COMPARISON OF COARSE- AND FINE-GRAINED QUARTZ TEXTURES USING THE POLE DENSITY INDEX (PDI)

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COMPARISON OF COARSE- AND FINE-GRAINED QUARTZ TEXTURES USING THE POLE DENSITY INDEX (PDI)

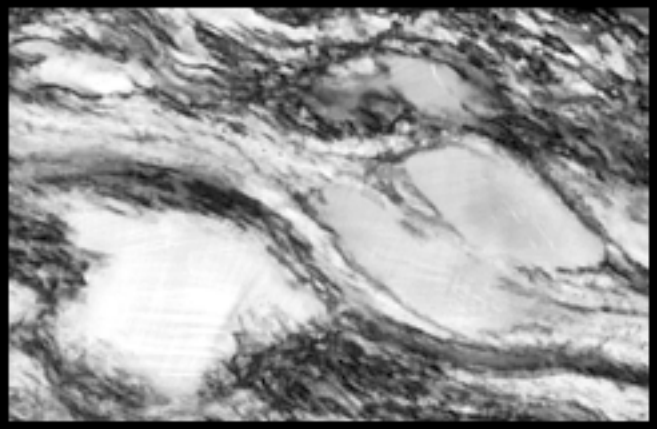
…bridges …visualization

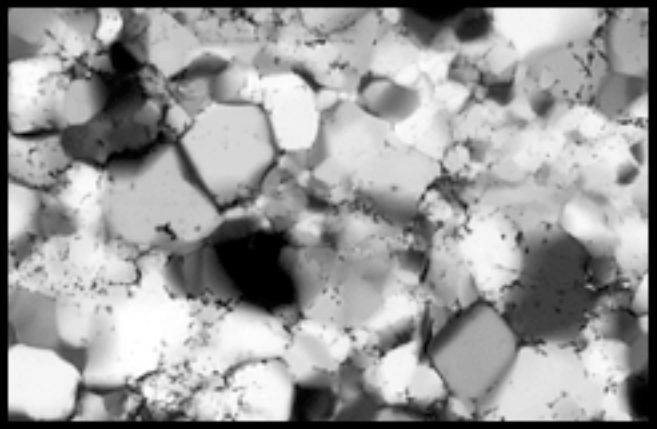
K.V. Mardia, key note lecture IAMG2002

deformed

annealed

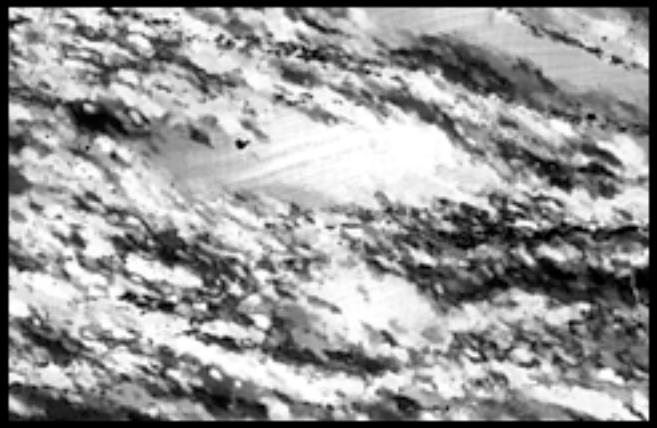
regime 1

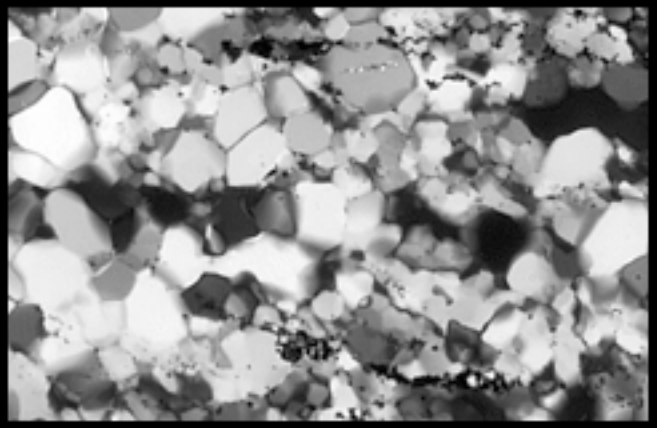




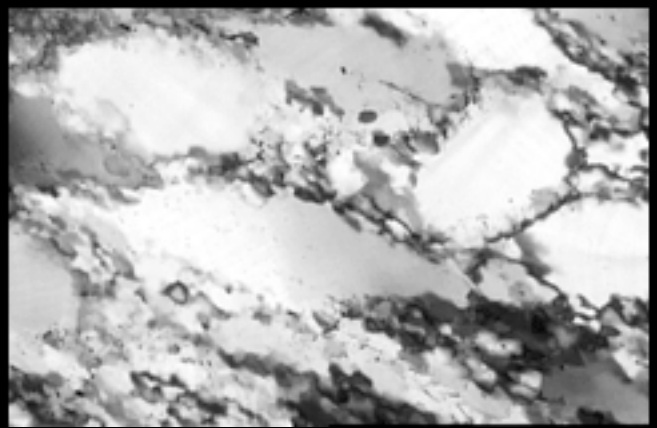
Exp. deformation & anneling BHQ Quartzite

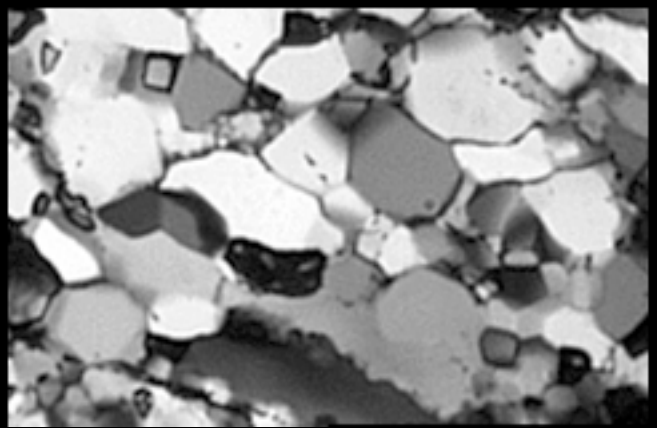
regime 2



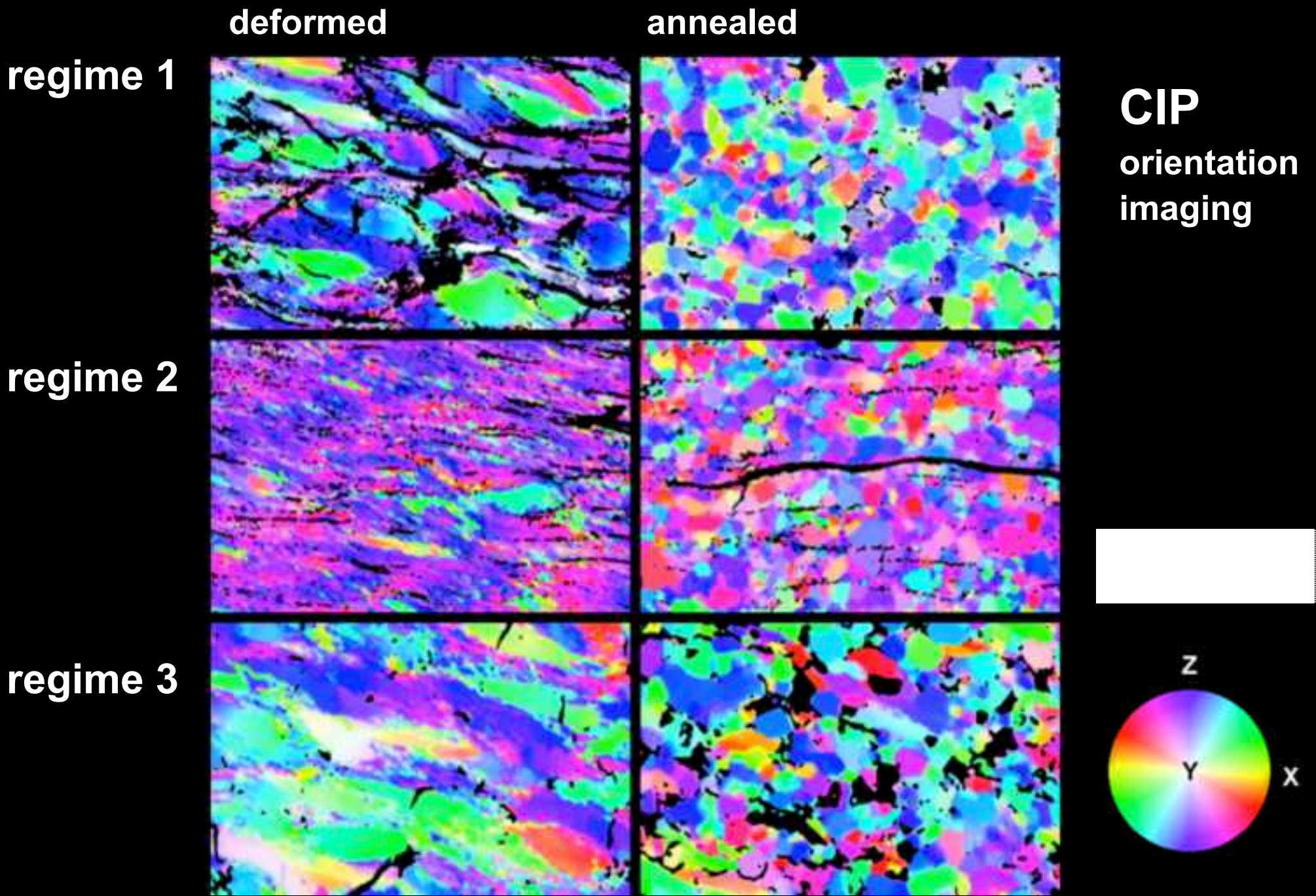


regime 3





expts.: Jan Tullis


deformed
annealed
regime 1
regime 2
regime 3
CIP
orientation
imaging
Z
Y
X

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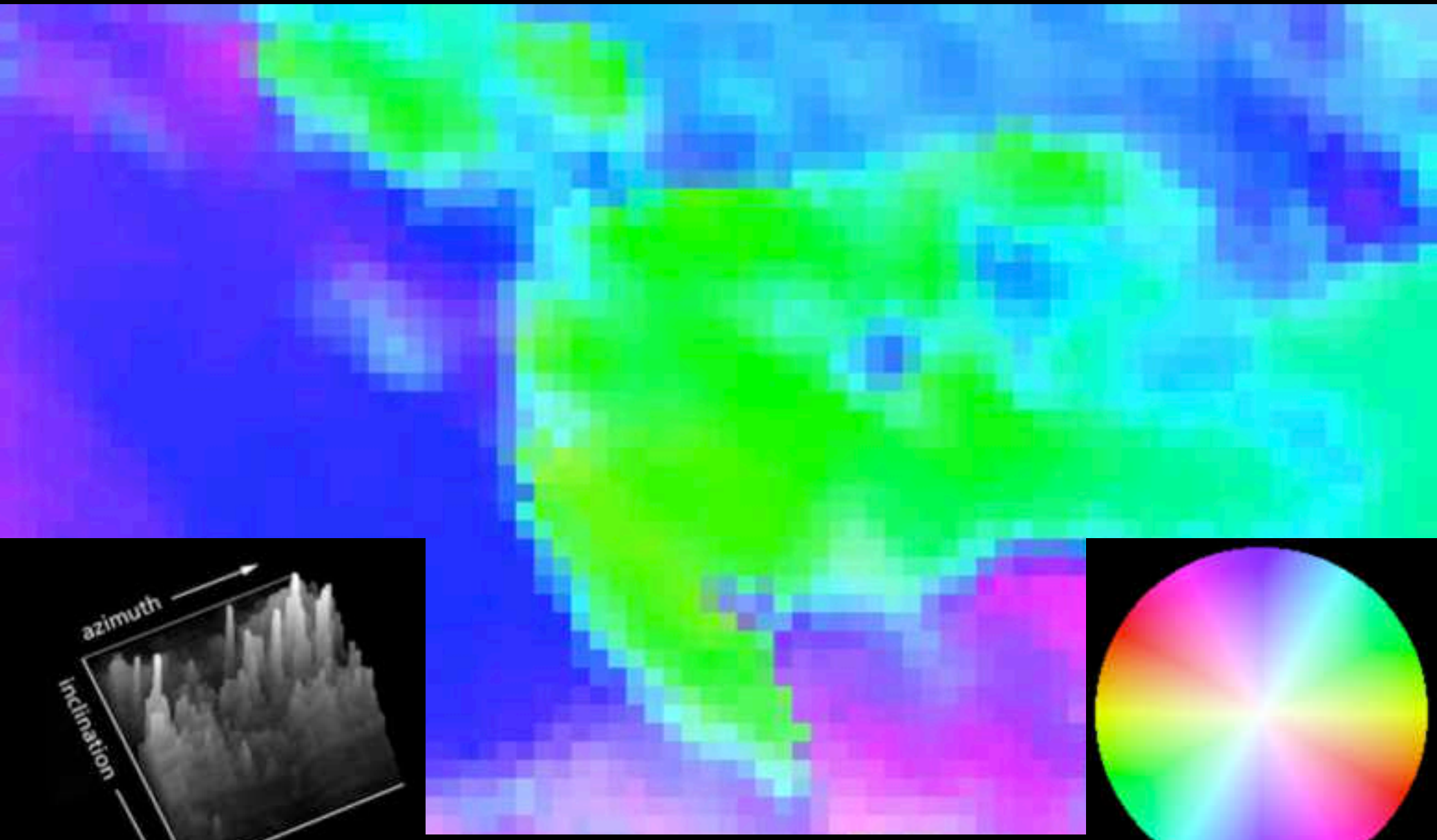
c-axis pole figure stereographic projection of azi-inc histogram



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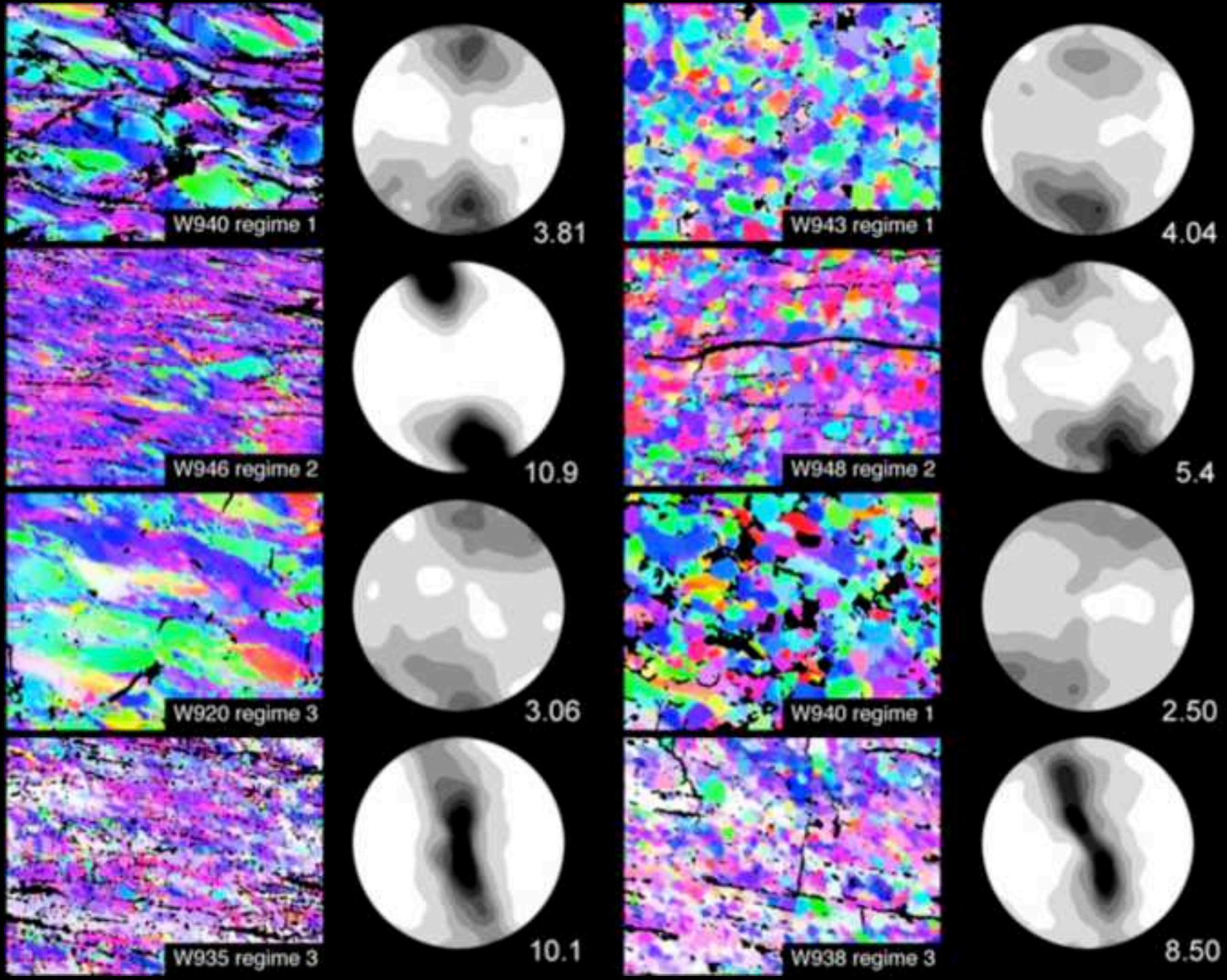
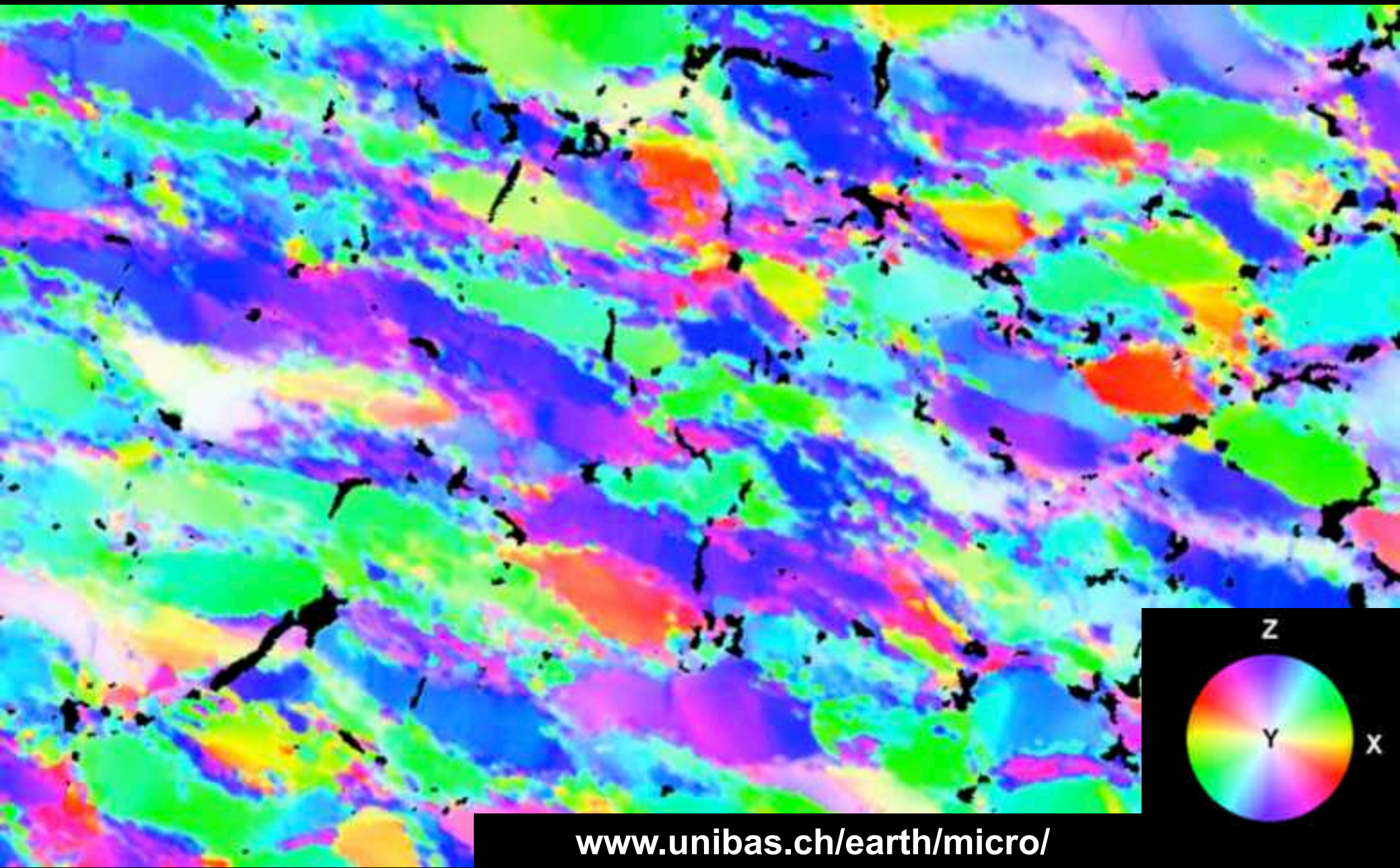

W940 regime 1
3.81
W943 regime 1
4.04
W946 regime 2
10.9
W948 regime 2
5.4
W920 regime 3
3.06
W940 regime 1
2.50
W935 regime 3
10.1
W938 regime 3
8.50

cf Xray texture

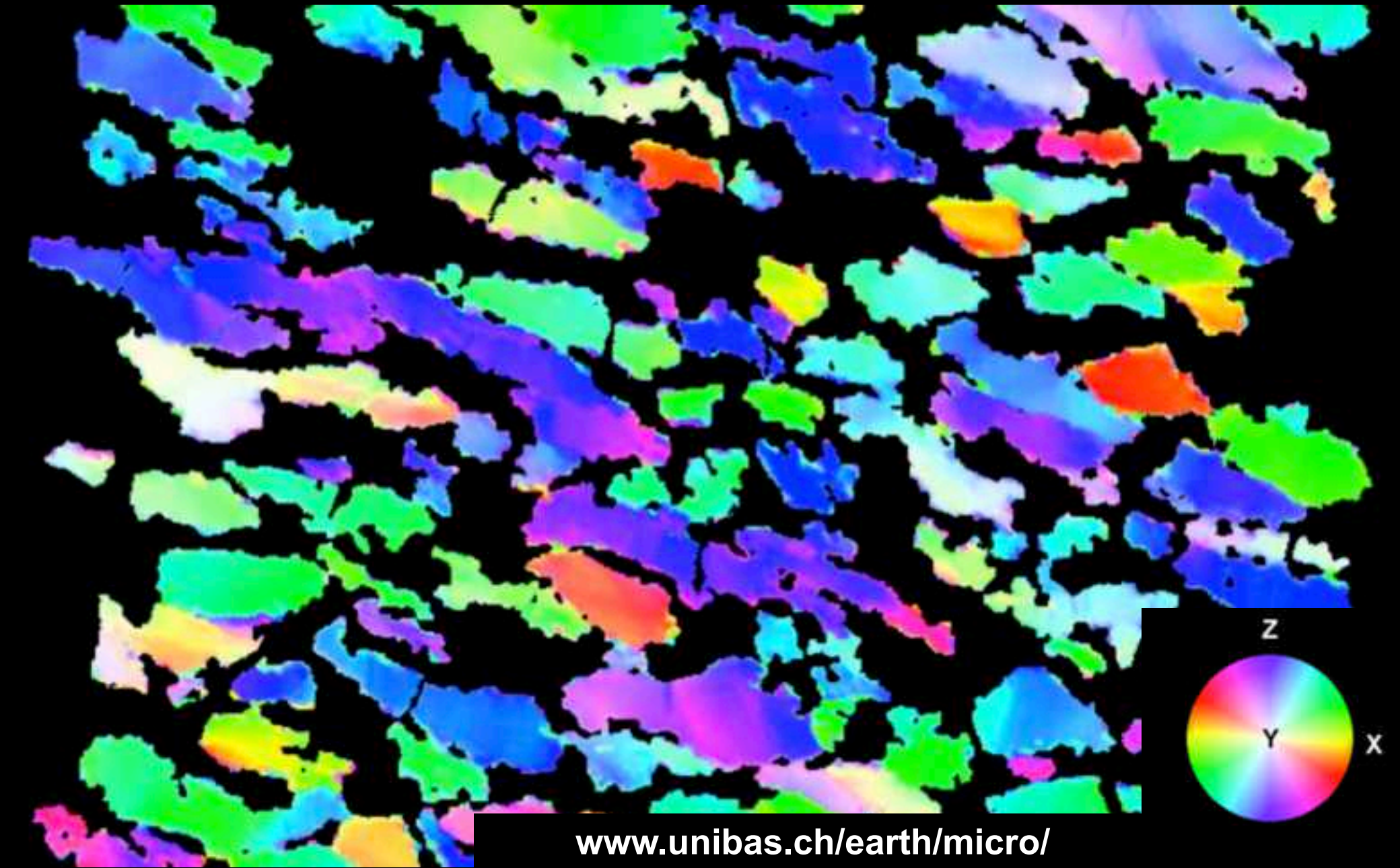
c-axis pole figure bulk fabric



www.unibas.ch/earth/micro/

cf Xray texture

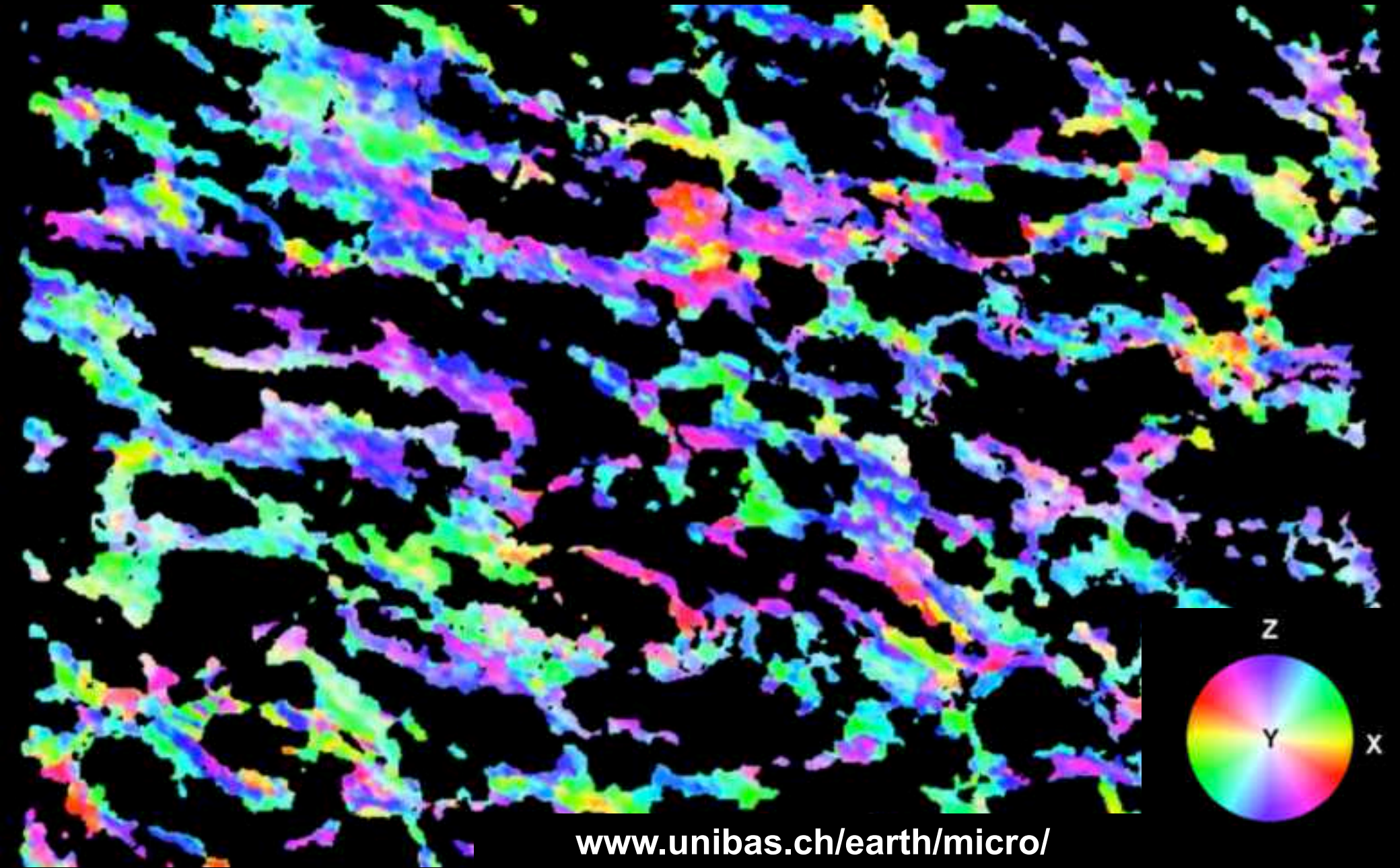
c-axis pole figure of porphyroclasts



www.unibas.ch/earth/micro/

cf Xray texture

c-axis pole figure of recrystallized grains



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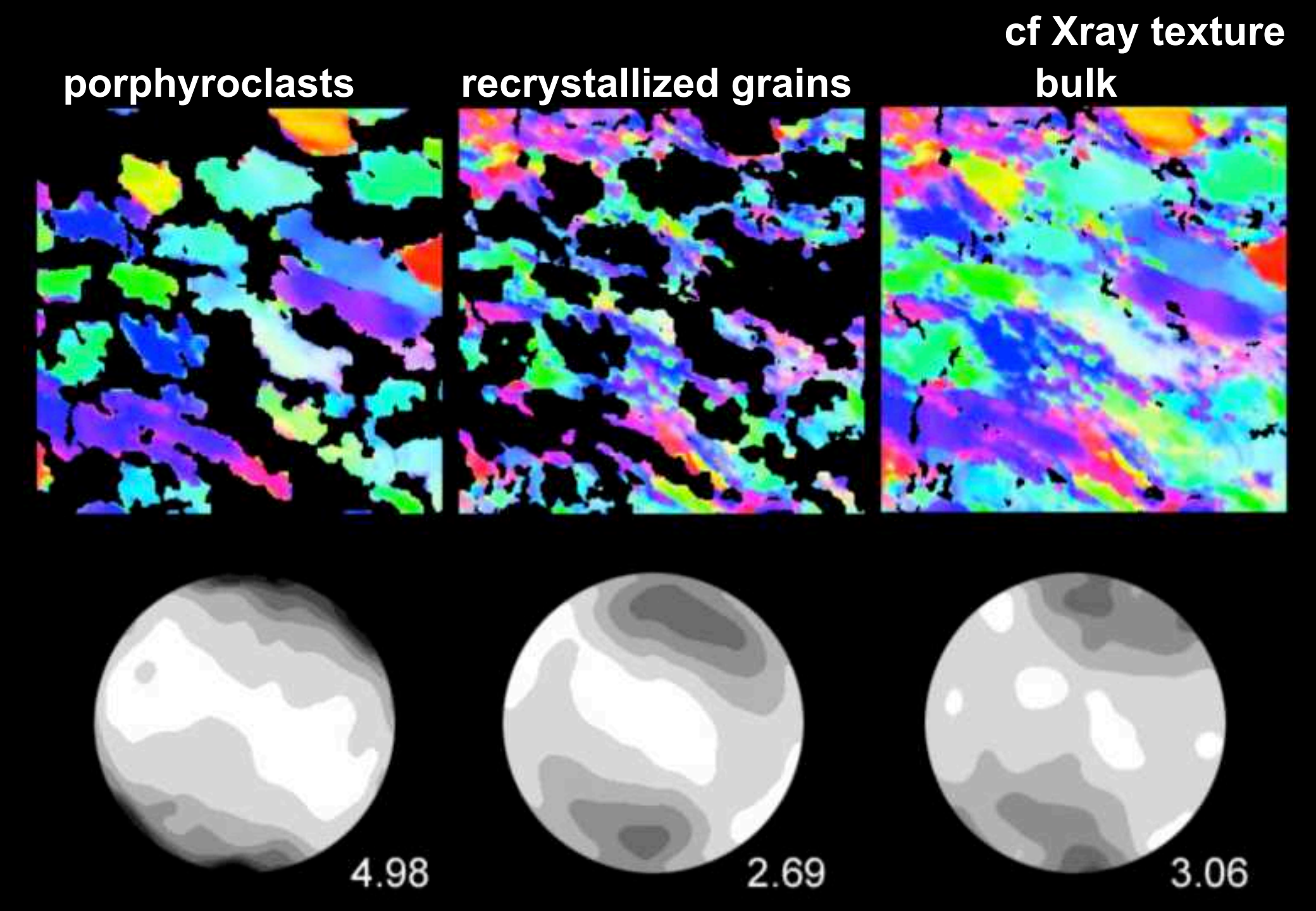
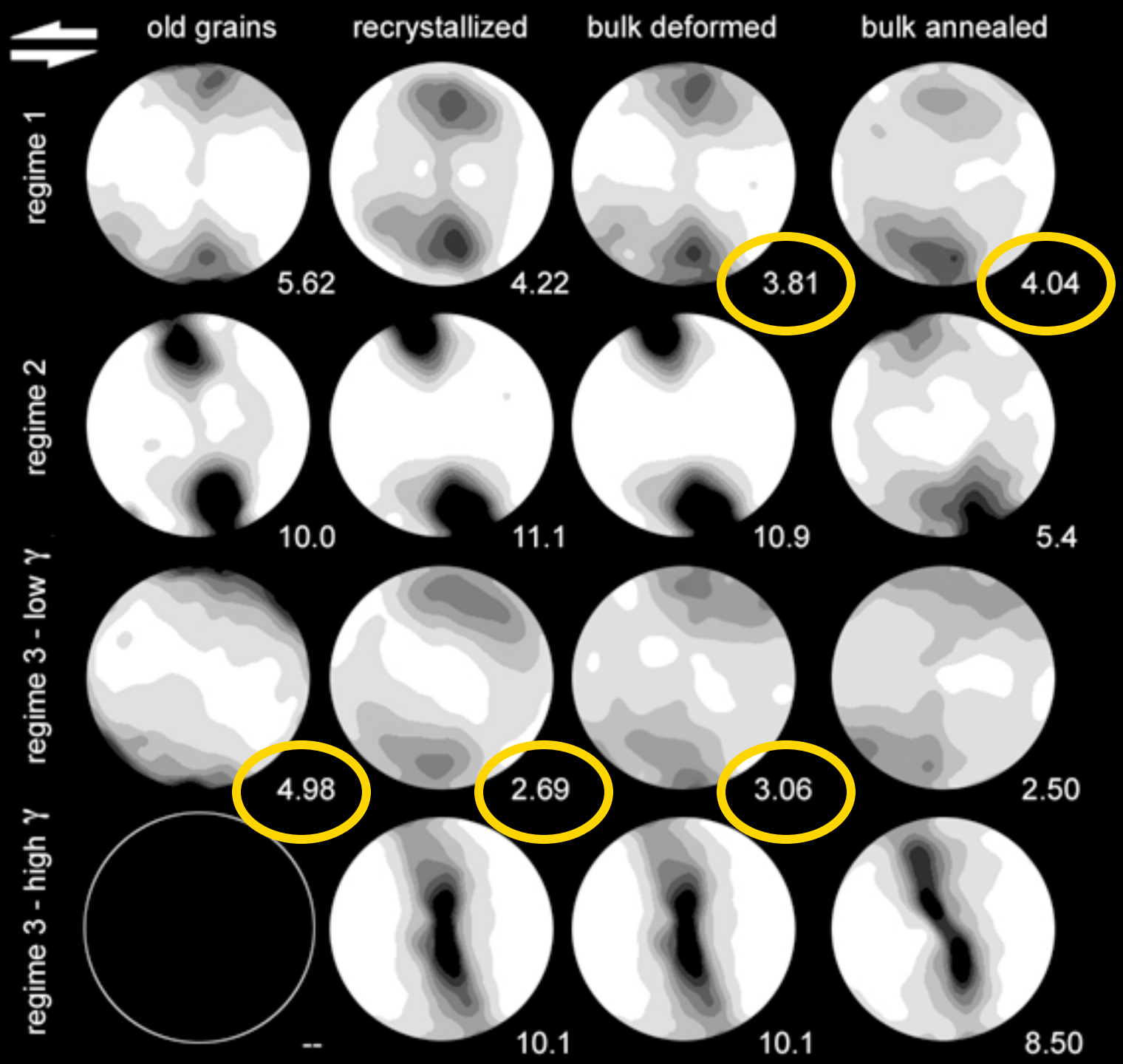

porphyroclasts
recrystallized grains
cf Xray texture
bulk
4.98
2.69
3.06

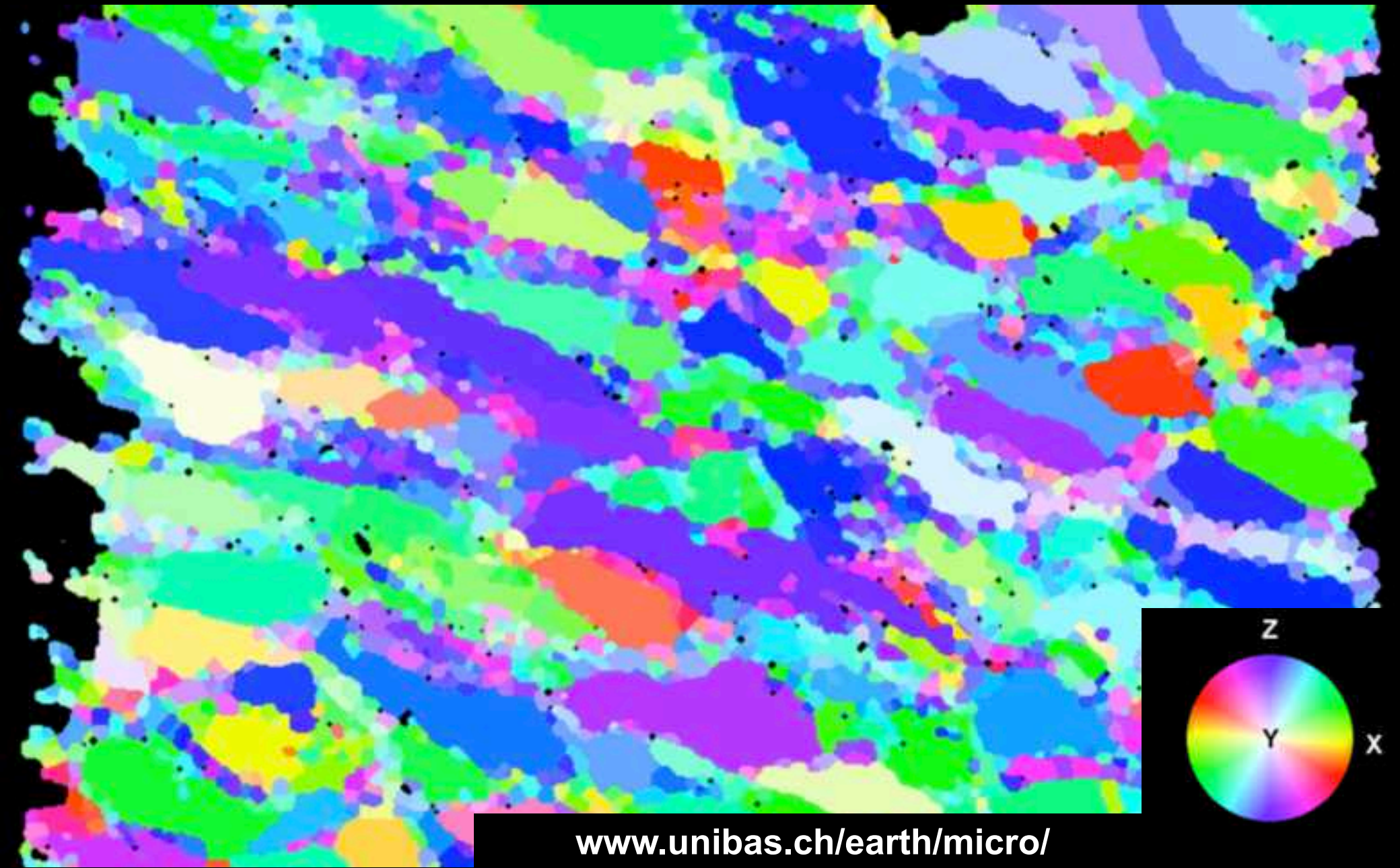


does annealing reduce or increase texture strength ??

is the bulk texture stronger or weaker than its parts ??

cf EBSD

c-axis pole figure bulk fabric FLAT



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cf EBSD

c-axis pole figure of porphyroclasts FLAT

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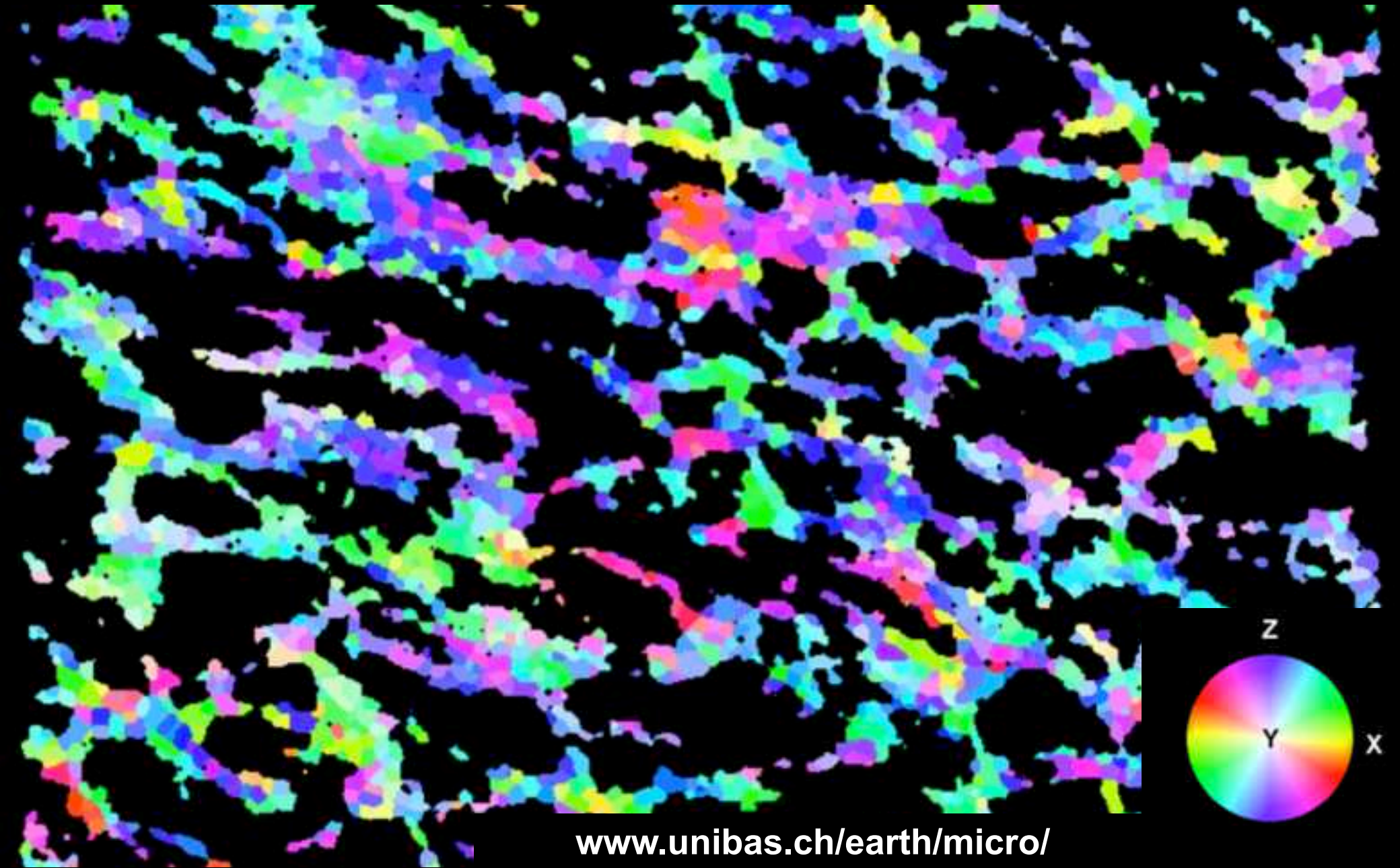
cf EBSD

c-axis pole figure of recrystallized grains FLAT



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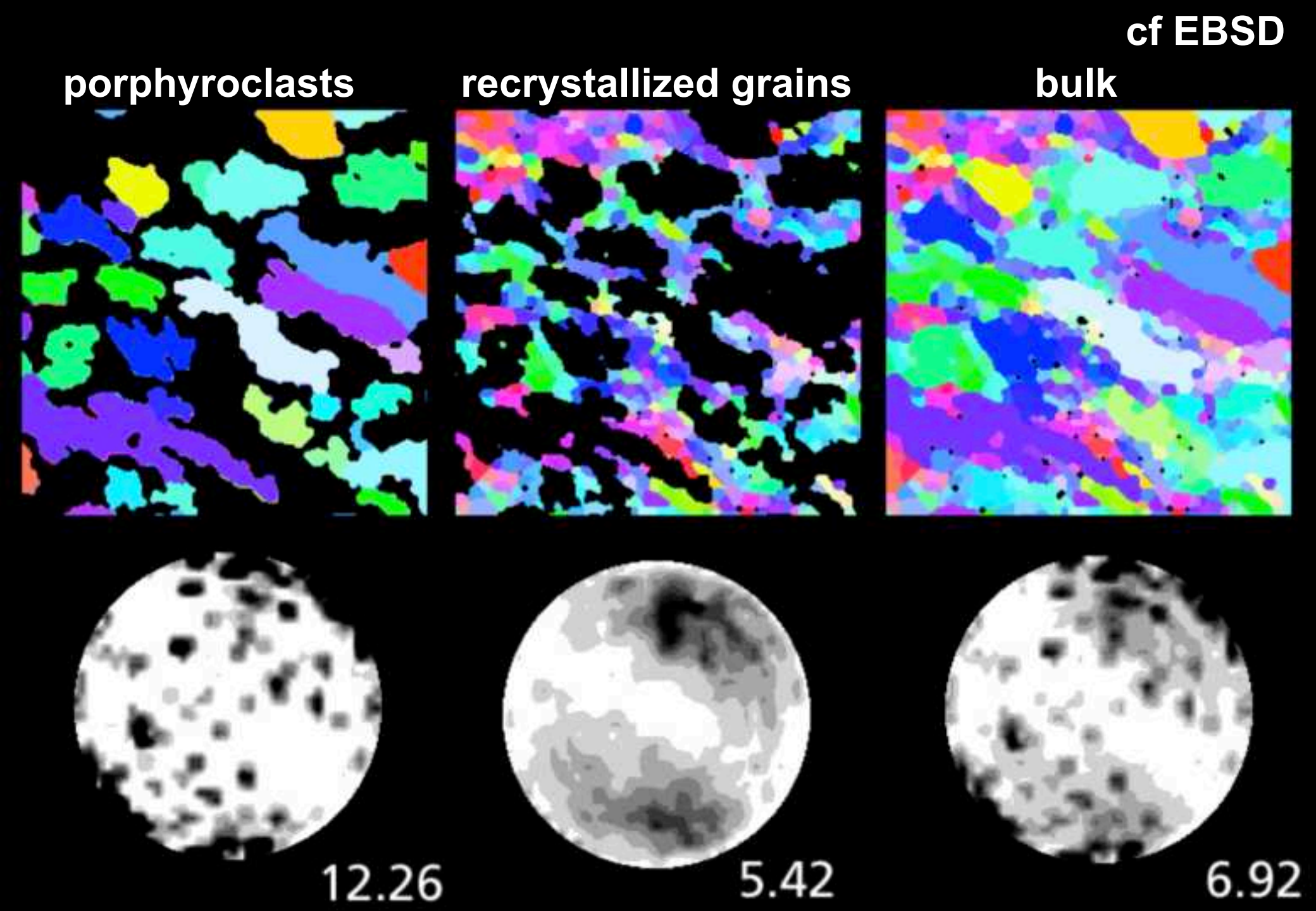
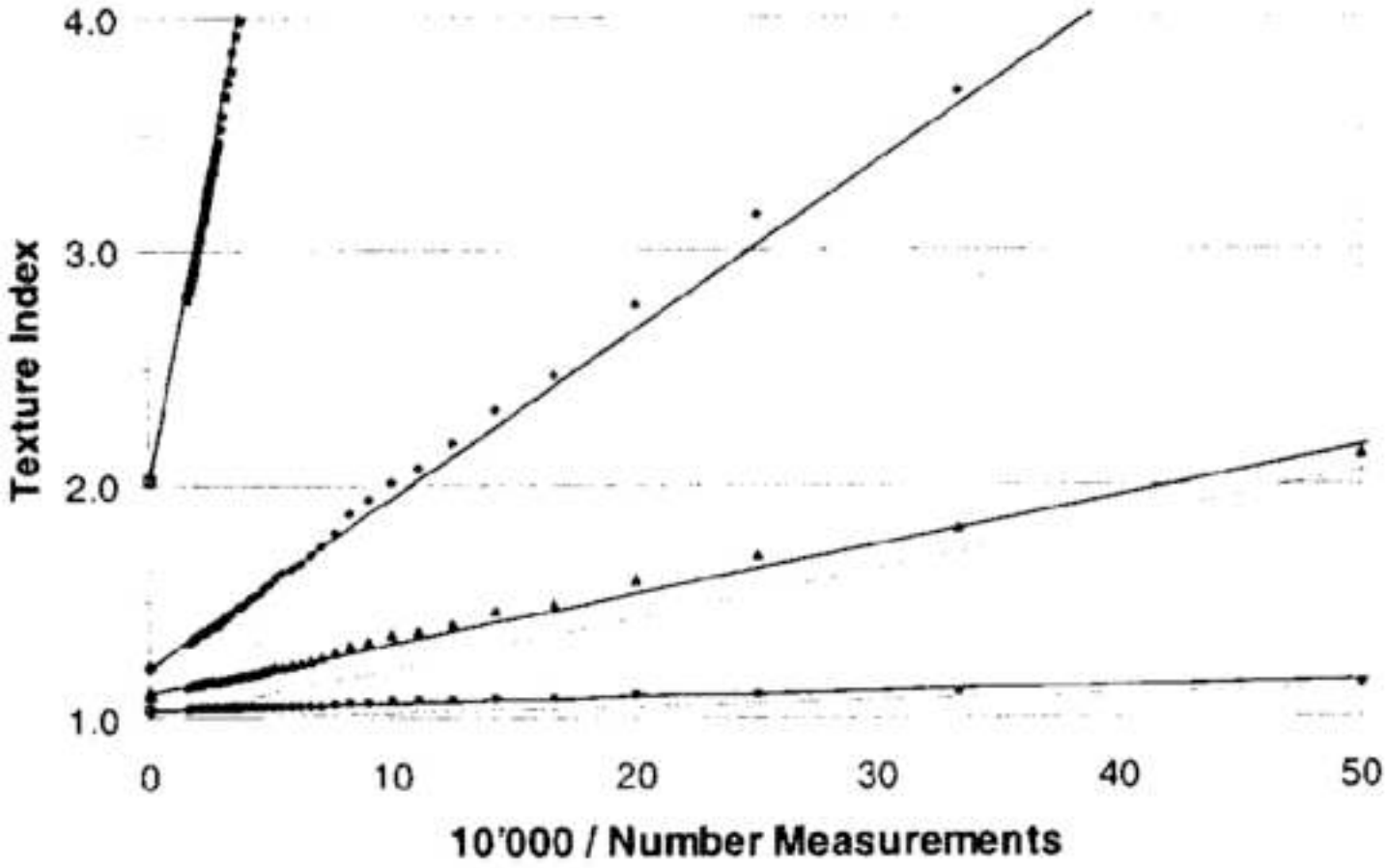

cf EBSD
porphyroclasts
recrystallized grains
bulk
12.26
5.42
6.92

how many measurements?

Sample w920	1200·900	meas. pixels	720·560	meas. grains	720·560 flat
total no. of pixels	1'080'000		403'200		403'200
bulk	3.06	390'000	3.82	3584	6.92
porphyroclasts	4.98	187'000	6.53	172	12.26
recrystallized	2.69	134'000	3.55	3424	5.42

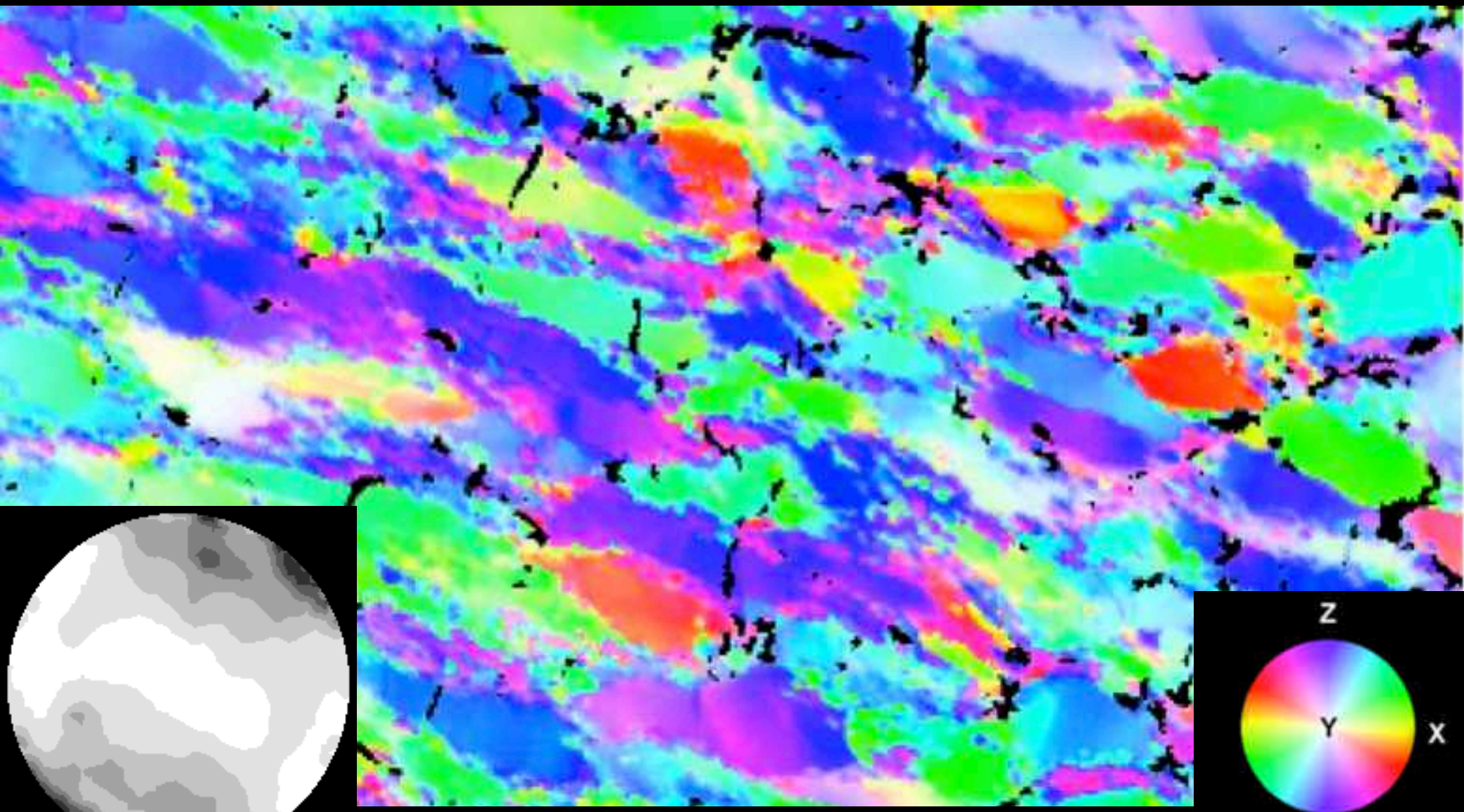
1/n law



Burlini, L. & Kunze, K. 2000. Fabric and seismic properties of Carrara marble mylonite. *Physics and Chemistry of the Earth (A)*, 25, 133-139.

Mathies, S. & Wagner, F. 1996. On the 1/n law in texture related single orientation analysis. Phys. Stat. Sol. B196, K11.

c-axis pole figure bulk fabric



3.82

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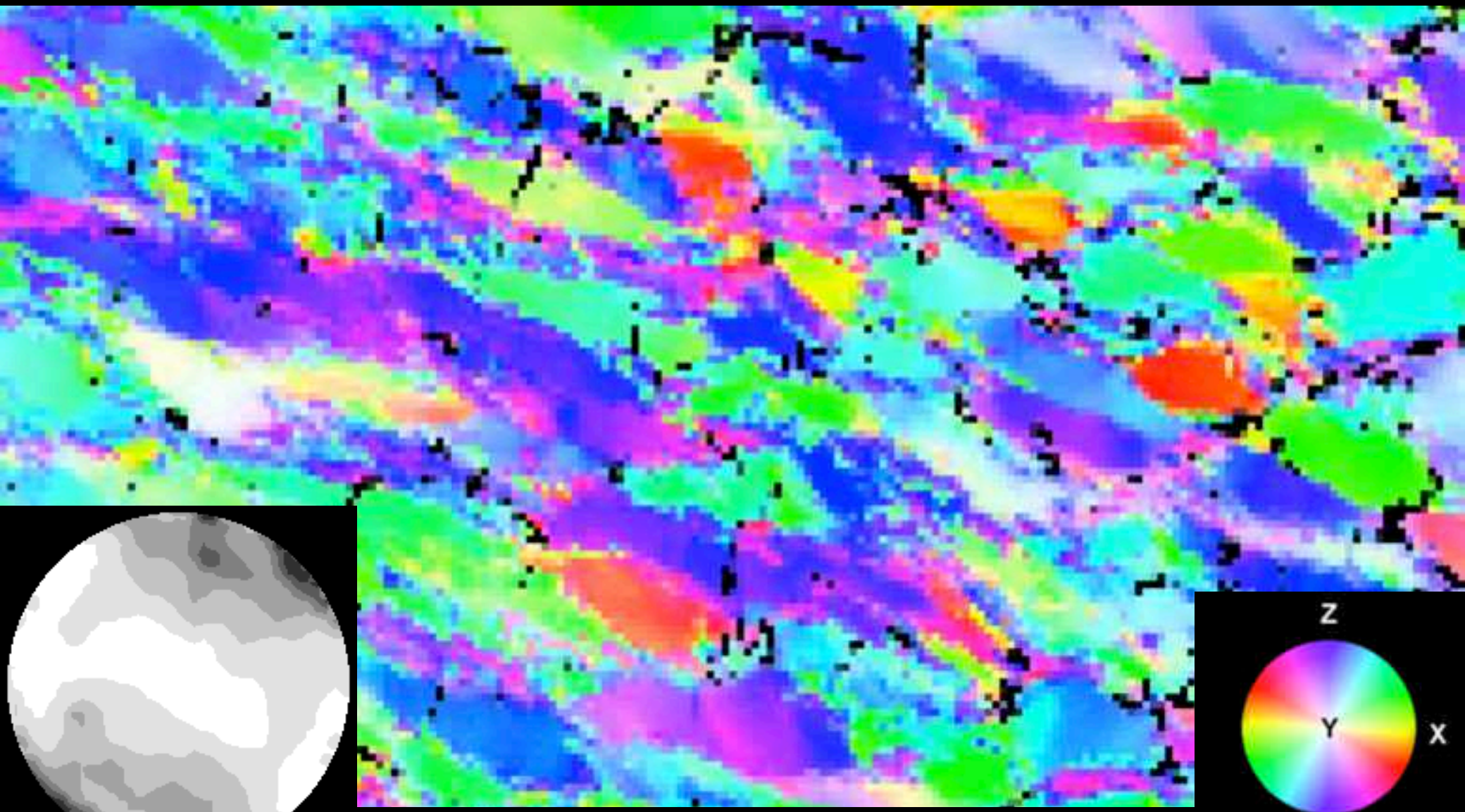
c-axis pole figure bulk fabric 1/2 · 1/2



3.82

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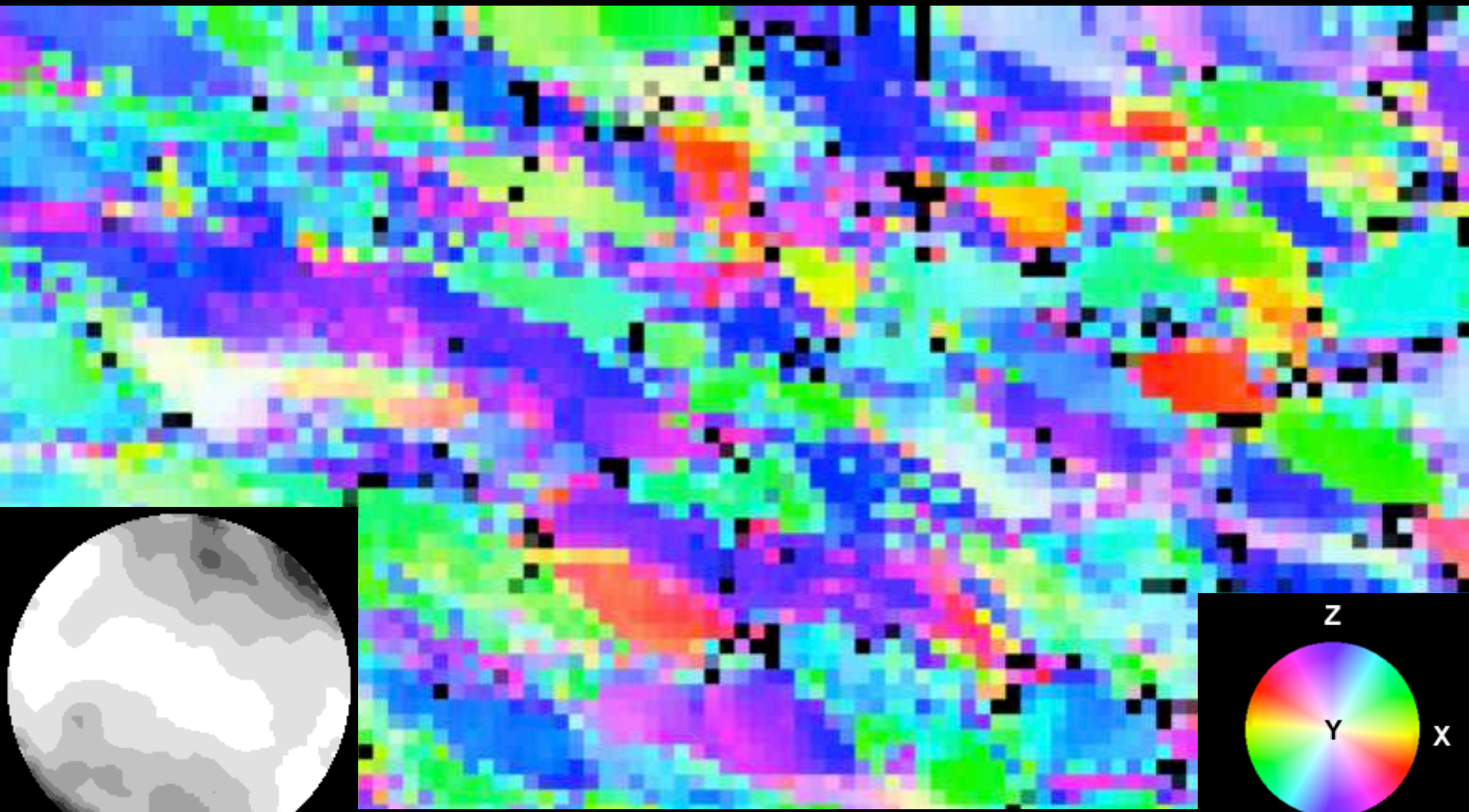
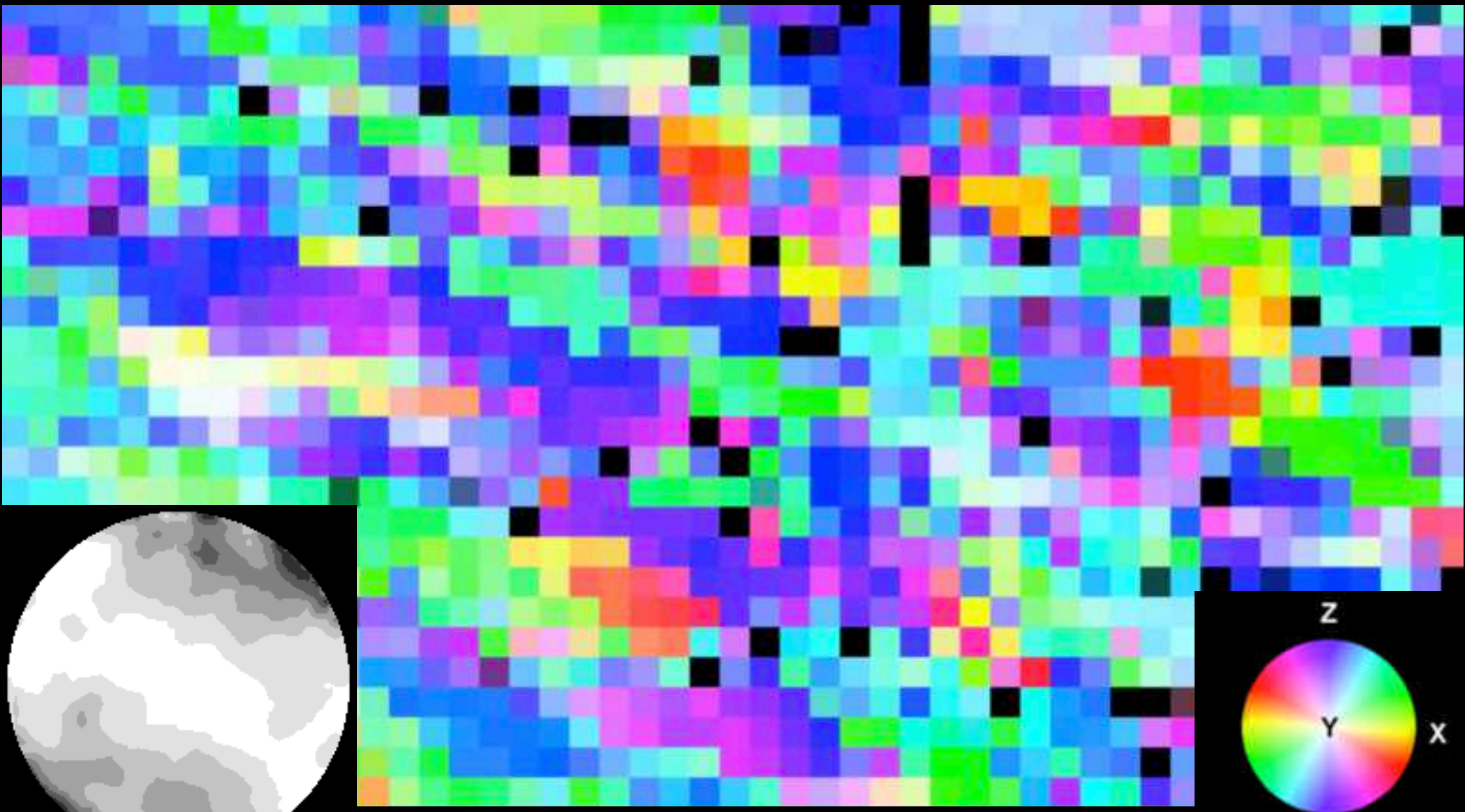
c-axis pole figure bulk fabric 1/4 · 1/4



3.84

c-axis pole figure bulk fabric 1/8 · 1/8



3.69

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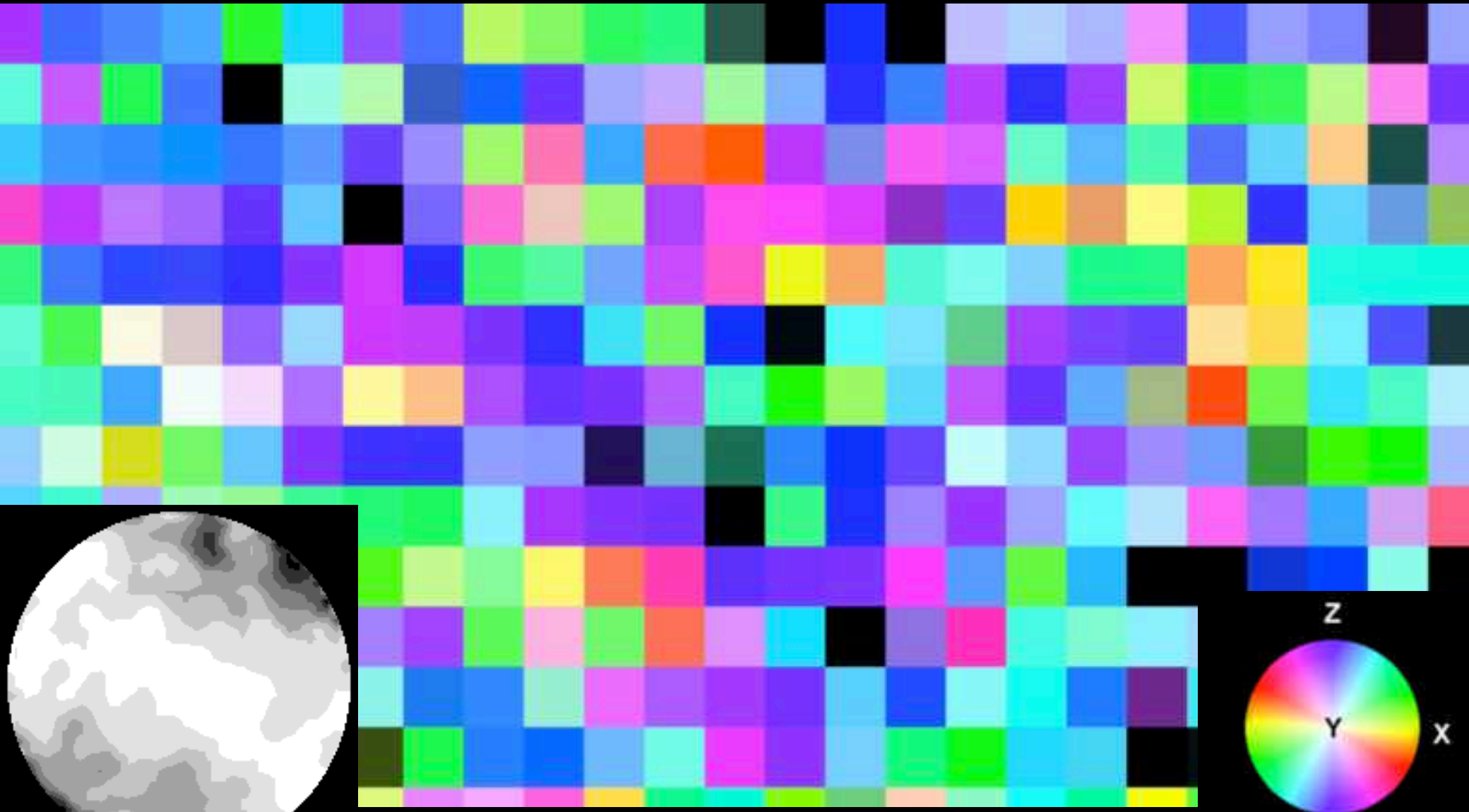
c-axis pole figure bulk fabric 1/16 · 1/16



3.87

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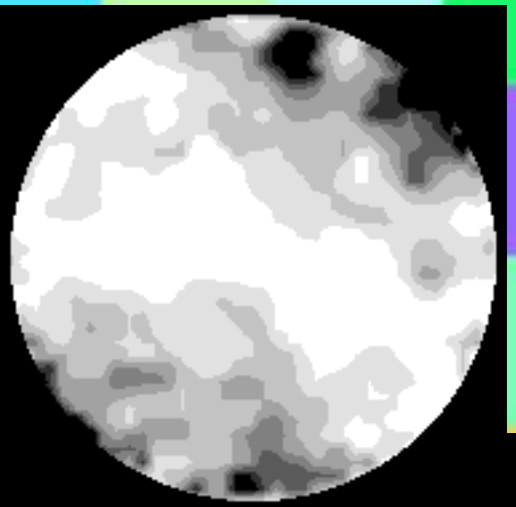
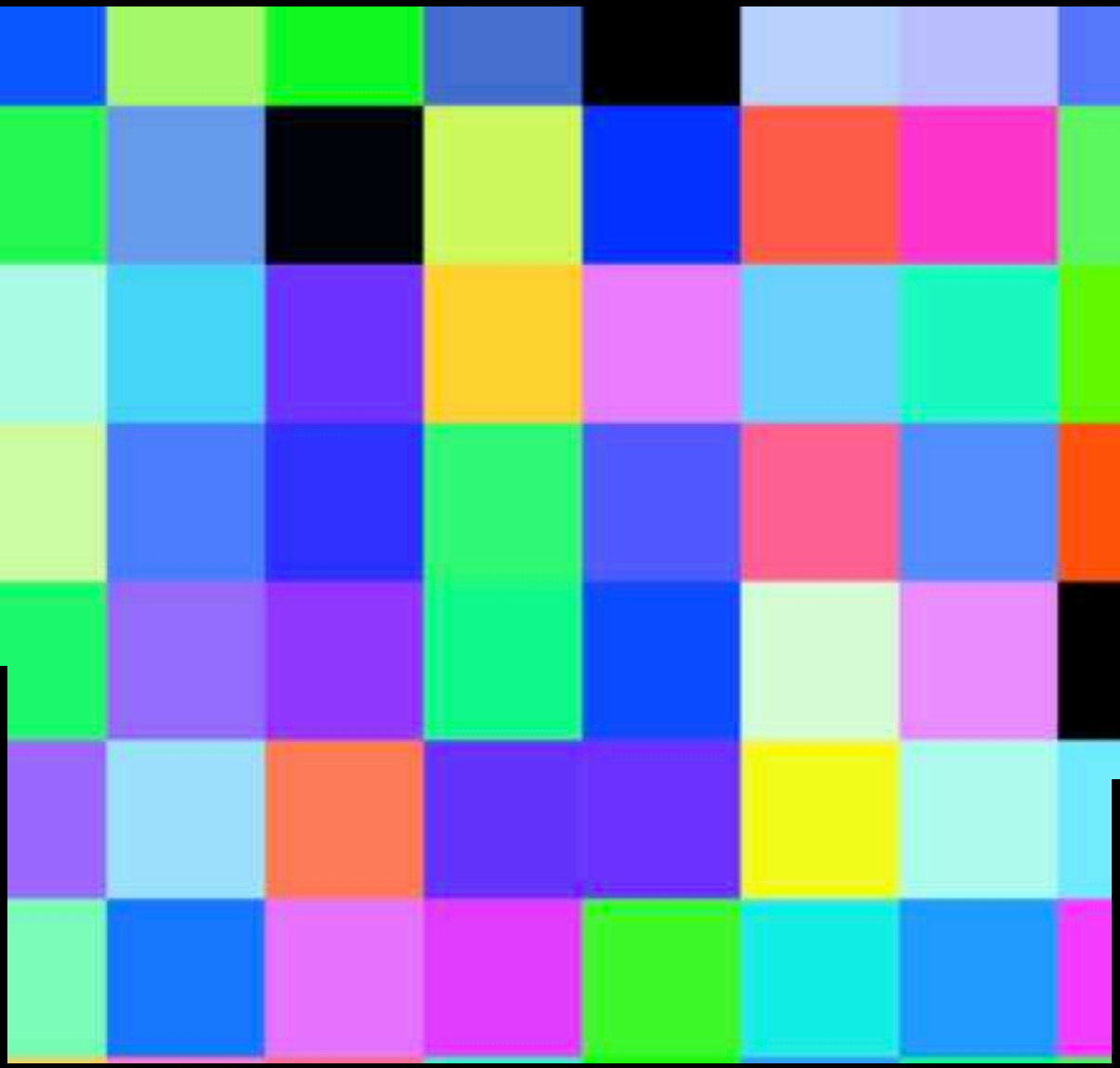
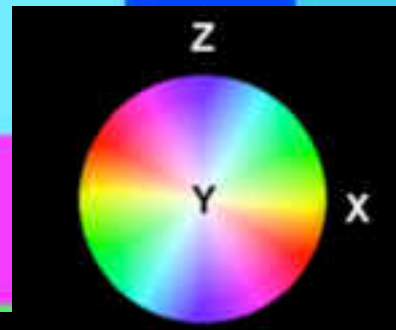
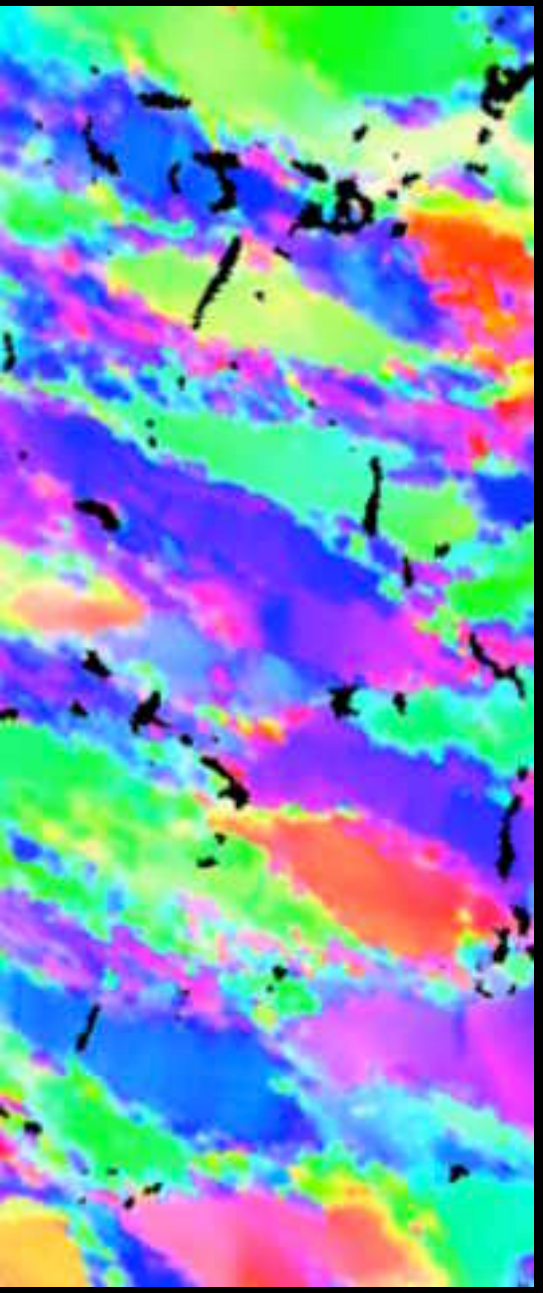
c-axis pole figure bulk fabric 1/32 · 1/32

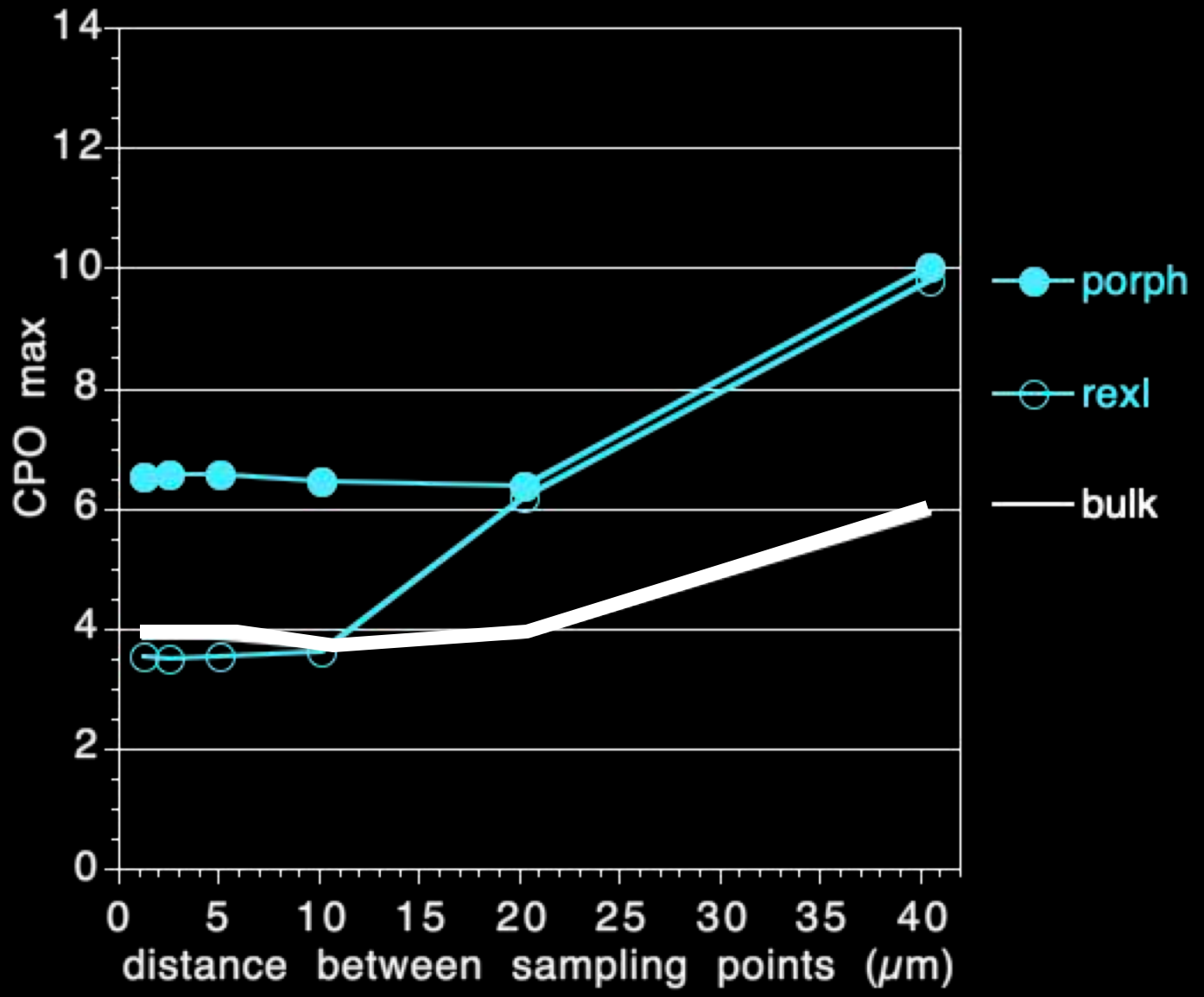








CPO max of continuous CIP as f(undersampling)



mathematical definition of PDI

pole density index (PDI)

$$I[\hat{P}_{\mathbf{c}}(\circ)] = \oint \hat{P}_{\mathbf{c}}^2(\mathbf{r})\mathrm{d}\mathbf{r} = \oint \left(\frac{1}{n}\sum_{i=1}^{n} k(\mathbf{r}_i'\mathbf{r})\right)^2 \mathrm{d}\mathbf{r} = \frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} V_{\mathbf{k}}(\mathbf{r}_i'\mathbf{r}_j)$$

expected value of PDI

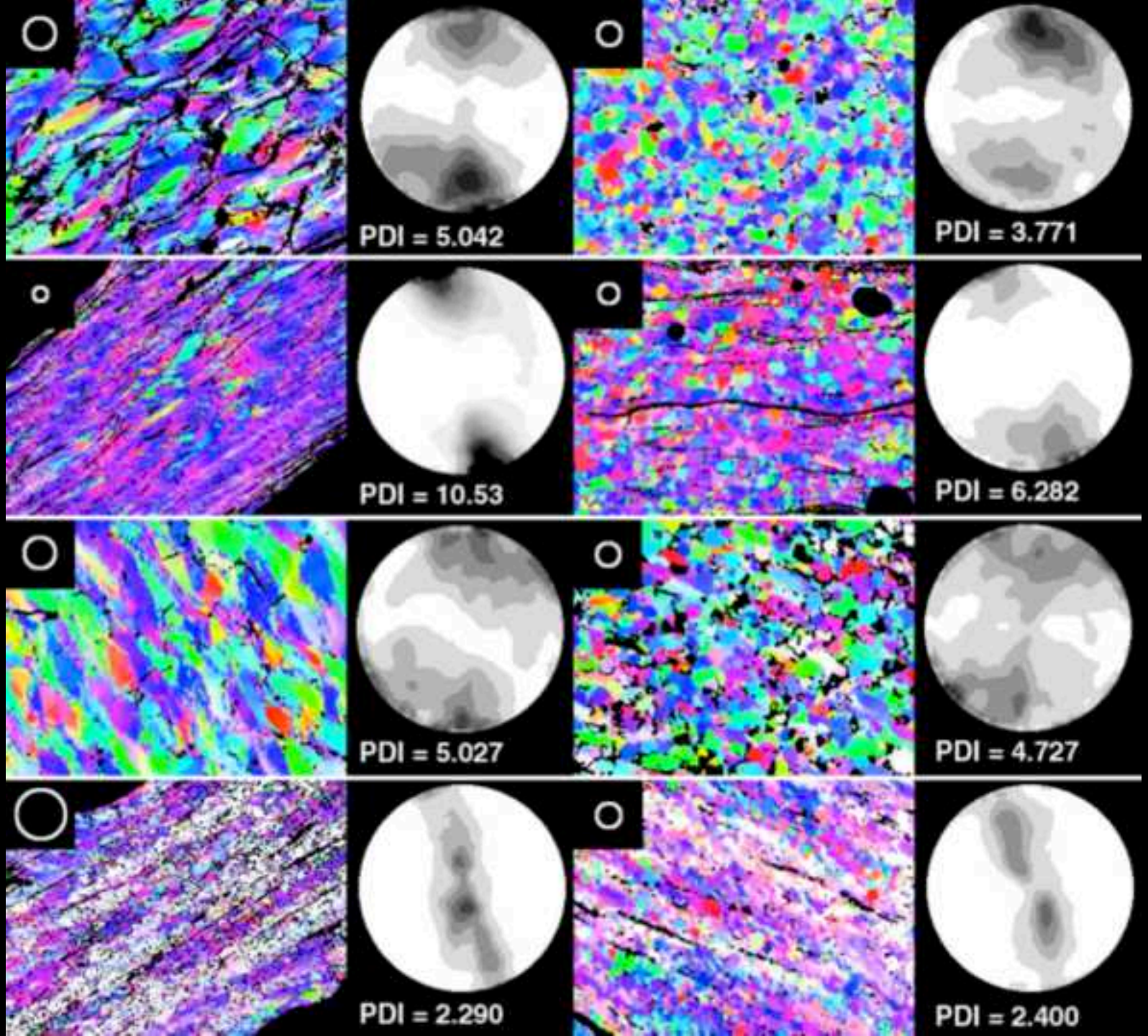
$$\mathrm{e}(I[\hat{P}_{\mathbf{c}}]) = \oint \mathrm{e}(\hat{P}_{\mathbf{c}}(\mathbf{r})^2)\mathrm{d}\mathbf{r} = \oint \mathrm{e}[\hat{P}_{\mathbf{c}}(\mathbf{r})]^2\mathrm{d}\mathbf{r} + \oint \mathrm{var}(\hat{P}_{\mathbf{c}}(\mathbf{r}))\mathrm{d}\mathbf{r}$$

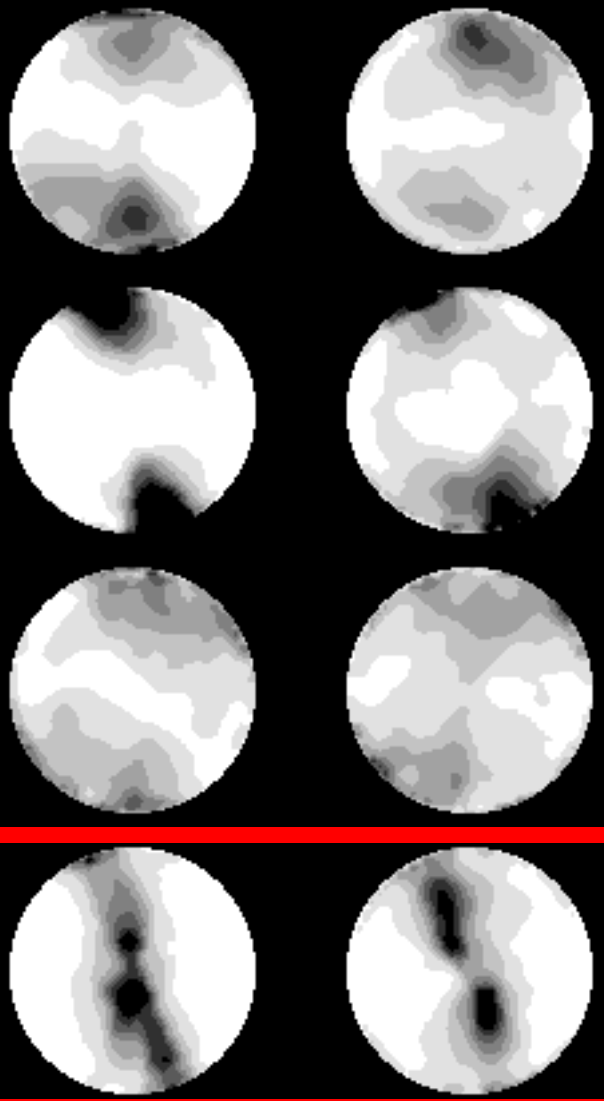
second term depends on no. of c-axes and spatial dependencies

$$\mathrm{gvar}(\hat{P}_{\mathbf{c}}(\circ)) \underset{df}{=} \oint \mathrm{var}(\hat{P}_{\mathbf{c}}(\mathbf{r}))\mathrm{d}\mathbf{r} \propto n > 0$$

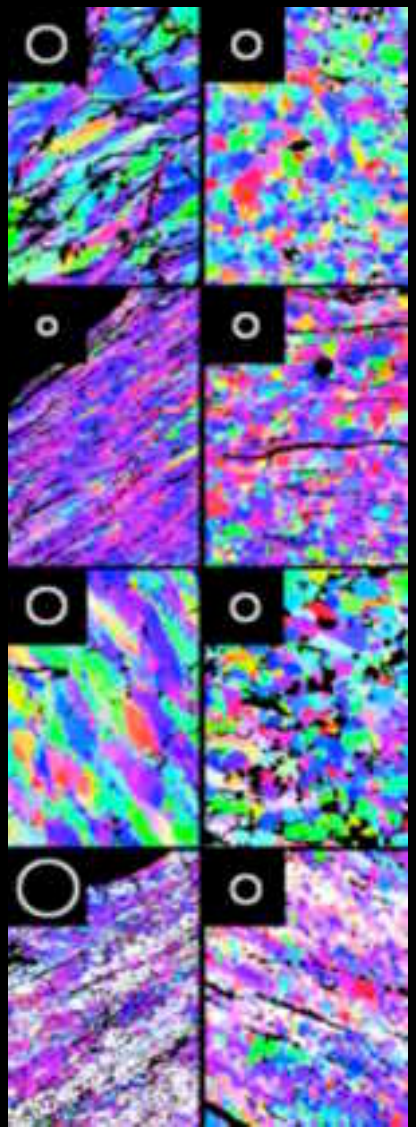
Unbiased estimator of I [P_c]

$$\hat{I}[P_{\mathbf{c}}] \;=\; I[\hat{P}_{\mathbf{c}}] - \hat{\mathrm{gvar}}(\hat{P}_{\mathbf{c}}(\circ))$$


PDI = 5.042
PDI = 3.771
PDI = 10.53
PDI = 6.282
PDI = 5.027
PDI = 4.727
PDI = 2.290
PDI = 2.400



max of CPO		pole density index (PDI)		different types of CPO
def.	ann.	def.	ann.	
3.86	3.84	5.042	3.771	•small circles
13.87	6.99	10.53	6.282	•single maximum
3.67	3.44	5.027	4.727	•small circles
6.77	5.74	2.290	2.400	•single girdle

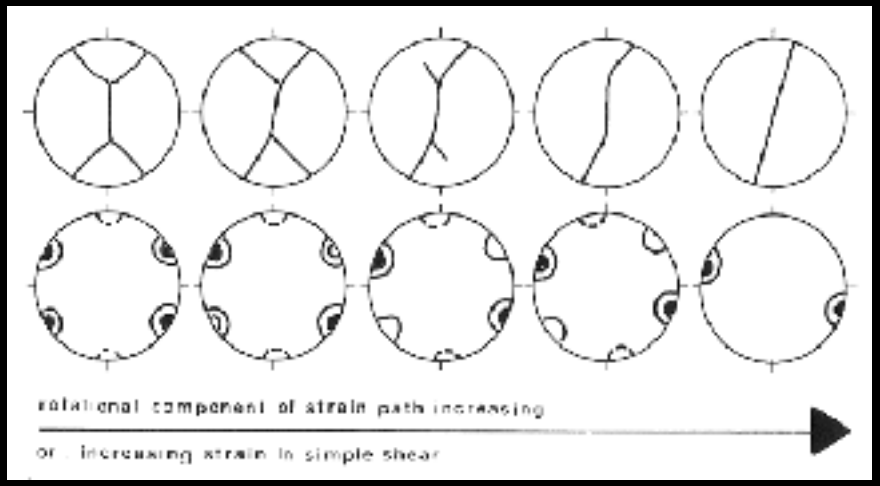


size of neighborhood		pole density index (PDI)		effect of correction
def.	ann.	def.	ann.	
25	17	5.137	3.807	uncorrected
		5.042	3.771	corrected
10	14	10.56	6.332	uncorrected
		10.53	6.282	corrected
10	14	5.160	4.802	uncorrected
		5.027	4.727	corrected
40	18	2.333	2.449	uncorrected
		2.290	2.400	corrected

Discussion

strength of CPO
weakening - strengthening w/r to type CPO (skeleton)
weakening - strengthening unbiased

type of CPO ("skeleton")
single maximum
girdle
small circle



"intuitive" value of PDI vs CPO max

open questions

what is the "bulk texture"

PDI for other axes

PDI for ODF

Size of correlation area? Automatic or presribed (as now)

Absolute volume change per direction ? Misor?