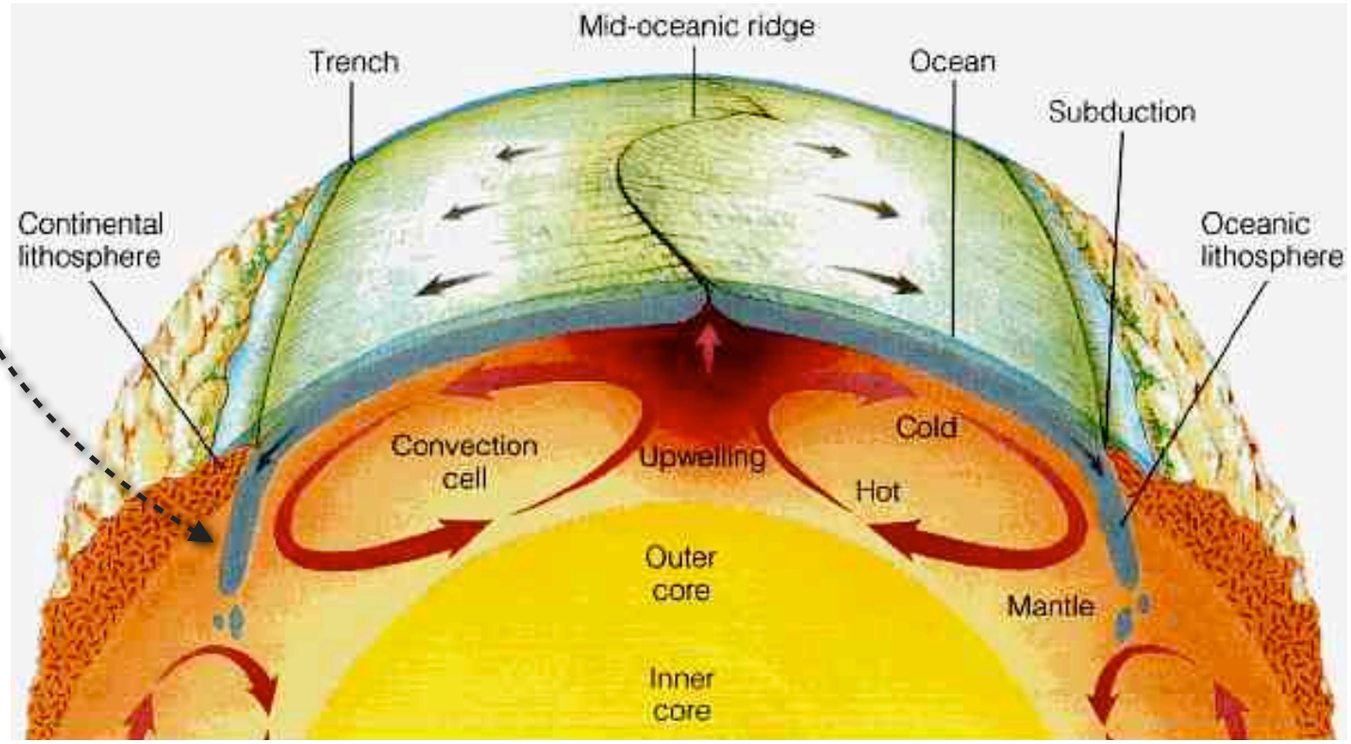
warum bewegen sie sich ?



seismische Tomografie

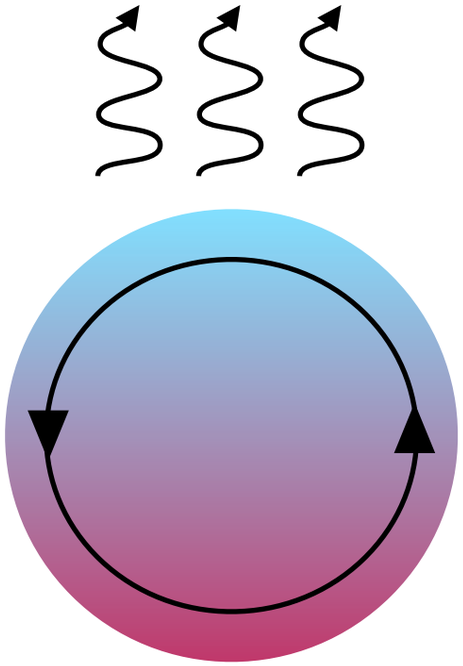


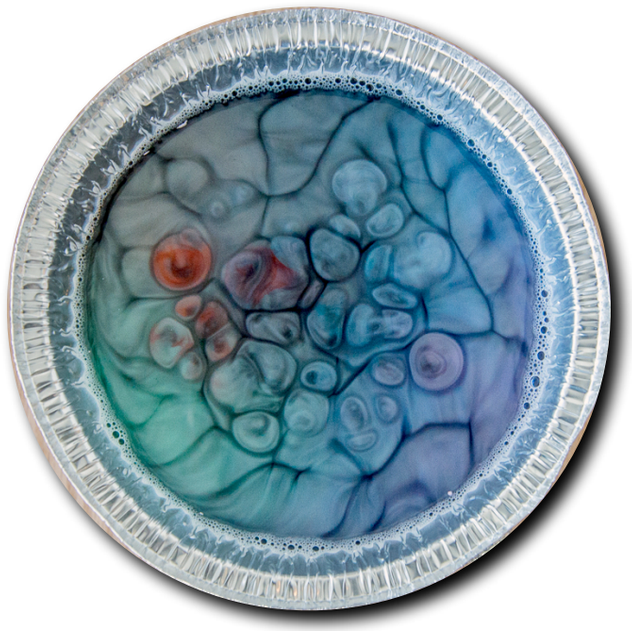
Konvektionszelle

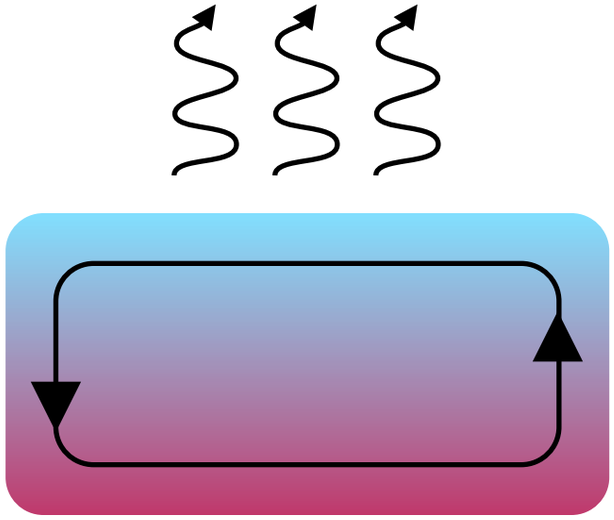


... weil der Mantel konvektiert

... Konvektion kennen wir !



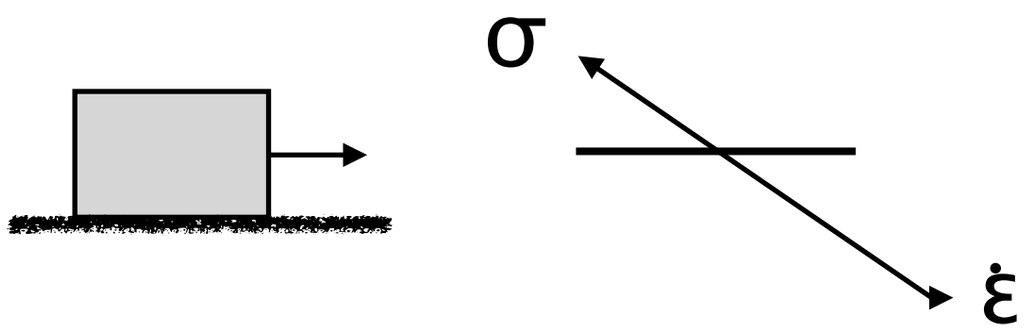




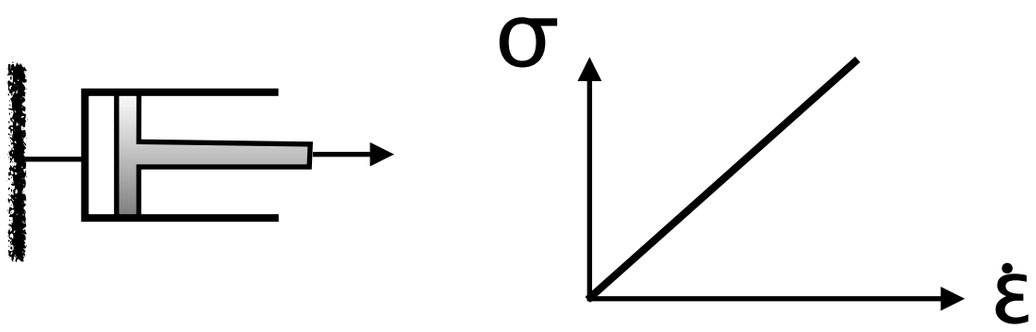
... und wissen: Café crème ≠ Hot chocolate ...

alles eine Frage der Rheologie ...

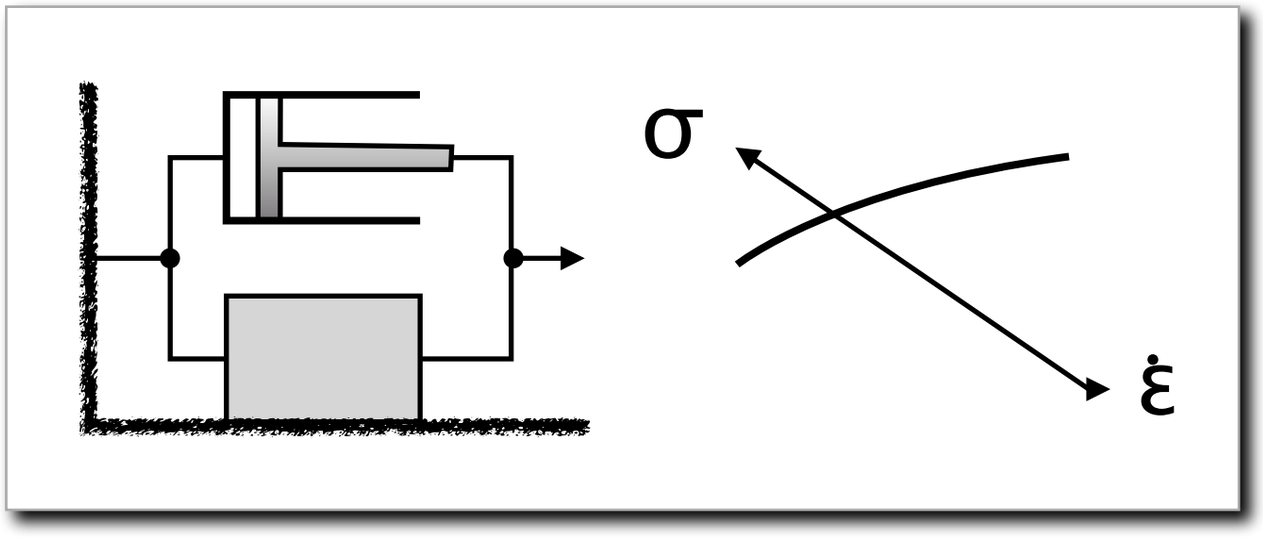
St Venant Körper - ideal plastisch



Newton Körper - ideal viskös

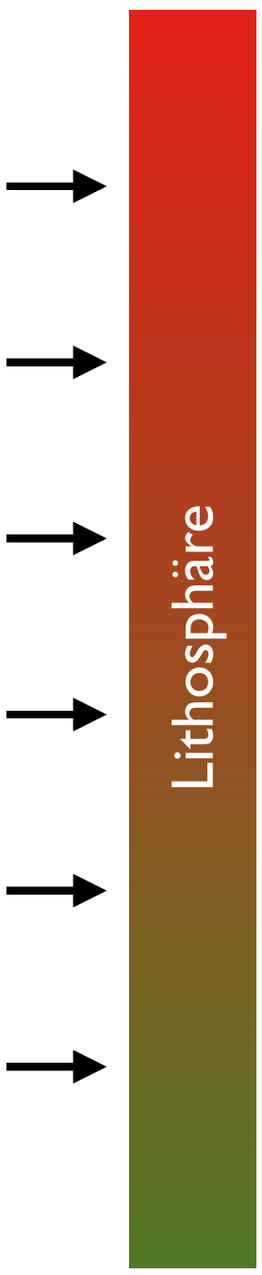


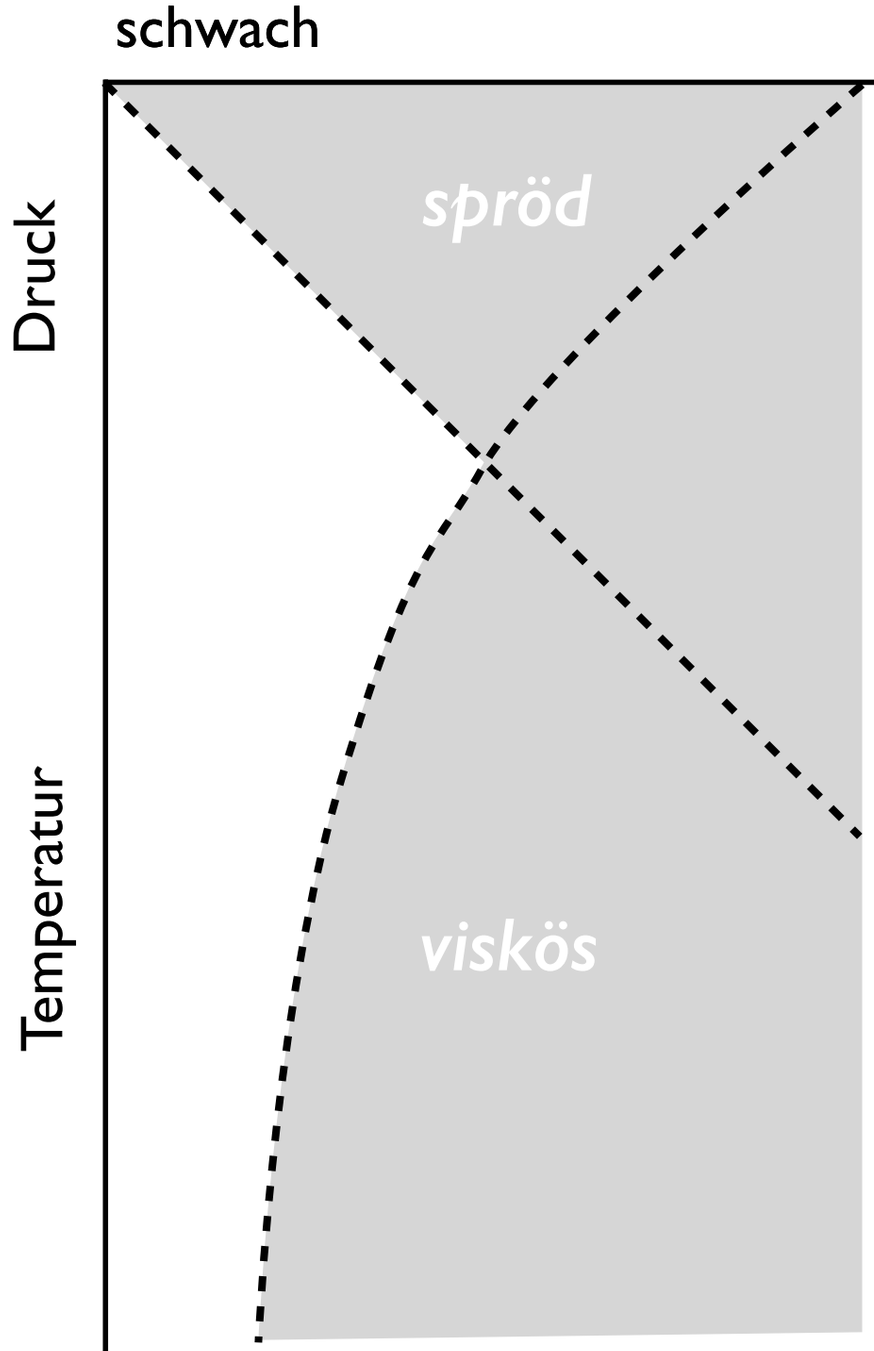
Bingham Körper - real existierend

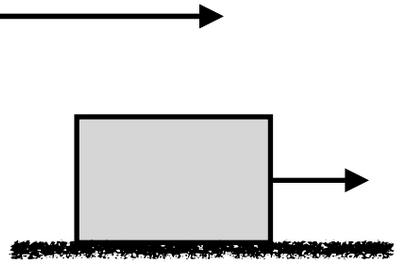


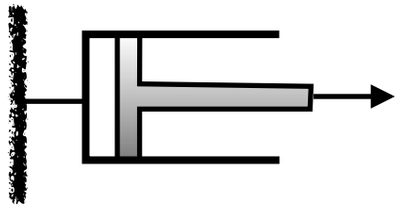
... von Spannung und Verformungsrate

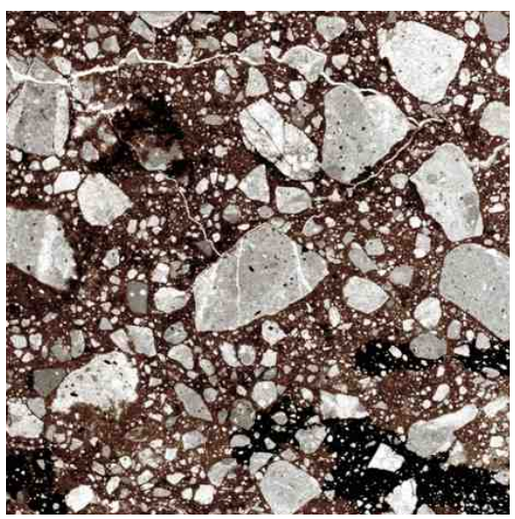
... die Lithosphäre als Bingham-Körper





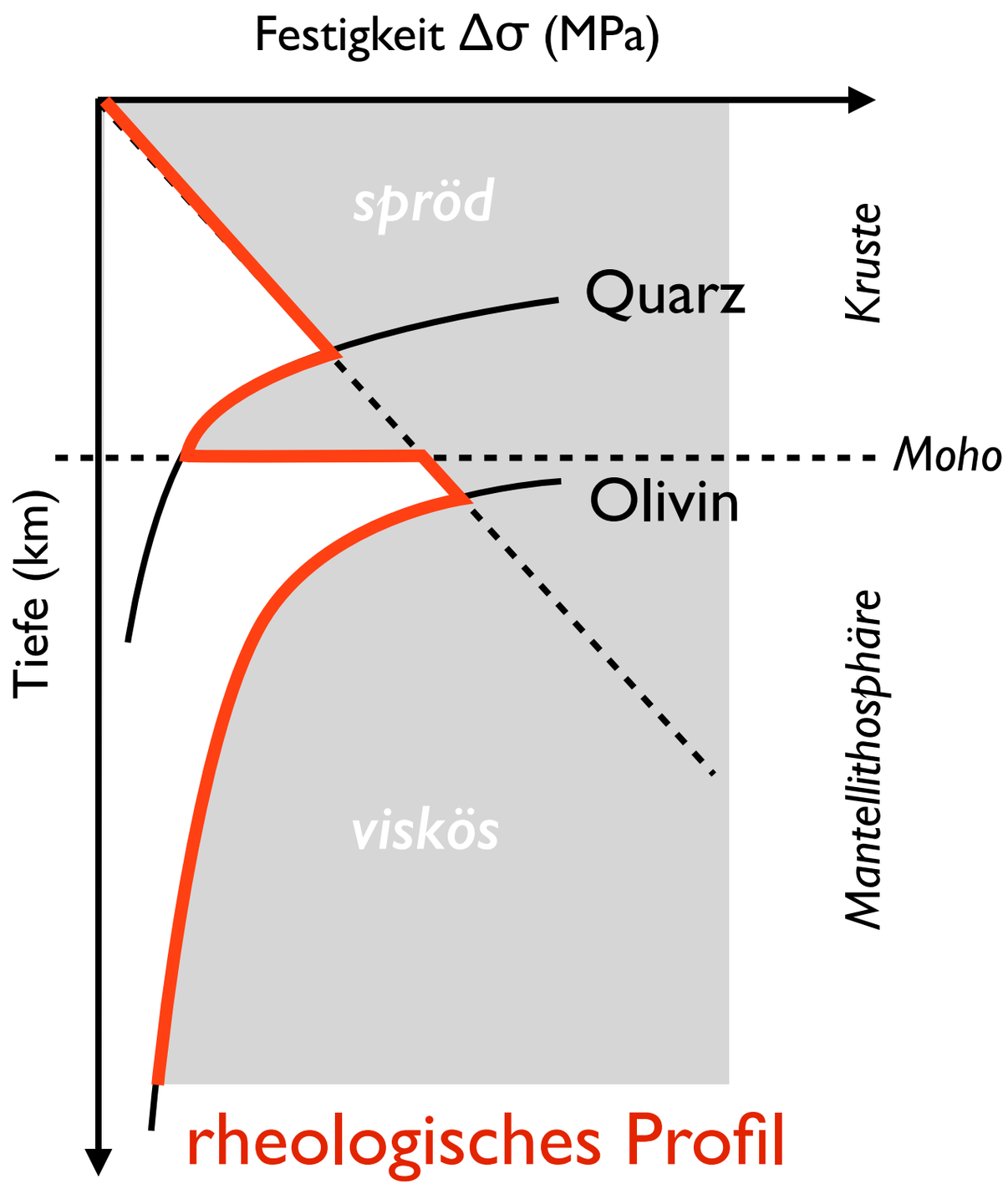






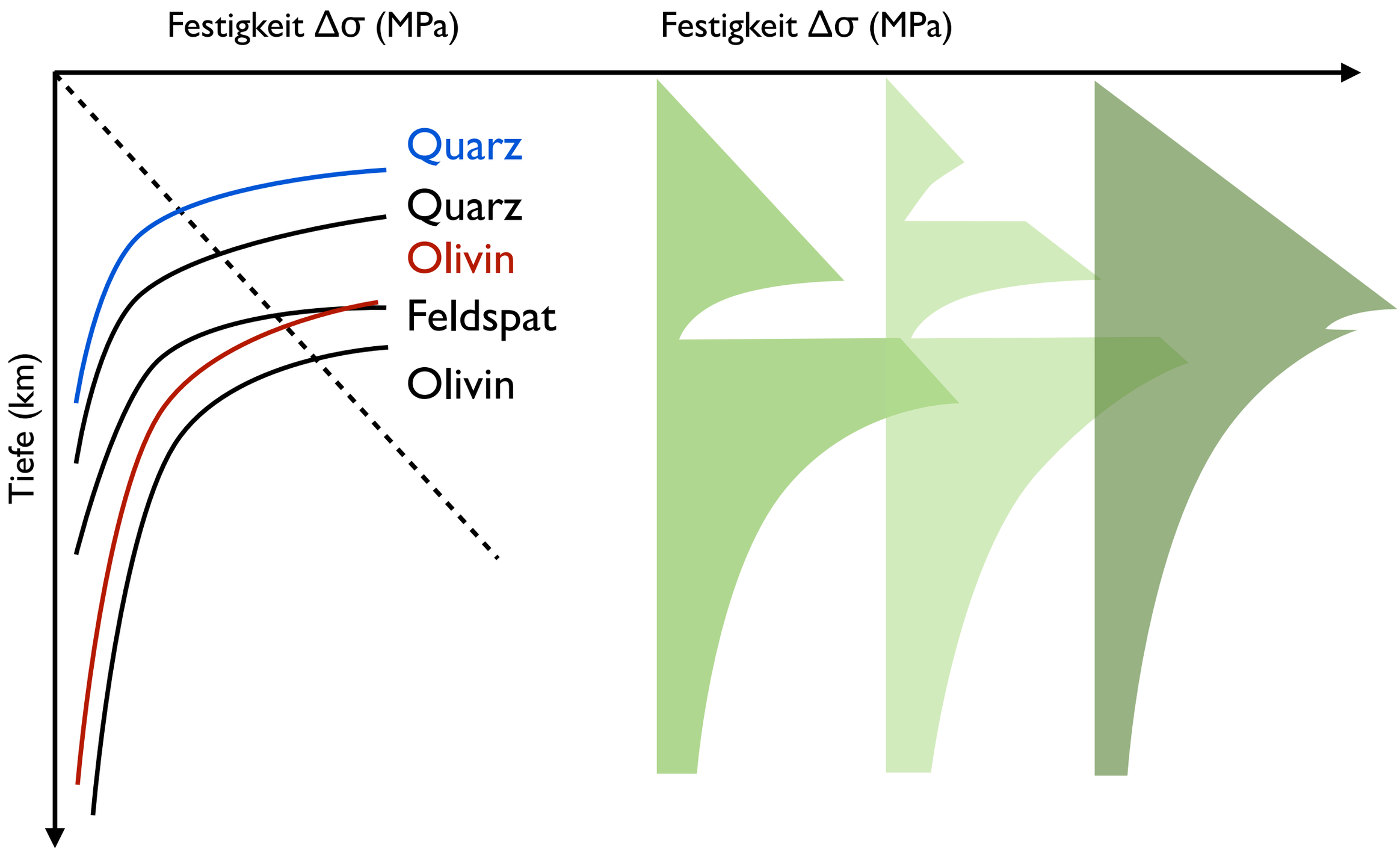
... oben stark und stärker - unten schwach und schwächer

vereinfachte Annahme:



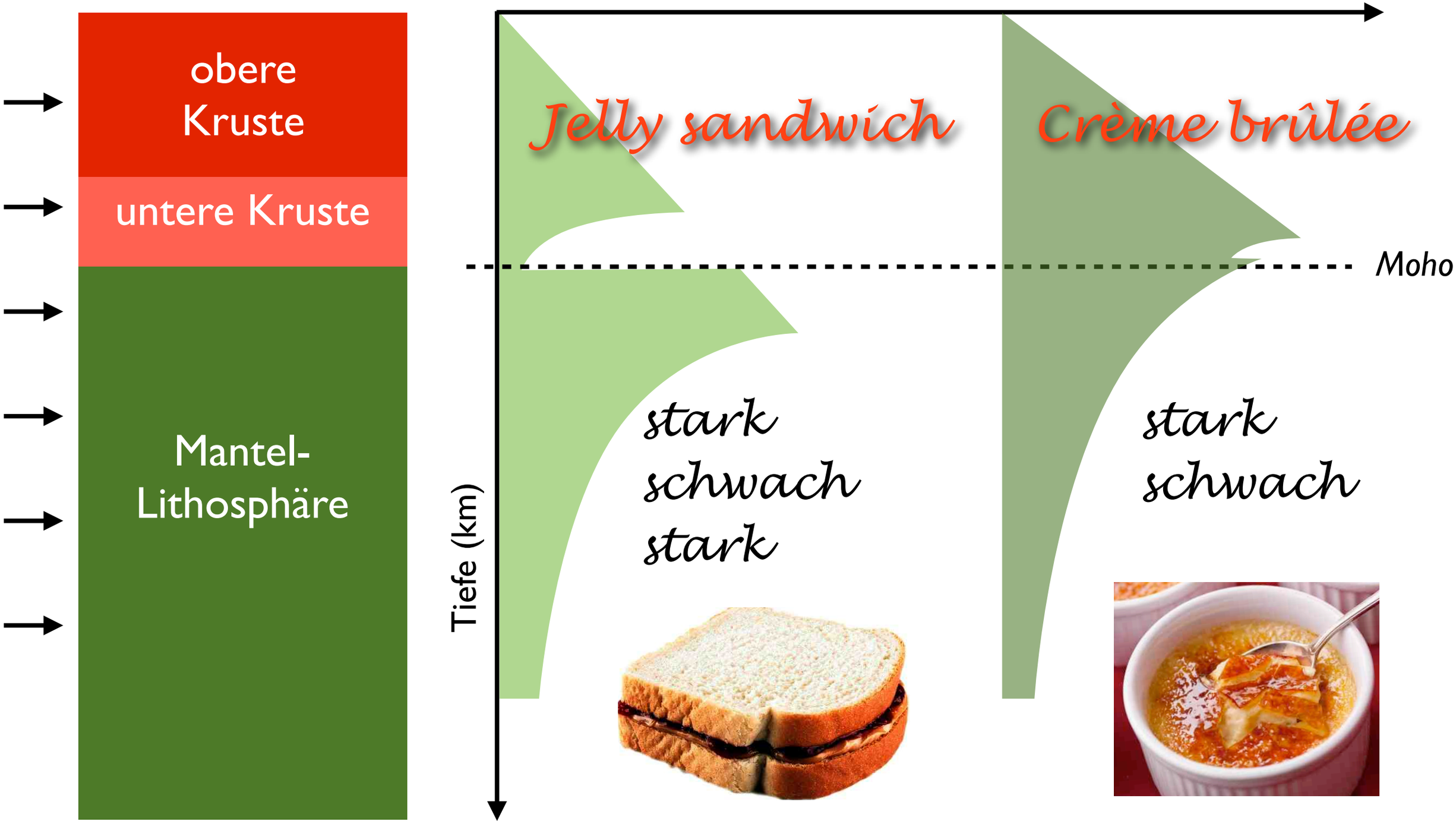
Kruste besteht aus Quarz - Mantellithosphäre aus Olivin

... aber die Lithosphäre ist vielschichtig ...



... rheologischen Profile werden zu Christmas trees ...

Menu für den oberen Teil der Lithosphäre:



... insbesondere der obere Teil der Lithosphäre ?

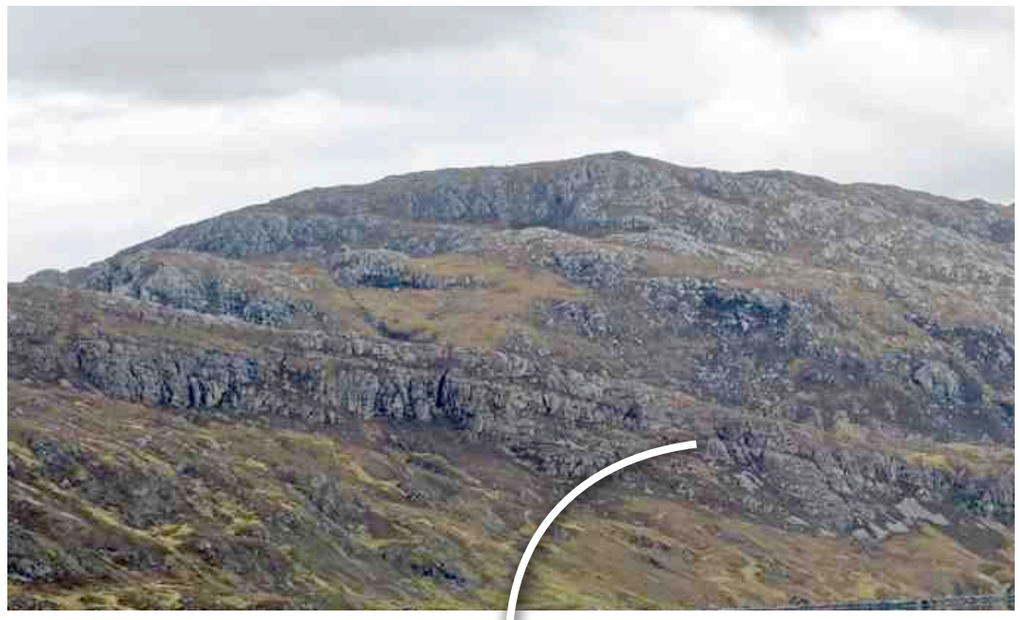
wie schwach ist "schwach" ?

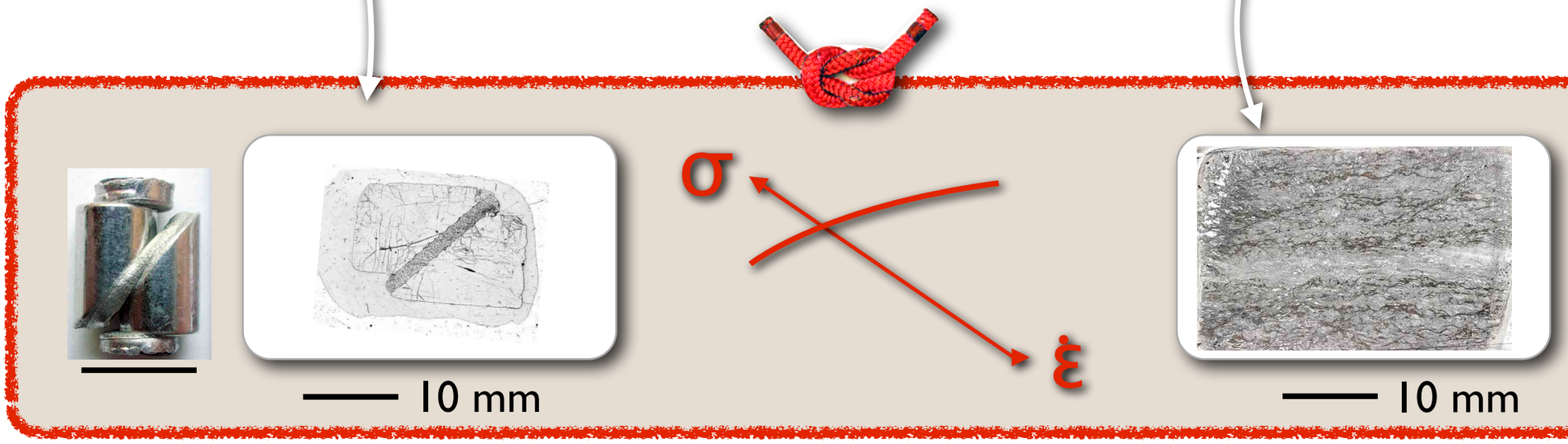
$\dot{\varepsilon} = 10^{-6}\,s^{-1}$ T = 900°C

t = 1 Woche ——— *1 : 100'000'000* ———→

$\dot{\varepsilon} = 10^{-14}\,s^{-1}$ T = 300°C

t = 2 Mio Jahre

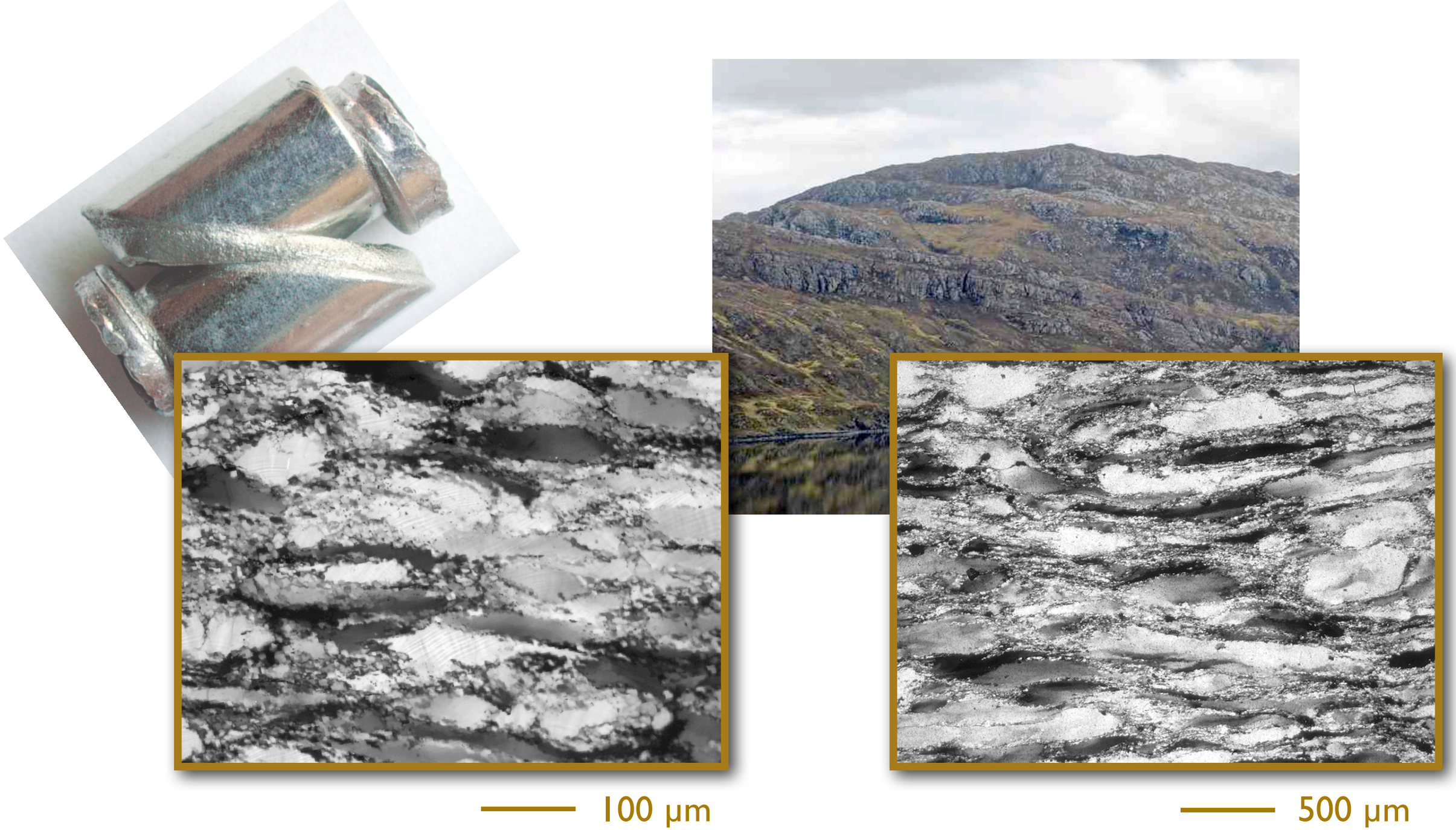




... wir machen Deformations - Experimente

und vergleichen ...

kristallines Fliessen im Labor und in der Natur:

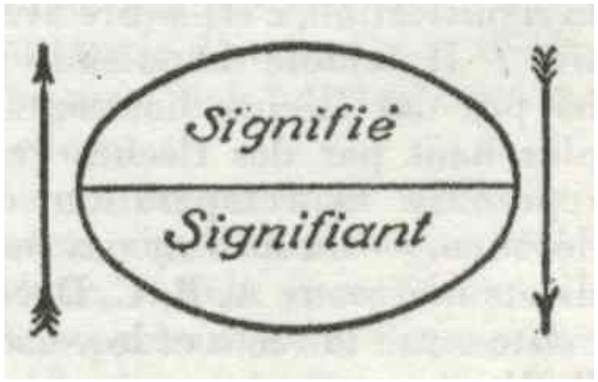


gleich oder nicht gleich ? das ist die Frage ...

auftritt die "geborene Geologin"

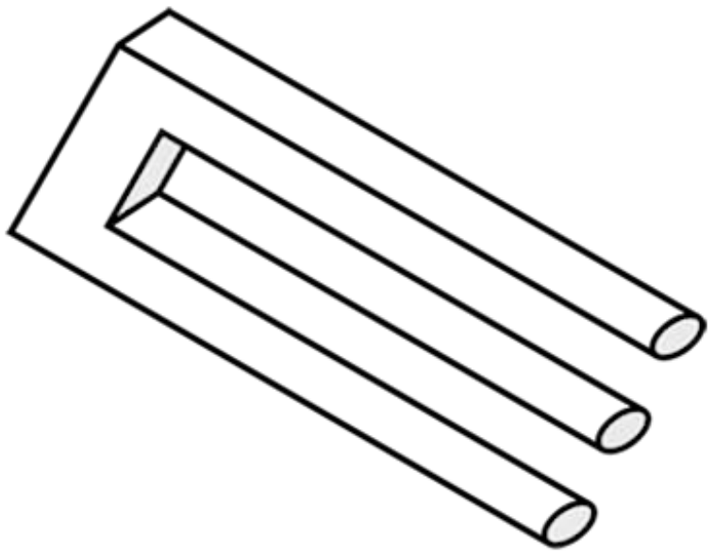
eine kleine Bilder - Geschichte

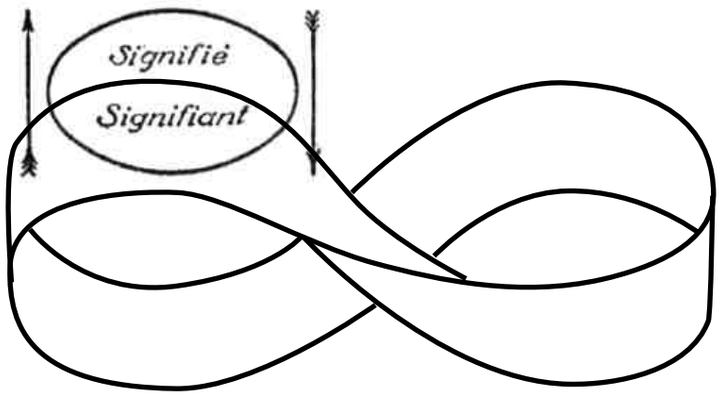
Bilder ...

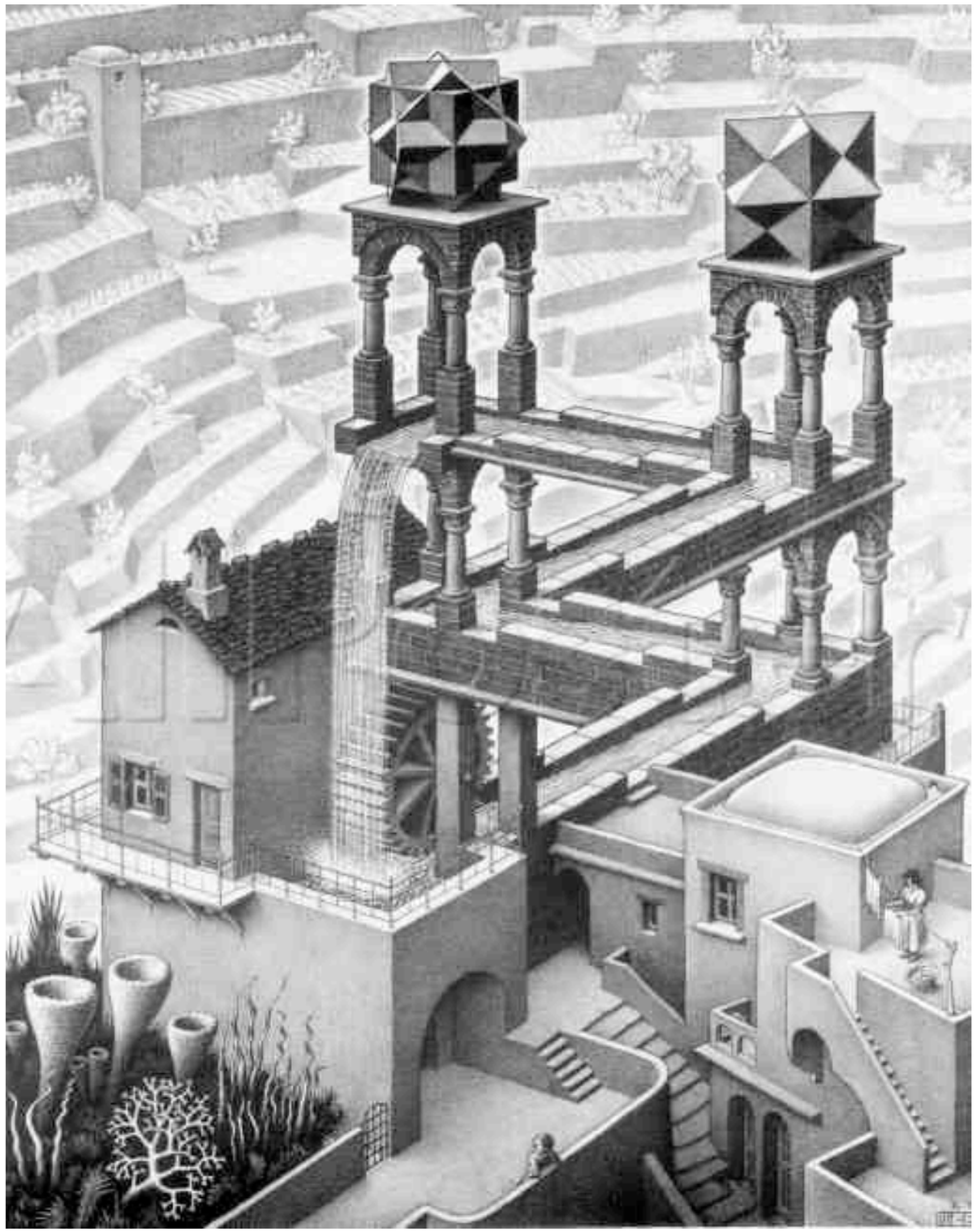


... und was sie bedeuten

Bilder ...

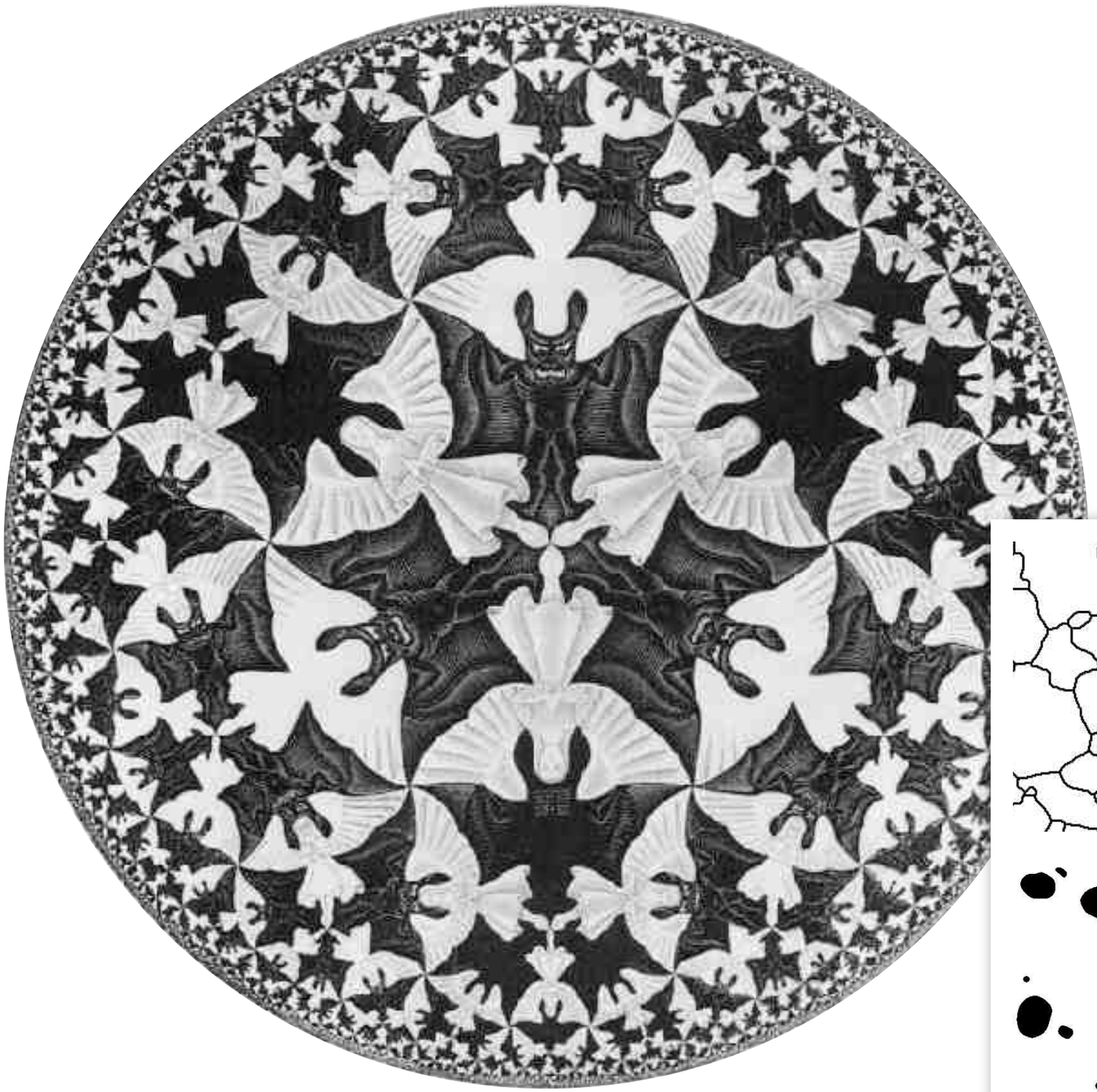


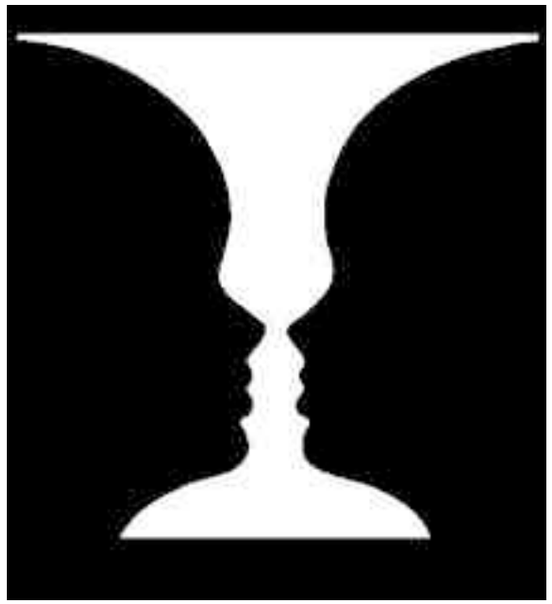


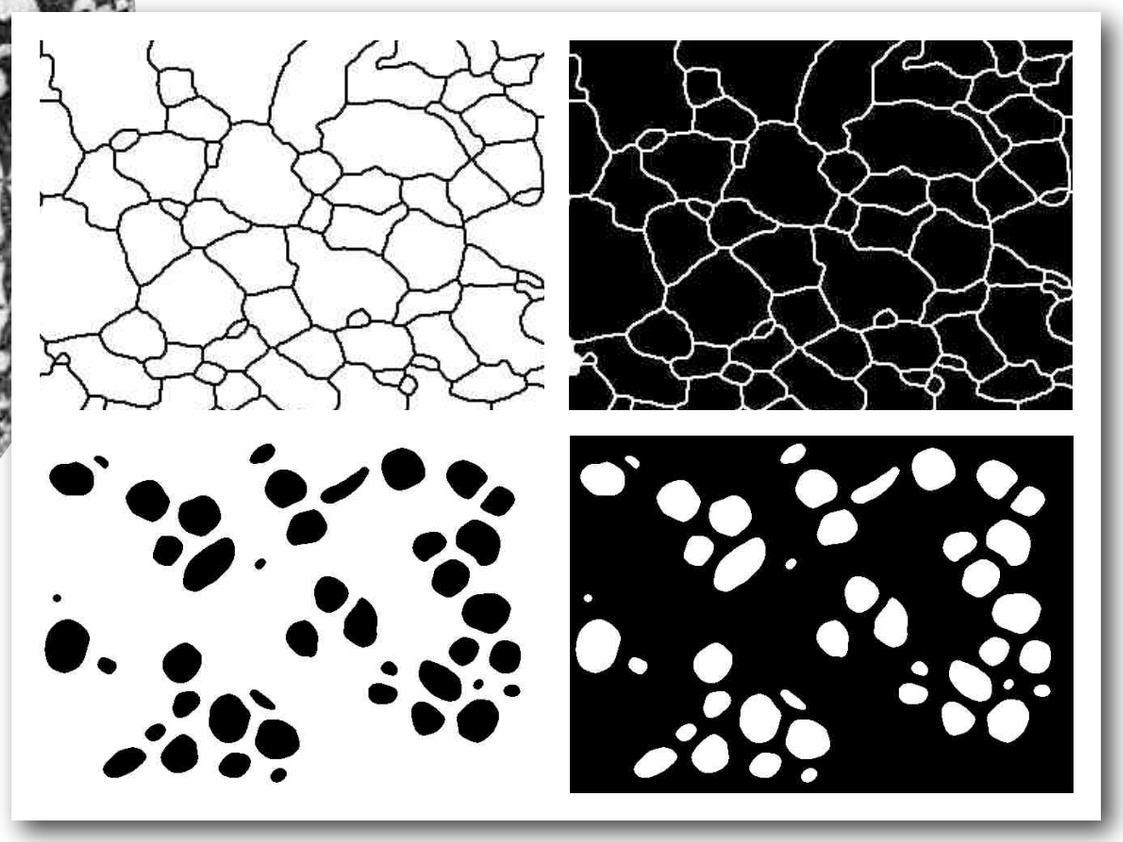


... und was sie darstellen ... oder auch nicht

plus oder minus ? schwarz oder weiss ? ja oder nein ?

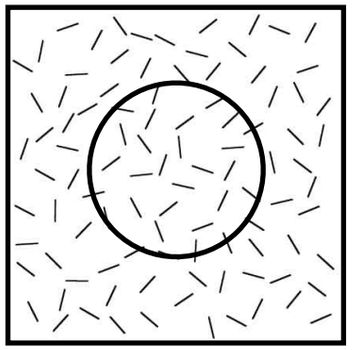


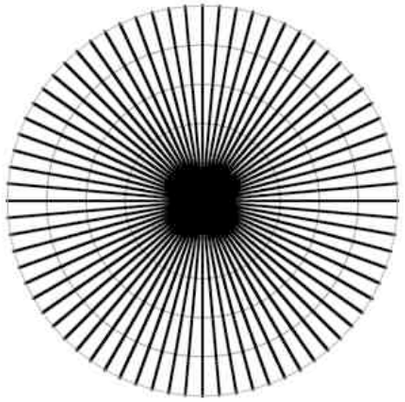


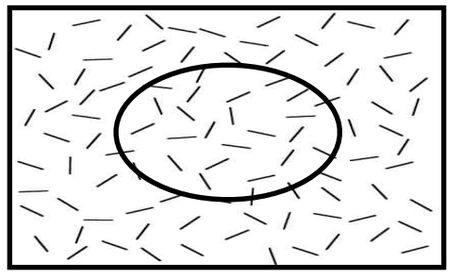


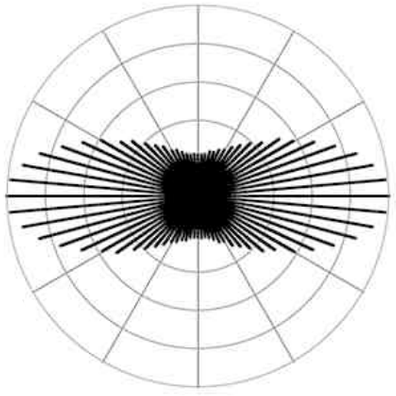
... Körner oder Korngrenzen ? Partikel oder Matrix ?

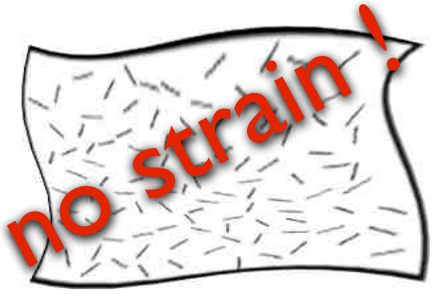
symmetrisch oder nicht ?

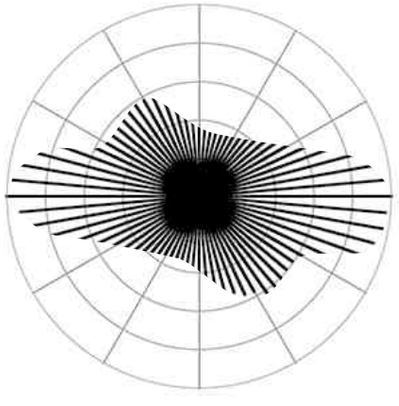


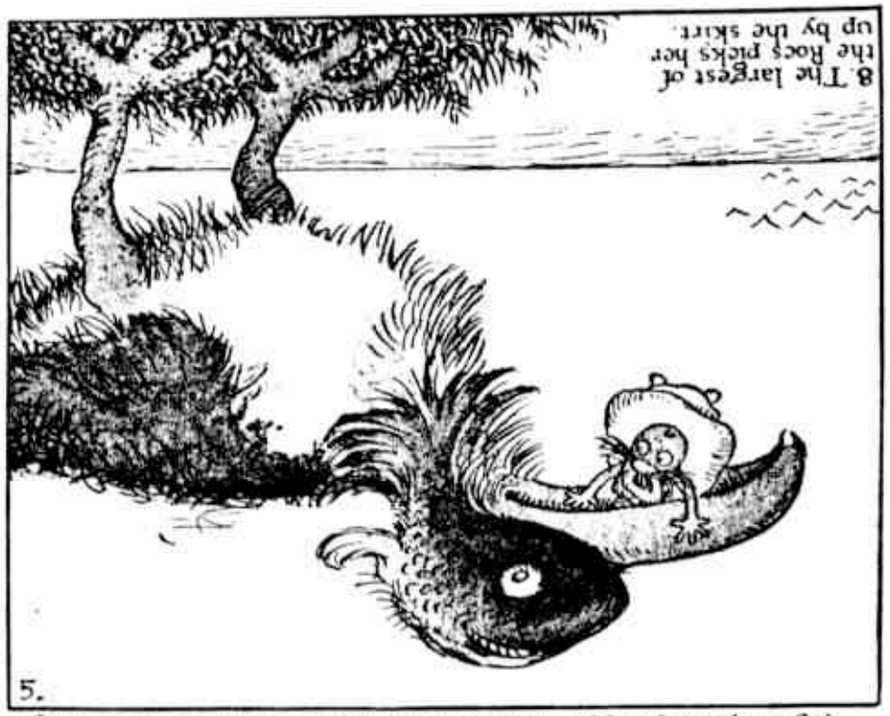


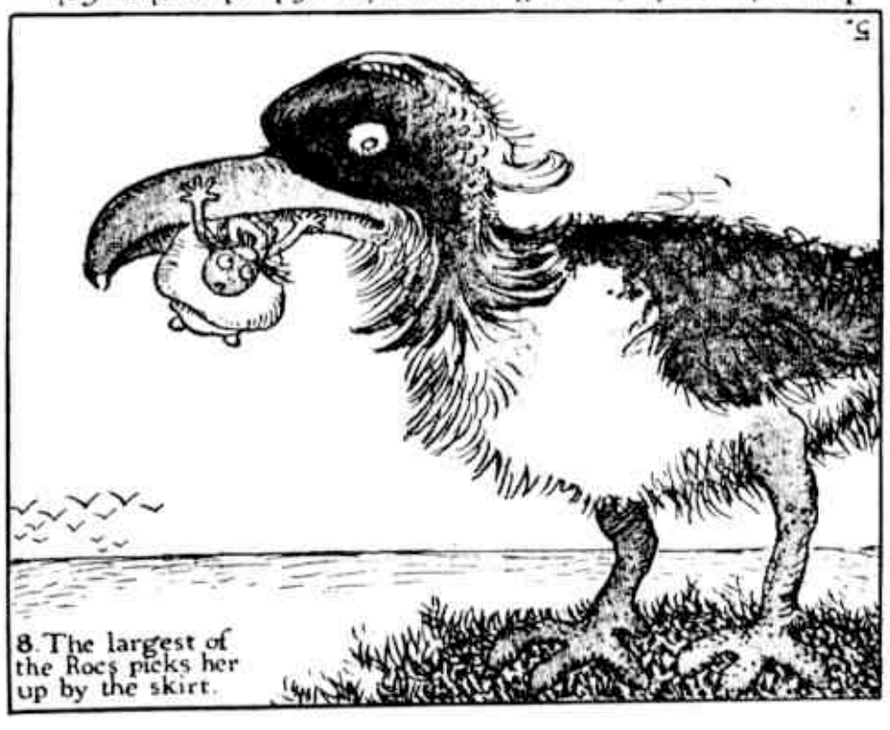






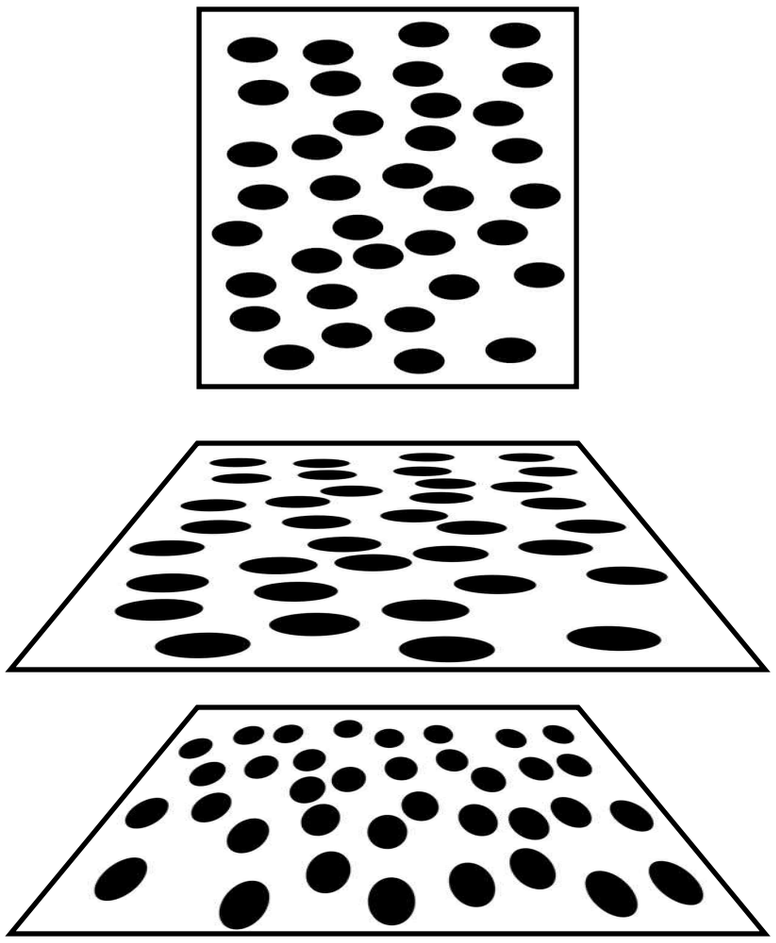






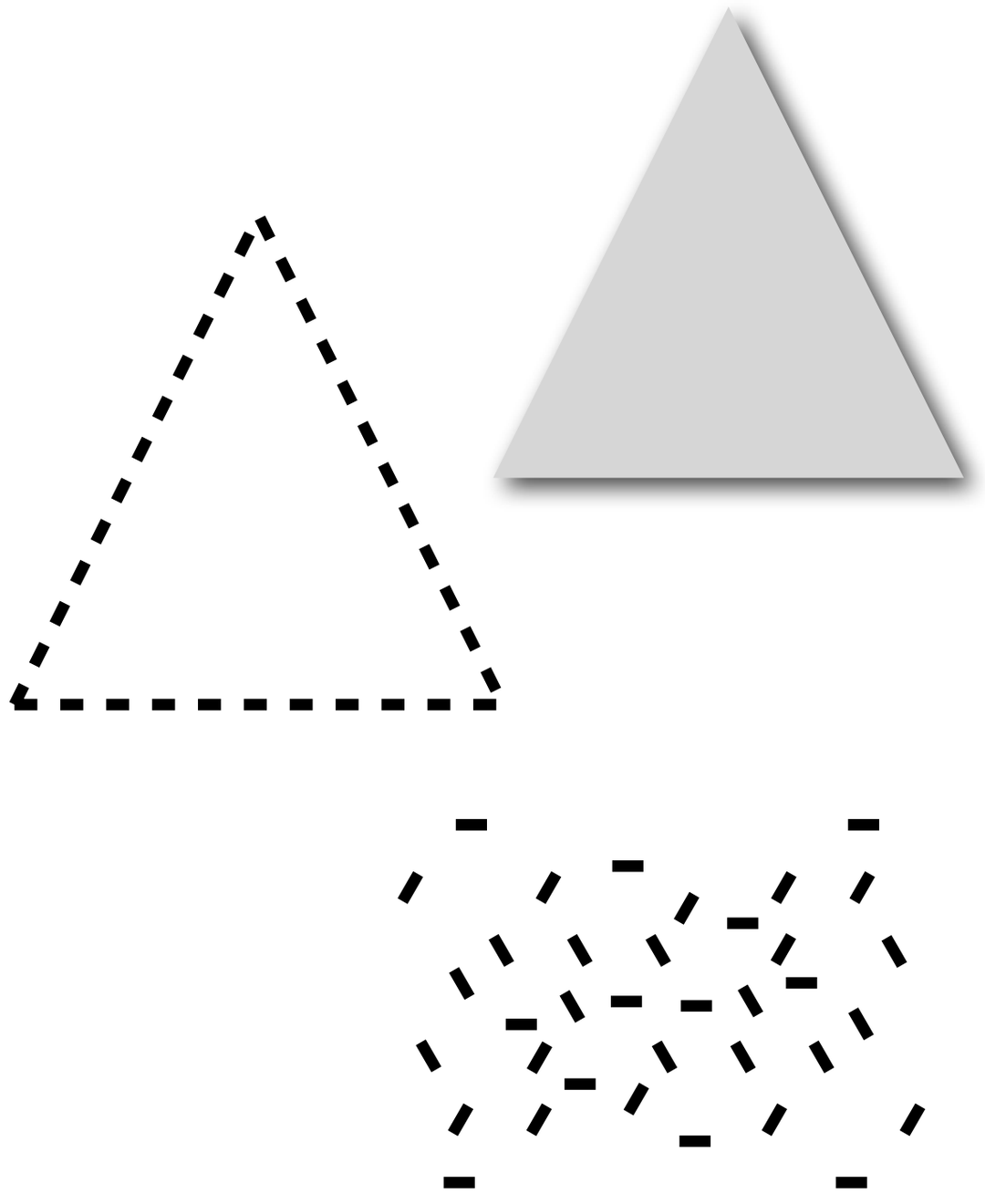
... strain - fact or fiction ?

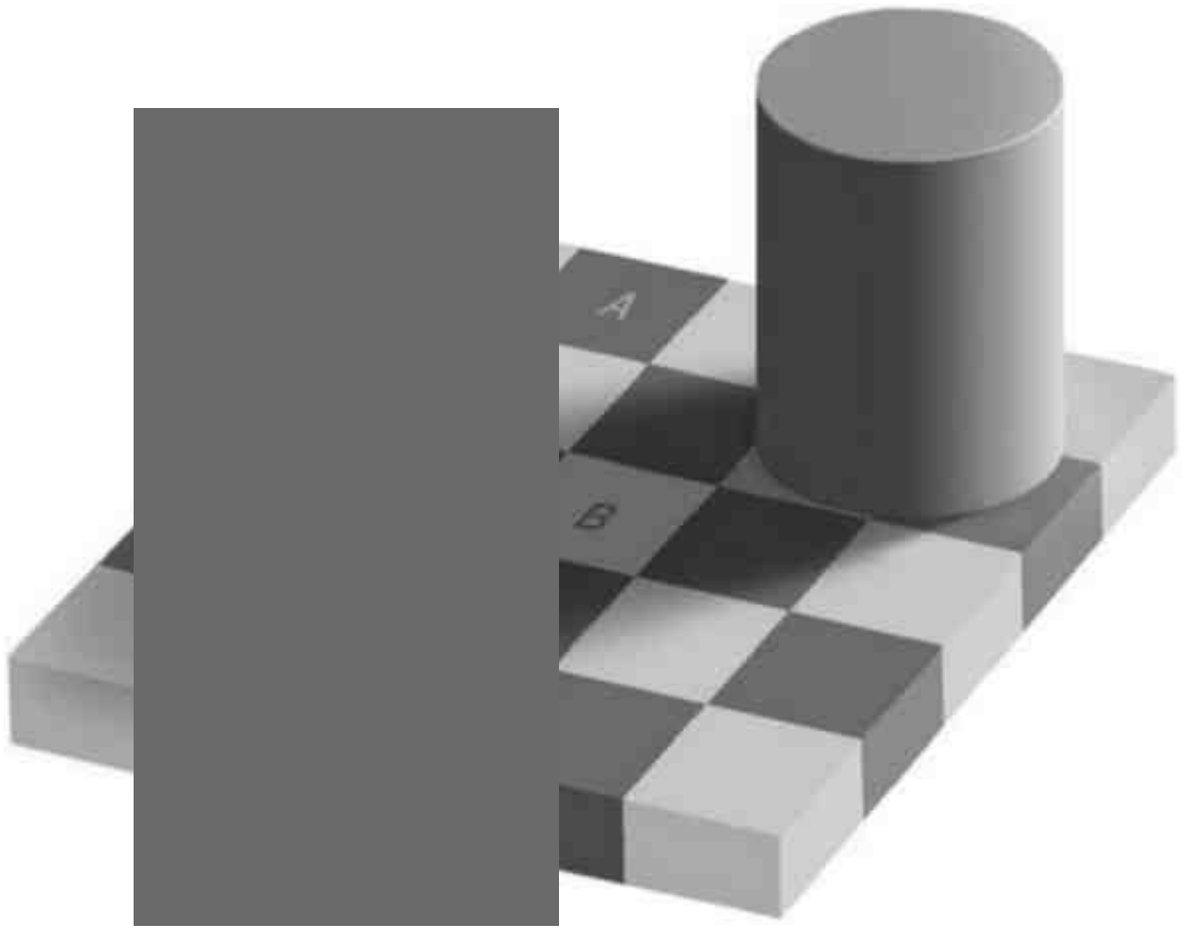
isotrop oder anisotrop ?



... und wenn ja - in welche Richtung ?

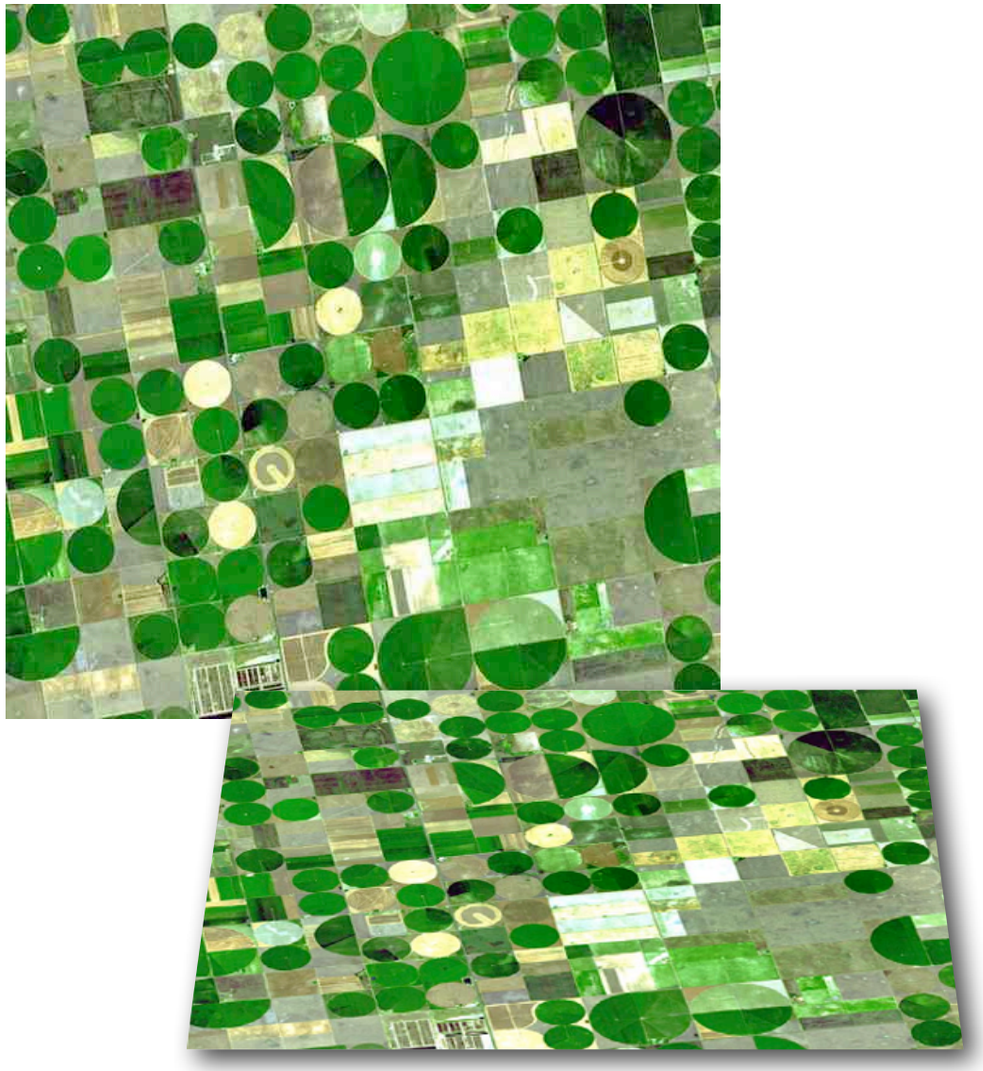
und dann noch das: computer vision

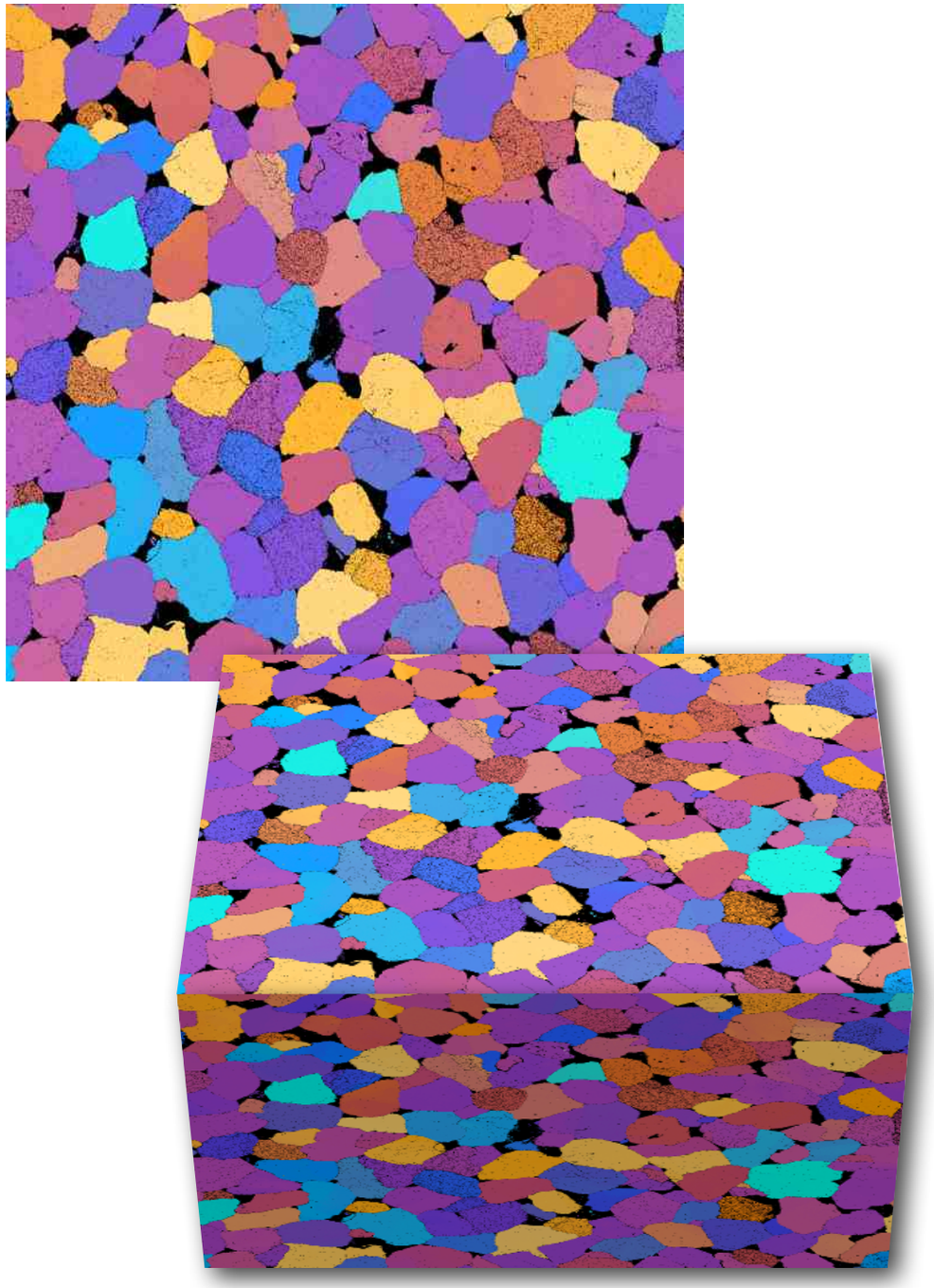




now you see it ... now you don't

Karte oder Schnittfläche ?

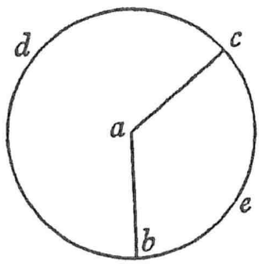


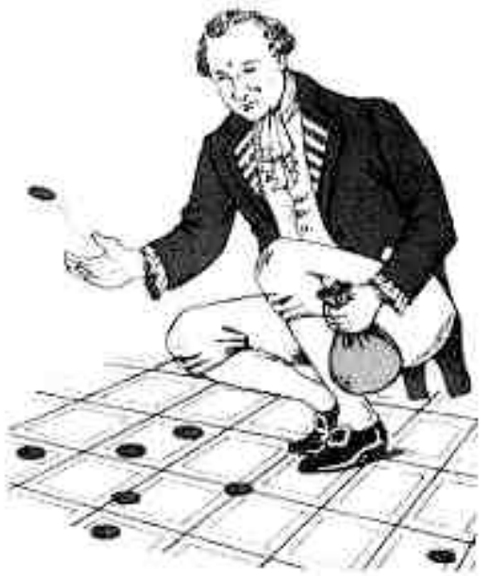


... Muster oder Stichprobe ?

Statistik...

I. Newton





Comte de Buffon

"Mémoire sur le jeu du franc-carreau"

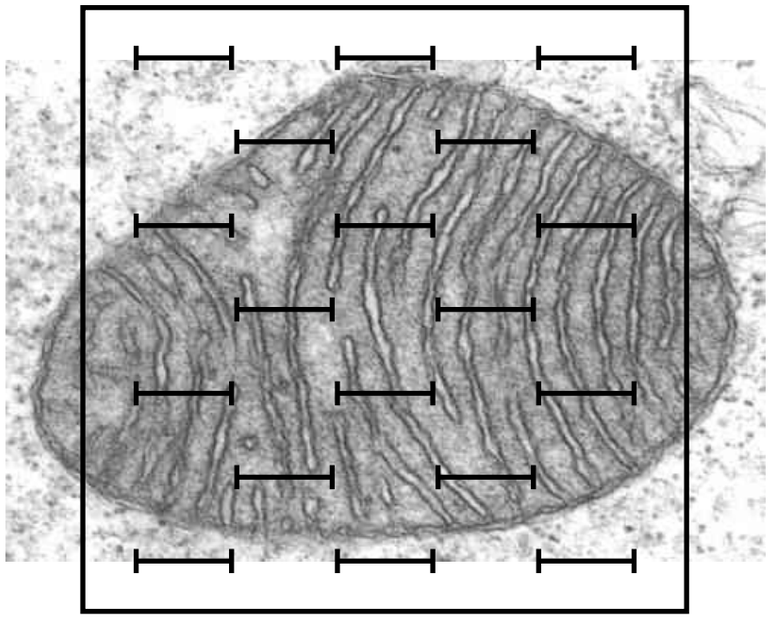
Blaise Pascal

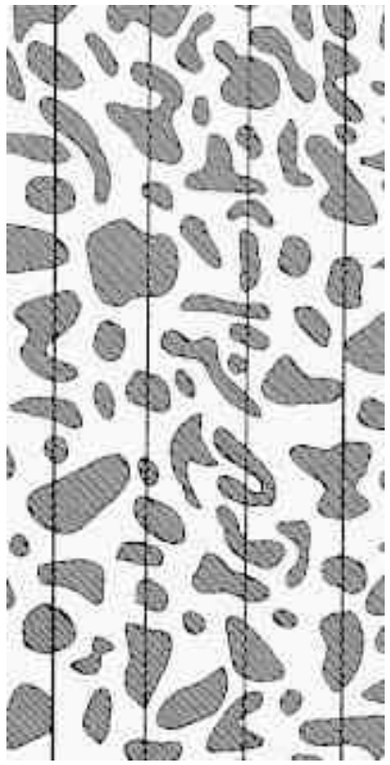
Laplace

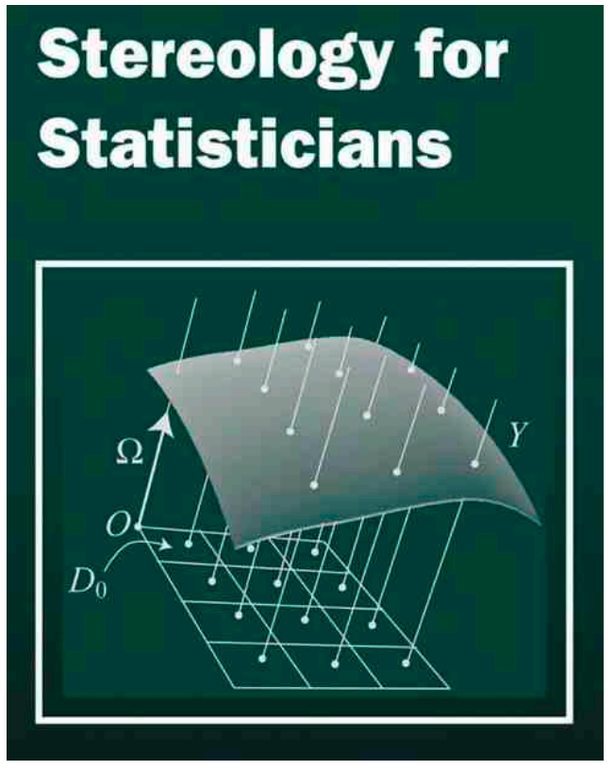
A.-L. Cauchy

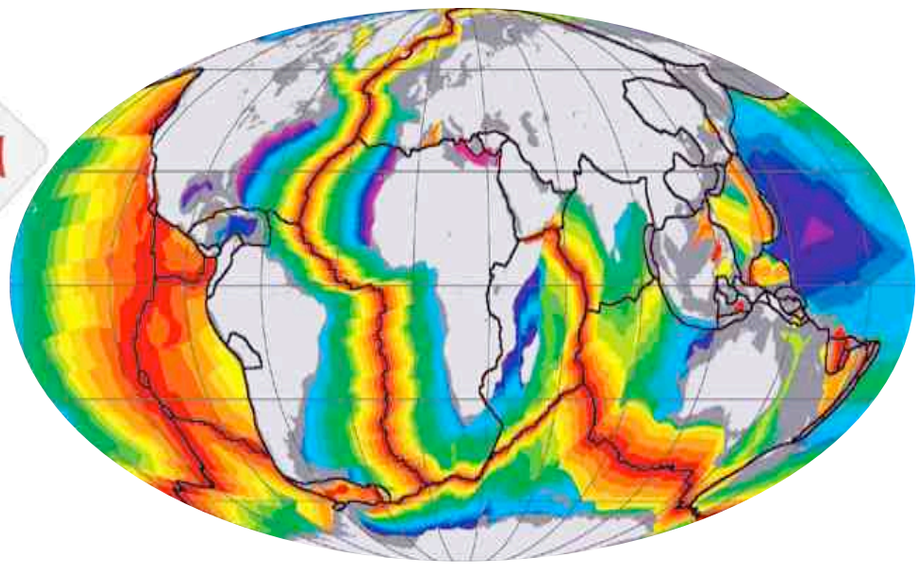
... beginnt mit Glück und Zufall

... über Photographie, Elektronenmikroskopie ...





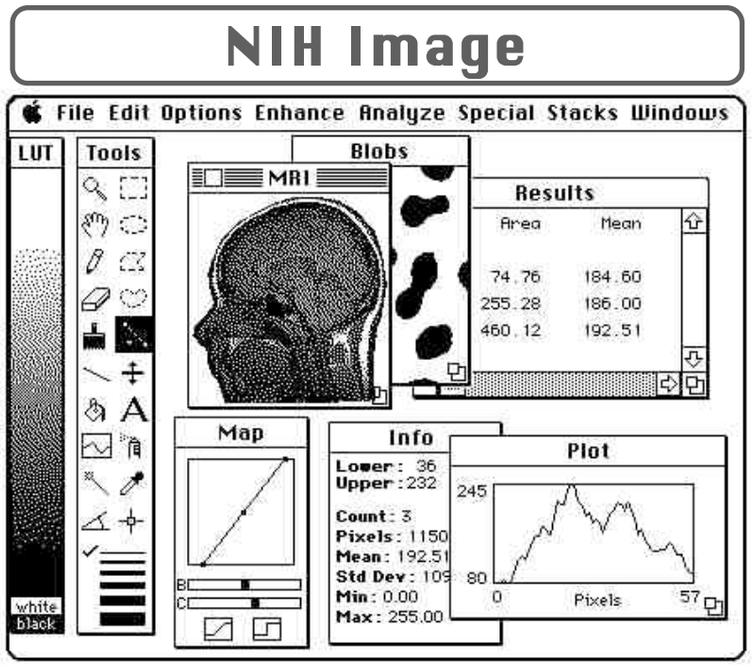




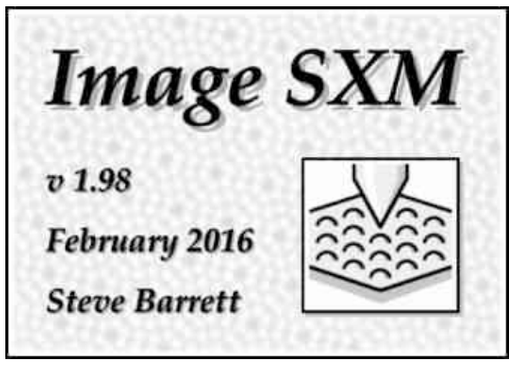
... zur Geologie, d.h. den "Naturwissenschaften"

von kilobyte zu Gigabyte

Wayne Rasband

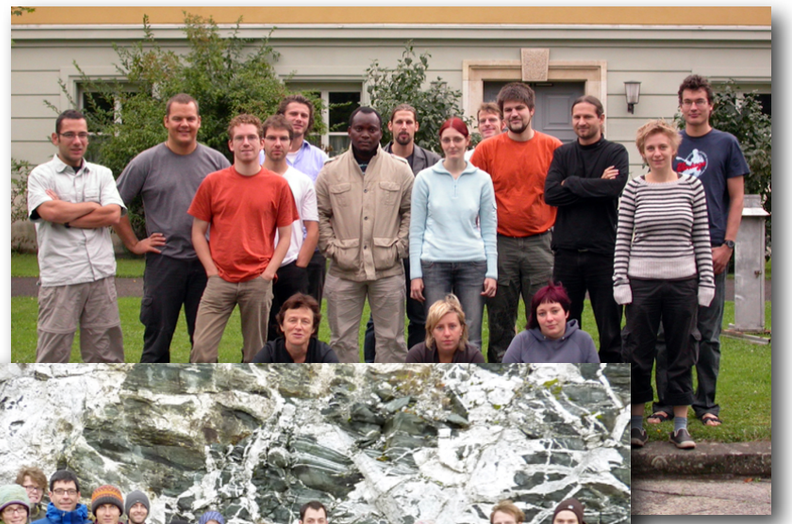


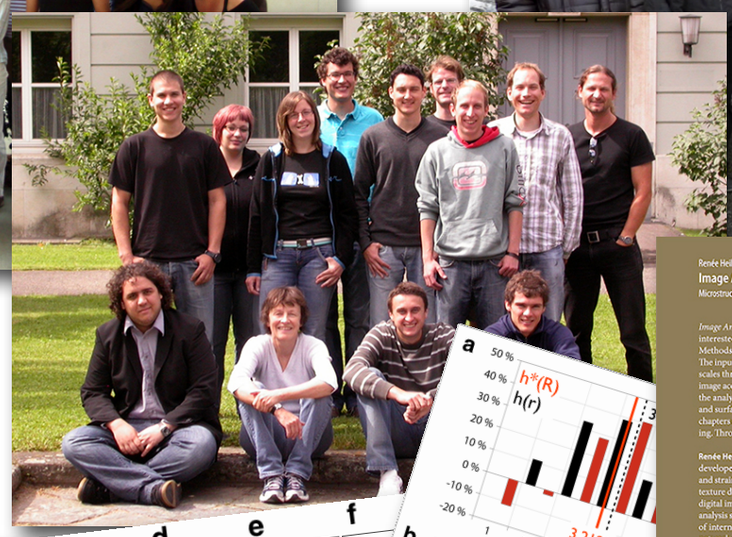
Steve Barrett

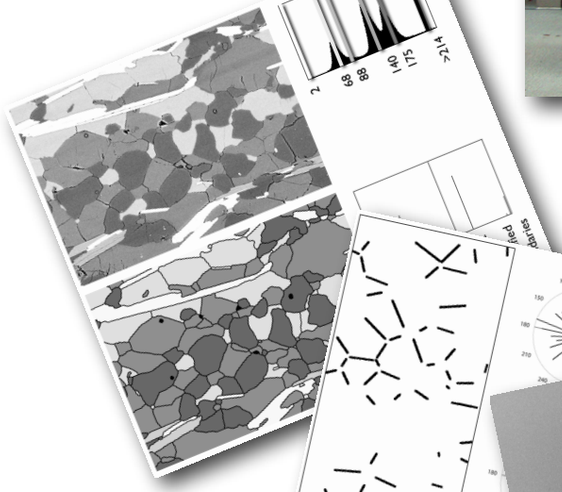


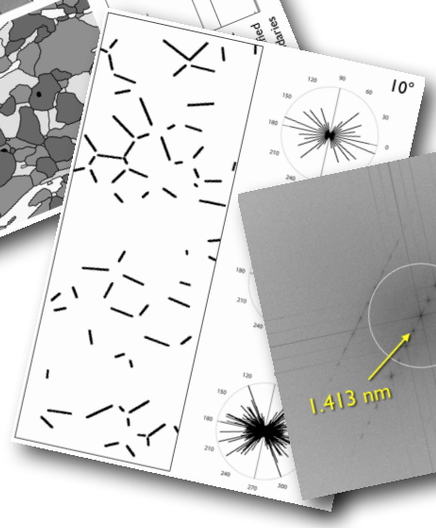
von Pascal zu Java ... zu Pascal

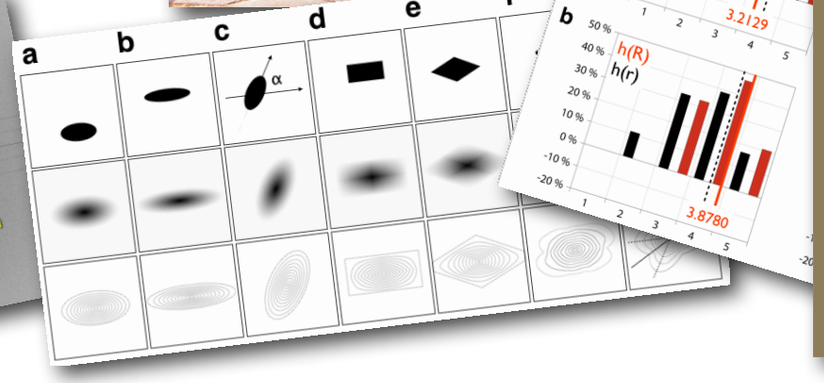
from workshops

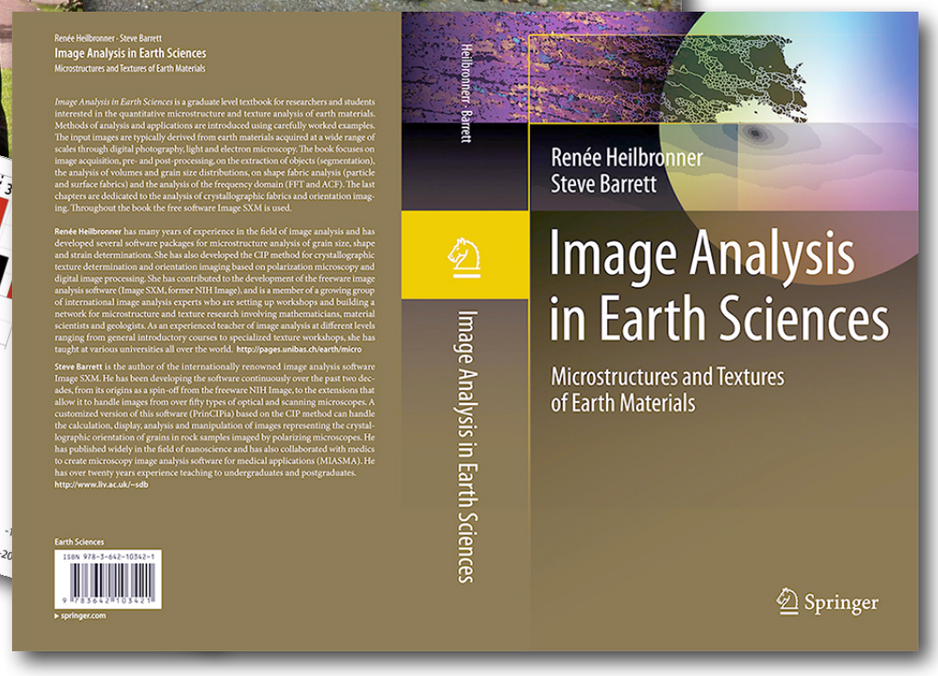






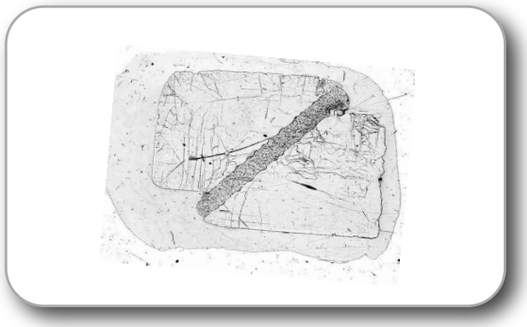


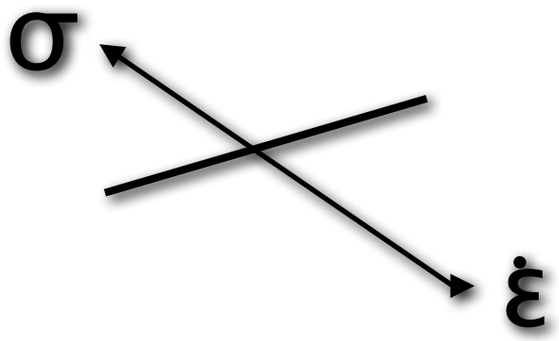




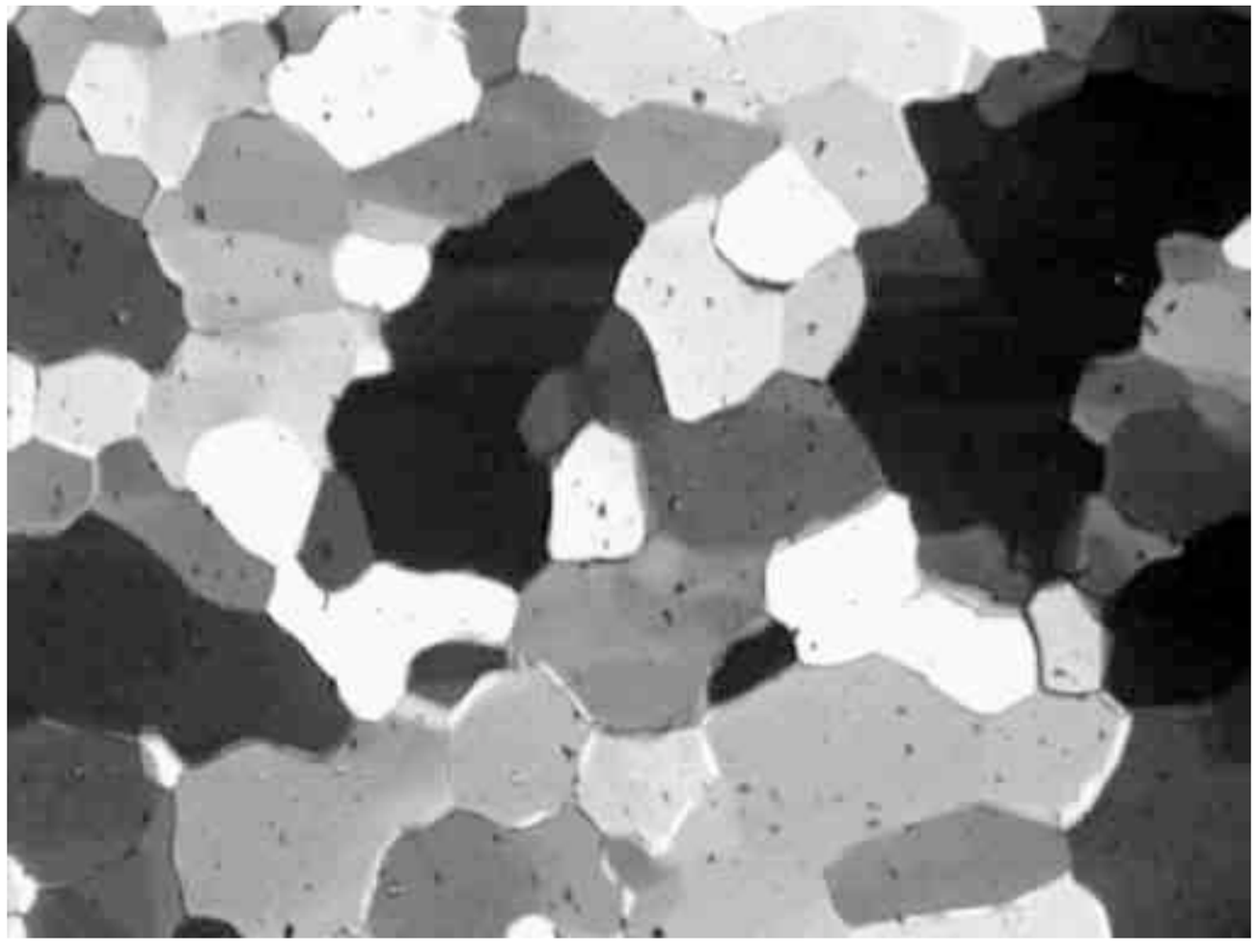
... to textbook

kristallines Fliessen ...





10 mm

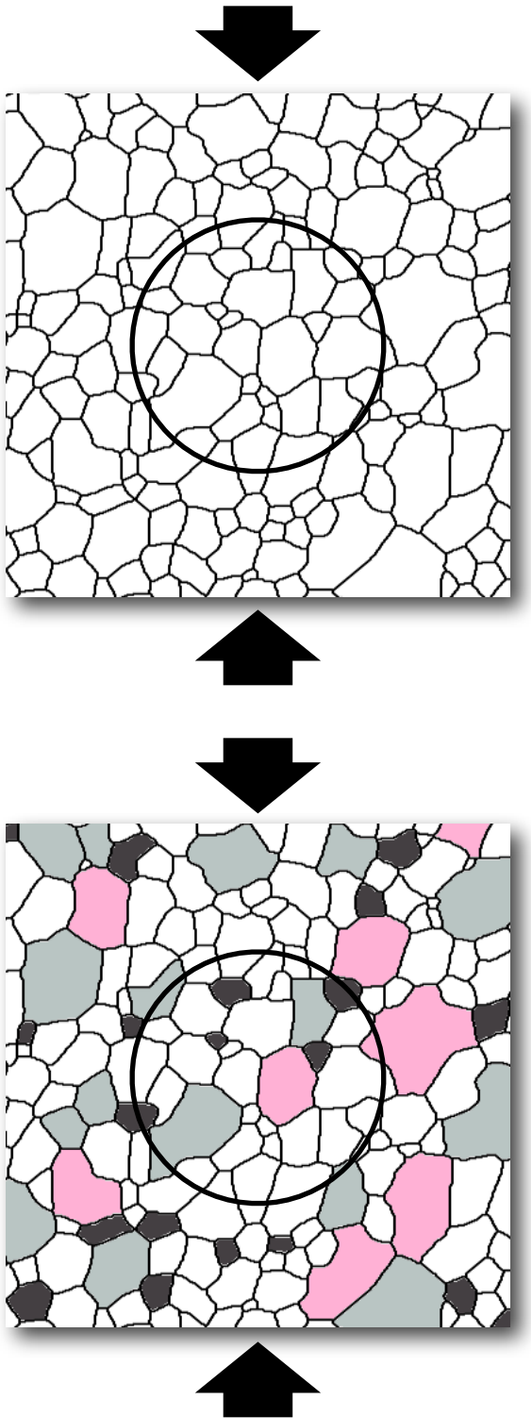


kristallines Octochloropropan

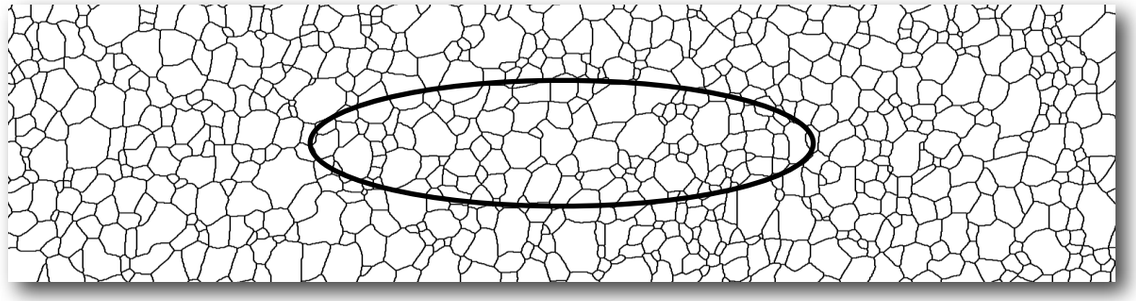
... wie geht das überhaupt ?

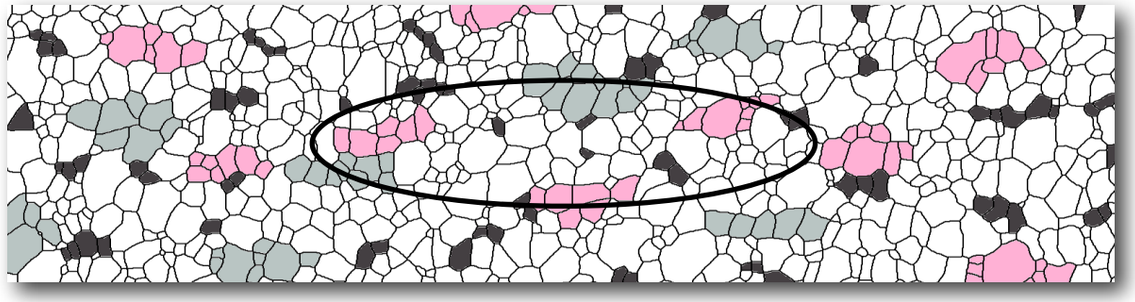
πάντα ῥεῖ ... aber wie ?

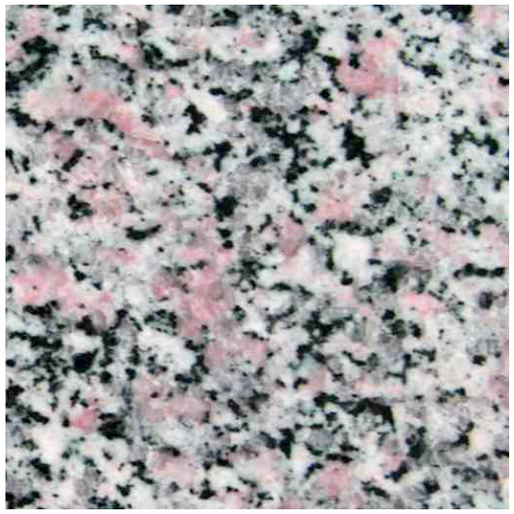
monophases
Material



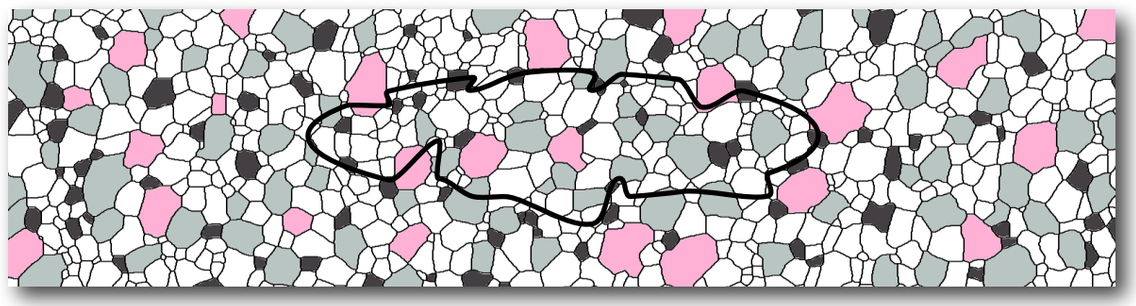
Dislokationskriechen







polyphases
Material

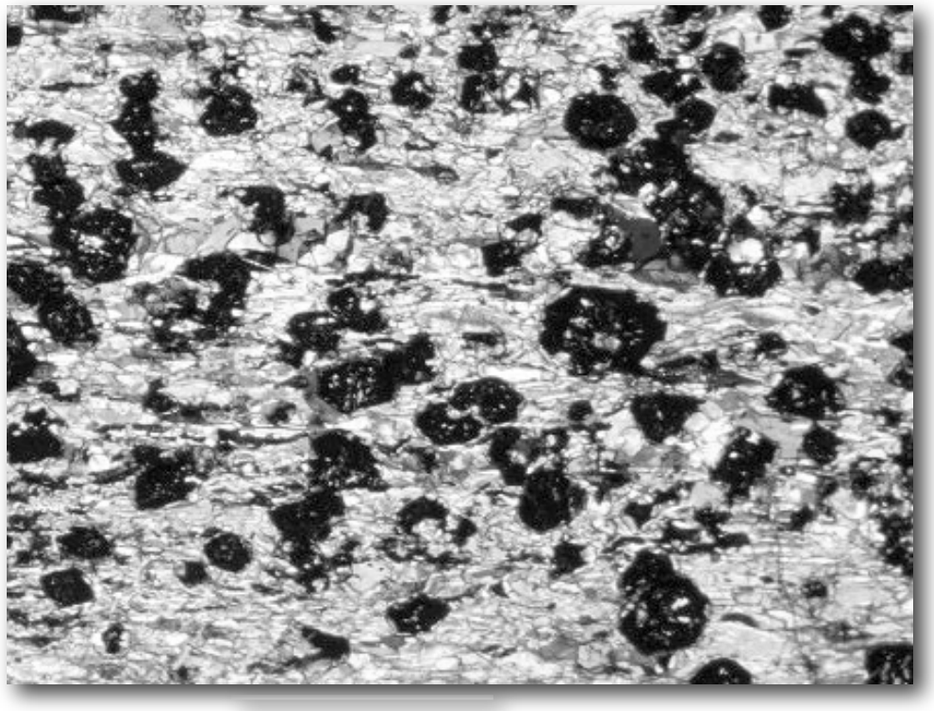


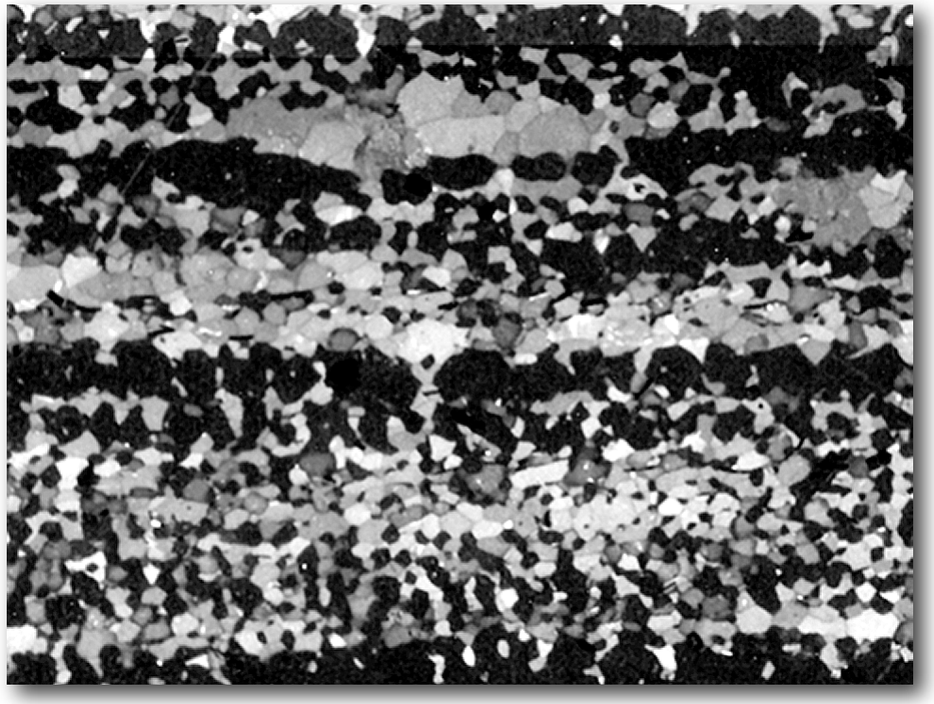
Diffusionskriechen

... von schwach zu schwächer ...

zurück zur Frage "gleich oder nicht gleich ?"

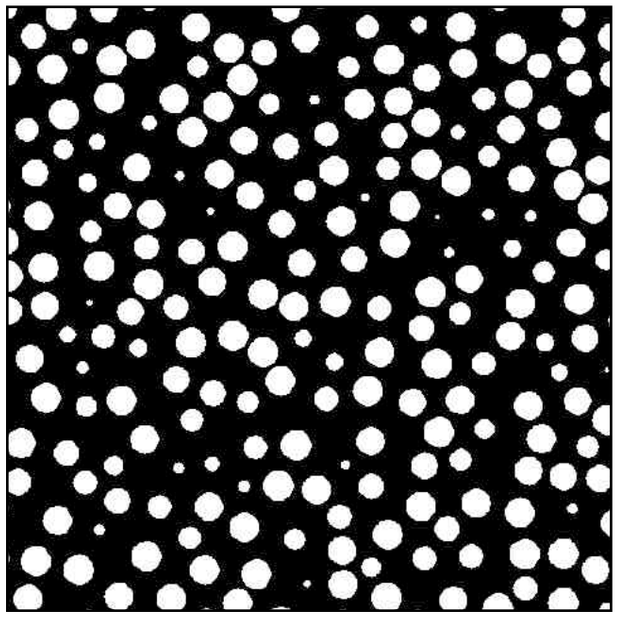
bzw. ... gleiche Grösse ?



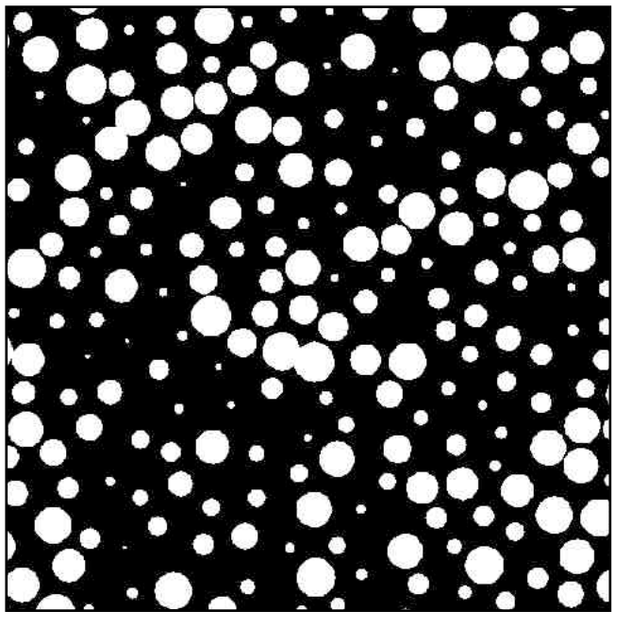


... gleiche Verteilung ?

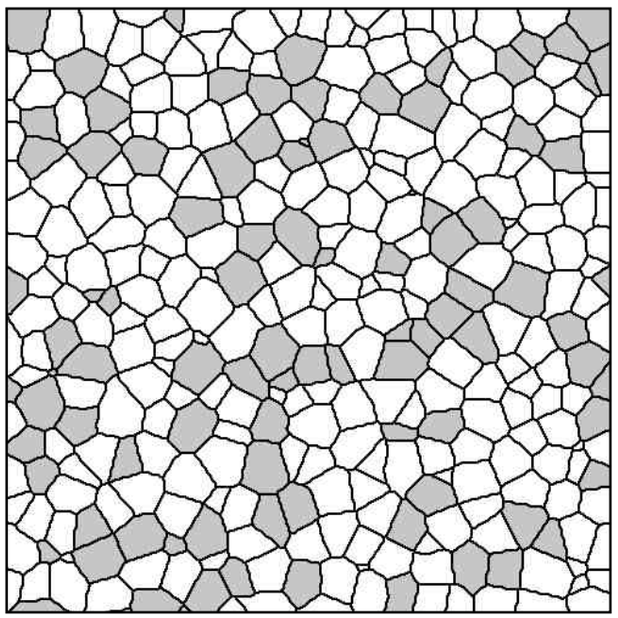
ein kurzer Blick genügt



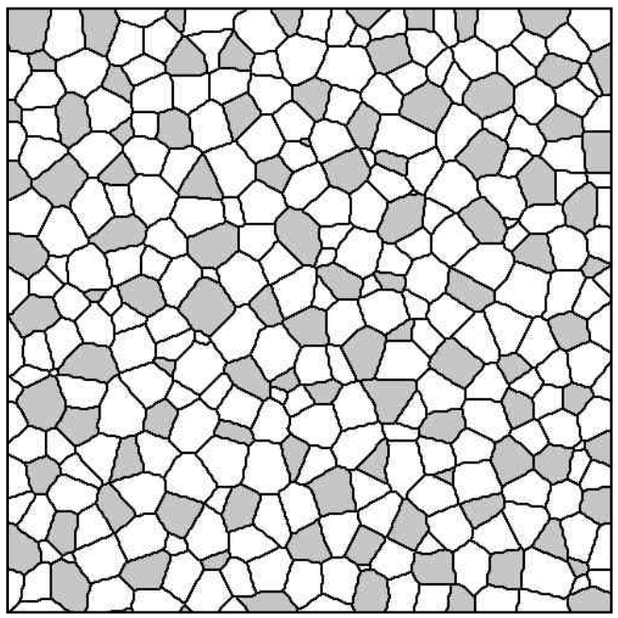
ein bitzeli kleiner



ein bitzeli grösser



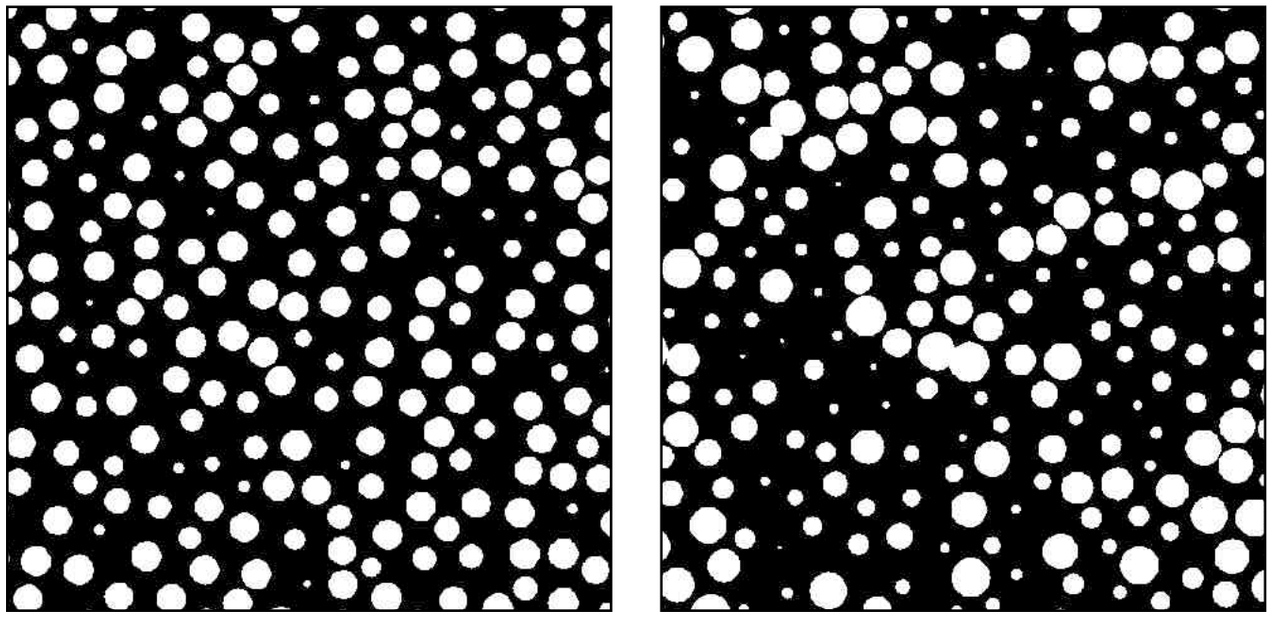
schön ge-clustered



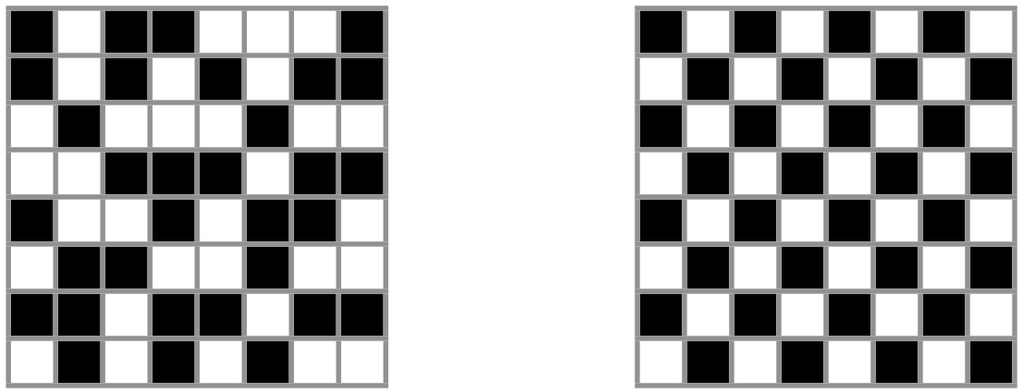
zufällig verteilt

... oder vielleicht doch nicht ...?

wie man sich täuscht !



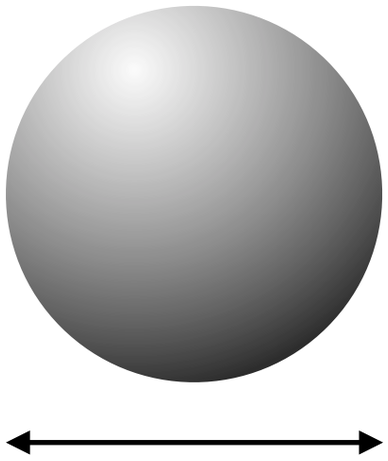
im Durchschnitt
beide genau gleich gross



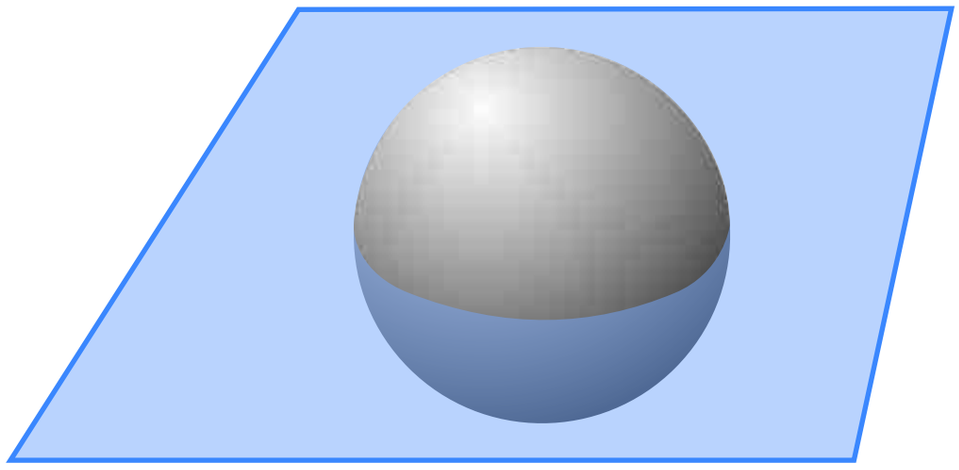
rein zufällig *super geordnet*

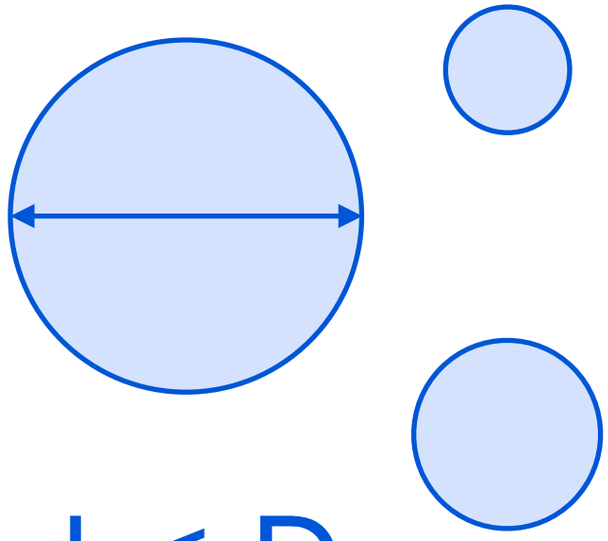
... dann schauen wir doch 'mal wie es richtig geht

Korngrössen

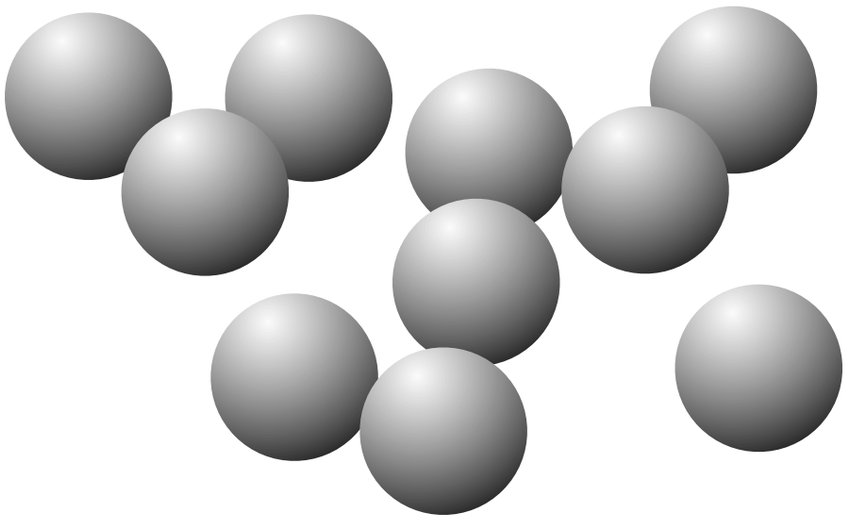


D

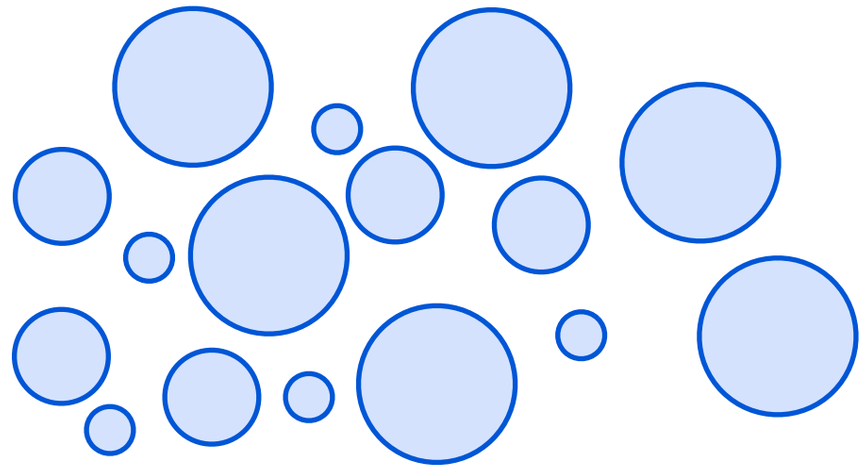




d ≤ D



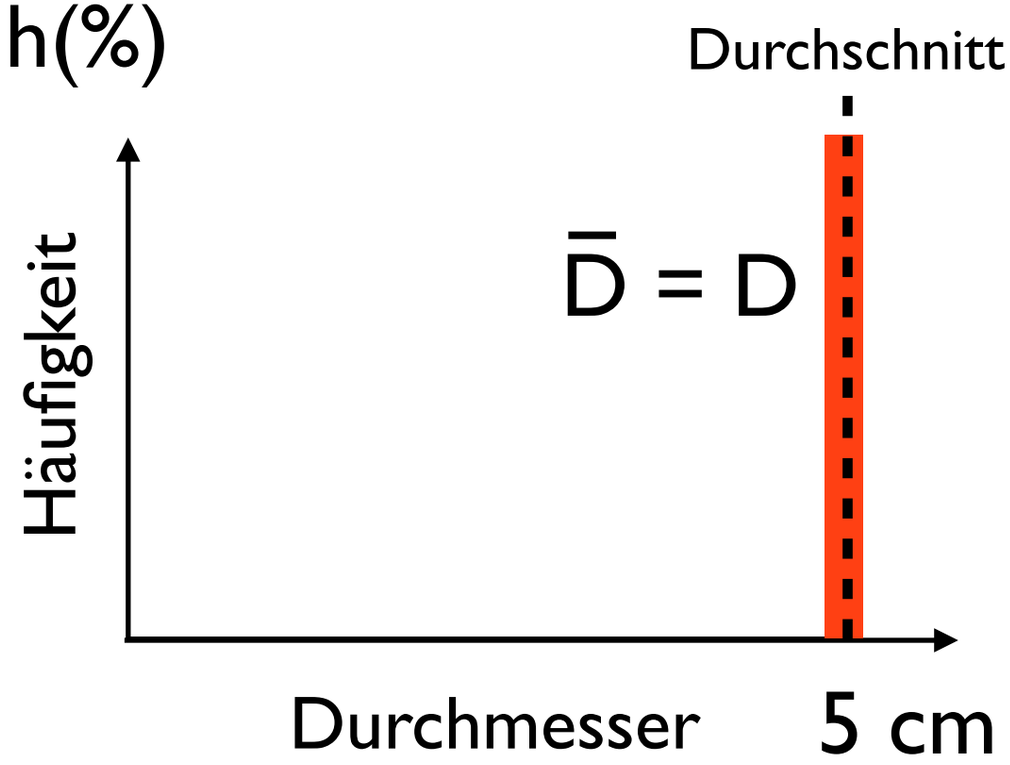
$\bar{D} = {}^{1}/_{n} \Sigma D = D$

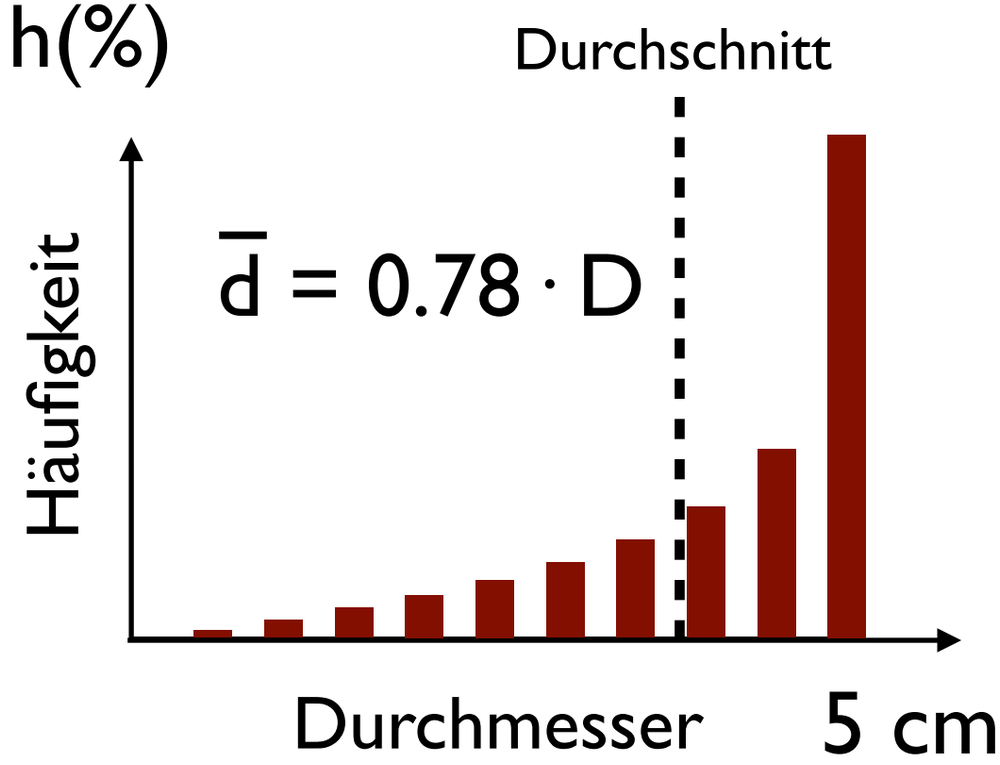


$\bar{\mu} = {}^{1}/_{n} \Sigma d < D$

was ist denn jetzt "die Korngrösse", $\bar{d}$ oder $\bar{D}$?

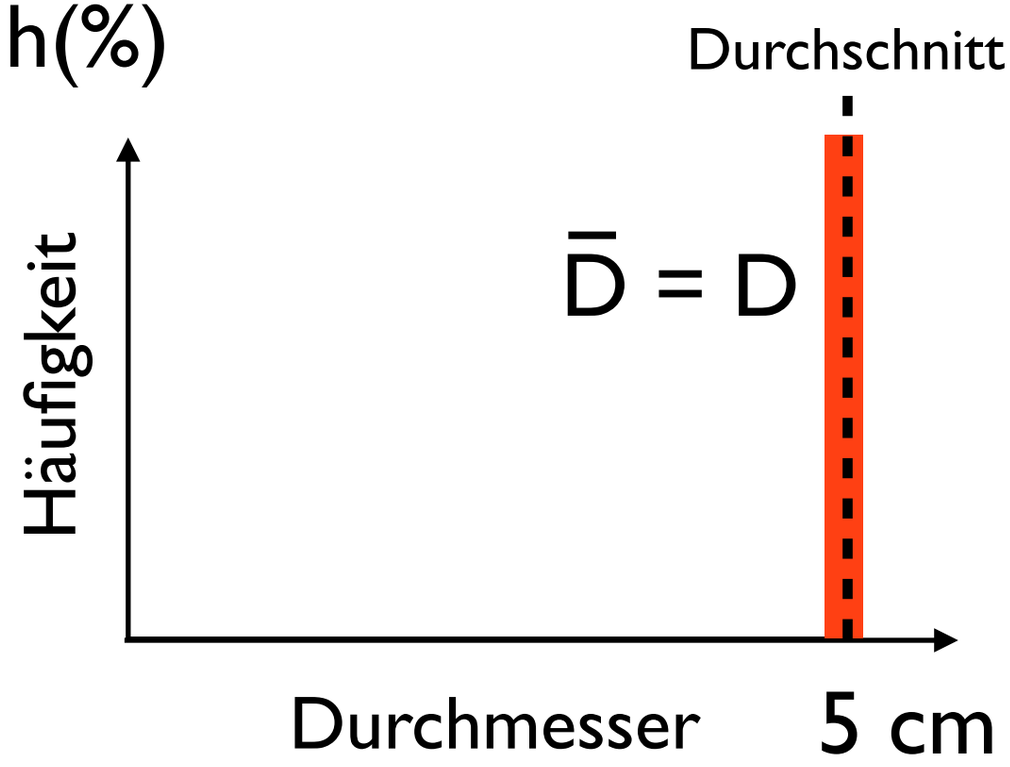
das Tomatensalat - Problem

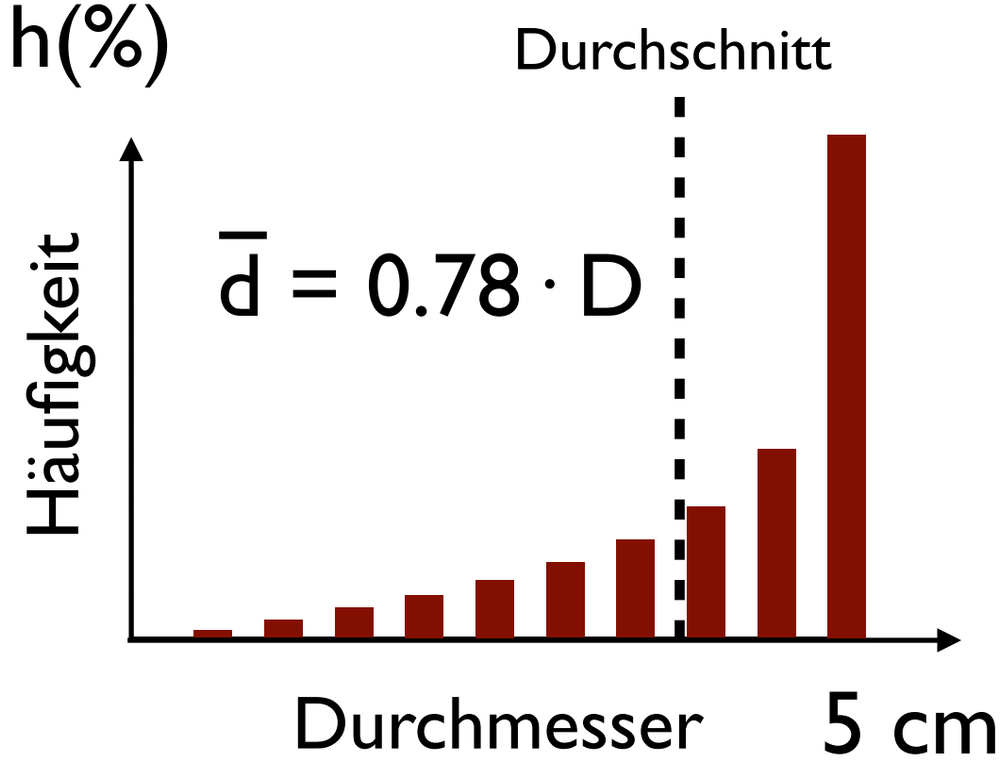




...Tomatensalat ist schnell gemacht

aber jetzt ?



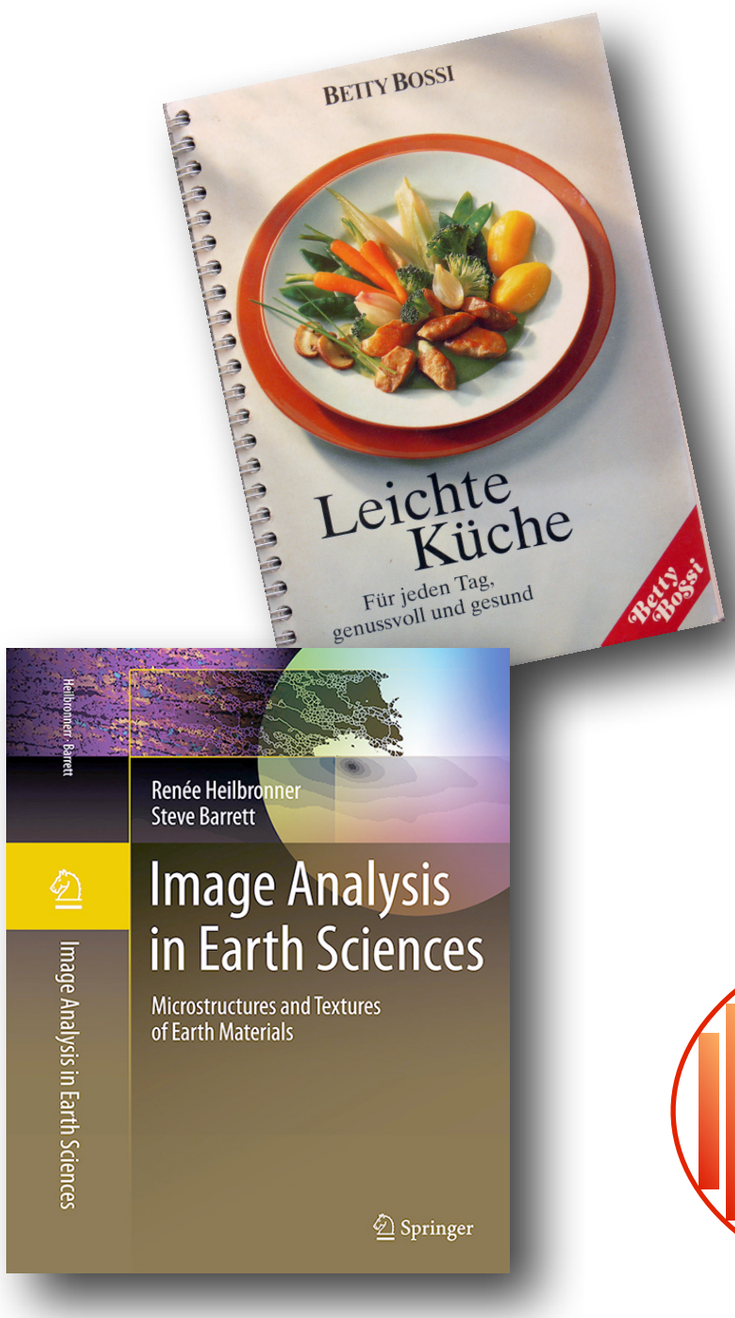


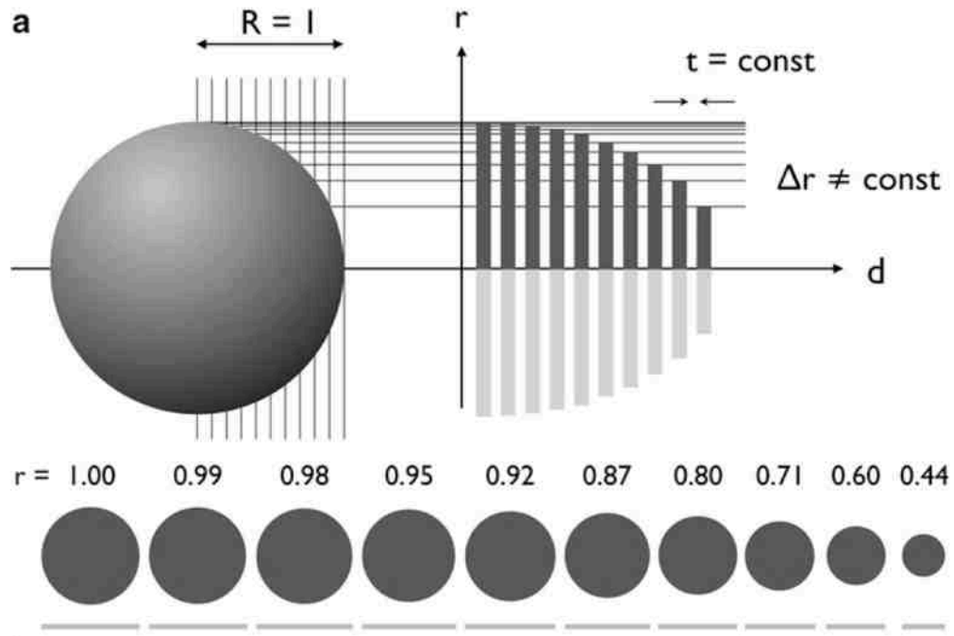
... wie gross waren die Tomaten

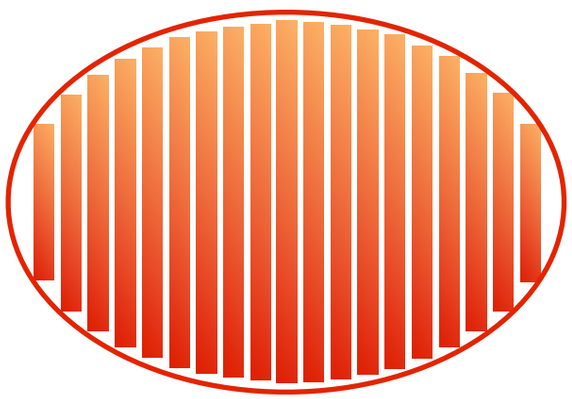
es müssen ja nicht alle Tomaten gleich gross sein...

sowohl d als auch D ist eine "verteilte Grösse"

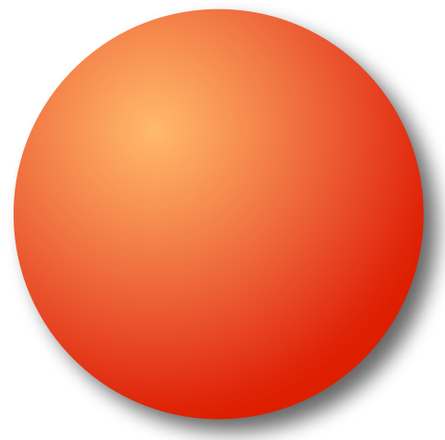
das andere Kochbuch





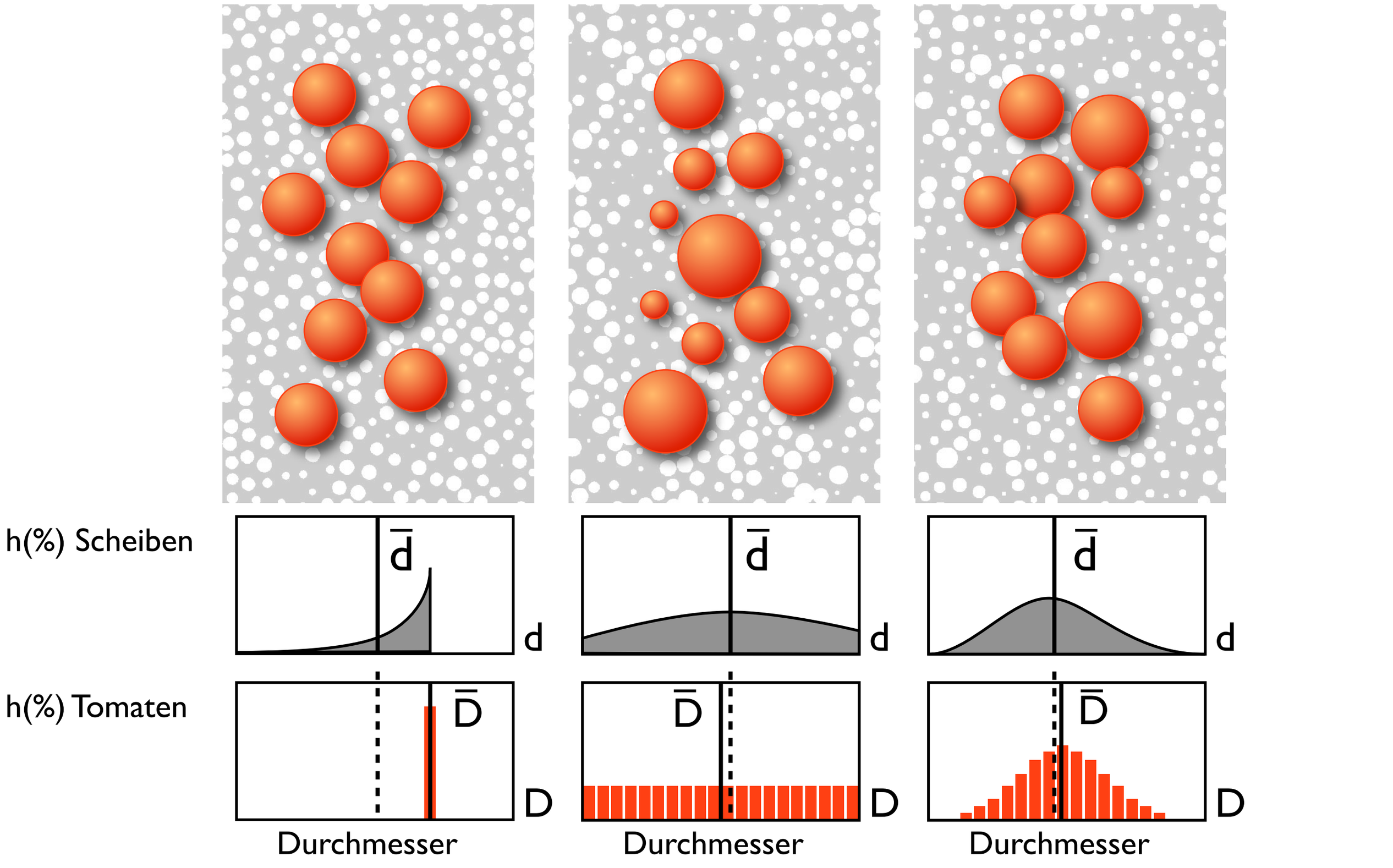


stripstar



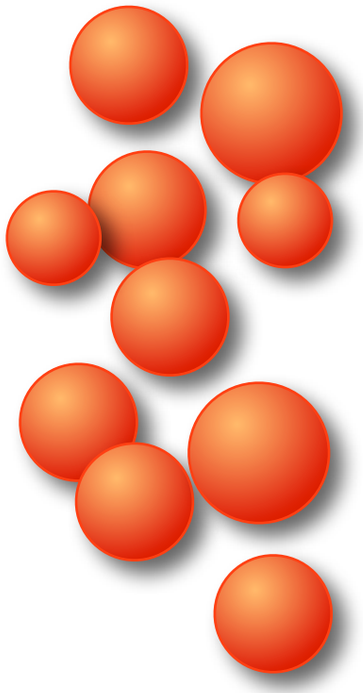
der inverse Tomatensalat, Rezept auf S. 210

wie man sich täuschen kann ...



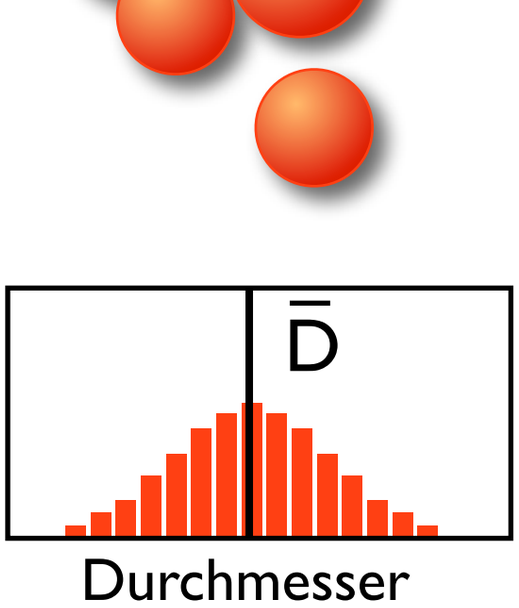
... vielleicht doch besser, wenn man ein bisschen rechnet ...

und schon haben wir die Fliessspannung !

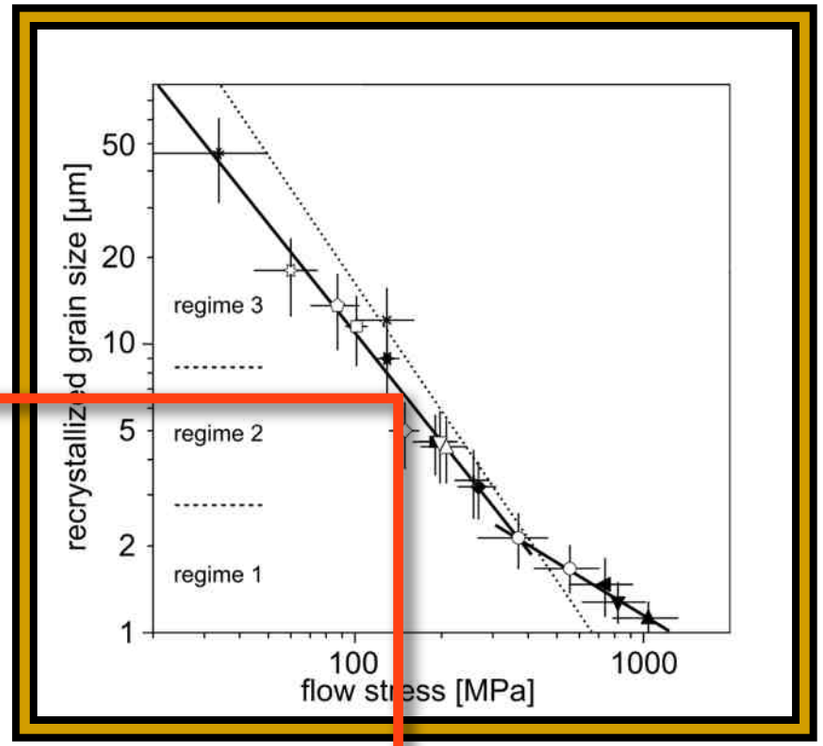


kein Thermometer
kein Barometer

aber ein Piezometer !



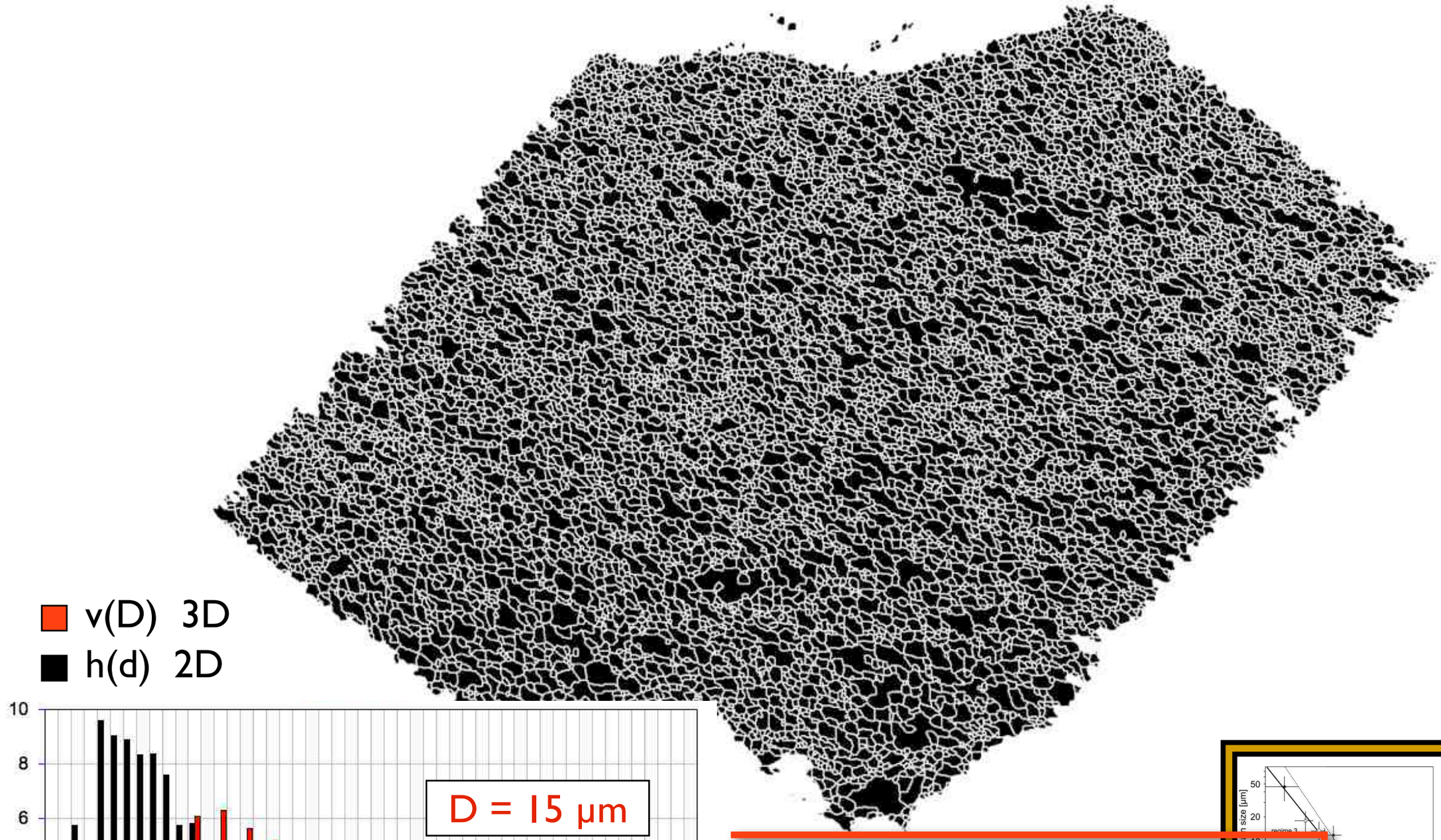
$\bar{D}$

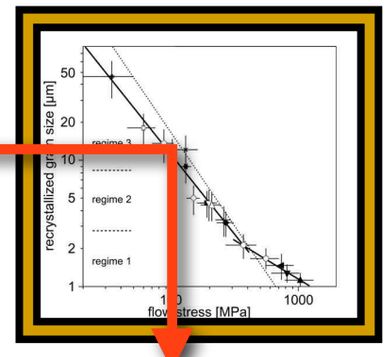


$\Delta\sigma$

Korngrösse 'rein - Spannung 'raus

also messen wir

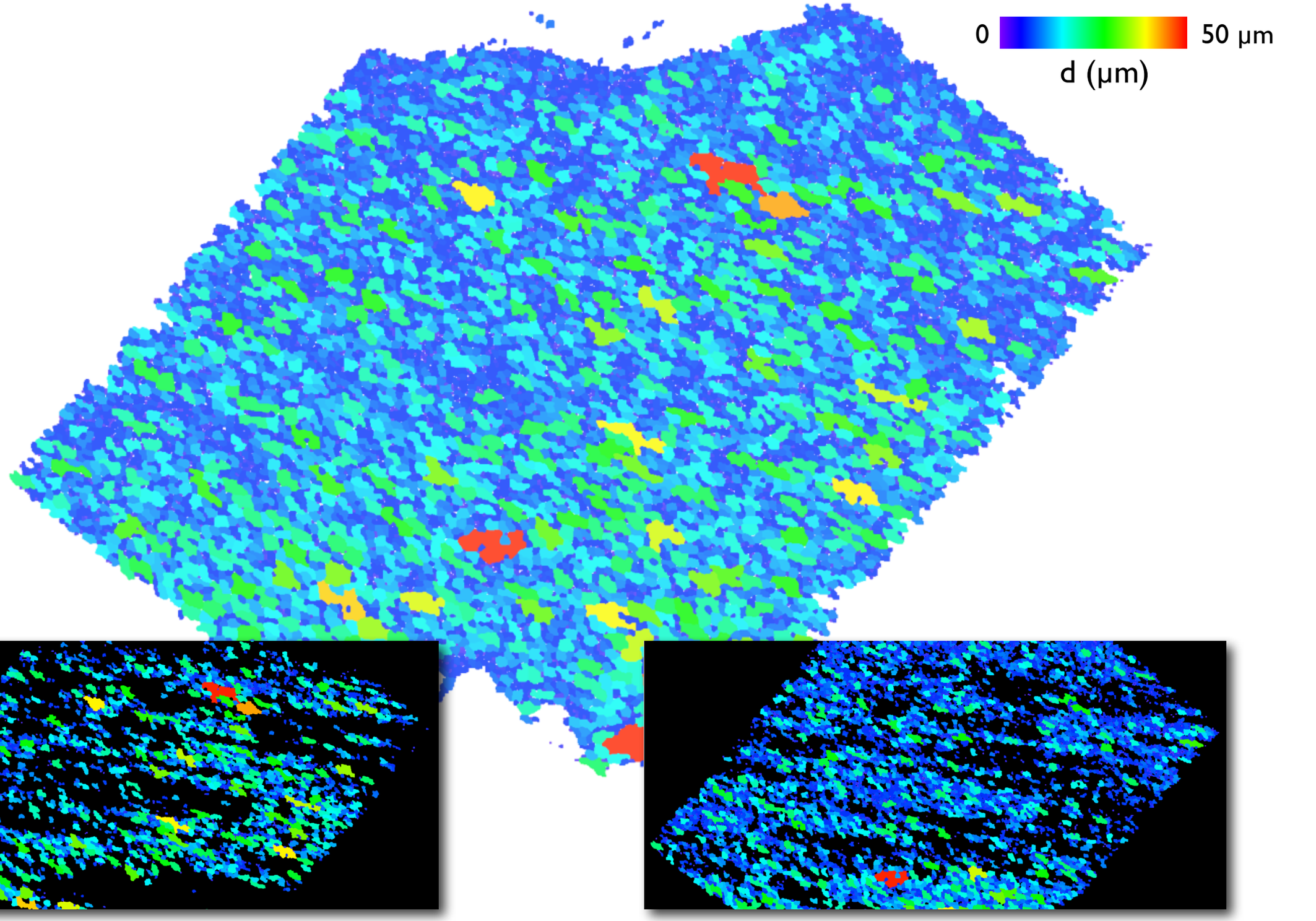




$\Delta\sigma$ = 100 MPa

... die Korngrösse, die Fliessspannung

verschieden Domänen sind verschieden stark !



$\Rightarrow \tau = 86$ MPa

$\Rightarrow \tau = 114$ MPa

.. dieser Binham Körper ist eigentlich zwei ... !

ist es nun Crème Brûlée oder Jelly Sandwich ?

... je nachdem, an welche Küche man sich hält ...

und zu guter Letzt ...

European Geosciences Union

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Renée Heilbronner

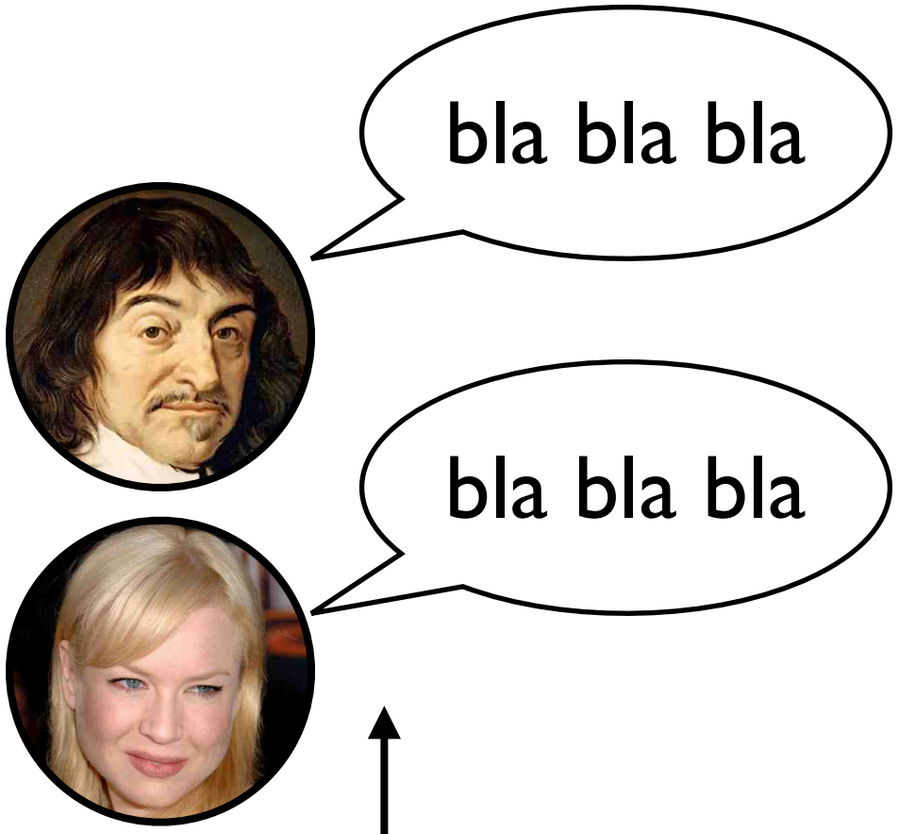
Stephan Mueller Medal 2016

The 2016 Stephan Mueller Medal is awarded to Renée Heilbronner for outstanding research on the analysis of rock microstructures and textures and the quantification of rock deformation.

Renée Heilbronner is an outstanding and internationally leading scientist in the field of rock physics and Earth deformation. She has distinguished herself by bringing extraordinary clarity and insightful perspective into the analysis of microstructures found in naturally and experimentally deformed rocks. She pioneered a very original approach based on image analysis applied to rock deformation that forms the foundation for much of our current understanding of the influence of grain boundary structure on natural deformation. The methods that Heilbronner developed have a tremendous impact on advancing our understanding of the strong link between microstructures and rock rheological properties. Her work has numerous applications that cover the whole set of rock deformation mechanisms, from fracture analysis to quantification of diffusion and dislocation creep, and the whole range of objects that characterise deformation, from grain boundary geometry to crystallographic preferred orientations, including the reconstruction of the evolution of such structures with time. Characteristically, her work uses stereological and statistical methods that were and are at the cutting edge of image analysis. Her application of rigorous image analysis techniques has advanced our understanding of strain partitioning amongst component minerals, the effect of

Finally (...) better acceptance of women in the scientific community

und zu guter Letzt ...

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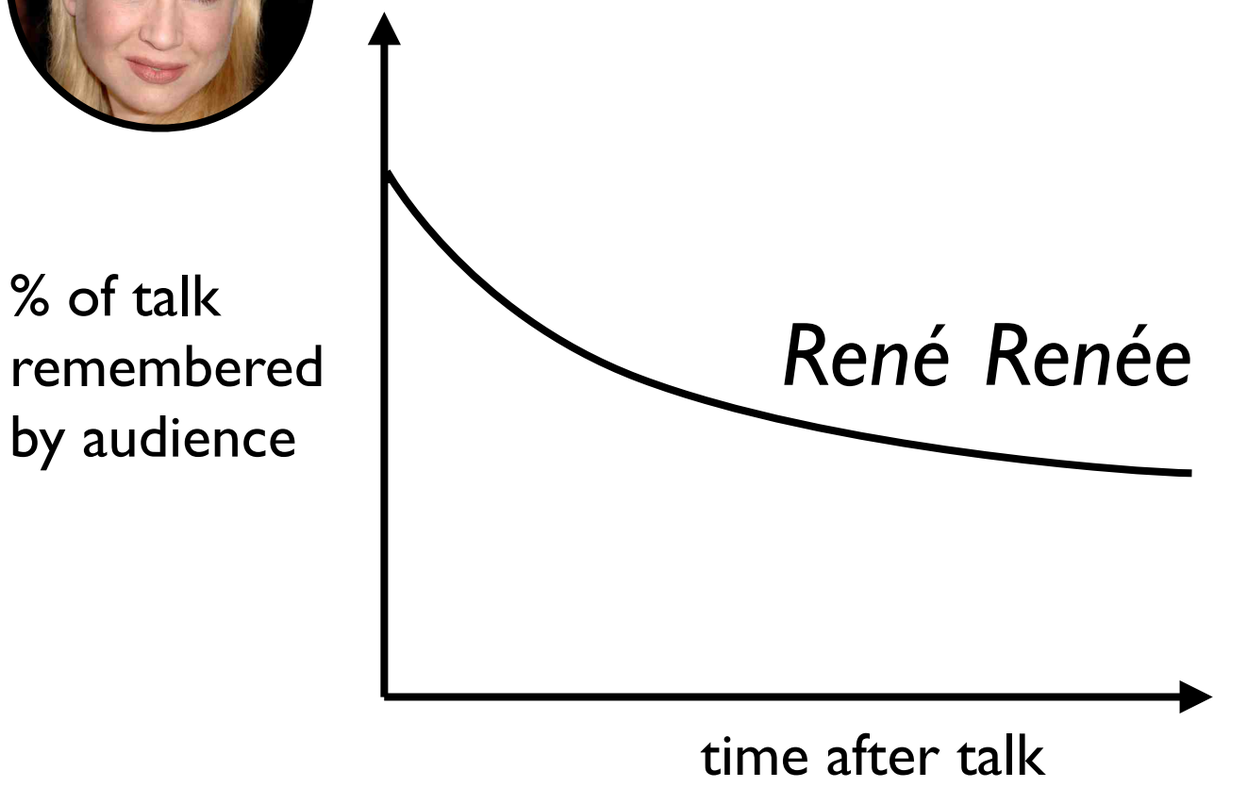

... der mid career award


THE END
ONCE UPON A TIME IN THE WEST

Betti Richter

Rüdiger Kilian

Sina Marti

Renée Heilbronner

volks— hochschule beider basel

FNSNF
Fonds national suisse
Schweizerischer Nationalfonds
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Swiss National Science Foundation

Willy Tschudin

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ONCE UPON A TIME IN ... BASEL