MICROFABRIC DEVELOPMENT IN NATURE AND EXPERIMENT

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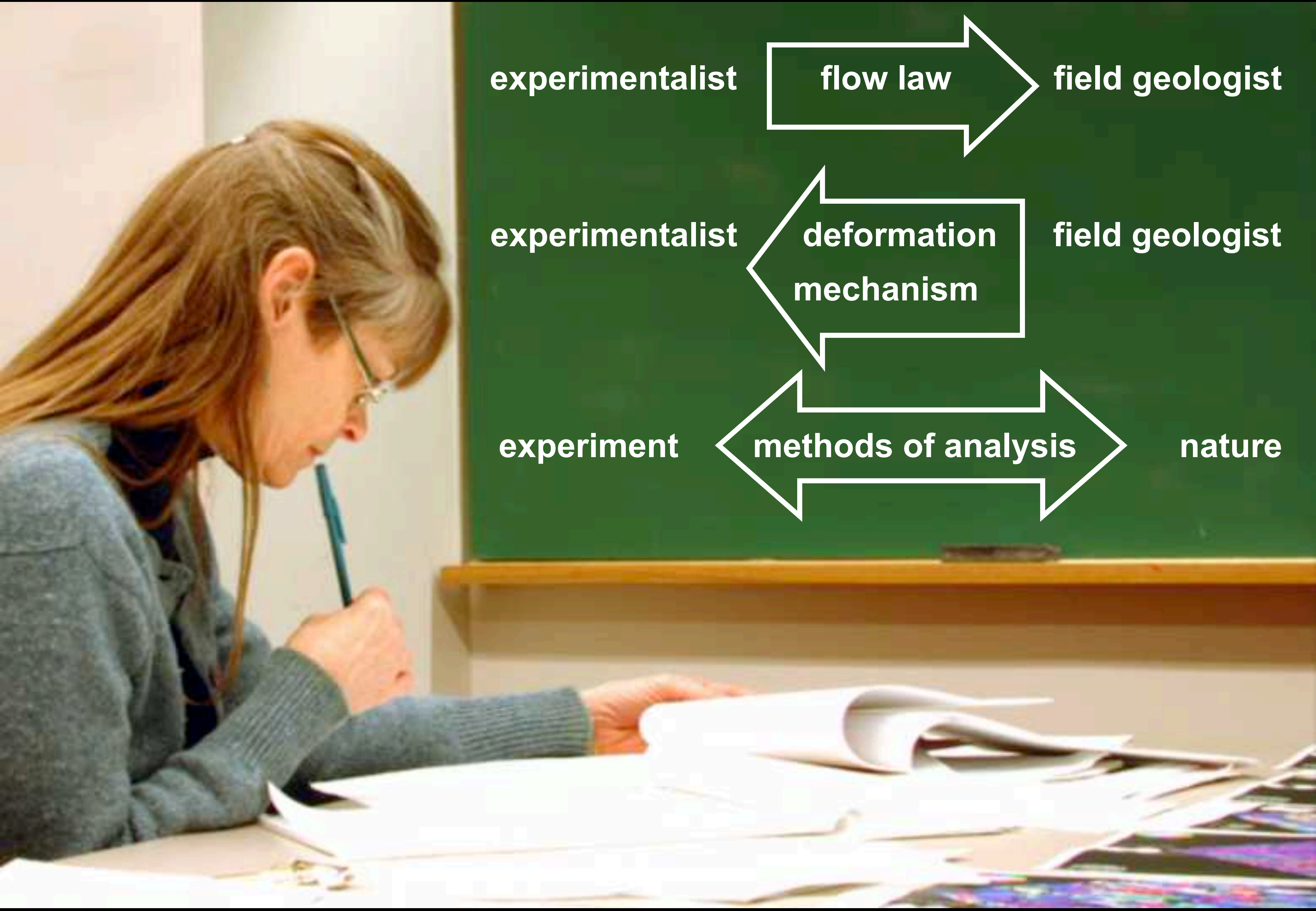
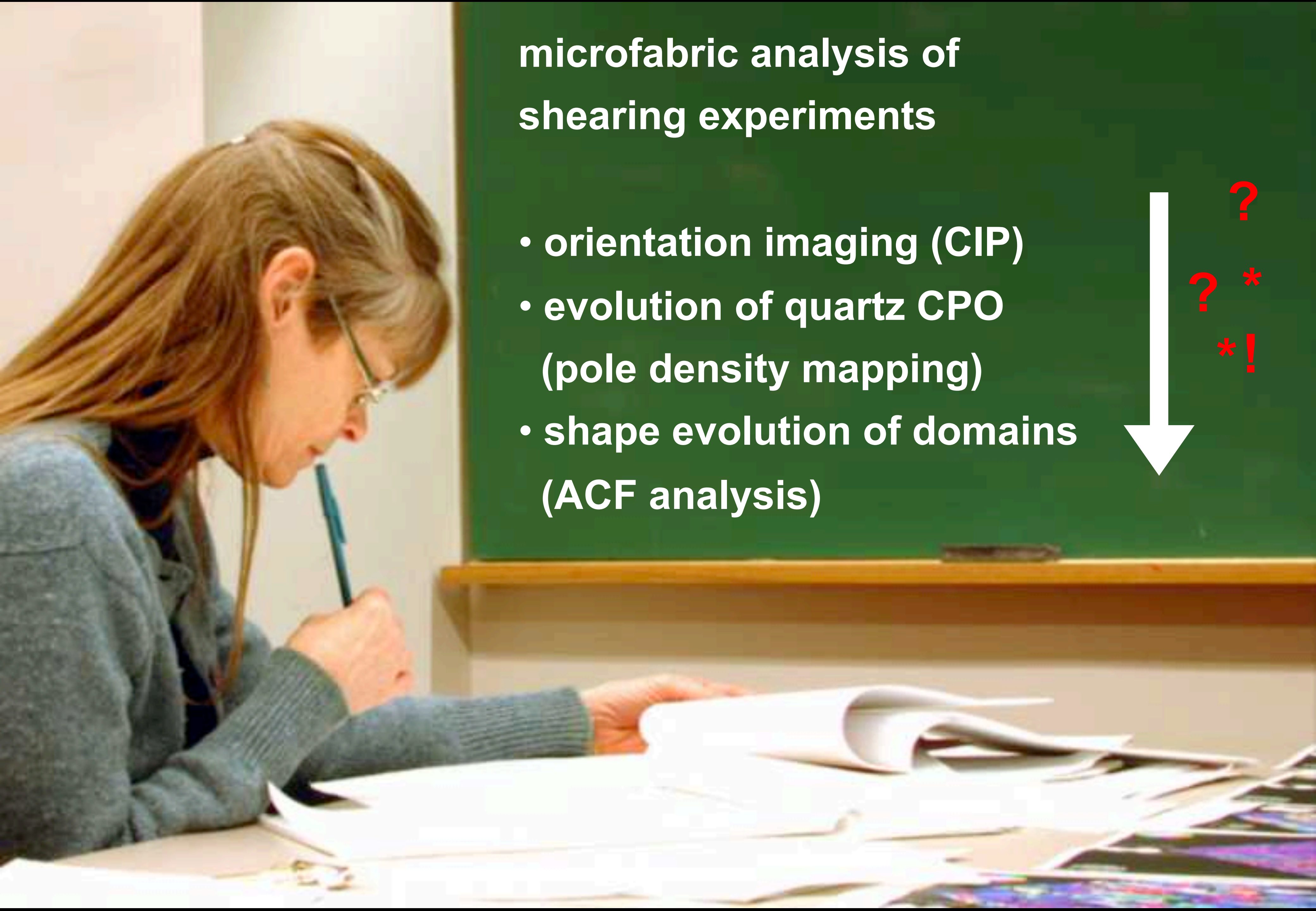

experimentalist
flow law
field geologist
experimentalist
deformation mechanism
field geologist
experiment
methods of analysis
nature



microfabric analysis of
shearing experiments

- orientation imaging (CIP)
- evolution of quartz CPO
  (pole density mapping)
- shape evolution of domains
  (ACF analysis)

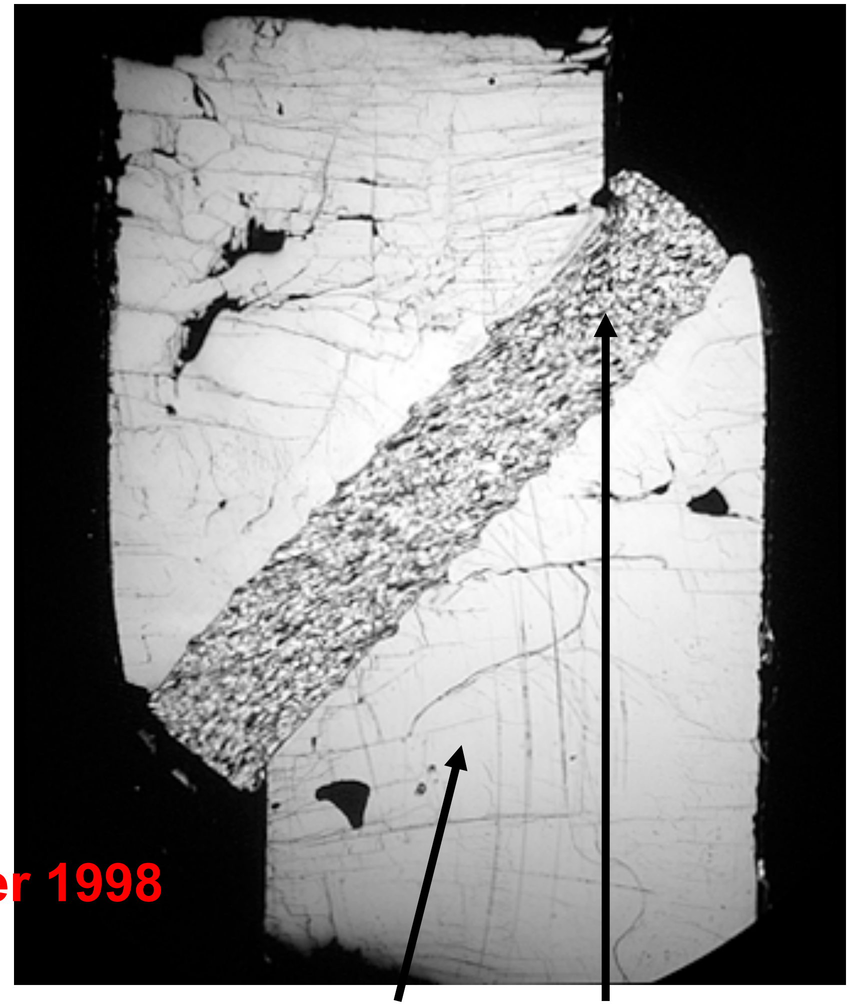
shearing experiments in solid medium apparatus

shearing & compaction, plane strain

Sample (& Pt jacket) after deformation

!

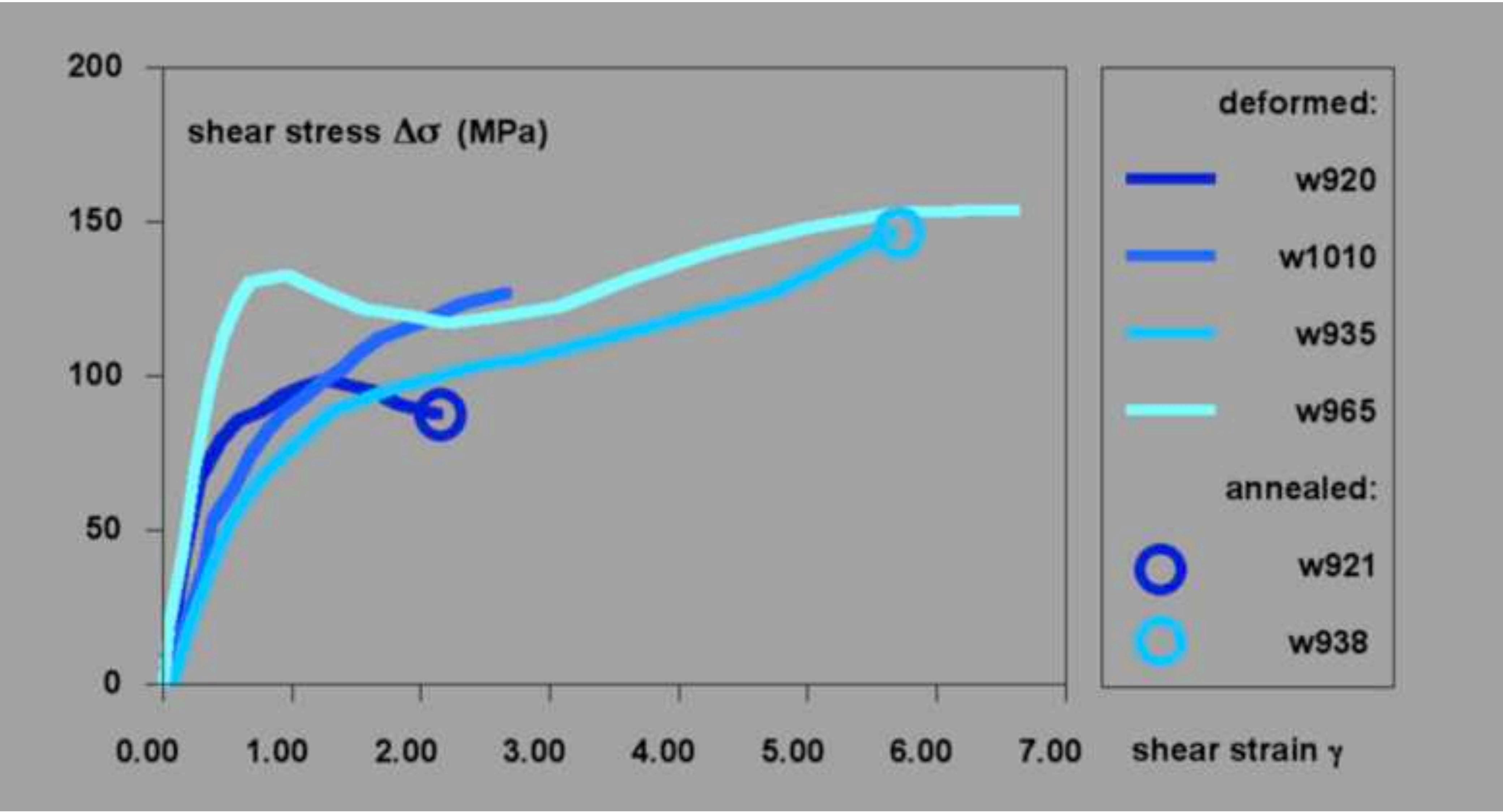
Rutter 1998



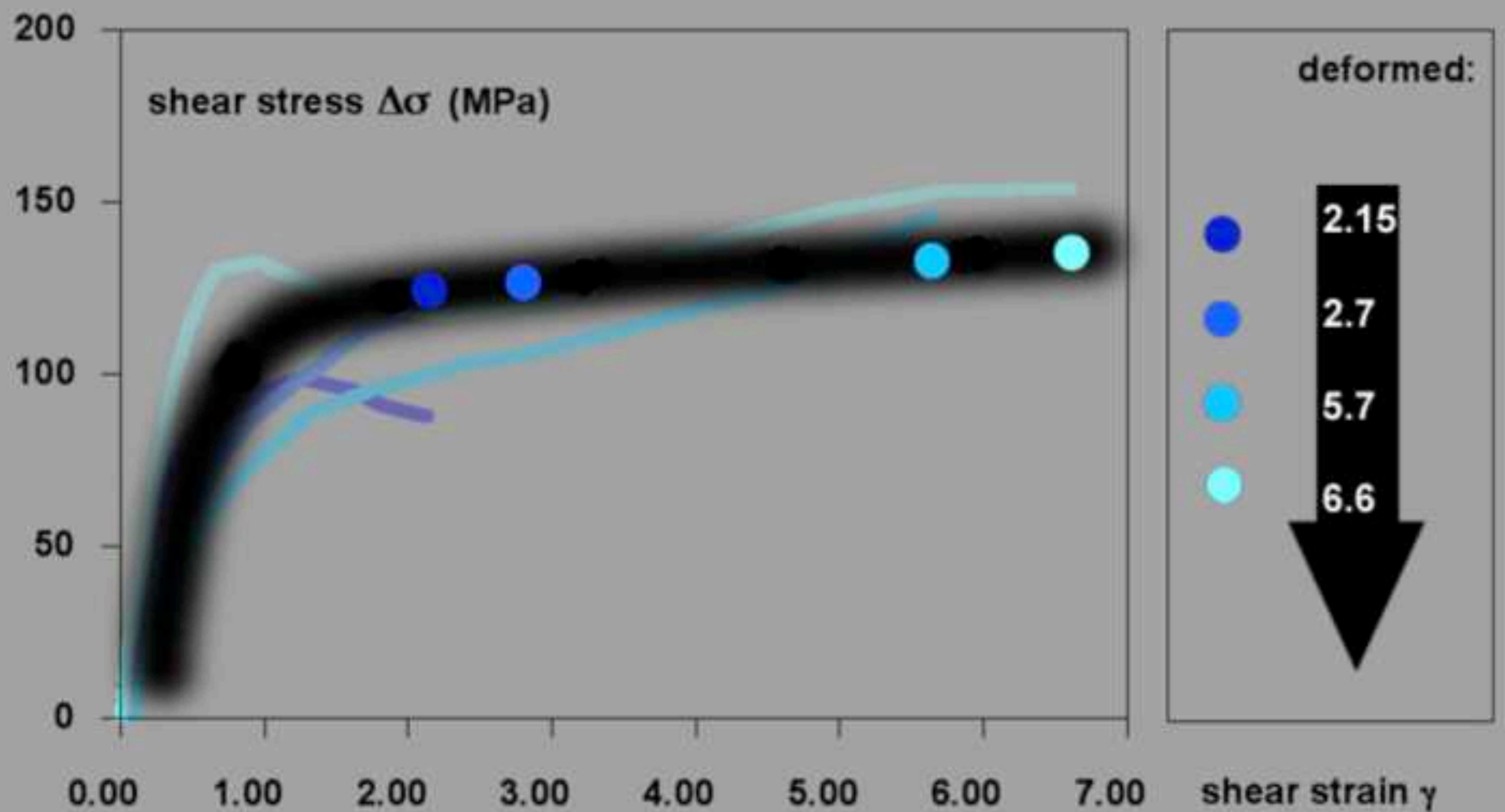
Brazil quartz (circular polarization)

Black Hillsquartzite

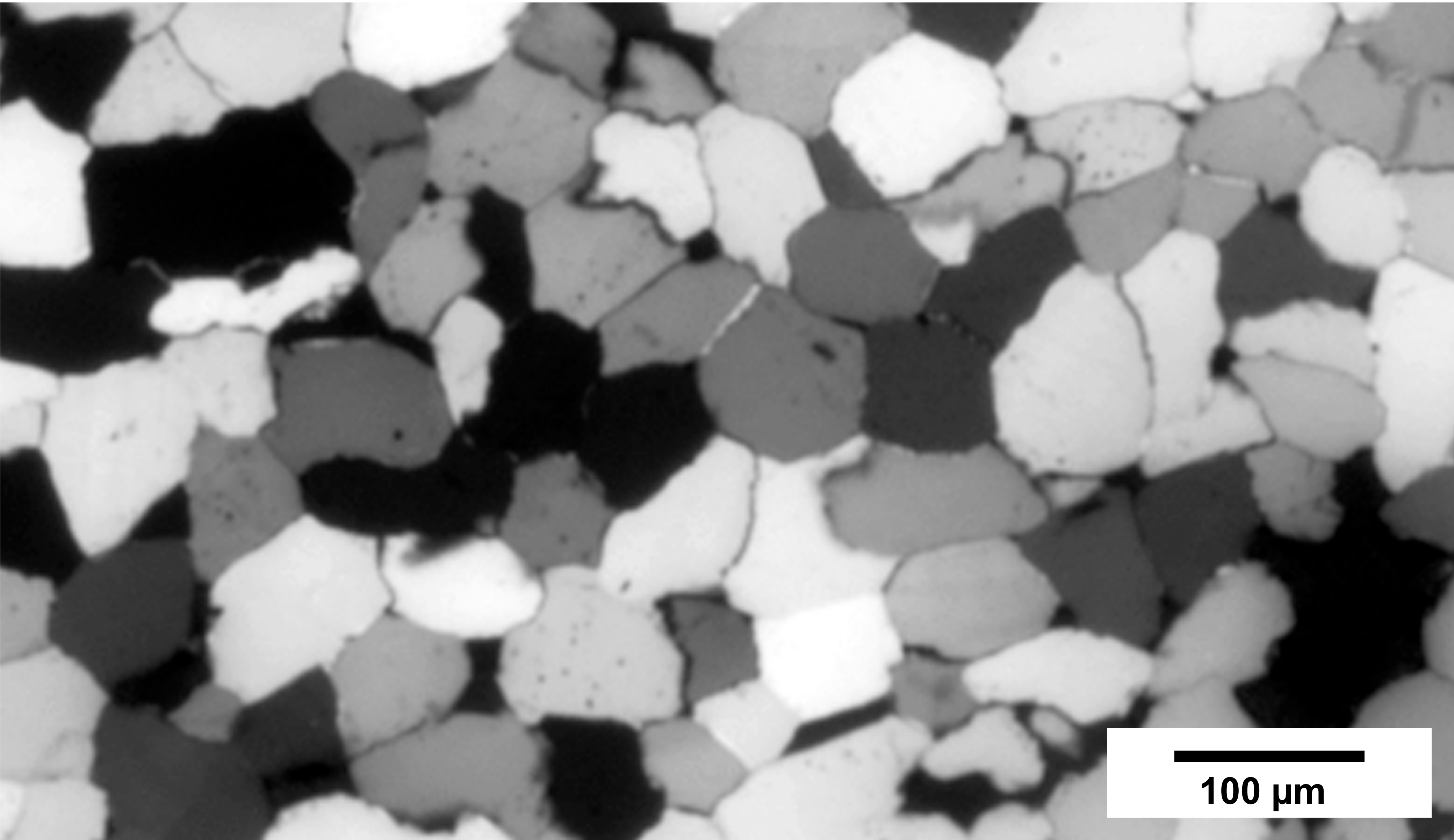
mechanical data **p_c = 1.5 GPa, T = 900°, $\varepsilon = 10^{-5} s^{-1}$, 0.17 wt% H_2O**



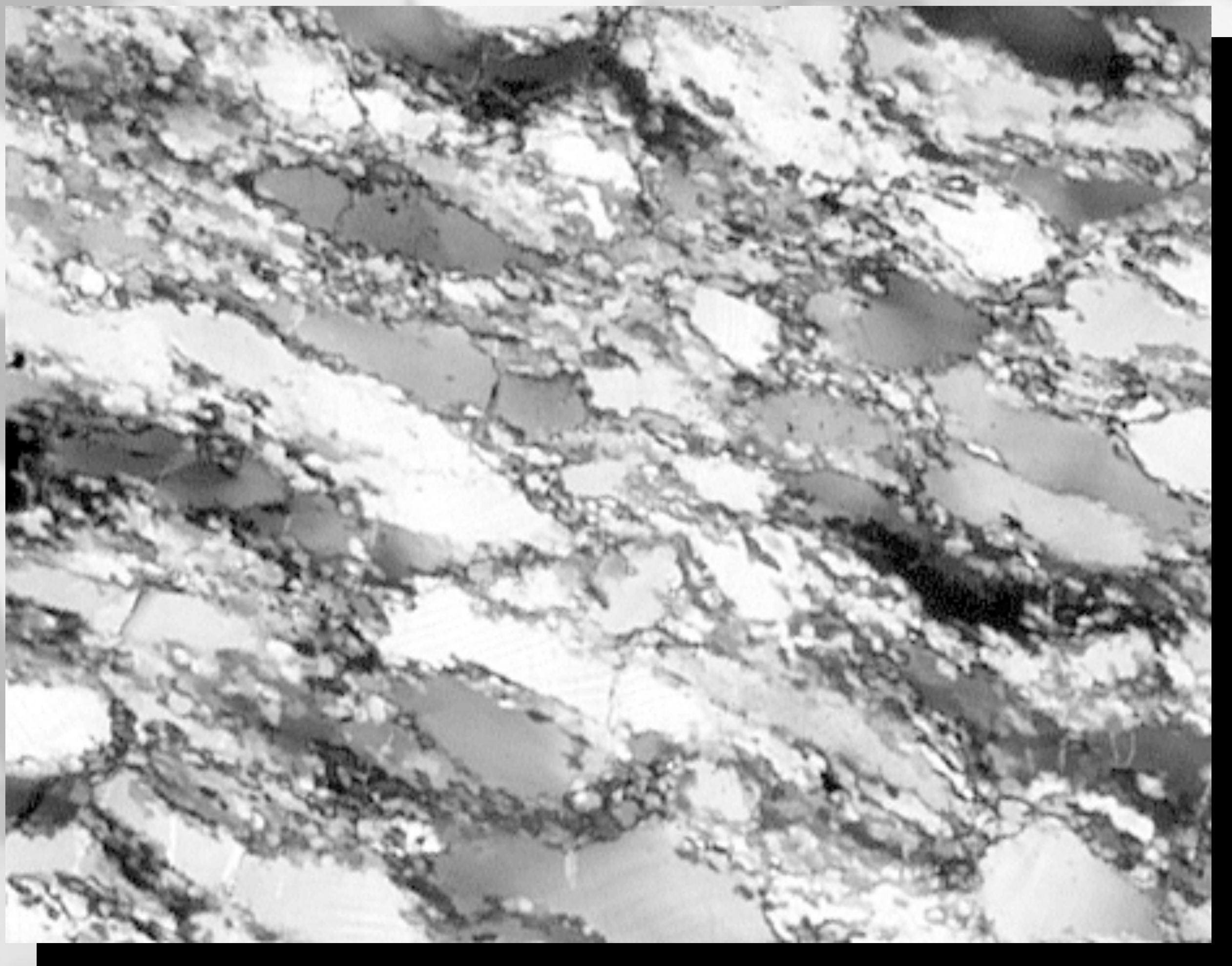
regime 3 of dislocation creep regime - grain boundary migration dominated



example of microfabric analysis **microstructure of undeformed**



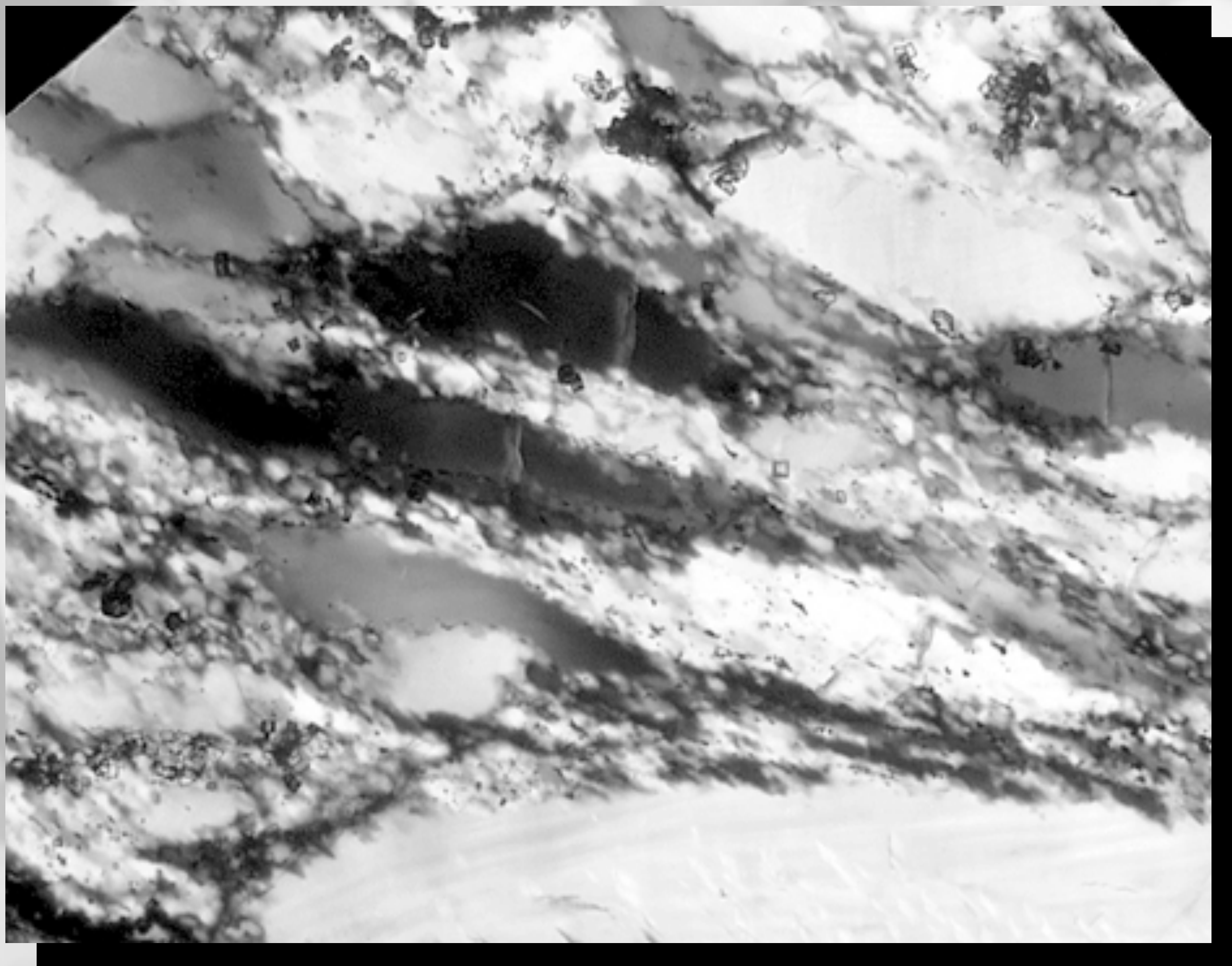
microstructure of low, ...



40 % rexl

100 µm

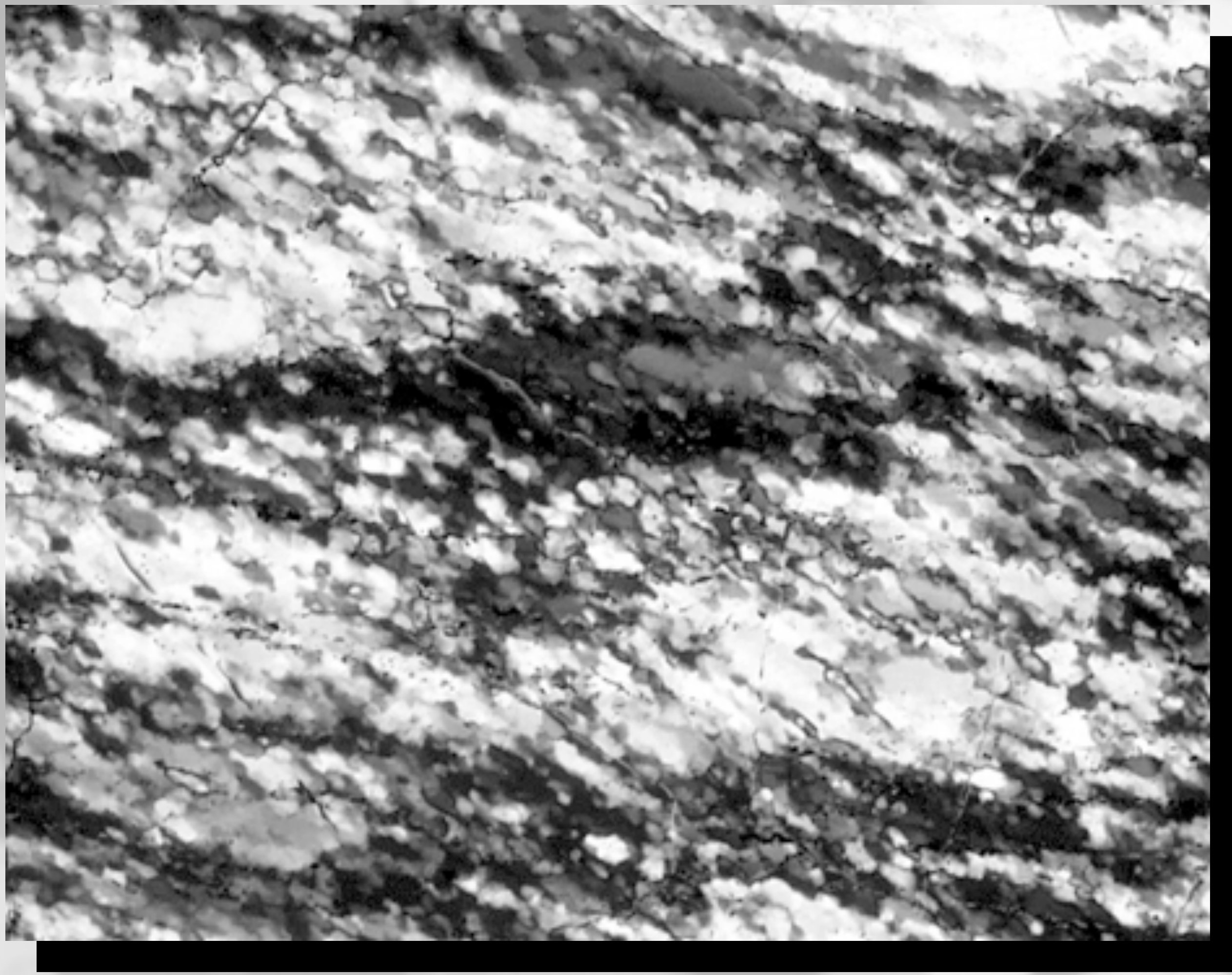
... intermediate, ...



70 % rexl

100 µm

...and high deformation



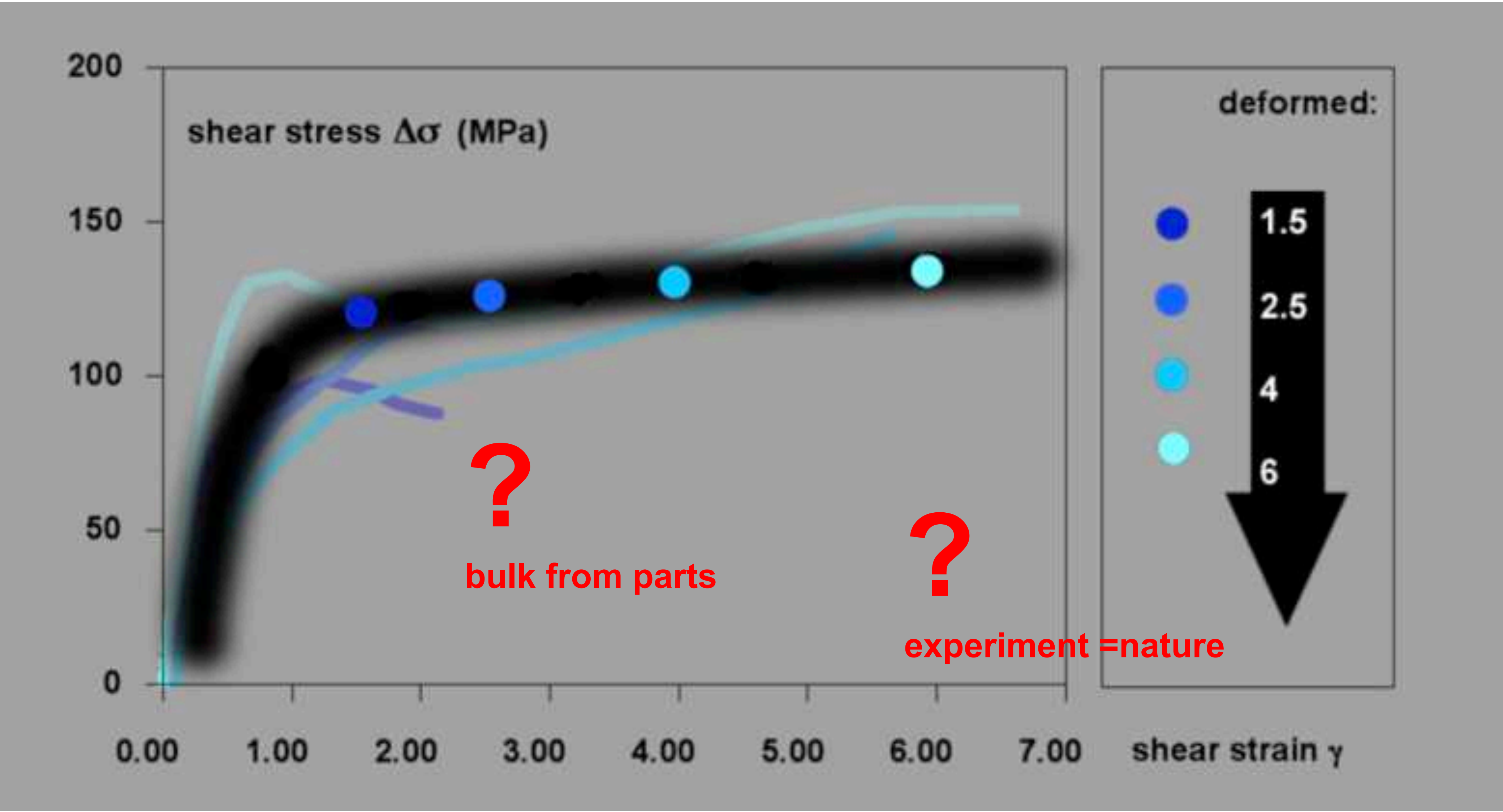
100 % rexl

?

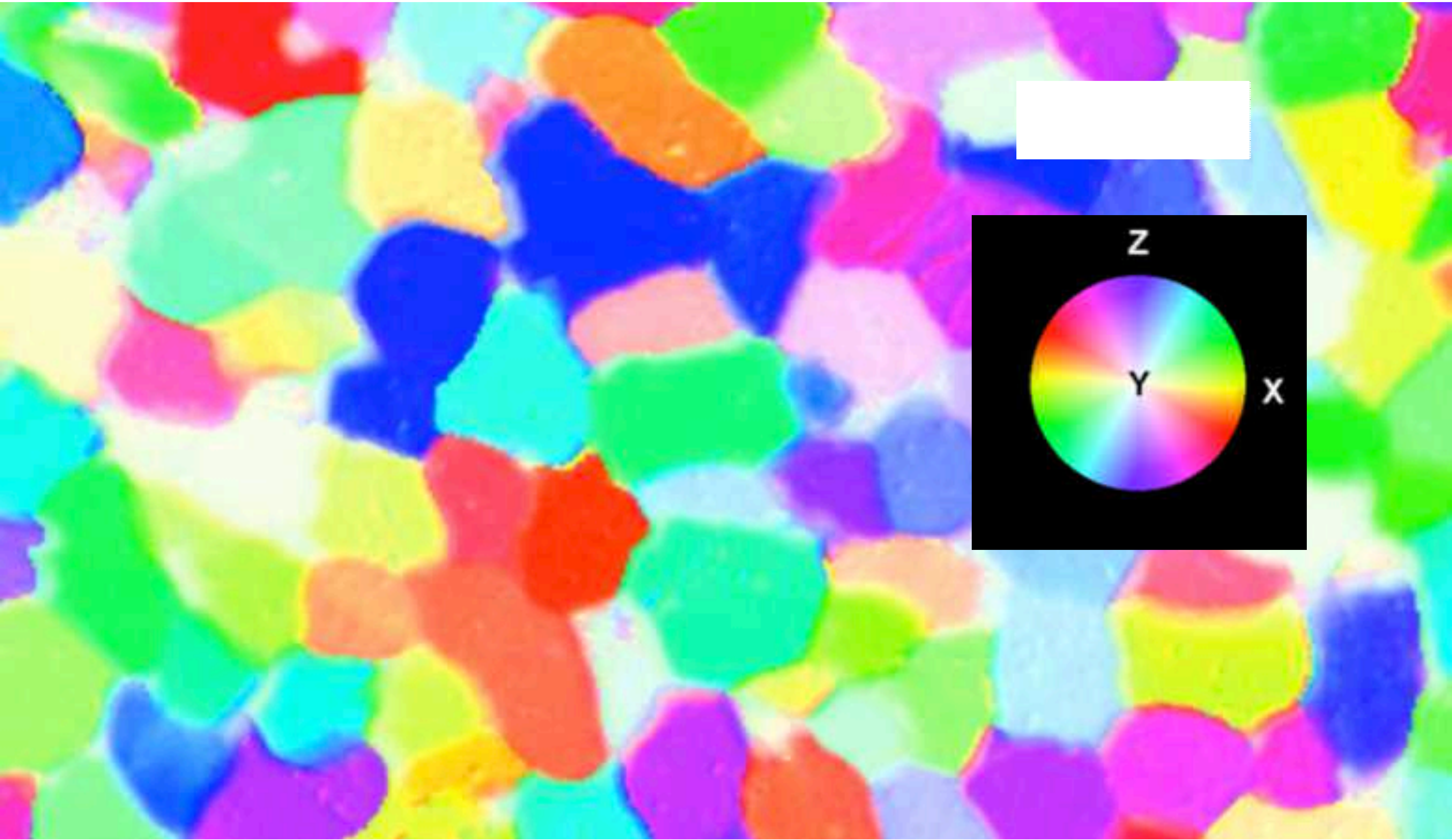
strain markers

100 µm

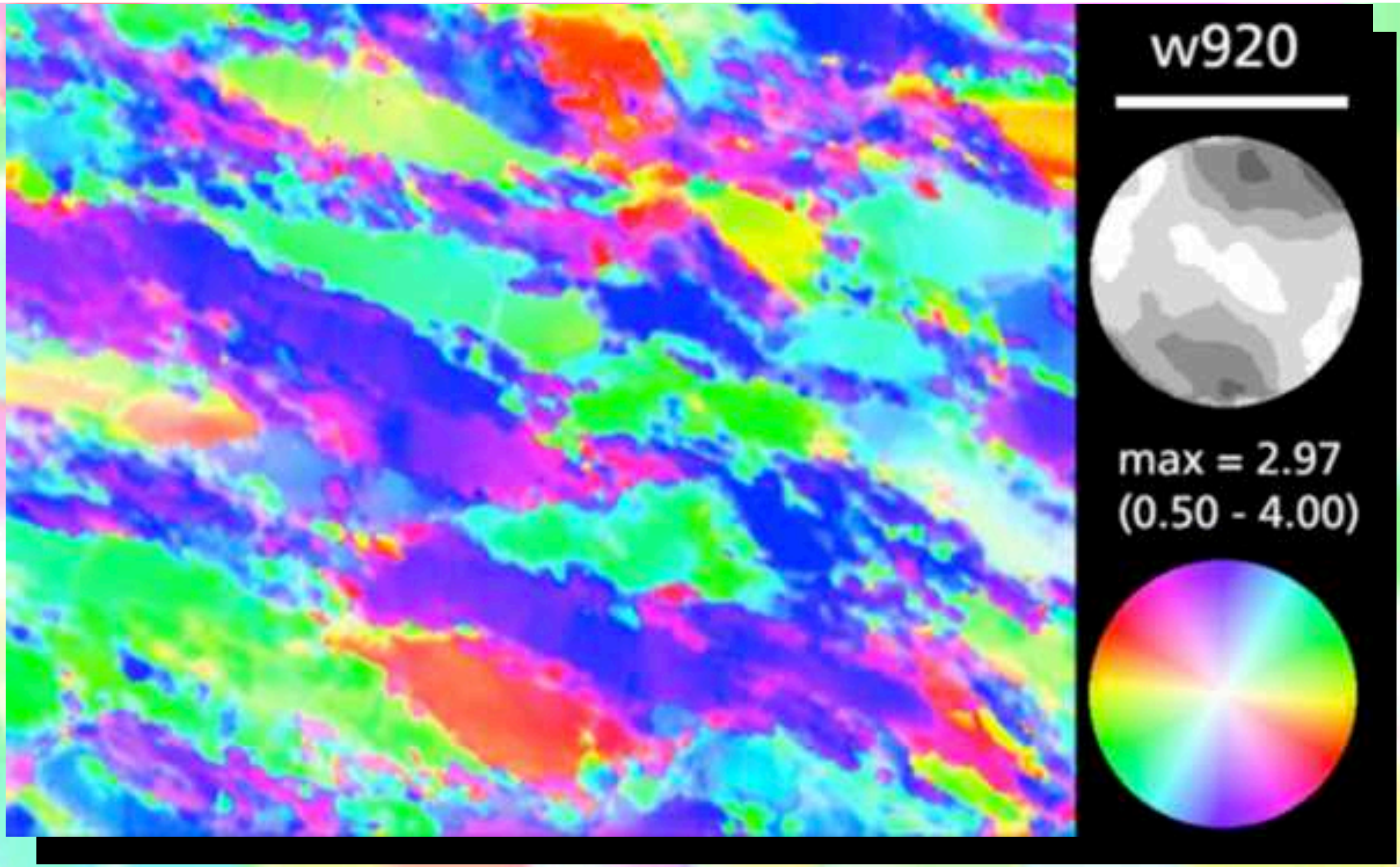
heterogenous deformation of sample → continuous spectrum of strain



c-axis orientation imaging (CIP)

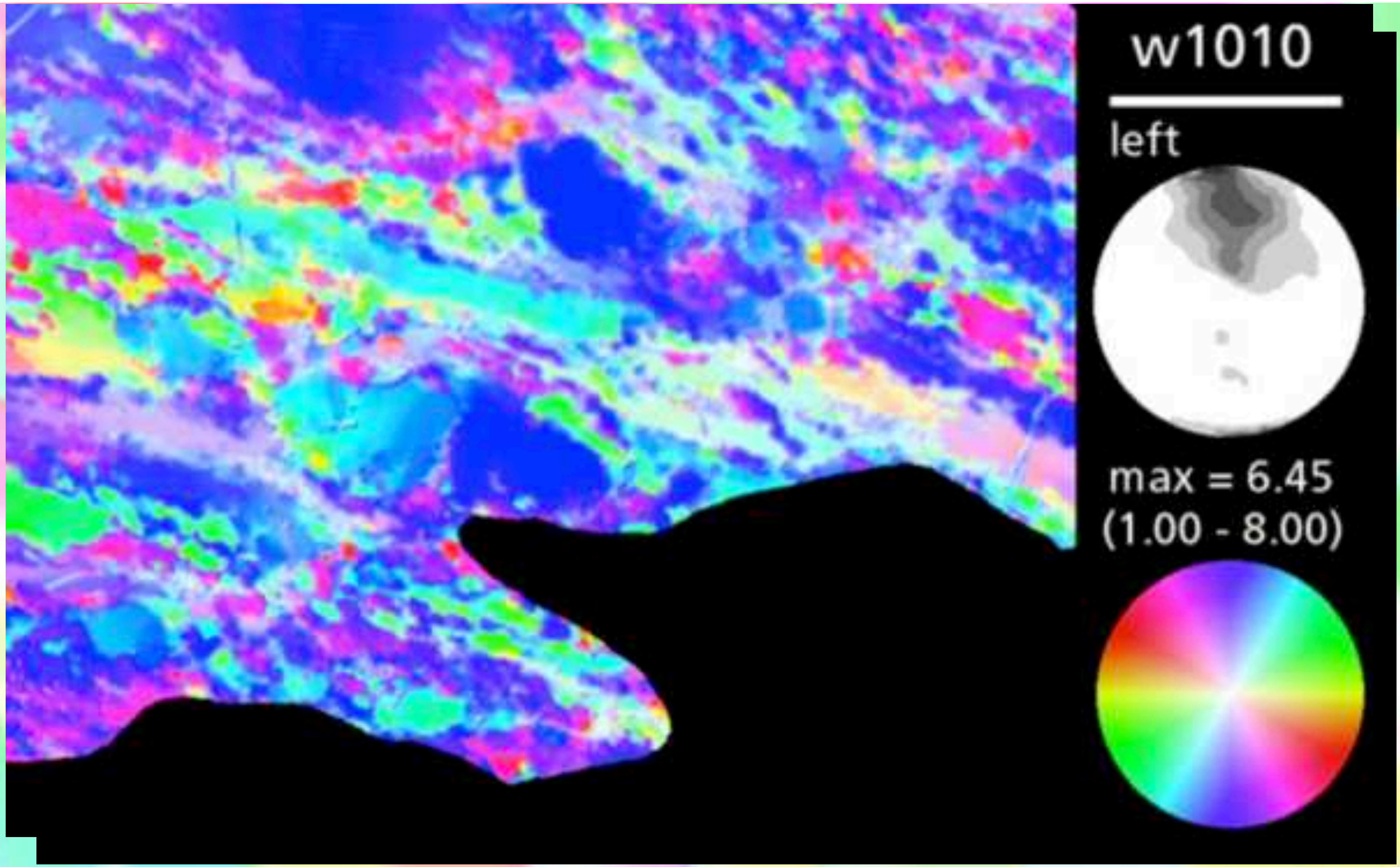


c-axis orientation imaging **$\gamma \approx 1.5$**



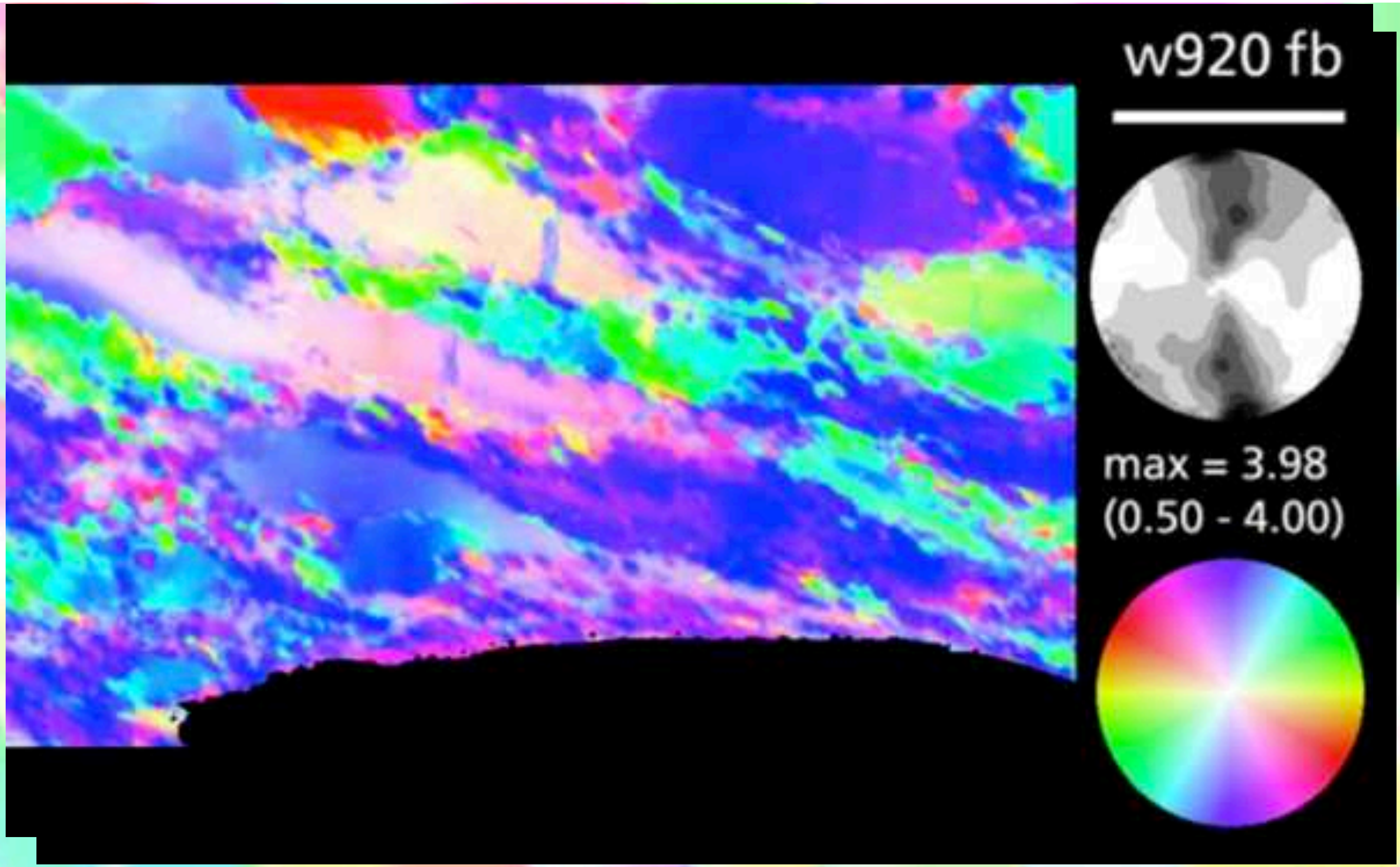
c-axis orientation imaging

$\gamma \approx 2.5$



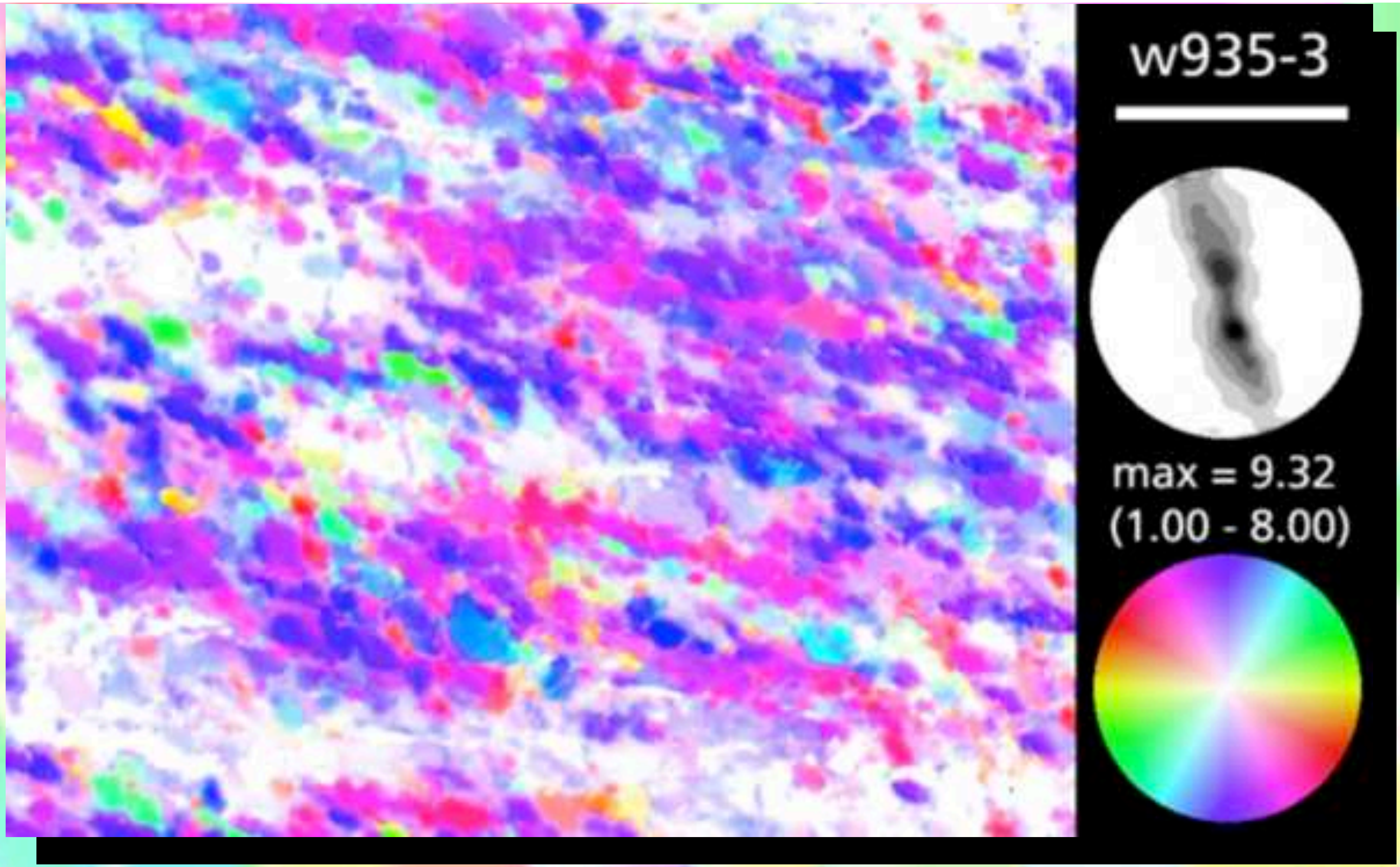
c-axis orientation imaging

$\gamma \approx 4$



c-axis orientation imaging

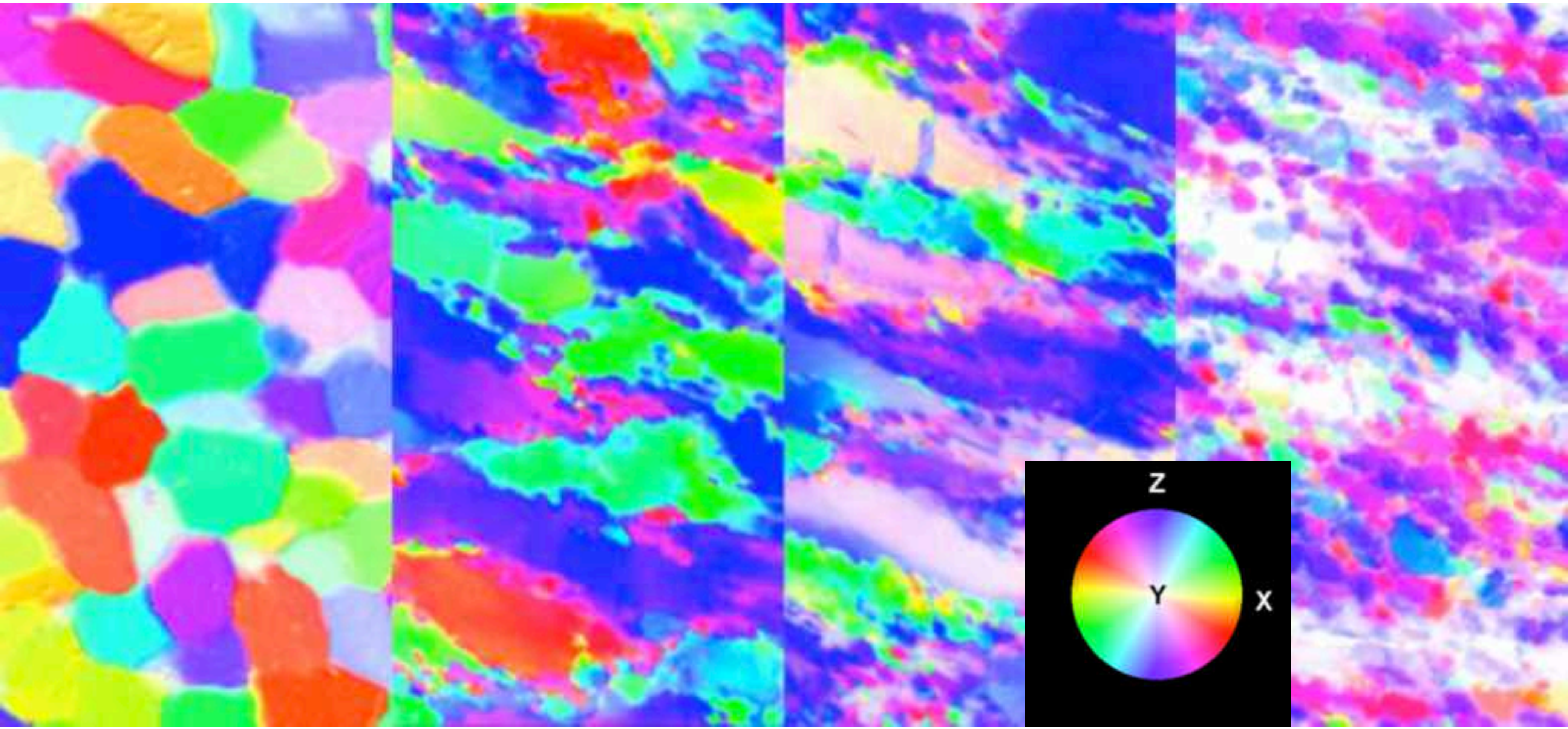
$\gamma \approx 6$



!

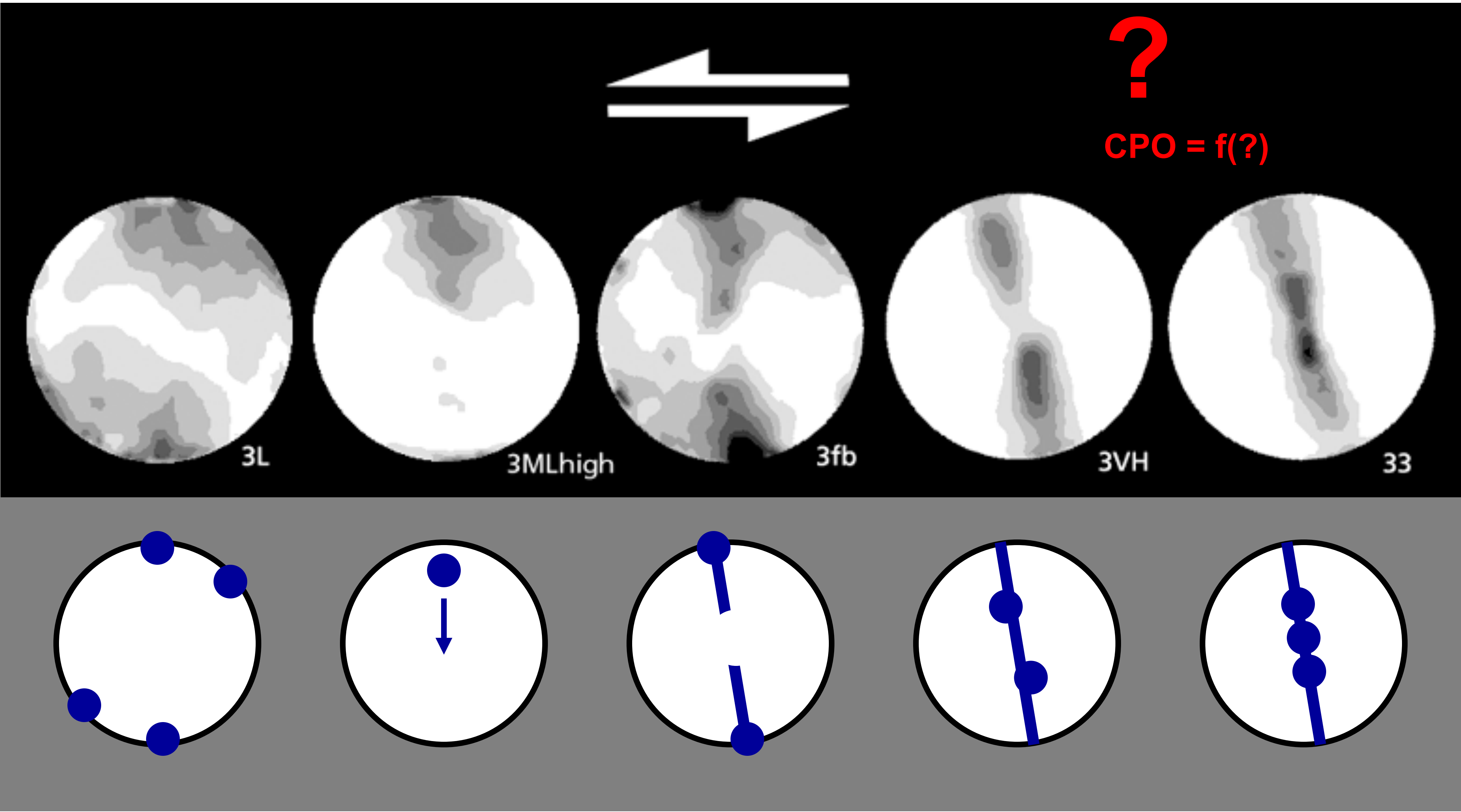
domain size

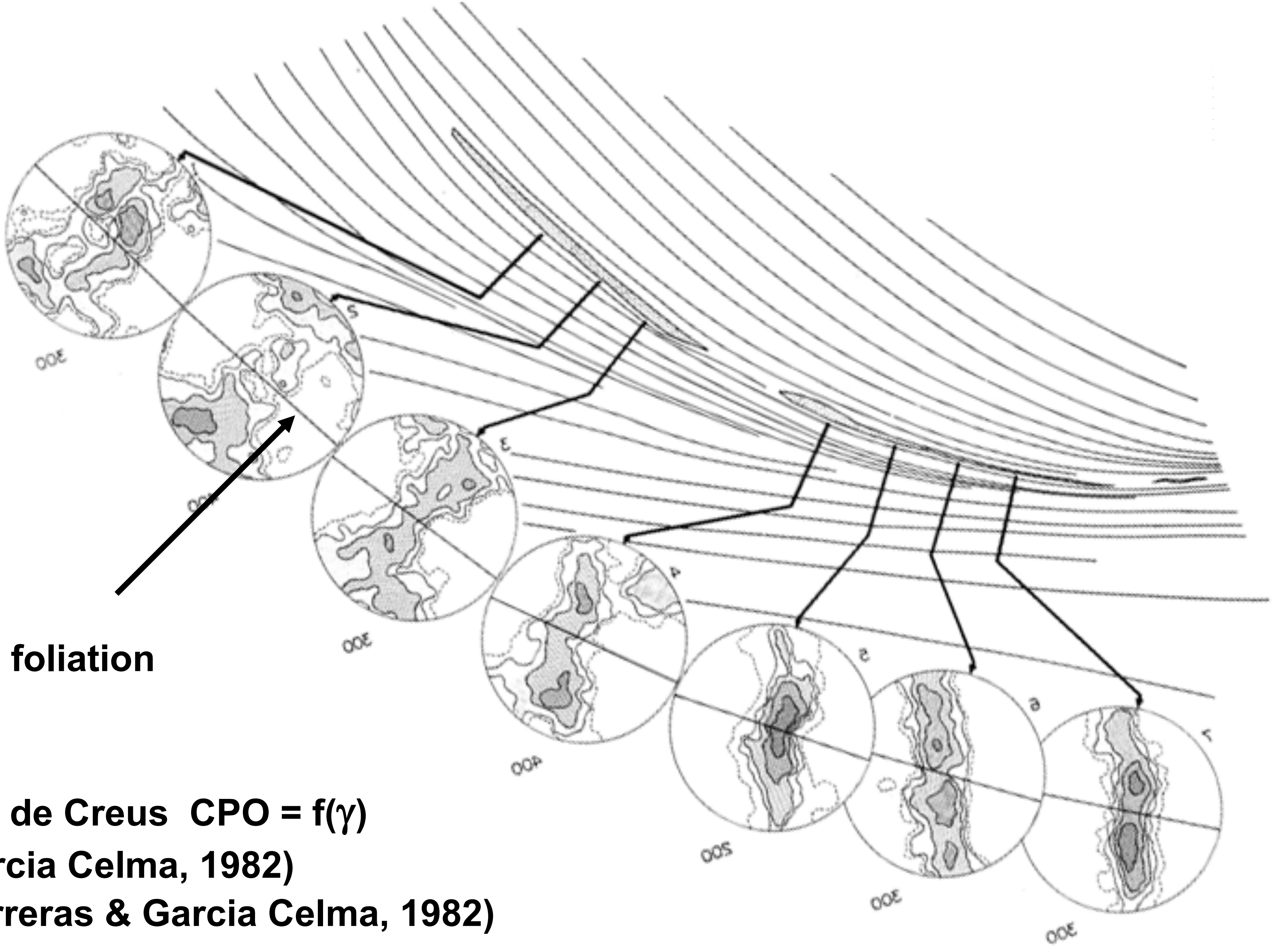
development of microfabric



γ = 0 1.5 4 6

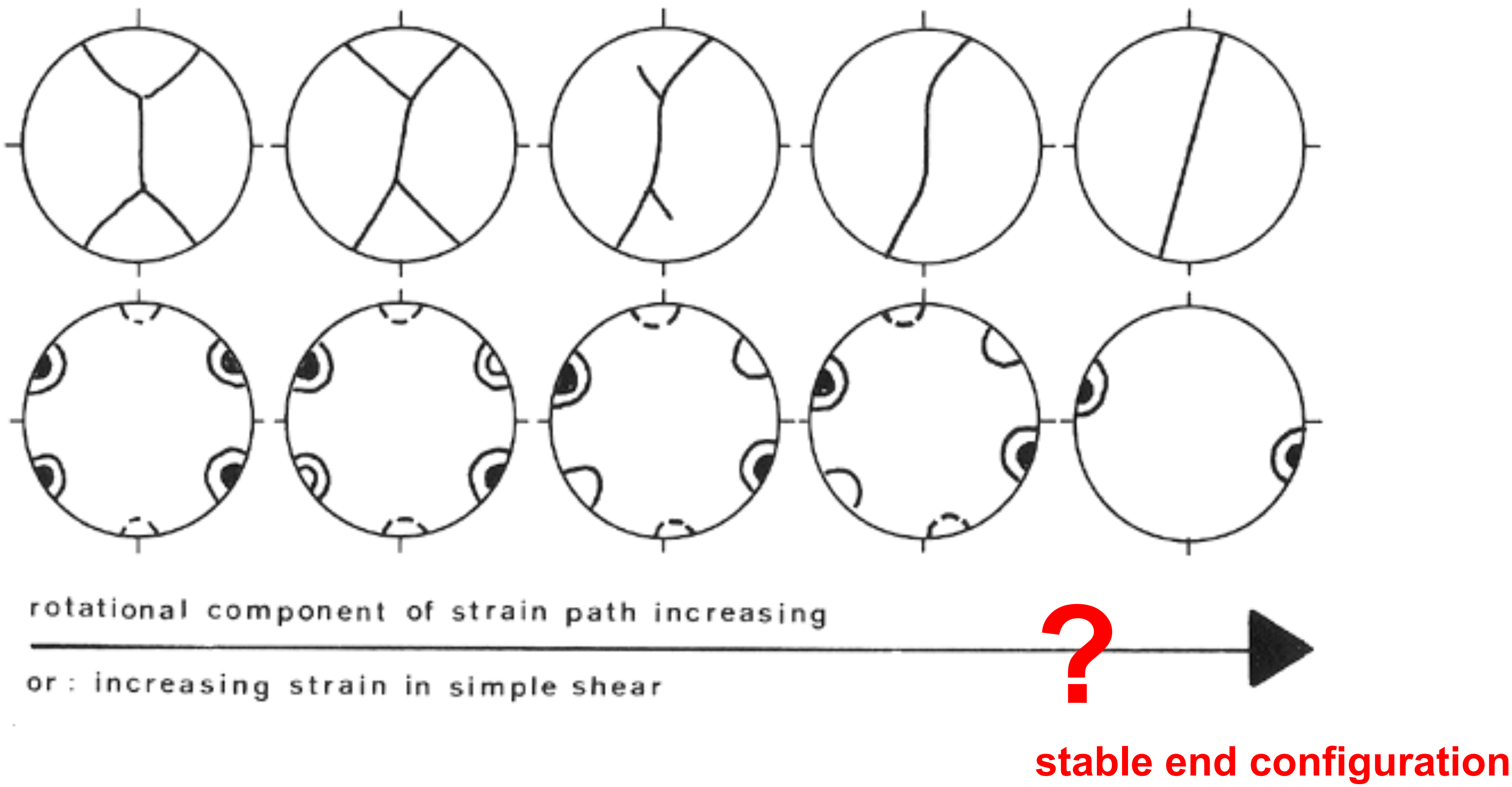
pole figure development



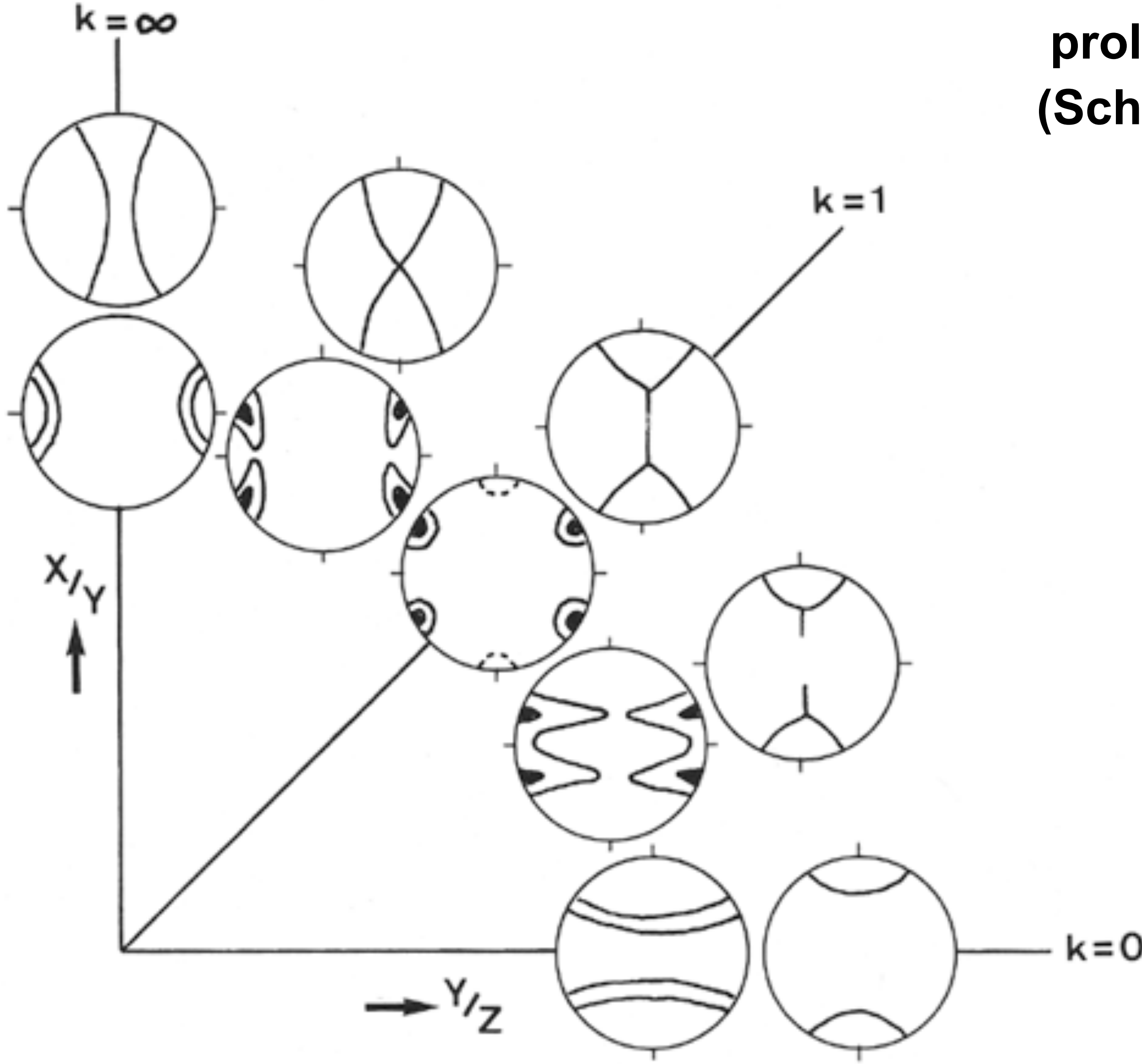


Cap de Creus CPO = f(γ)
(Garcia Celma, 1982)
(Carreras & Garcia Celma, 1982)

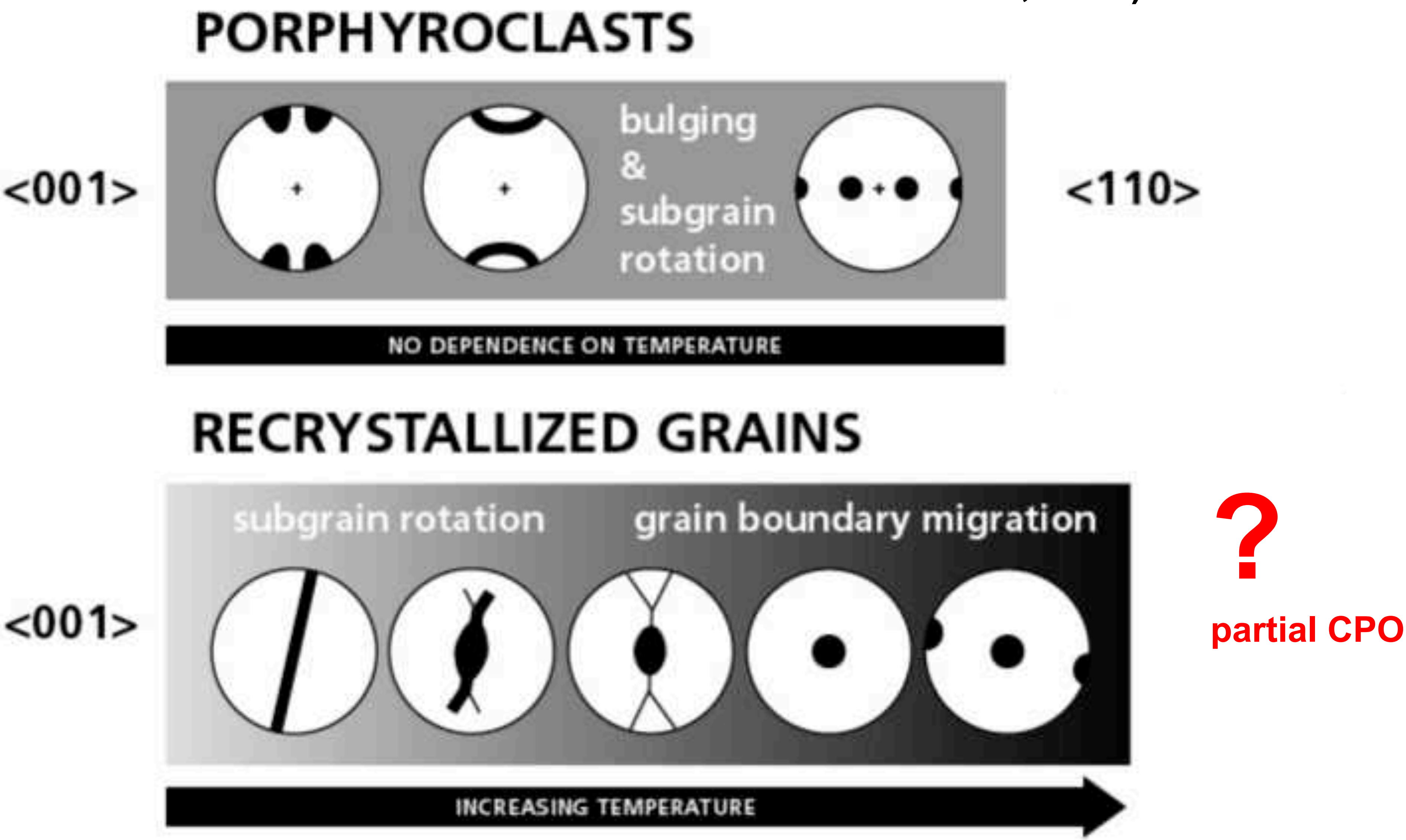
fabric skeletons
coaxial - shear
(Schmid & Casey, 1986)



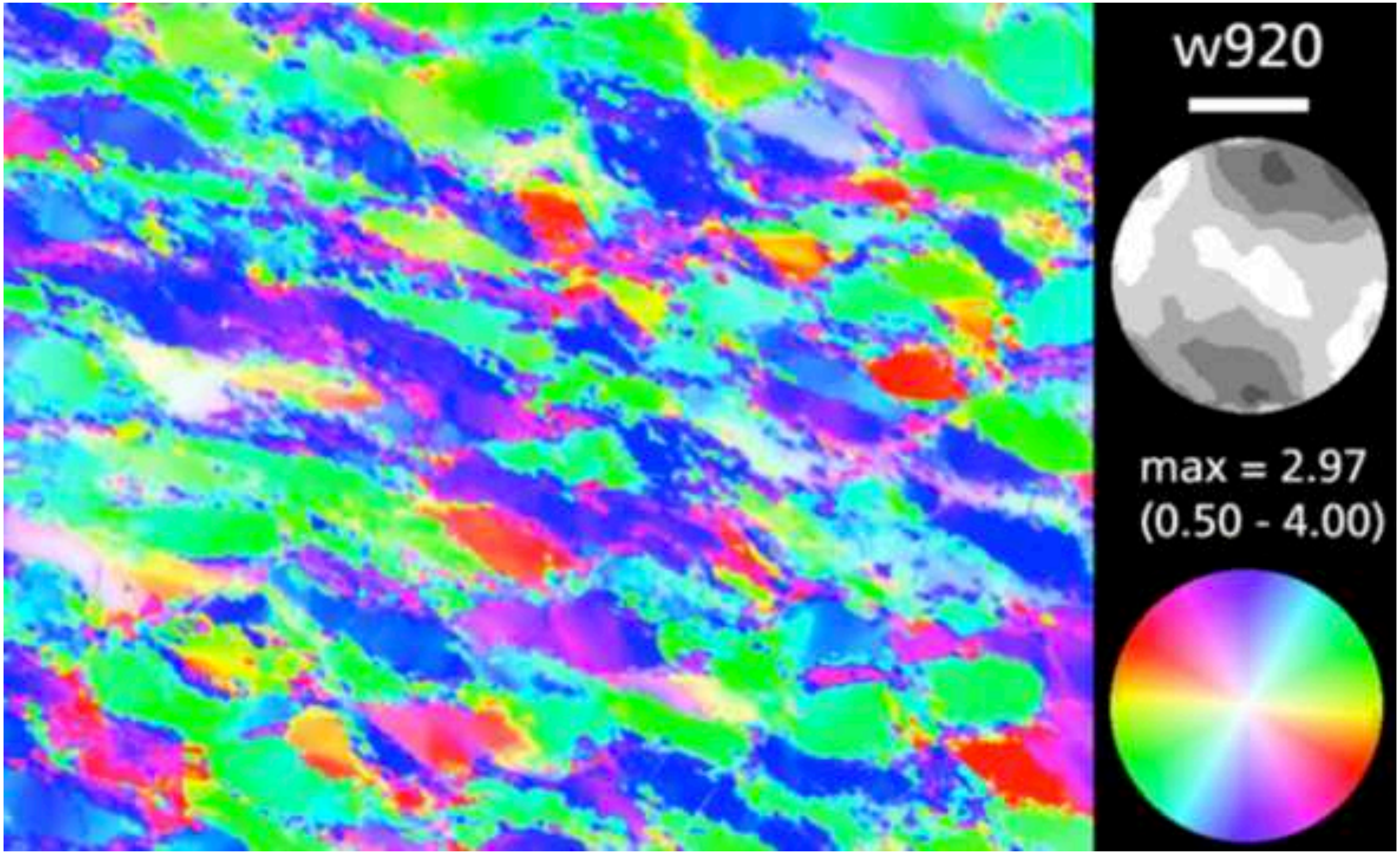
fabric skeletons
prolate - oblate
(Schmid & Casey, 1986)



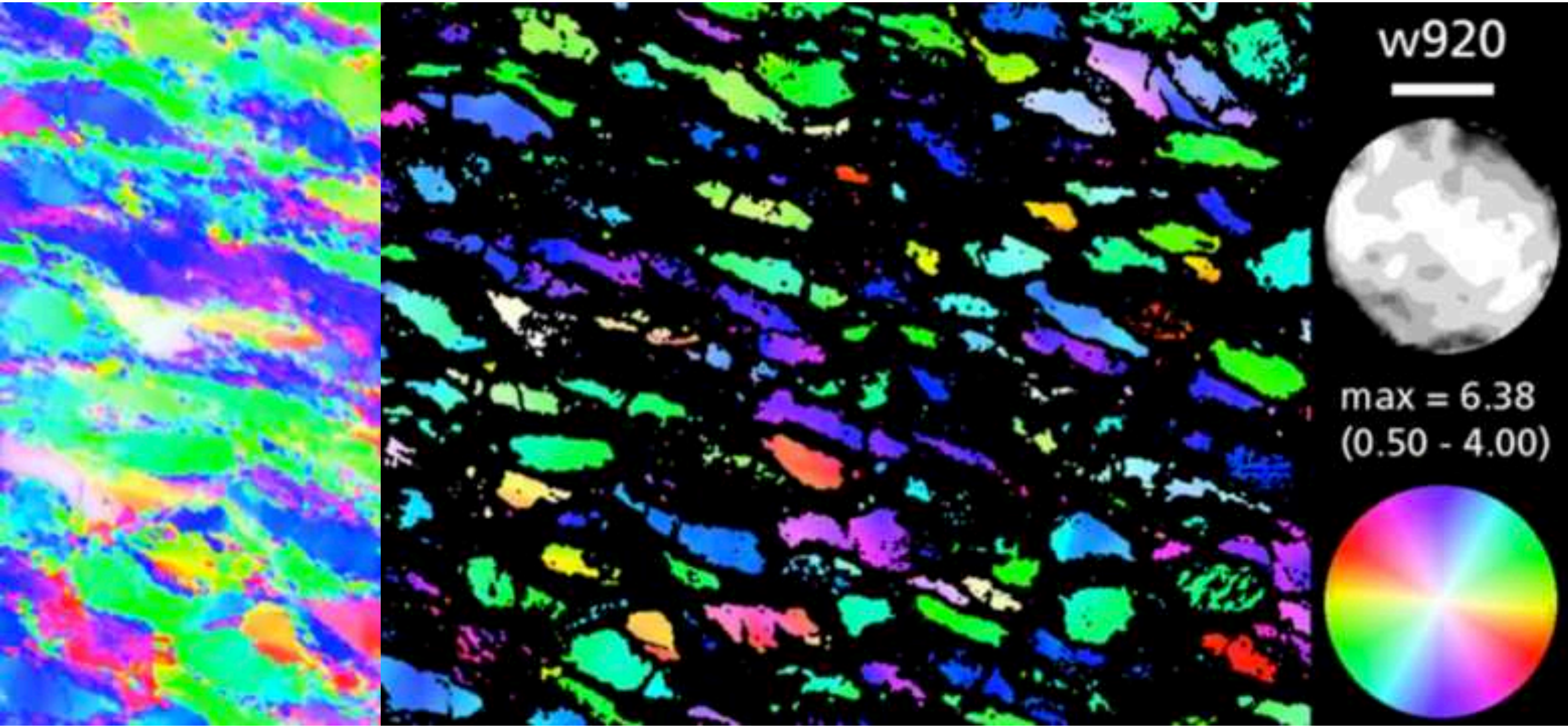
Tonale CPO = f(T)
(Stipp, Stünitz, Heilbronner & Schmid, 2002)



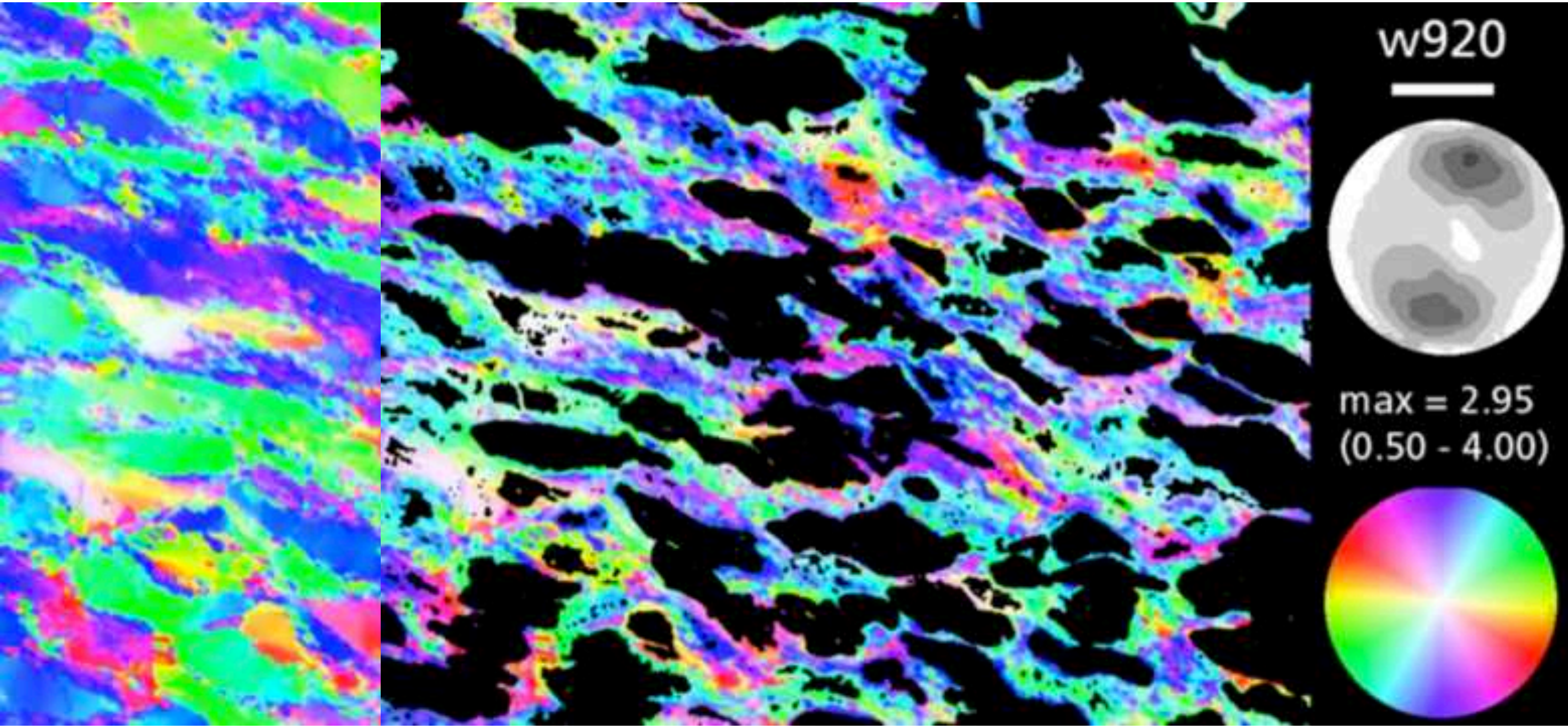
bulk CPO



partial CPO : porphyroclasts



partial CPO : recrystallized grains

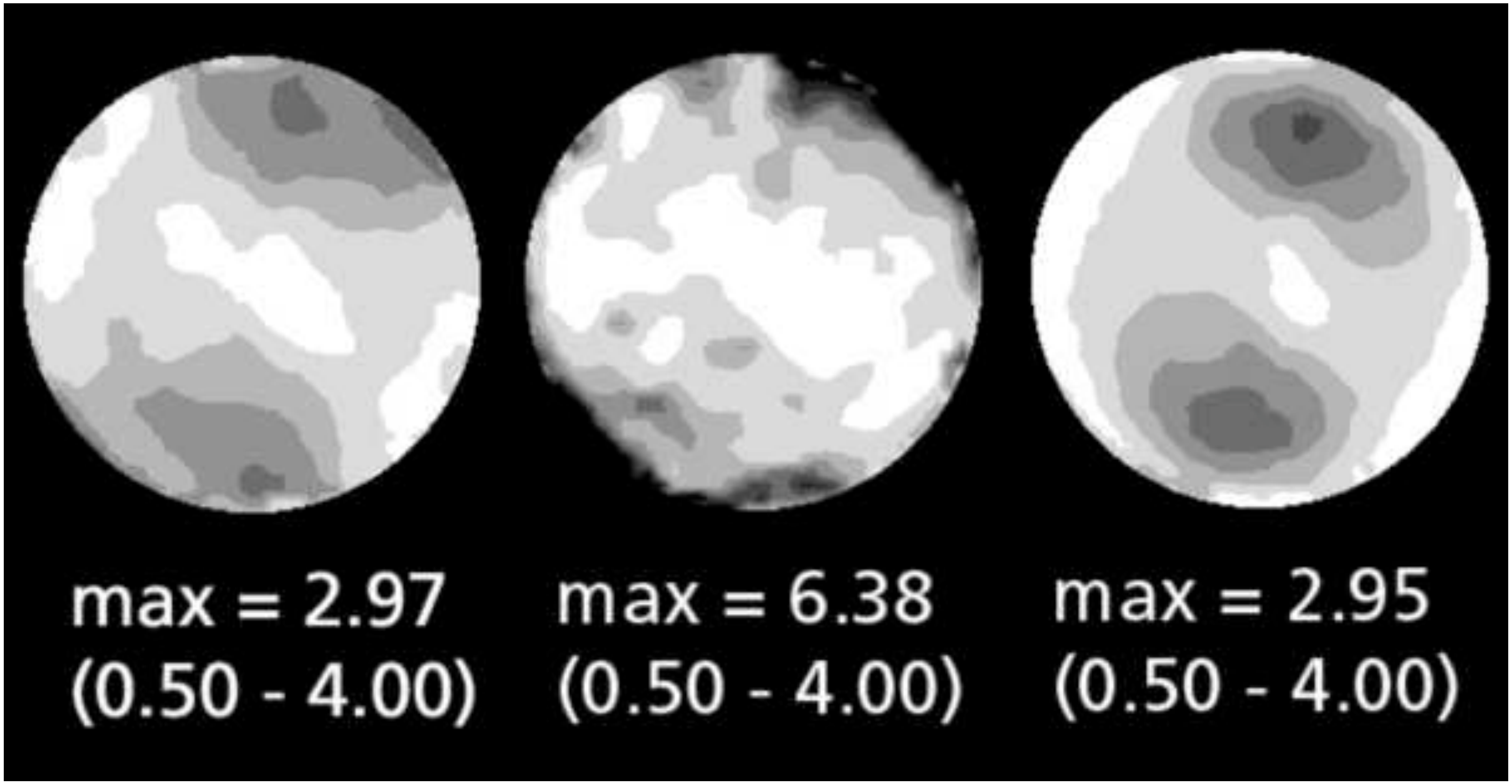


bulk CPO

partial CPOs :

porphyroclasts

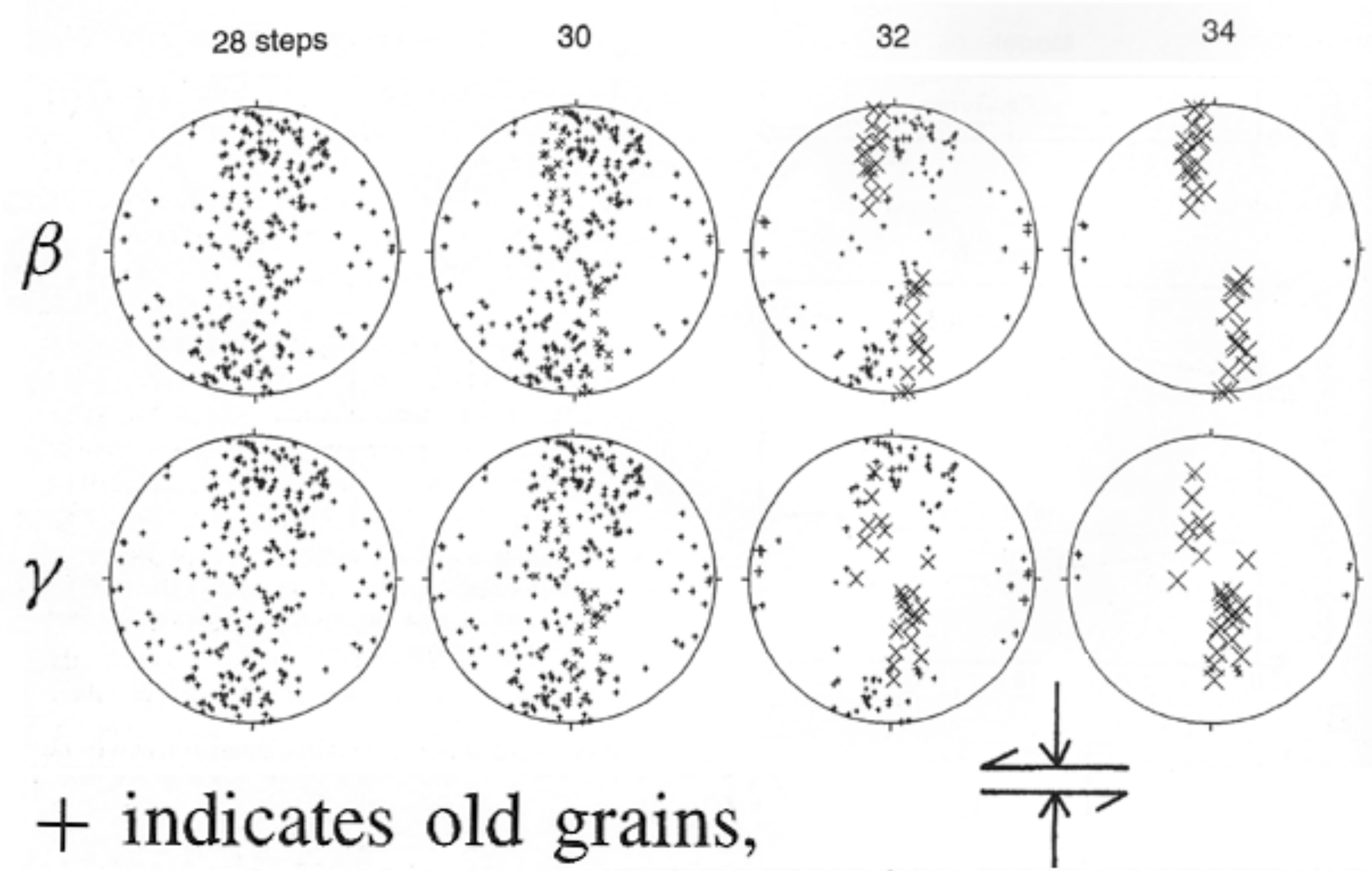
recrystallized grains



?

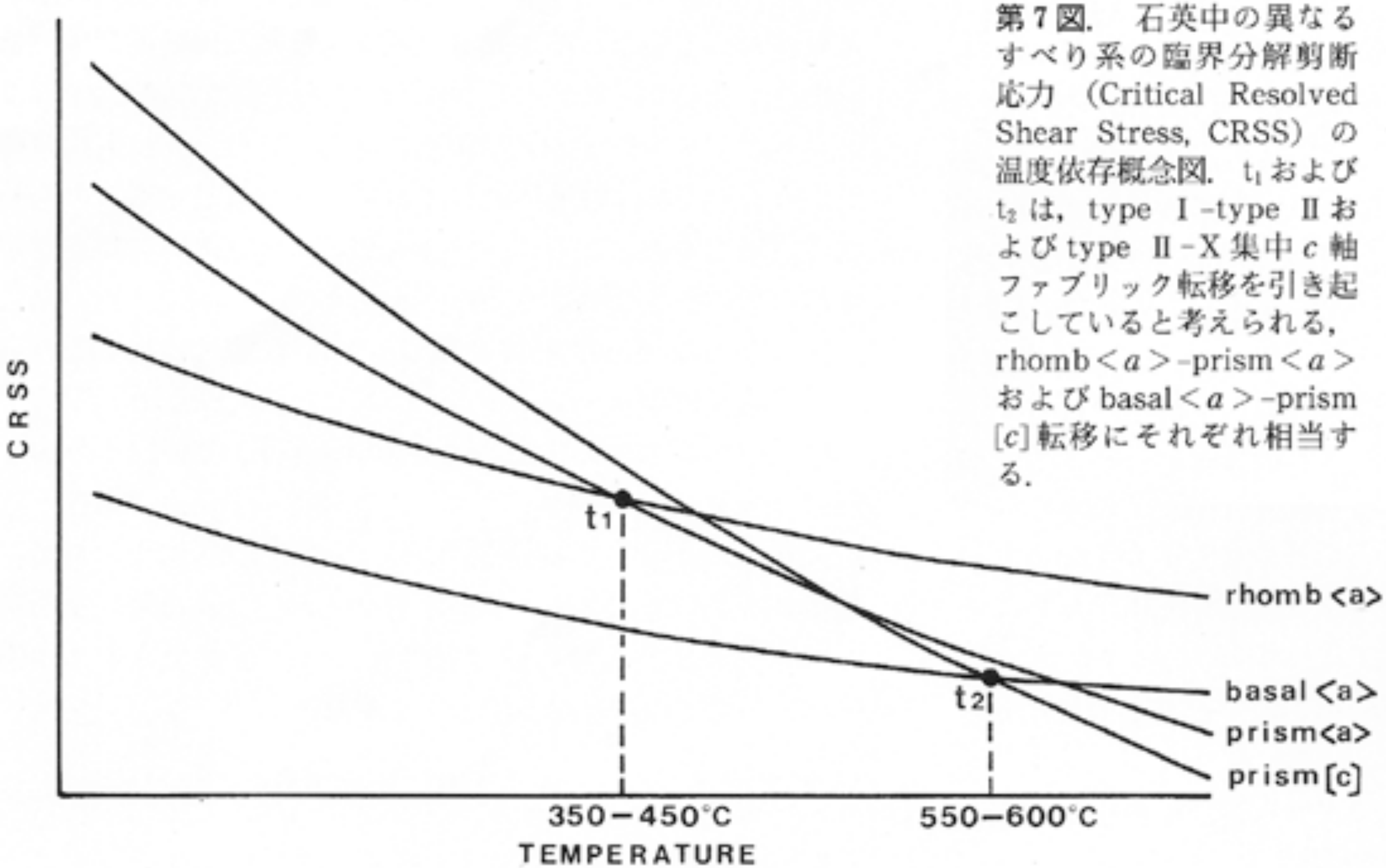
max of CPO

VPSC model
(Takeshita, Wenk & Lebensohn, 1999)



+ indicates old grains,
× grains that have nucleated at least once

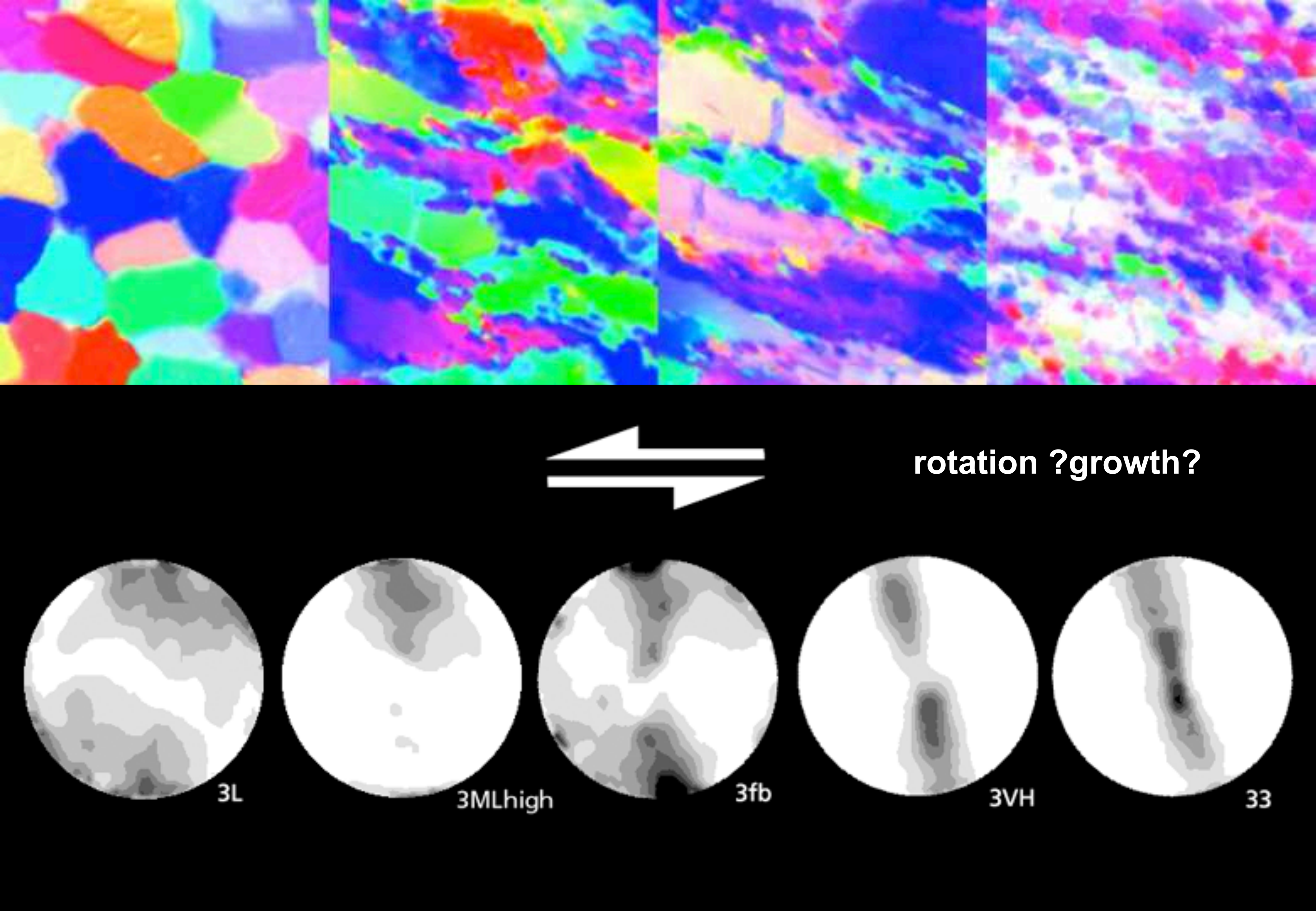
slip systems (Takeshita, 1996)



第7図. 石英中の異なるすべり系の臨界分解剪断応力（Critical Resolved Shear Stress, CRSS）の温度依存概念図. t_1 および t_2 は, type Ⅰ-type Ⅱおよびtype Ⅱ-X集中 *c* 軸ファブリック転移を引き起こしていると考えられる, rhomb<*a*>-prism<*a*>およびbasal<*a*>-prism[*c*]転移にそれぞれ相当する.

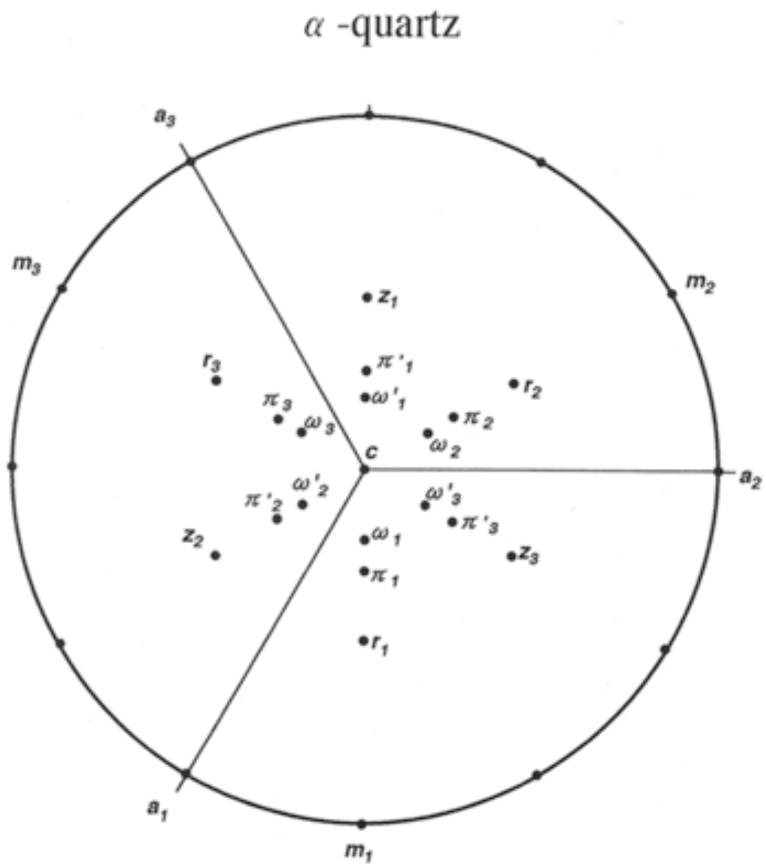
?

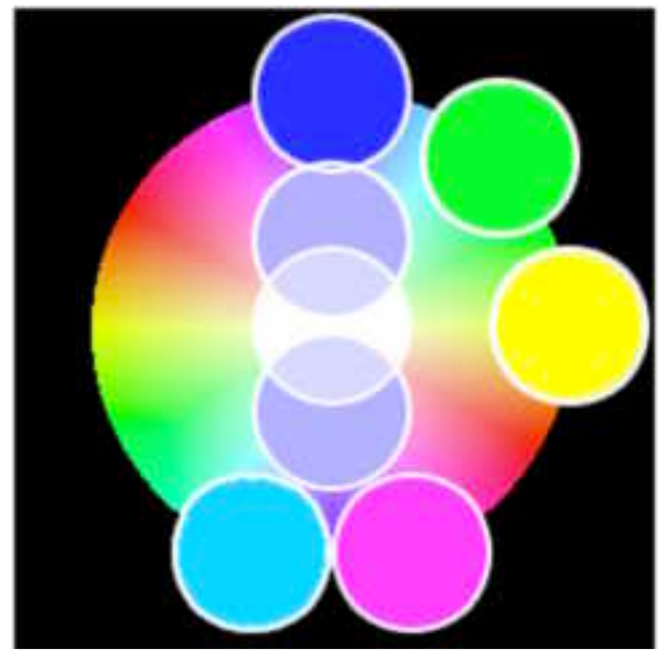
data

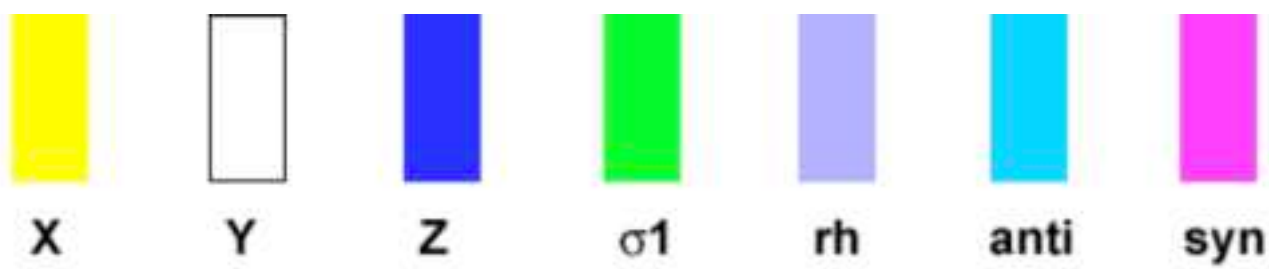

rotation ?growth?
3L
3MLhigh
3fb
3VH
33

volume % of domains - pole density estimation

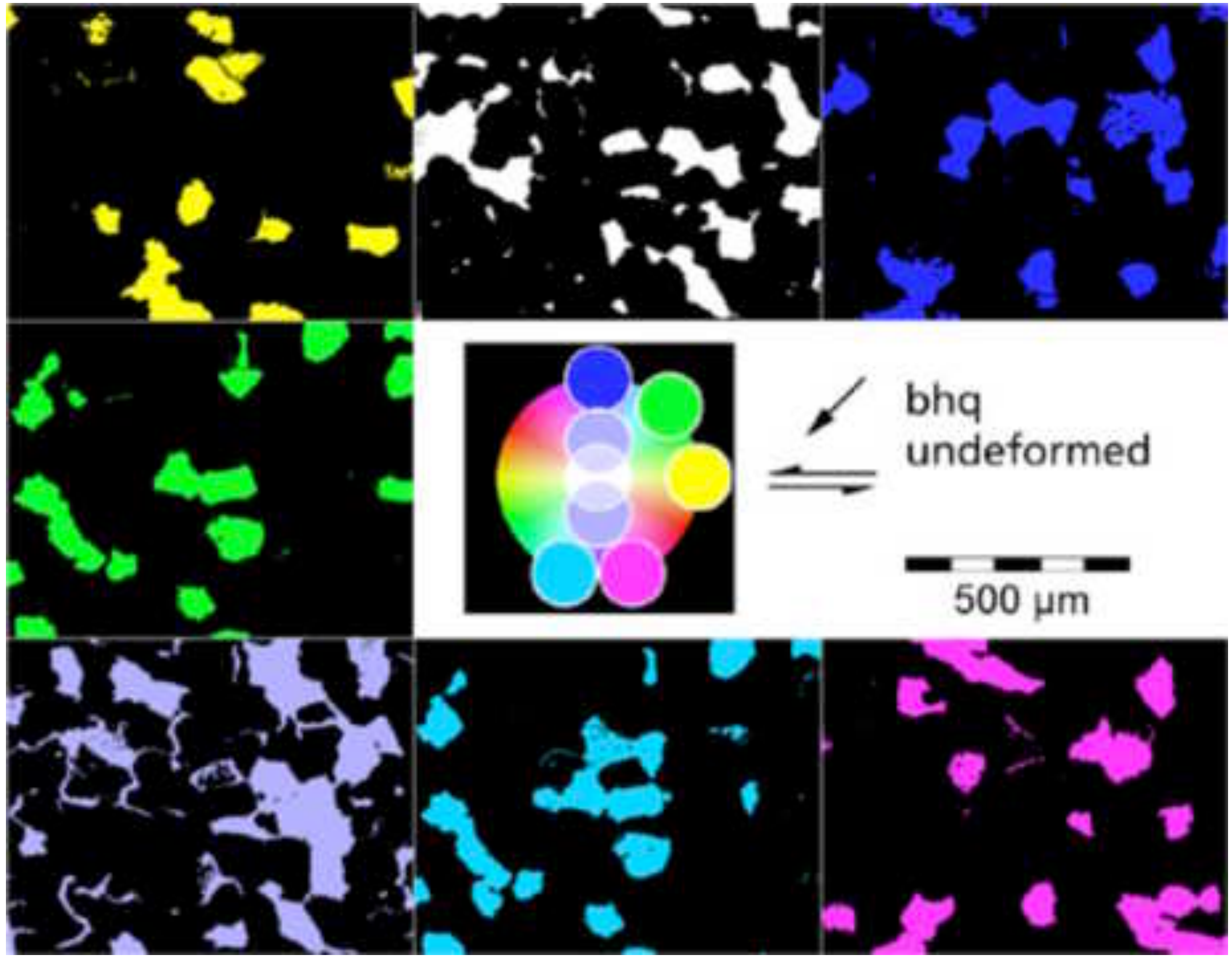
monitor selected orientations

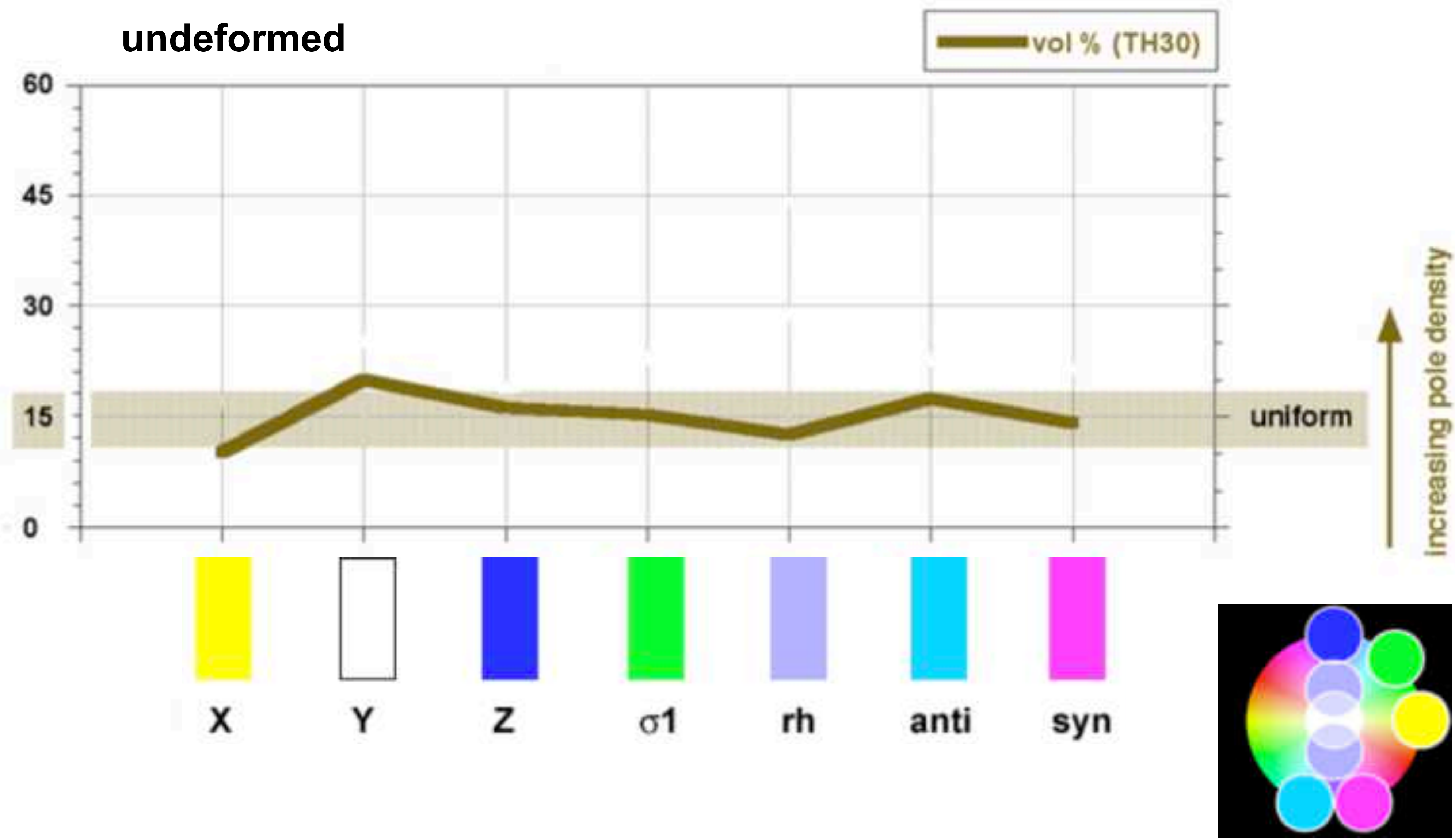




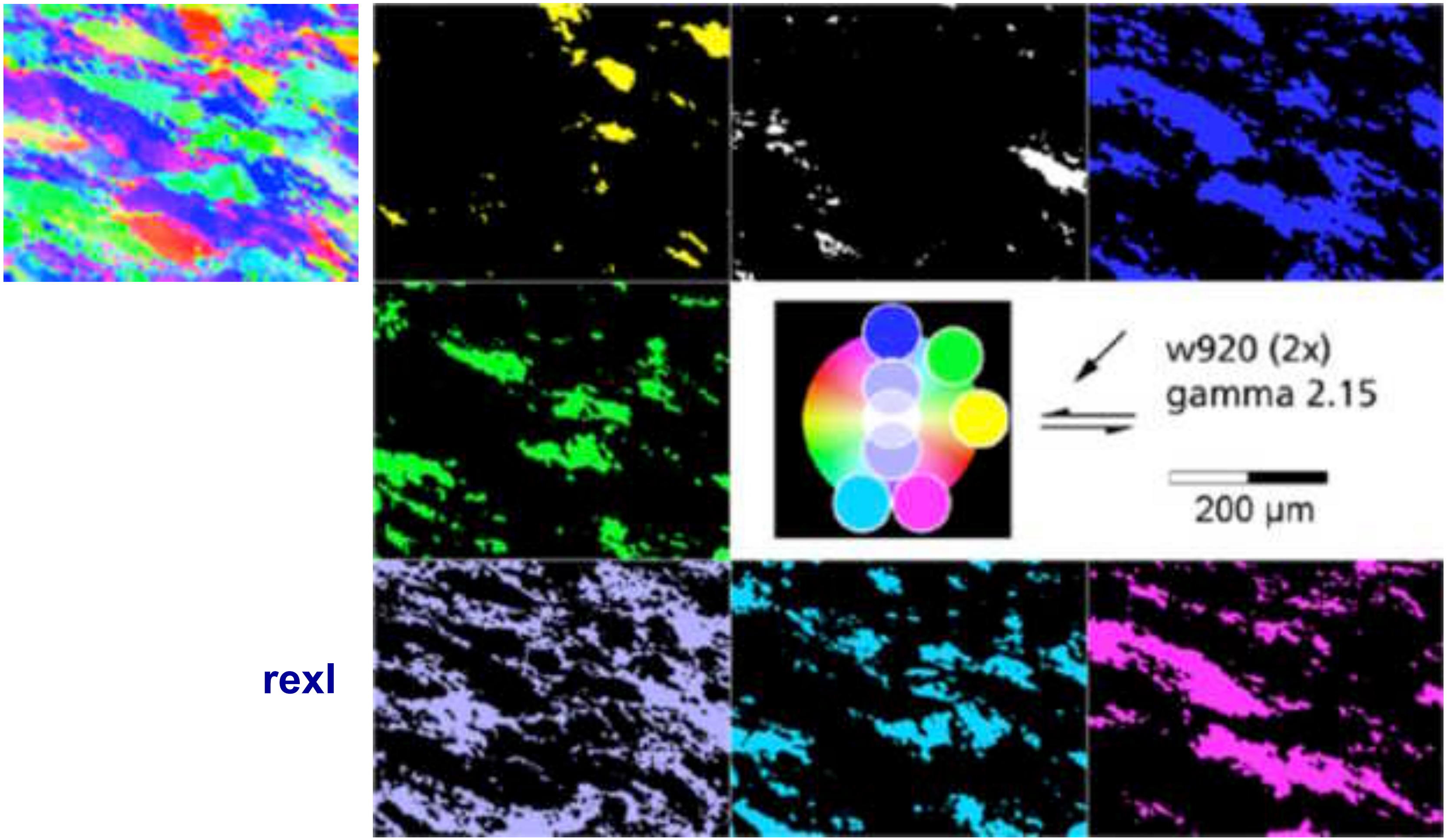


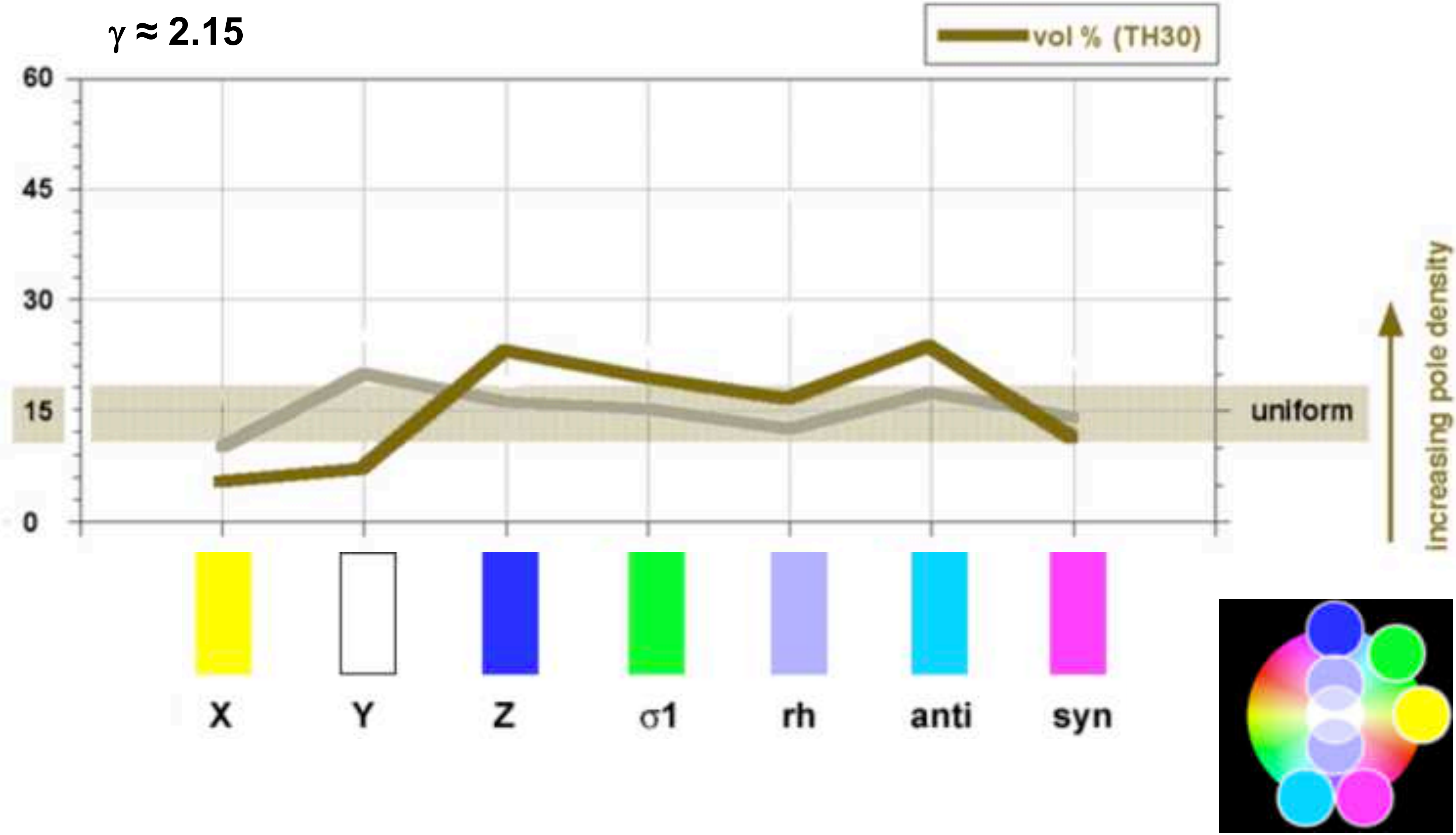
area % = volume %




undeformed
vol % (TH30)
60
45
30
15
0
uniform
increasing pole density
X
Y
Z
σ1
rh
anti
syn

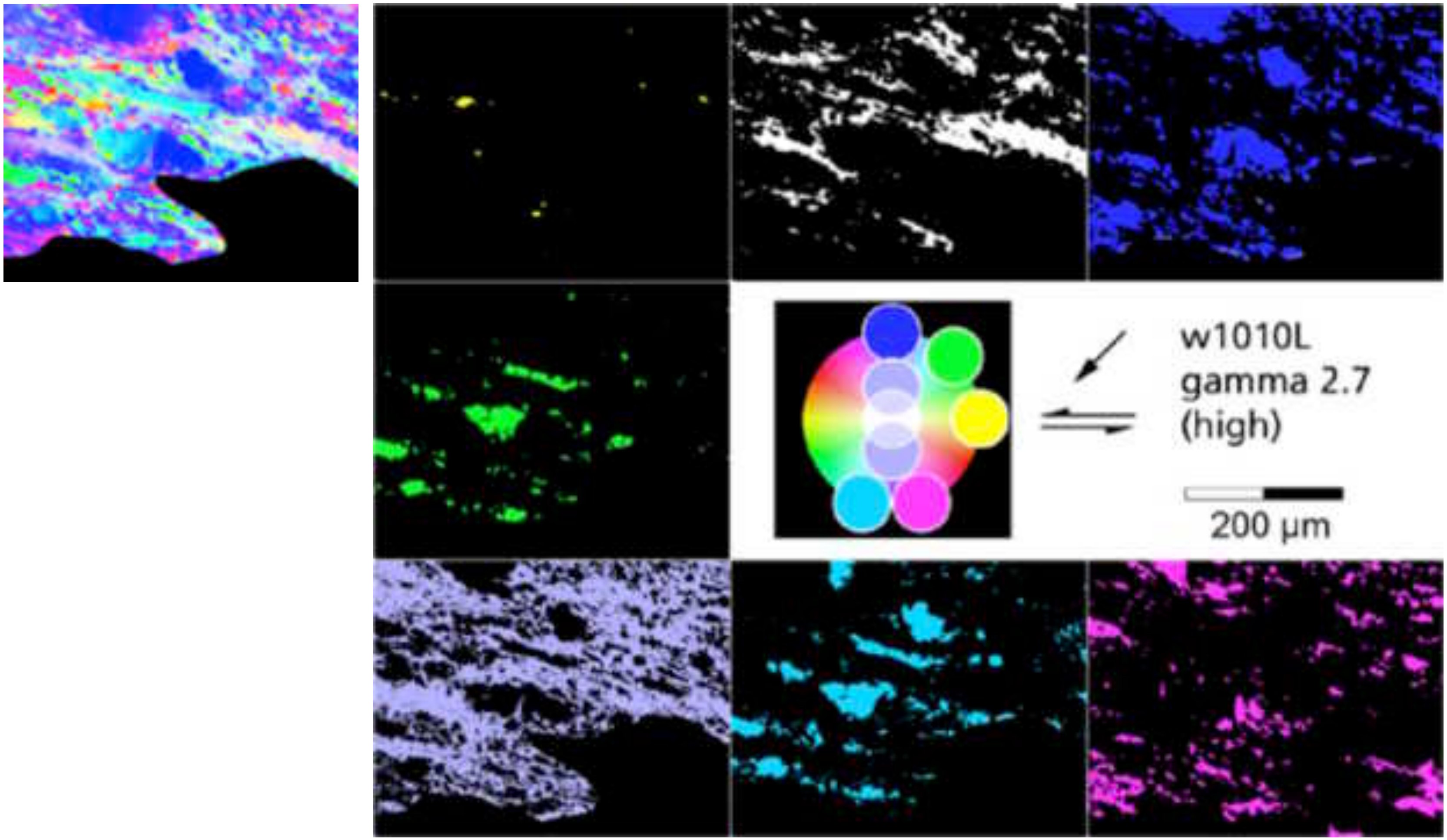
area % = volume %

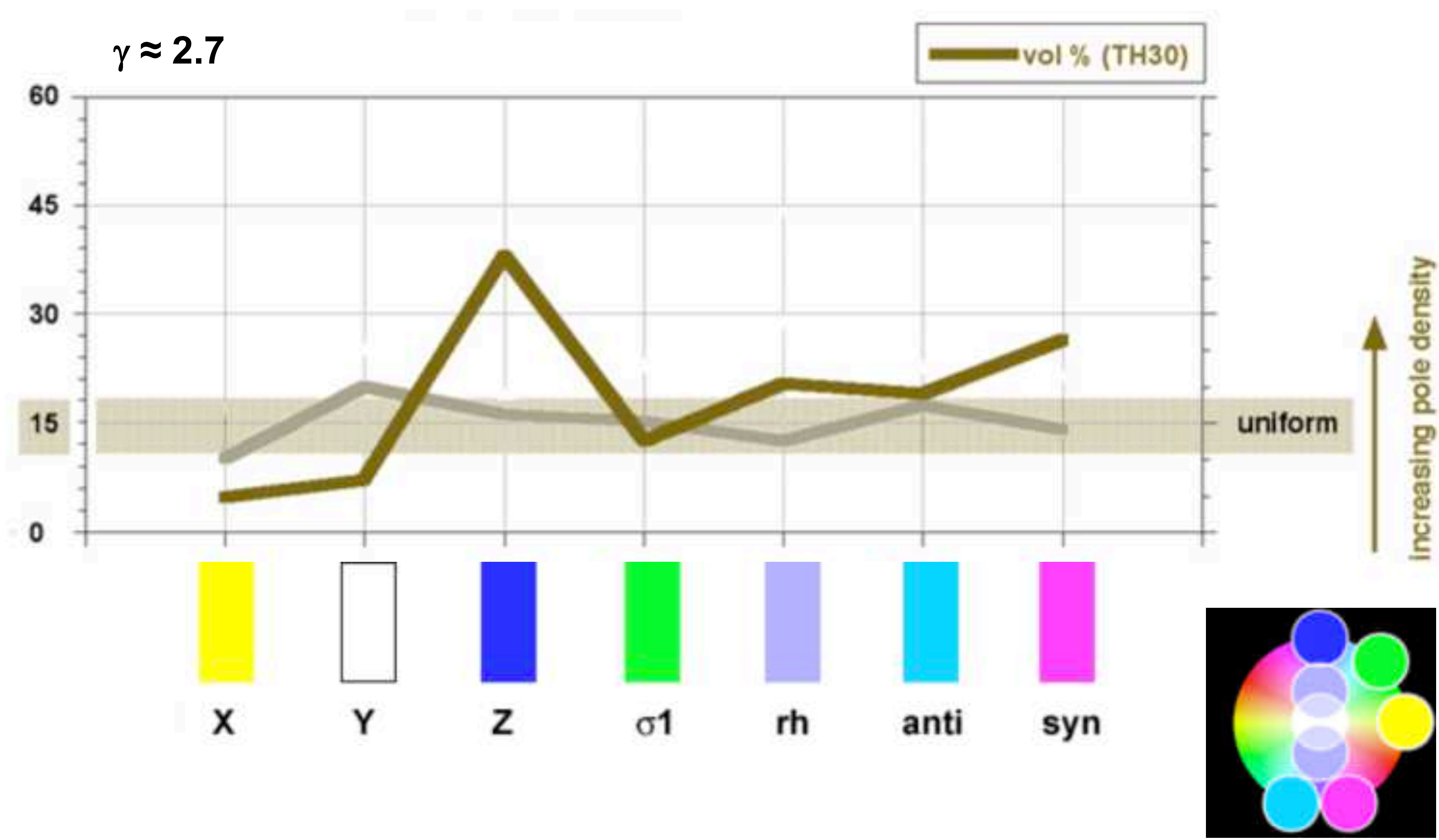




γ ≈ 2.15
vol % (TH30)
60
45
30
15
0
uniform
increasing pole density
X
Y
Z
σ1
rh
anti
syn

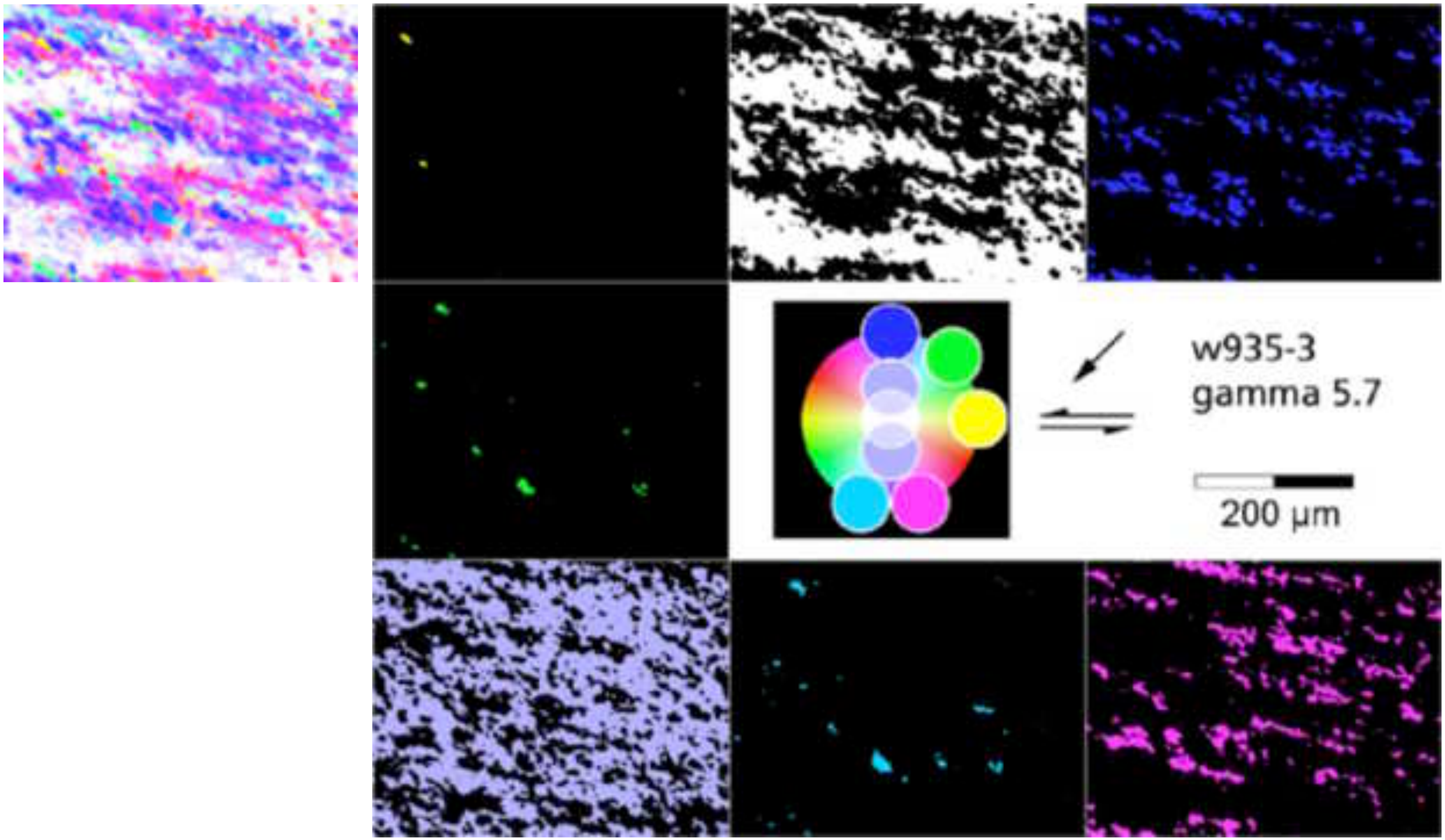
area % = volume %

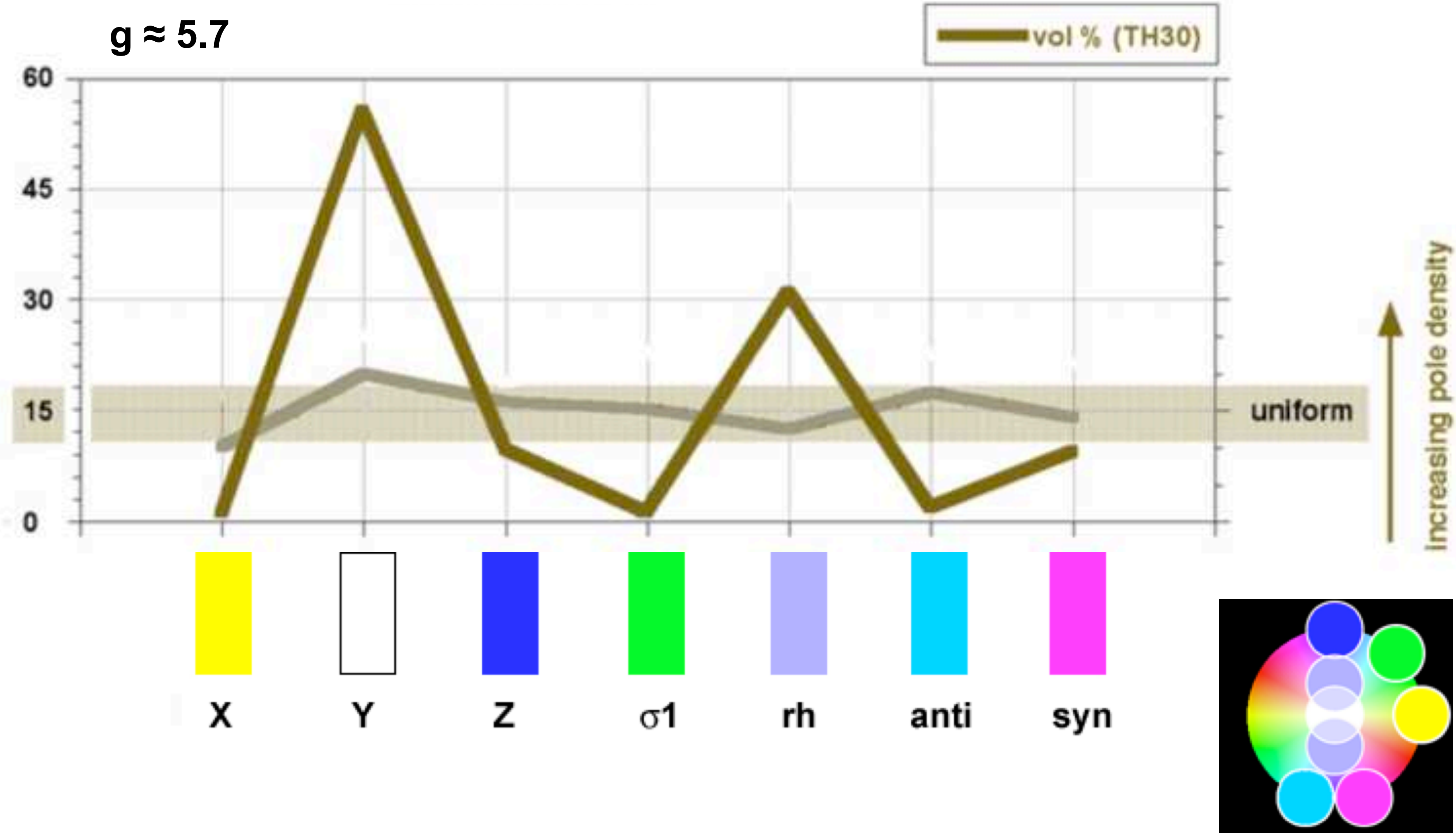




γ ≈ 2.7
vol % (TH30)
60
45
30
15
0
uniform
increasing pole density
X
Y
Z
σ1
rh
anti
syn

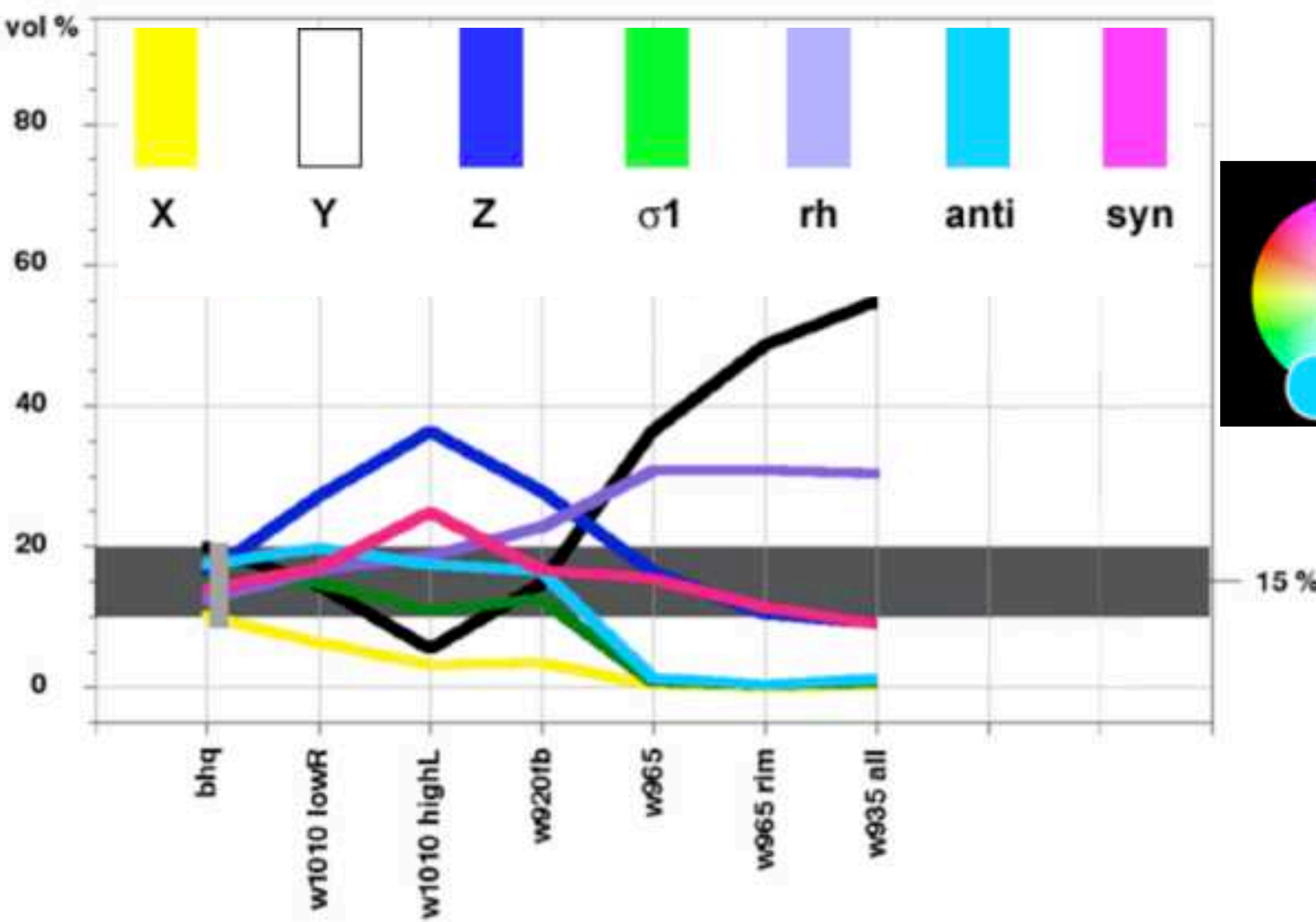
area % = volume %



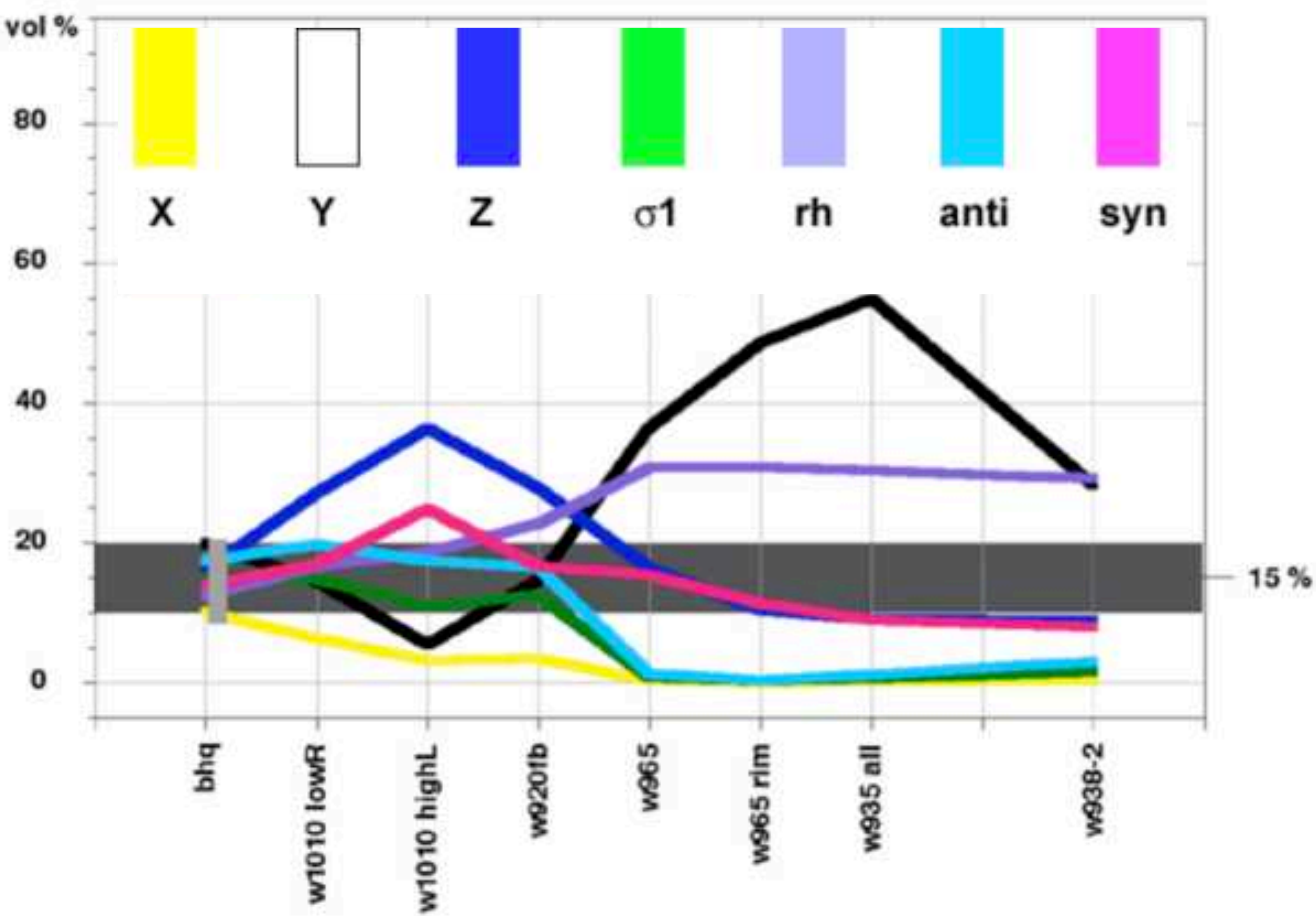


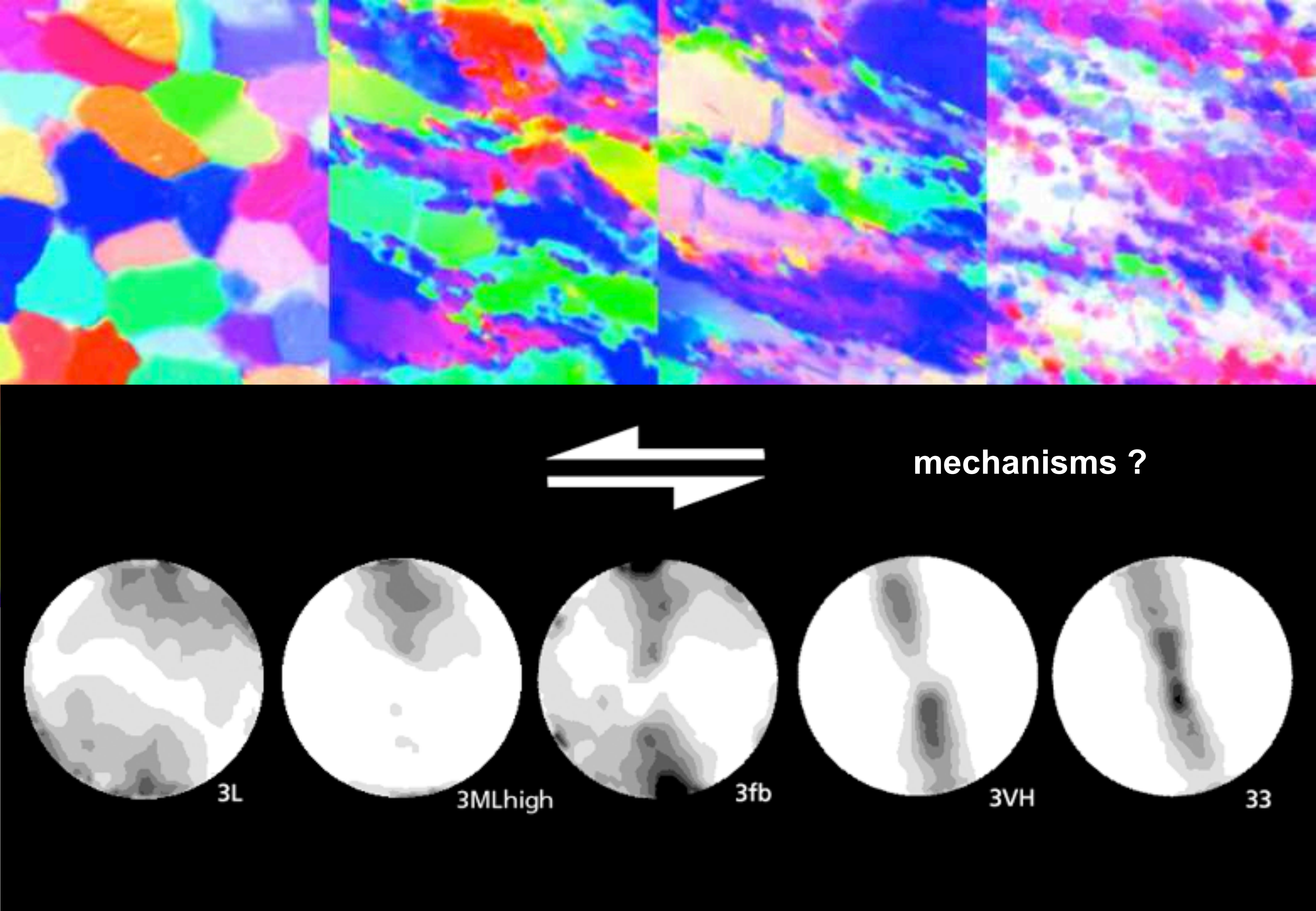
g ≈ 5.7
vol % (TH30)
60
45
30
15
0
uniform
increasing pole density
X
Y
Z
σ1
rh
anti
syn

development of CPO

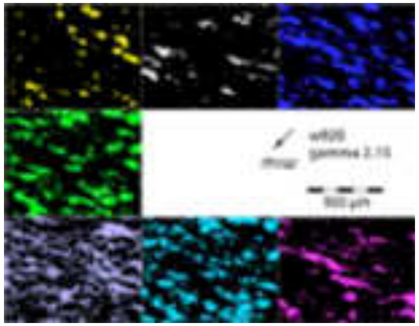


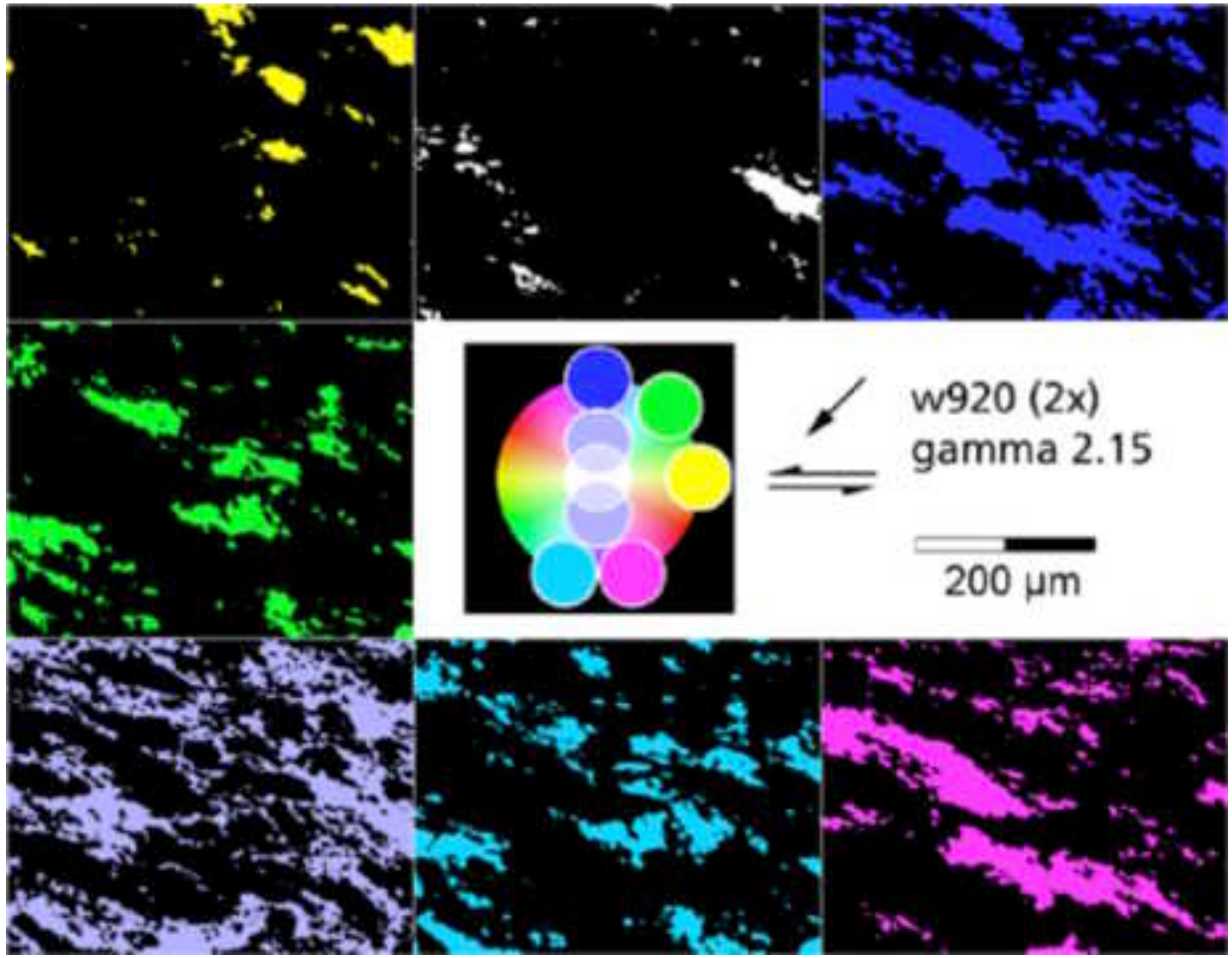
development of CPO & annealing



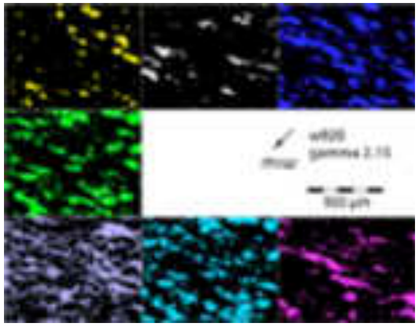

mechanisms ?
3L
3MLhigh
3fb
3VH
33

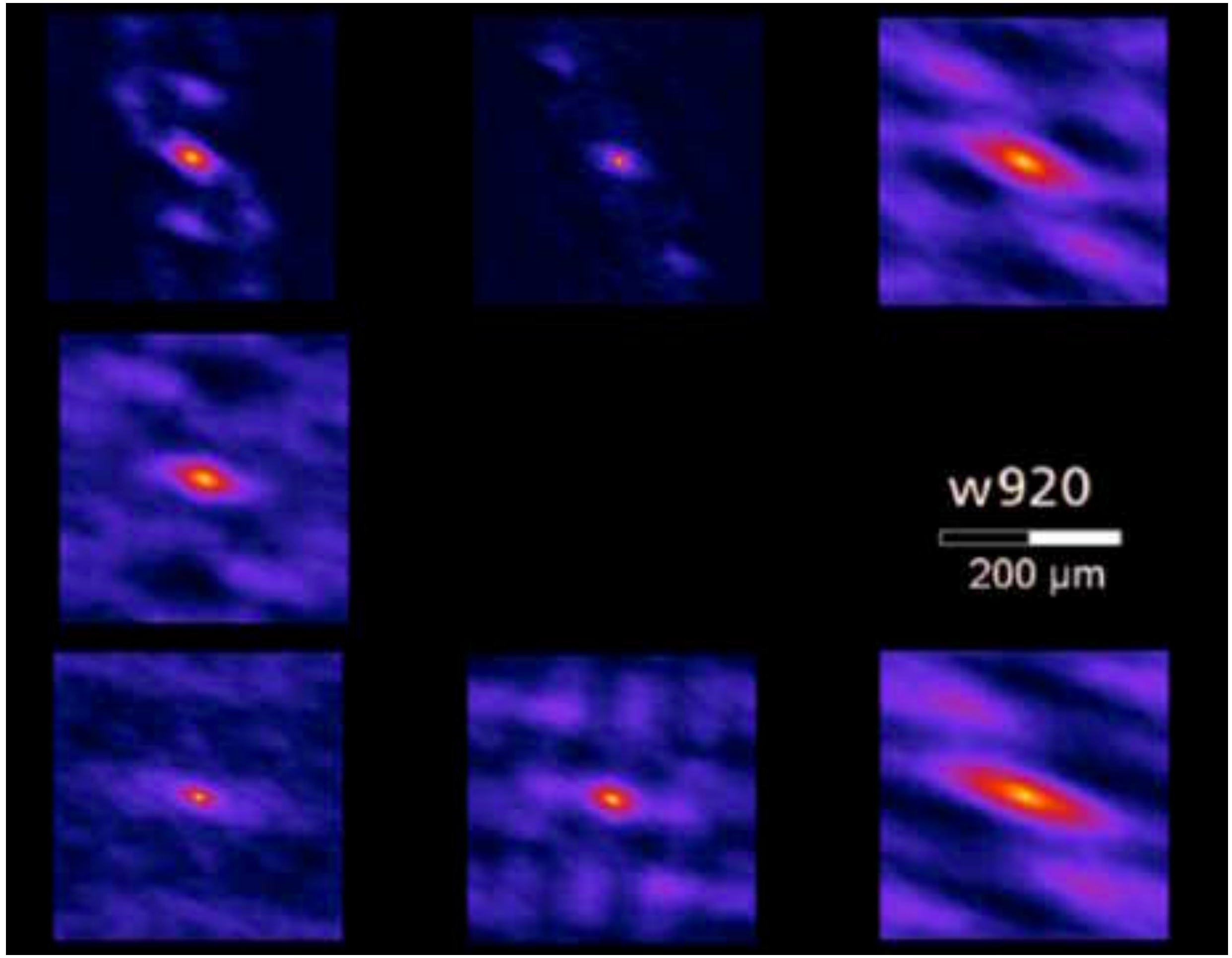
shape of 7 domains



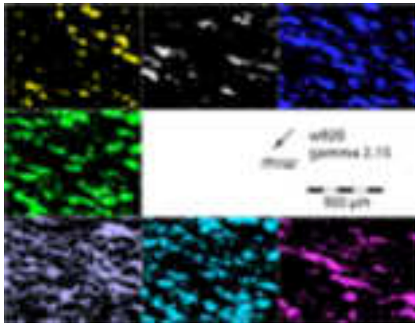


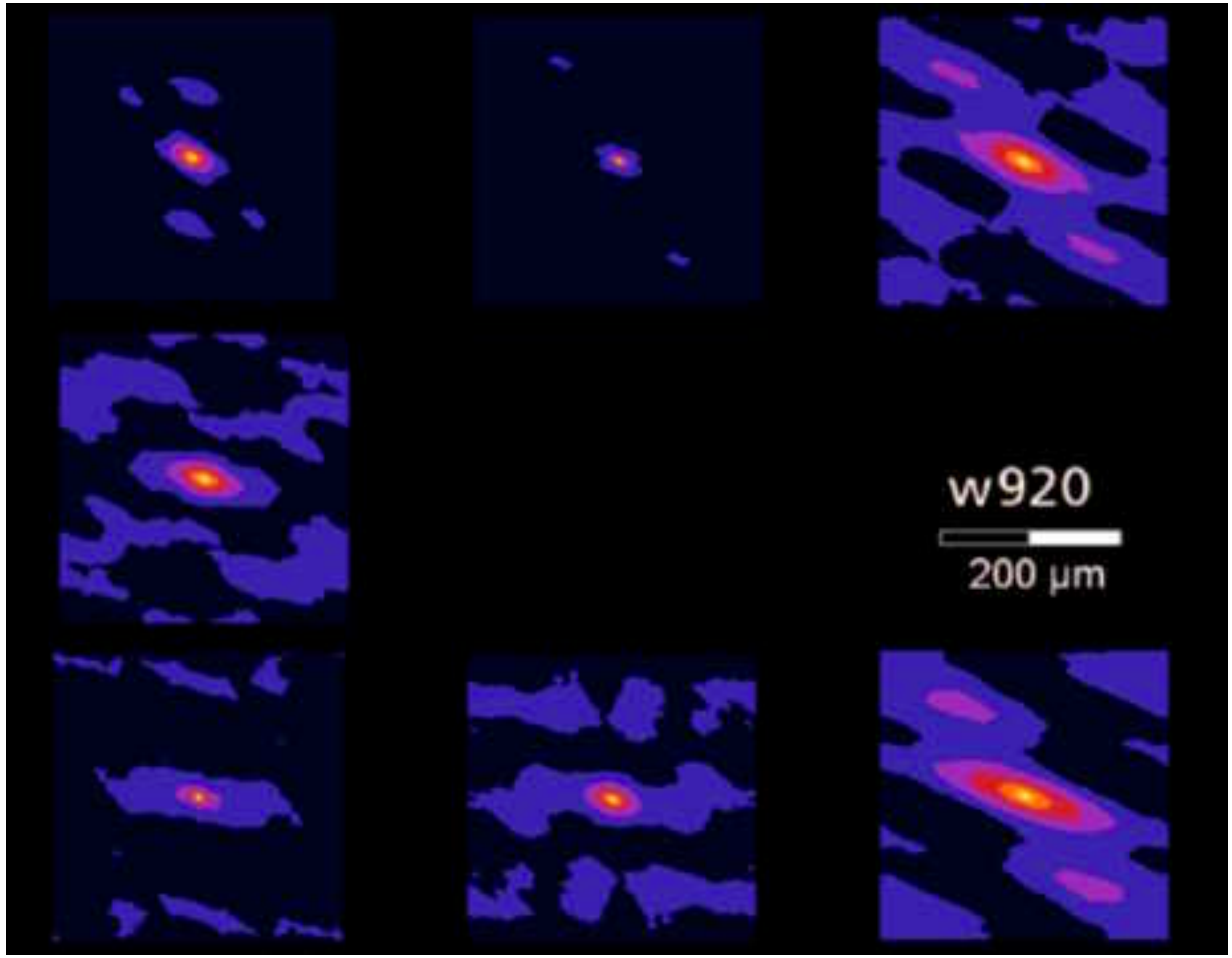
ACF, coloured



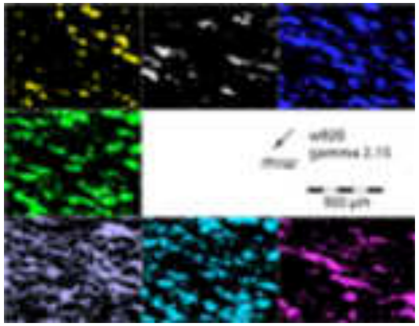


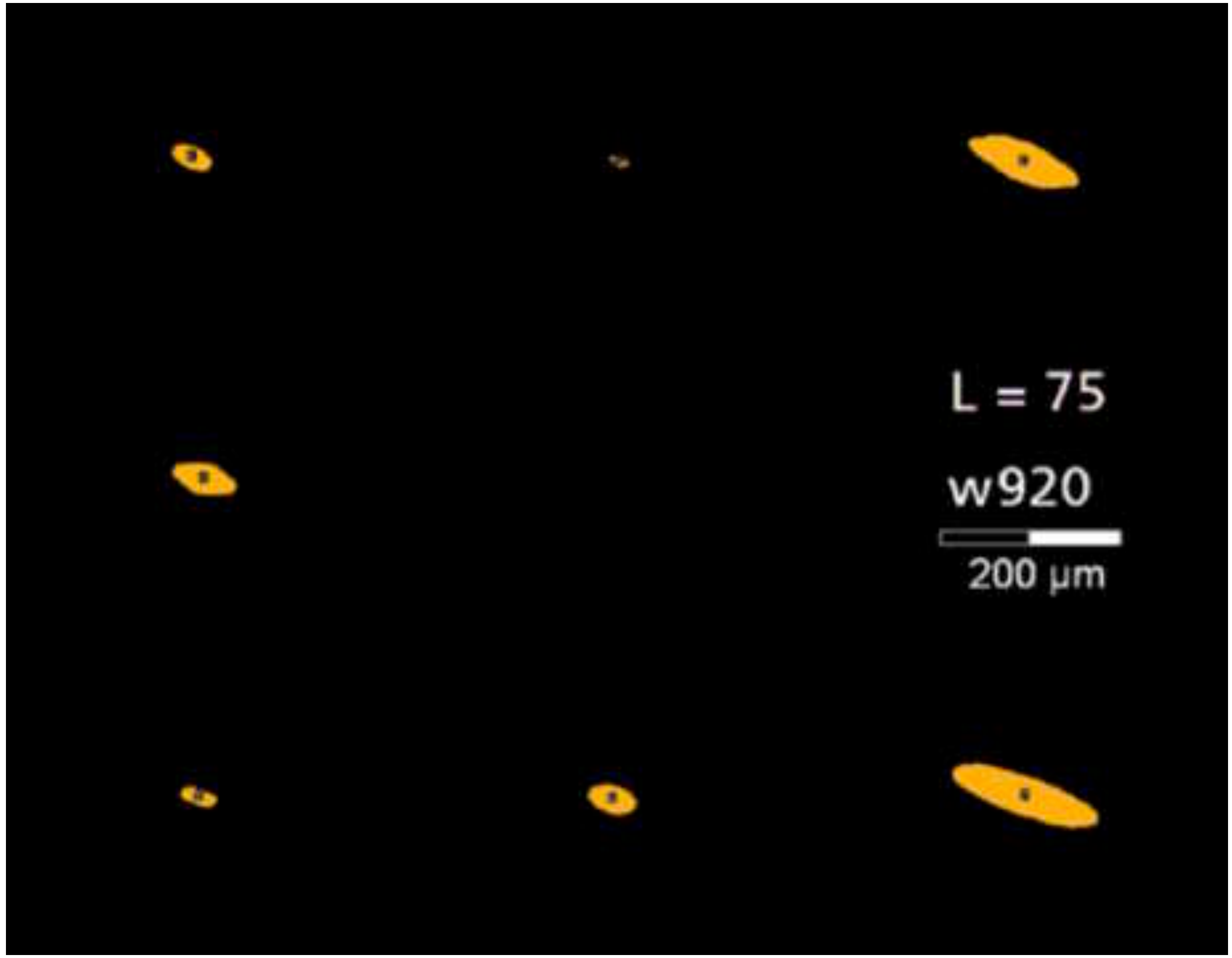
ACF, 8 steps





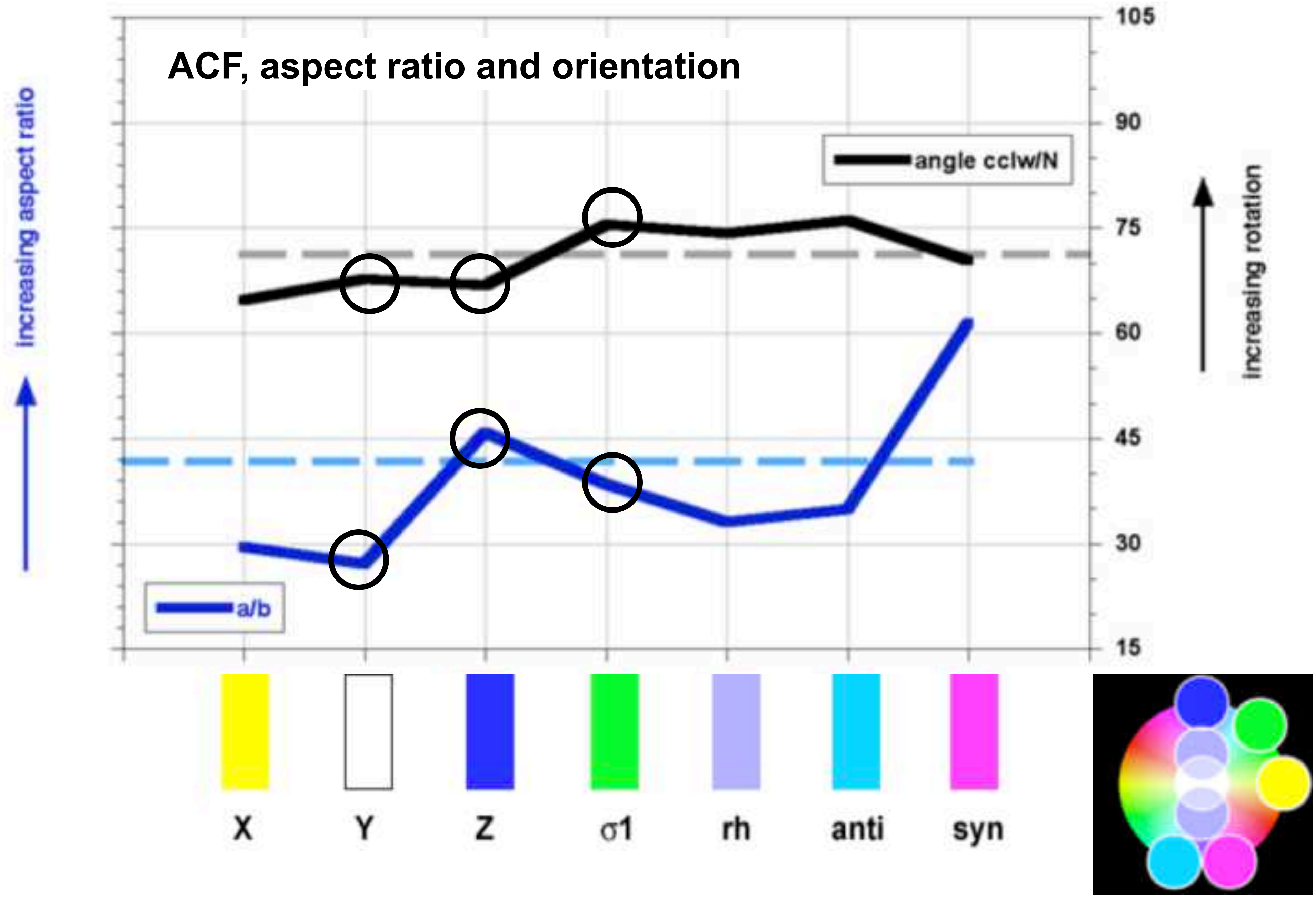
ACF, thresholded





?

ACF "size"



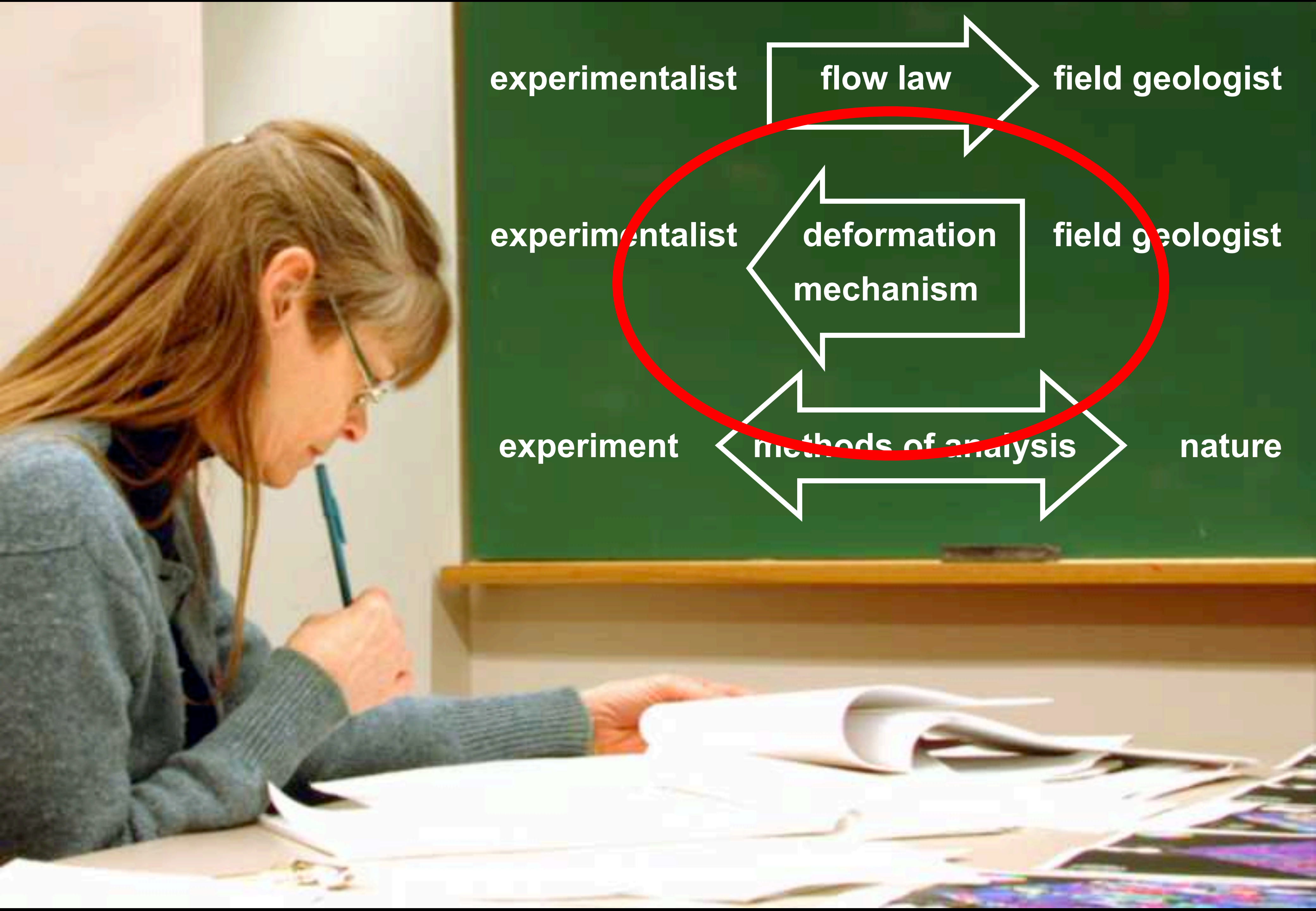
ACF, aspect ratio and orientation
angle cclw/N
a/b
increasing aspect ratio
increasing rotation
105
90
75
60
45
30
15
X
Y
Z
σ1
rh
anti
syn

mechanical interpretation of acf analysis

	X	Y	Z	$\sigma 1$
a/b	-	=	+	-
rotation	-	=	-	+
η / η(bulk)	>>1 rigid	1 same	>1 softer	>1 harder

?

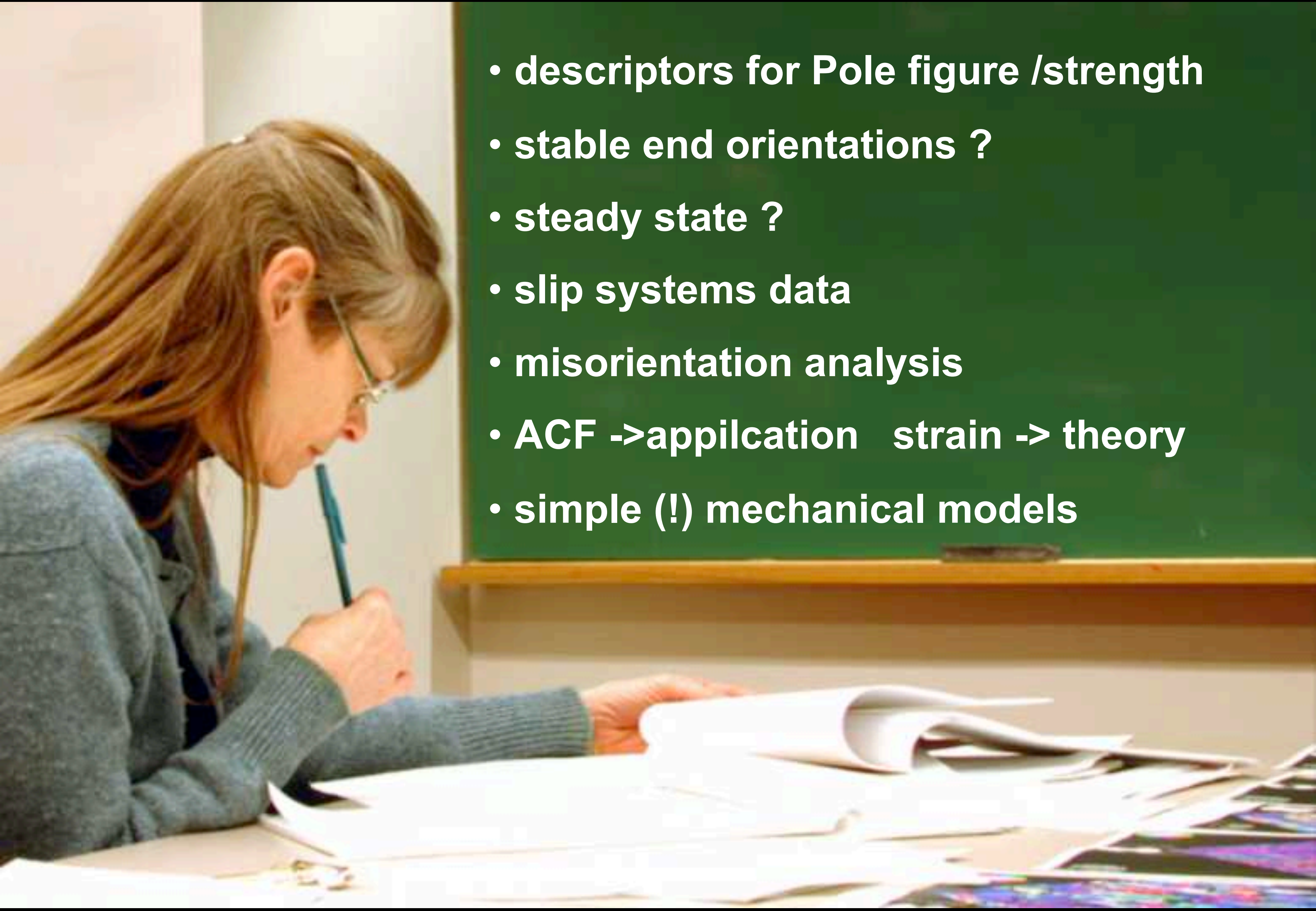
Strain interpretation


experimentalist
flow law
field geologist
experimentalist
deformation
mechanism
field geologist
experiment
methods of analysis
nature


"... You can observe a lot of
things by just watching..."
Yogi Berra

Things to do....

- high strain experiments
- "statistical" shape descriptors
- (percolation?) models for extrapolation
- contiguity and connectivity measures
- descriptors for CPO strength
- localized orientation / misorientation



- descriptors for Pole figure /strength
- stable end orientations ?
- steady state ?
- slip systems data
- misorientation analysis
- ACF ->appilcation   strain -> theory
- simple (!) mechanical models