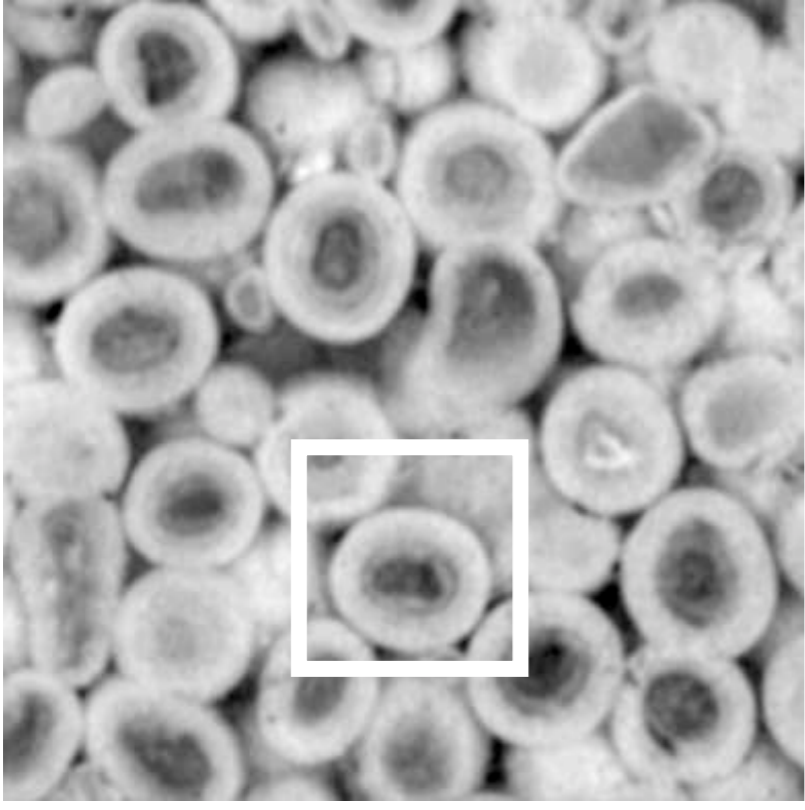
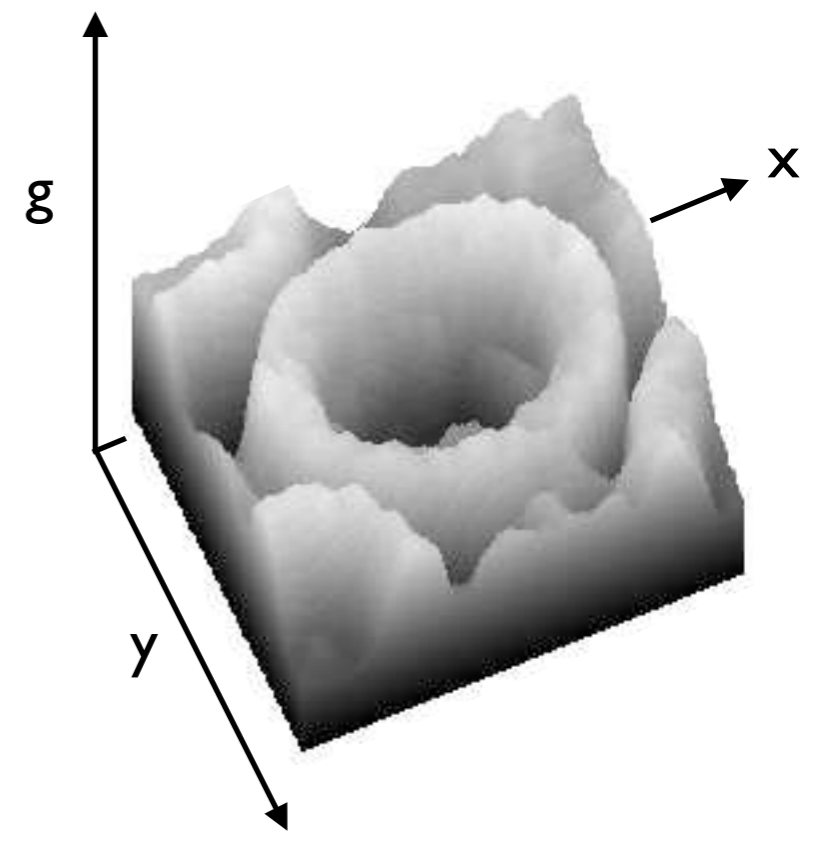
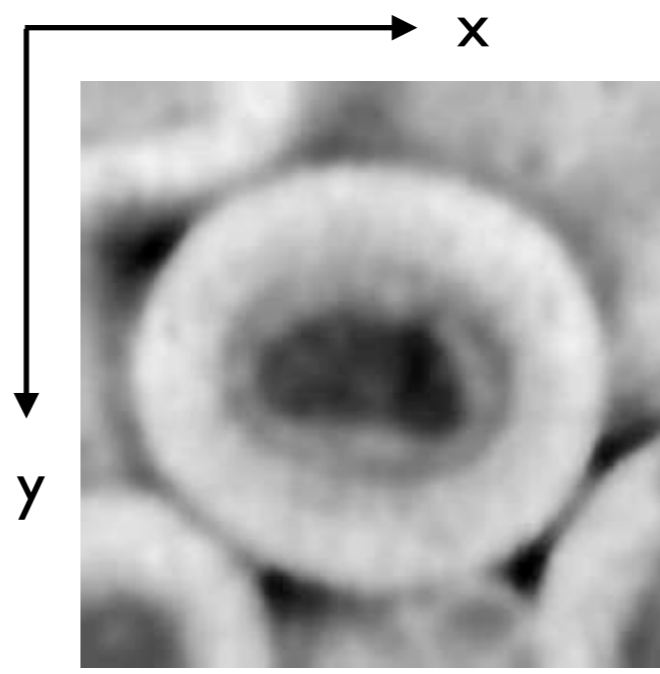
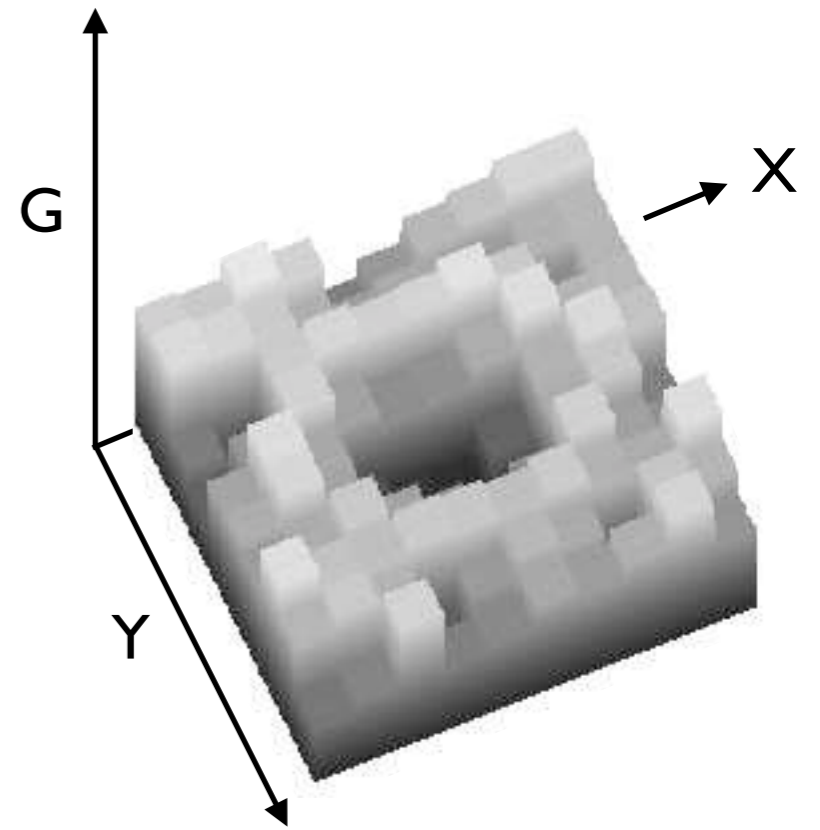
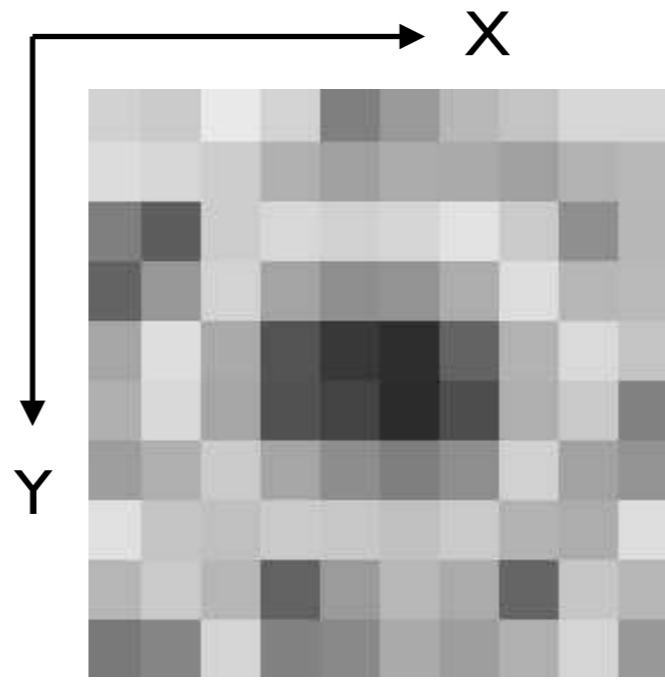


a**b****c****Figure 3.1**

The digital image.

(a) Micrograph of the surface of an oolitic limestone, detail outlined;

(b) continuous brightness function $g(x,y)$ of detail;

(c) discrete brightness function $G(X,Y)$ of detail;

details are shown in two different modes: as a brightness distribution, i.e., image (left) and as a topography (right).

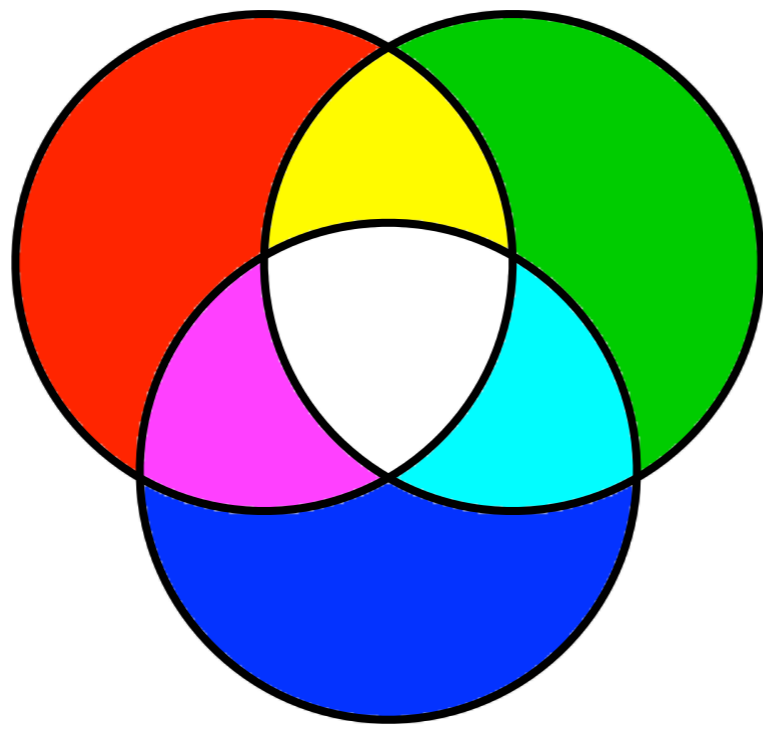
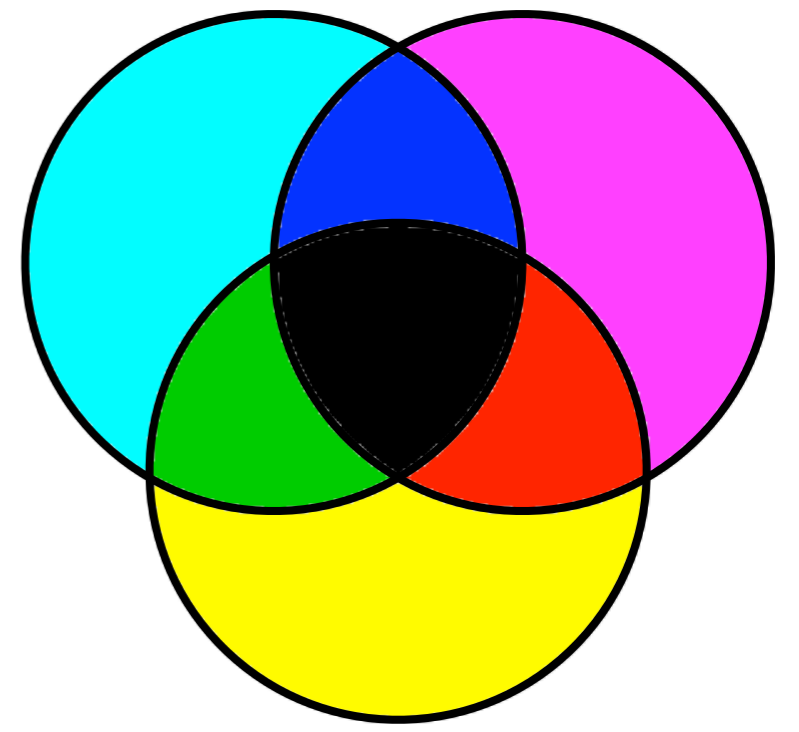
decimal	binary	octal	hexa- decimal	ASCII
0	00000000	000	00	NUL
127	01111111	177	7F	DEL
255	11111111	377	FF	ÿ
65	01000001	101	41	A
97	01100001	141	61	a
13	00001101	015	0D	CR
10	00001010	012	0A	LF

Table 3.1

Number systems and ASCII code for a few selected numbers and characters.

type	bit	byte	kB (1024 byte)	MB (1024 kB)
bitmap (1 bit / pixel)	1,500,000	187,500	183.1	0.179
grayscale (1 byte / pixel)	12,000,000	1,500,000	1464.8	1.431
grayscale (16 bit / pixel)	24,000,000	3,000,000	2929.7	2.810
colour (24 bit / pixel)	36,000,000	4,500,000	4394.5	4.292

Table 3.2
Digital size of 1500 · 1000 image.

a**b****c**

	R	G	B	C	M	Y
wavelength	400-500 nm					
500-600 nm						
600-700 nm						

Figure 3.2

Color systems.

(a) Additive system red-green-blue (RGB): mixing of light;

(b) subtractive system cyan-magenta-yellow (CMY): adding absorbers = subtracting light;

(c) spectral composition of color: white = high contribution of light or low optical density, dark gray = no contribution of light or high optical density.

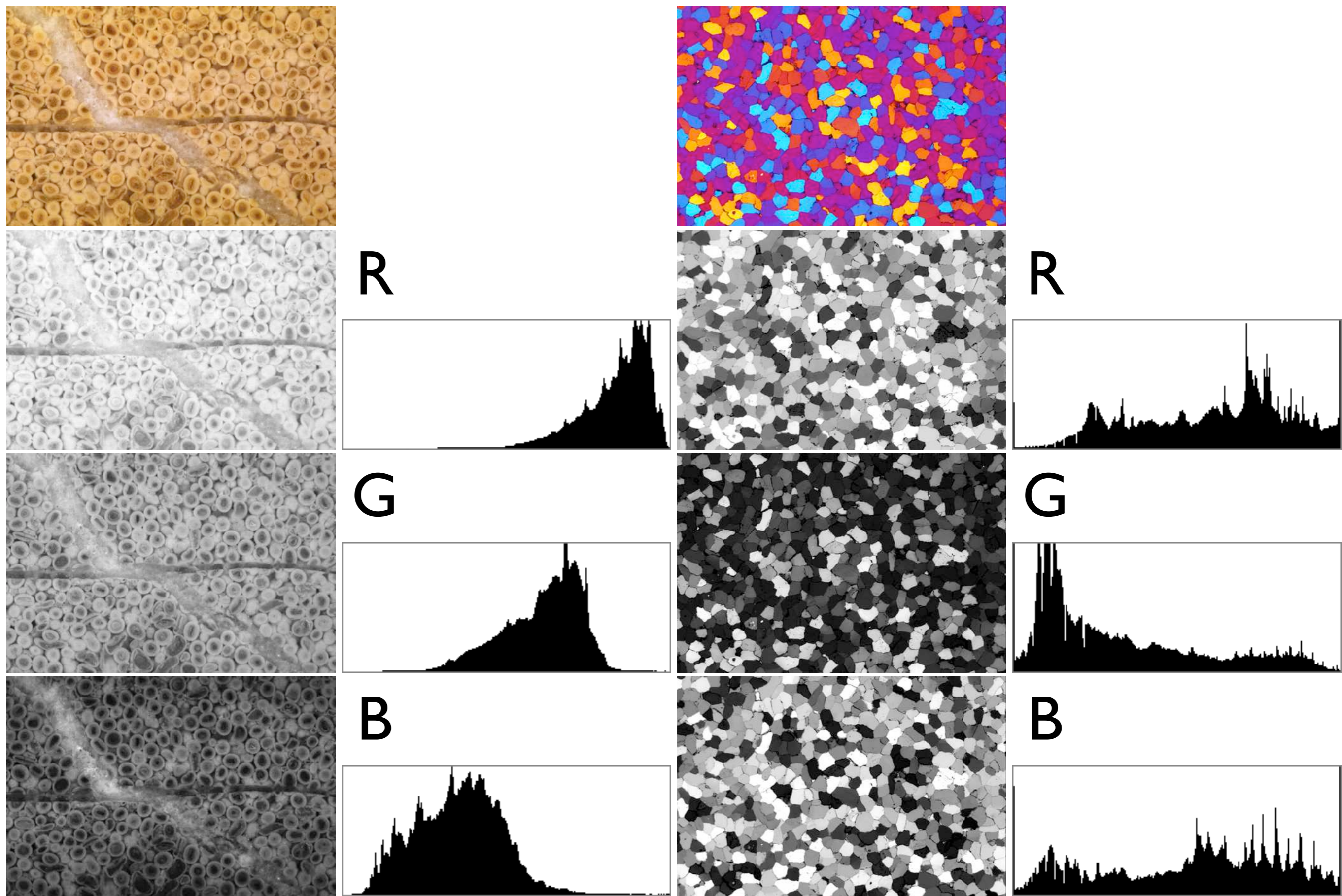


Figure 3.3

RGB color.

Two color micrographs are shown on top: polished surface of oolitic limestone (left) and thin section of Black Hills quartzite in cross polarization with lambda plate inserted (right); the (monochrome) color channels and histograms are shown below. Color separation is RGB: R = red, G = green, B = blue channel.

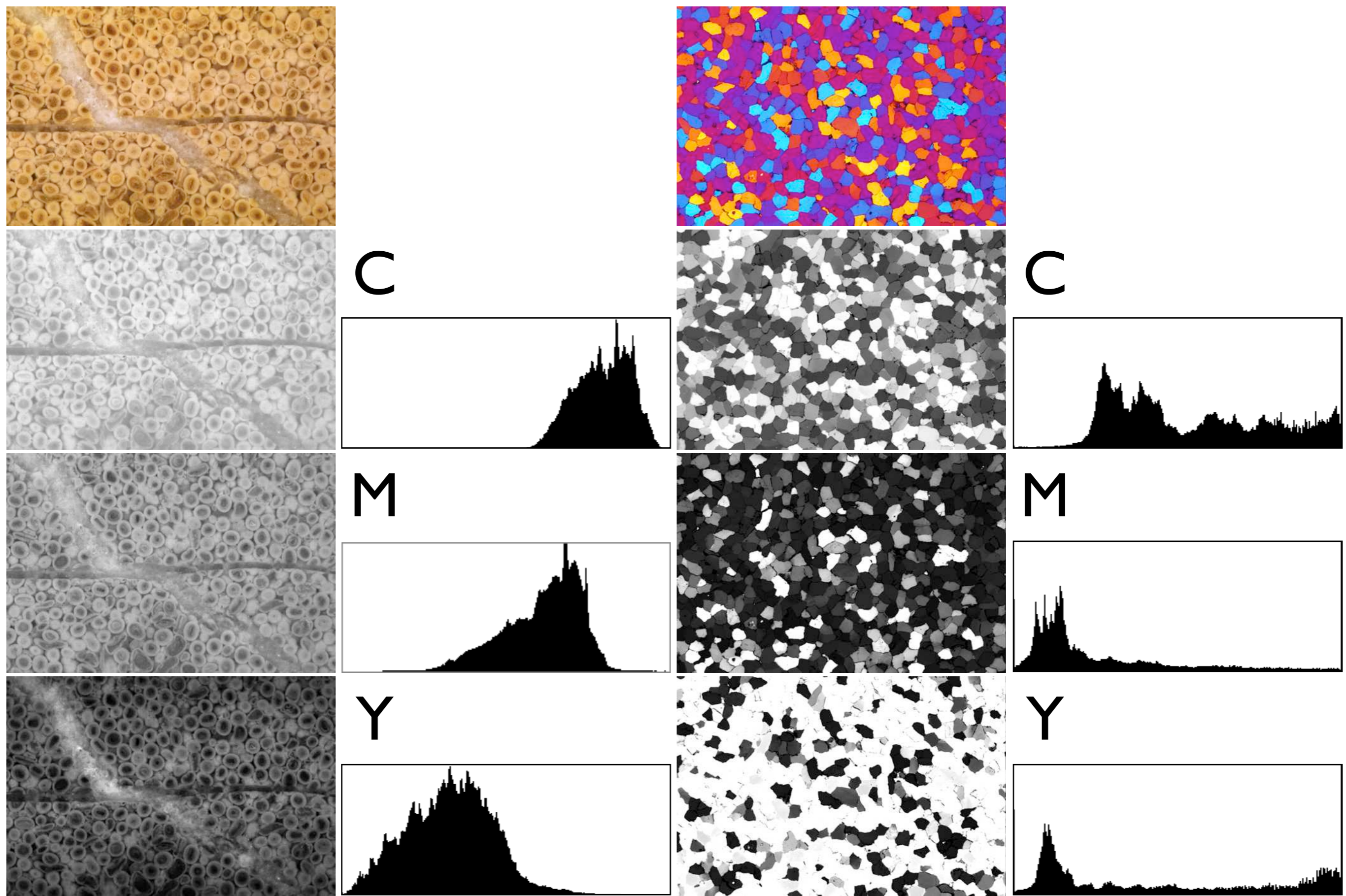


Figure 3.4

CMYK color.

The same color micrographs as in Figure 3.3. are shown on top: polished surface of oolitic limestone (left) and thin section of quartzite in cross polarization with lambda plate inserted (right). Color separation is by the CMYK system: the (monochrome) color channels, C, M, Y and histograms are shown below, K channel is not shown. C = cyan, M = magenta, Y = yellow.

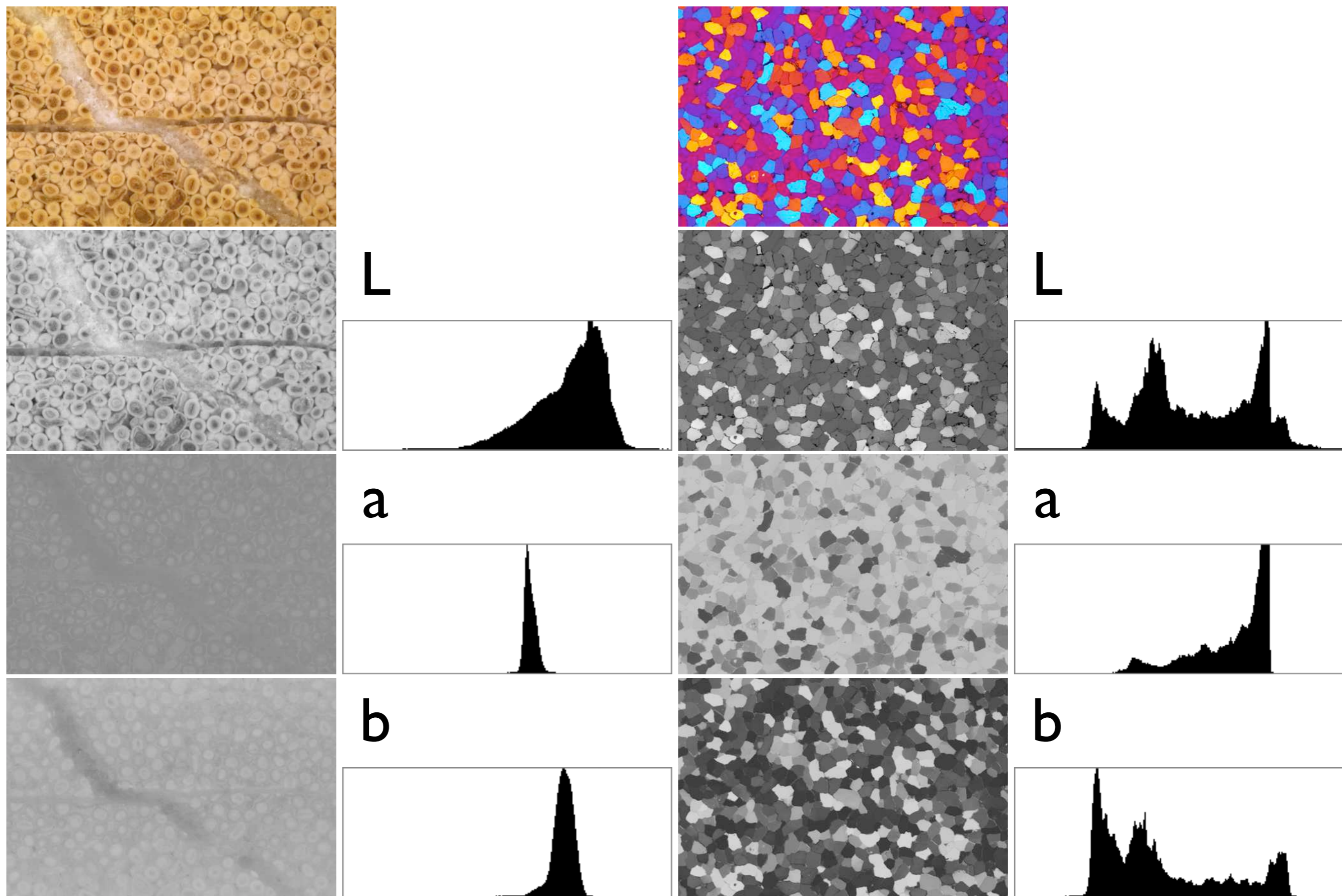


Figure 3.5

Lab color.

The same color micrographs as in Figure 3.3. are shown on top: polished surface of oolitic limestone (left) and thin section of quartzite in cross polarization with lambda plate inserted (right). Color separation is by the CIE Lab system: the (monochrome) color channels and histograms are shown below. L = luminosity; a = green-magenta color coordinate, b = blue-yellow color coordinate.

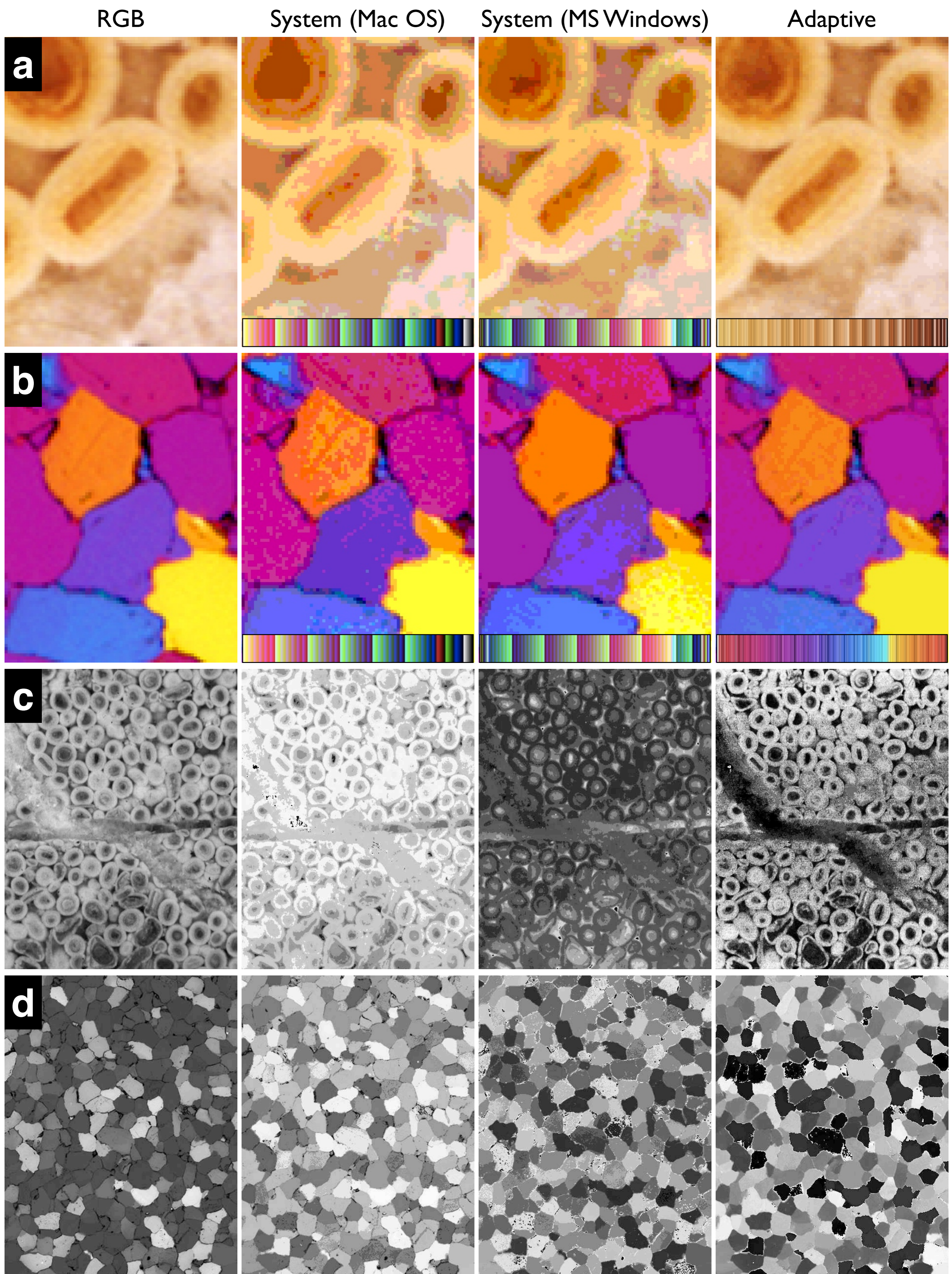


Figure 3.6
 Index Color.
 The same micrographs as in Figure 3.3 are converted to index color images using 3 different color look-up tables (LUT). (a), (b) Detail of the micrograph shown as RGB and Index Color using the System (Mac OS) LUT, the System (MS Windows) LUT and an adaptive LUT (from left to right) with the LUT shown next to the image. (c), (d) from left to right: RGB converted to grayscale, Index Color images shown as grayscale, i.e., with the color LUT removed.

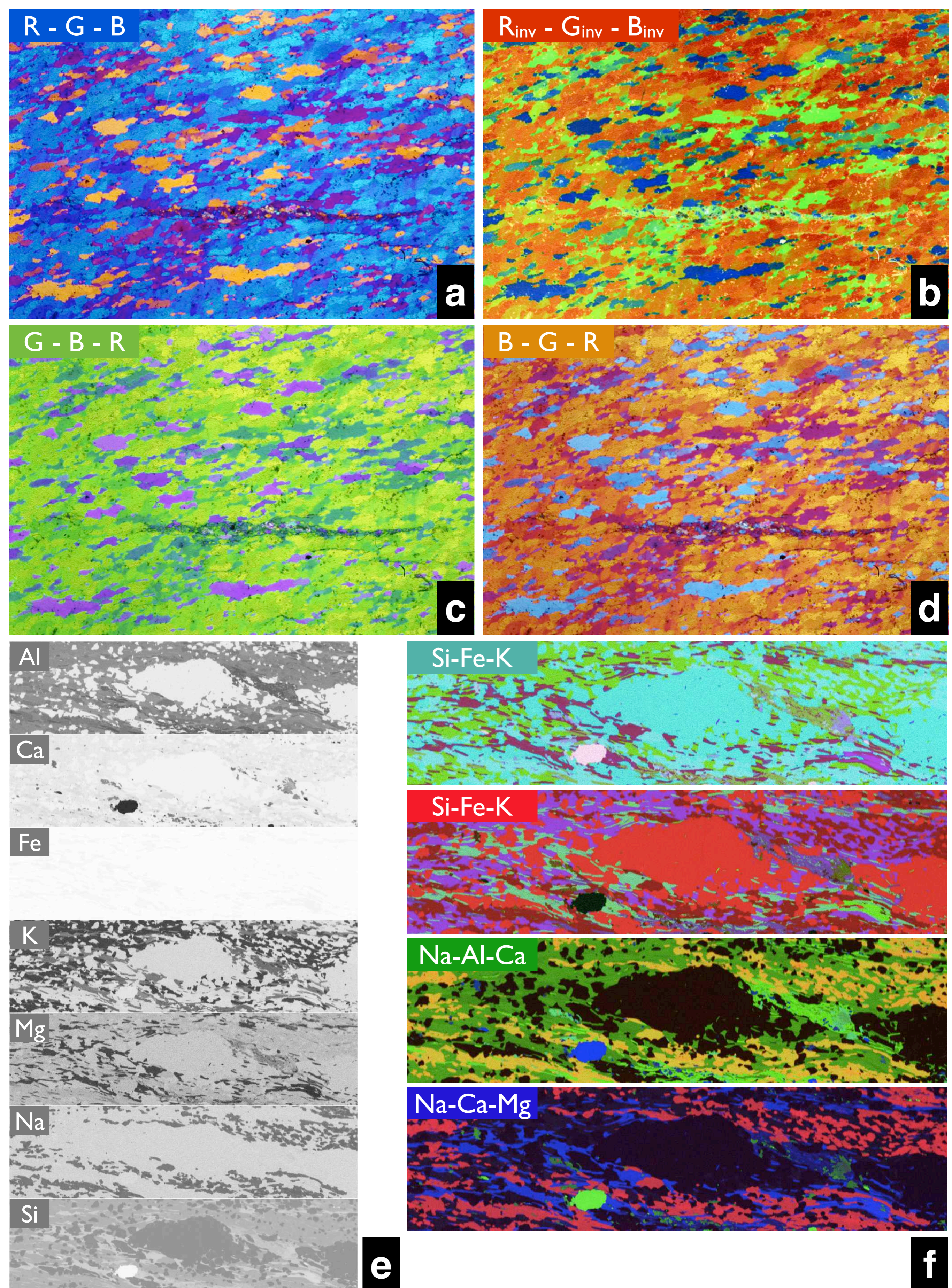


Figure 3.7

Color stacks. (a – d) Micrograph of quartz mylonite under crossed polarizer conditions with wave plate inserted; (e – f) element maps of granitoid rock. (a) Color channels in original sequence: 1=R, 2=G, 3=B; (b) inverse of every channel yields negative; (c) rotation of channels such that 1=G, 2=B, 3=R; (d) switch of R and B channel such that 1=B, 2=G, 3=R; (e) maps seven elements (white = low, black = high concentration); (f) combinations of 3 element maps to form maps of mineral phases; note that central clast is high in Si (= quartz).

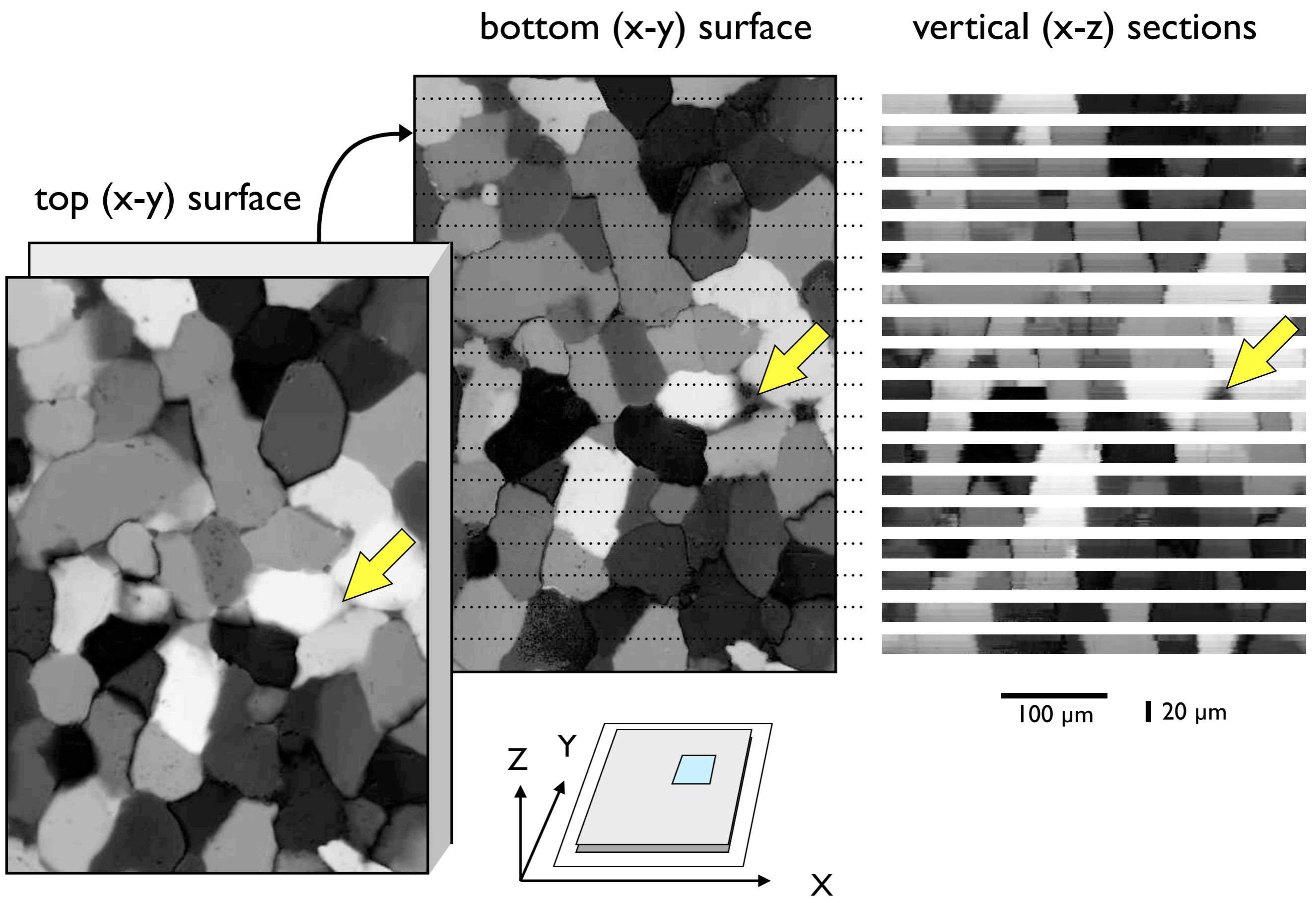
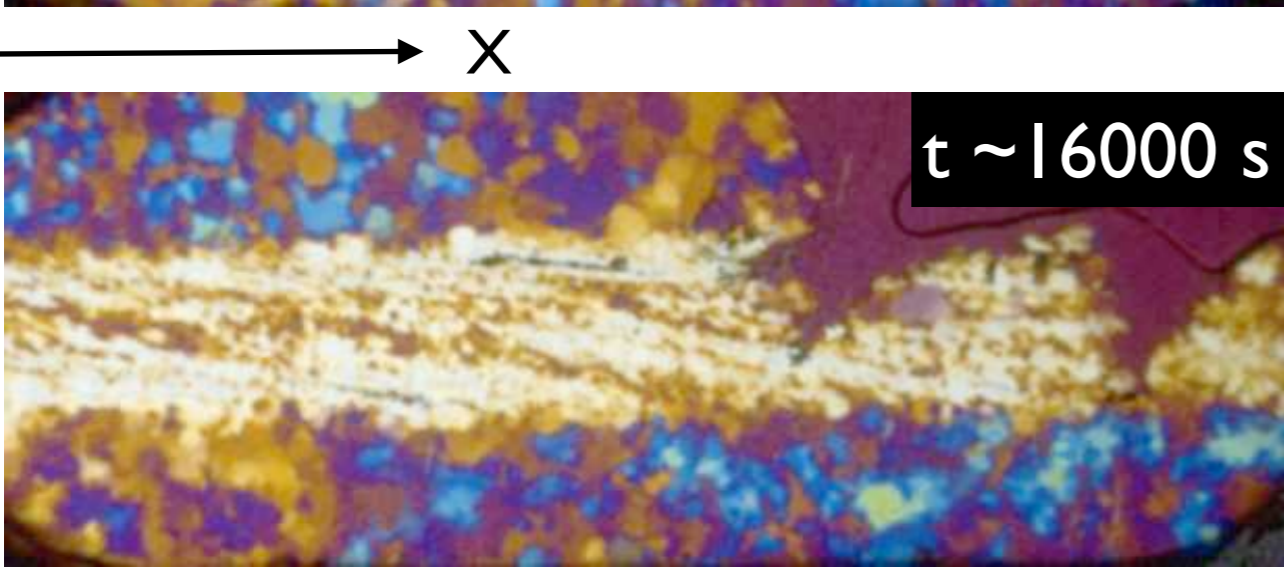
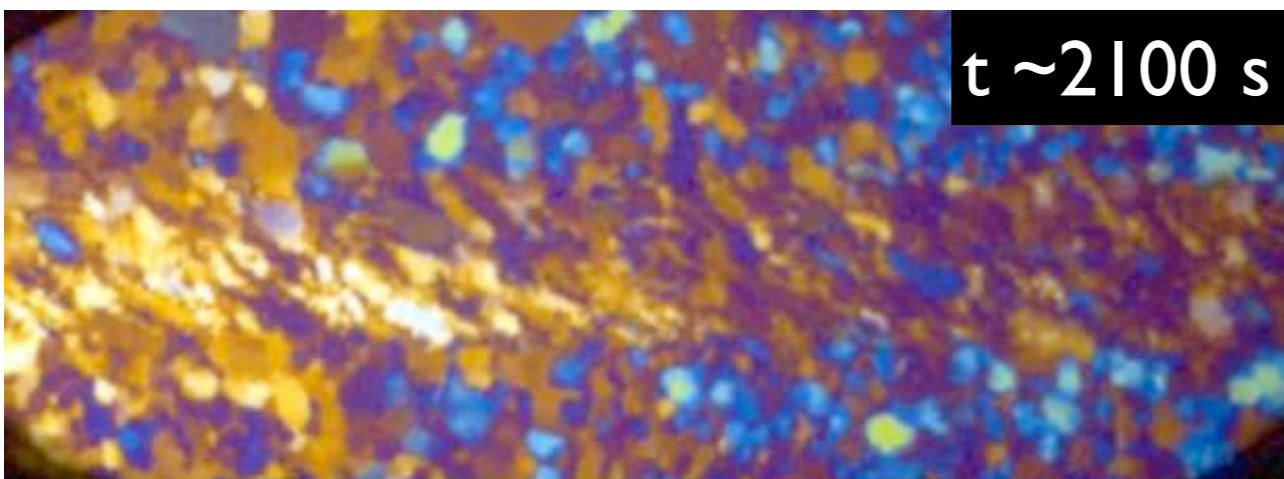
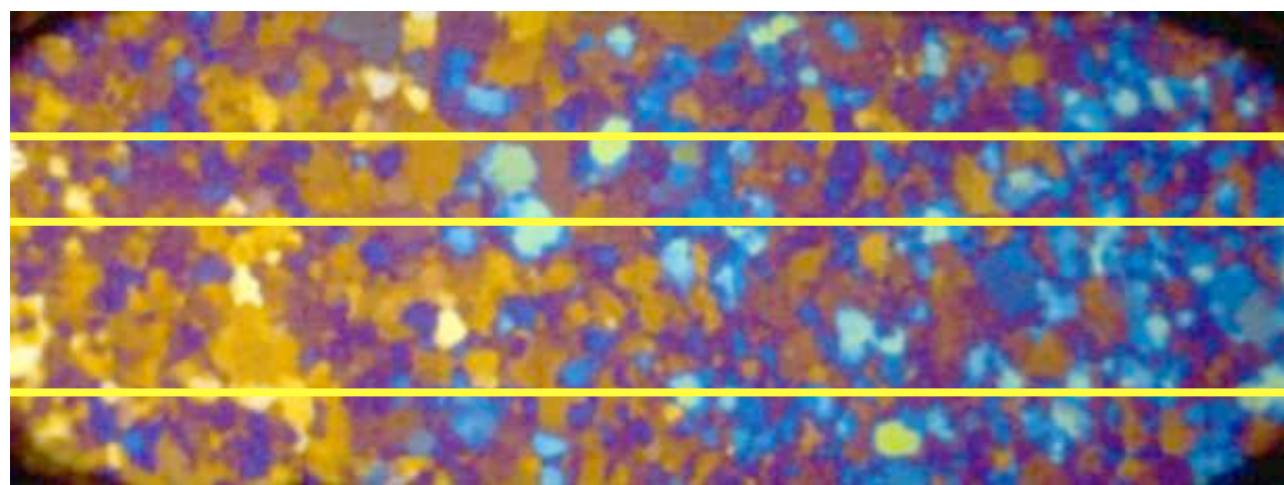
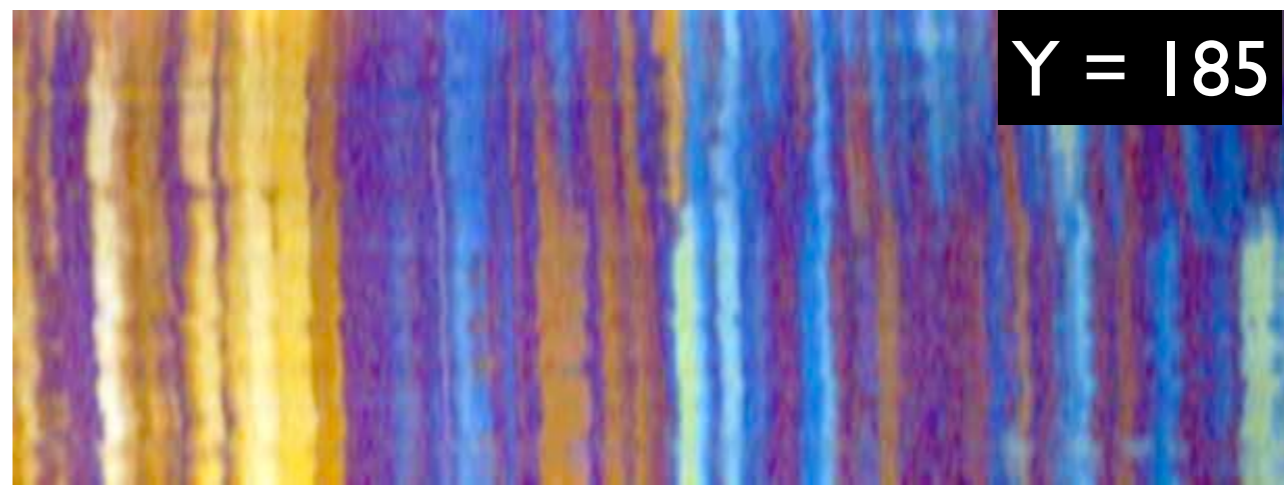
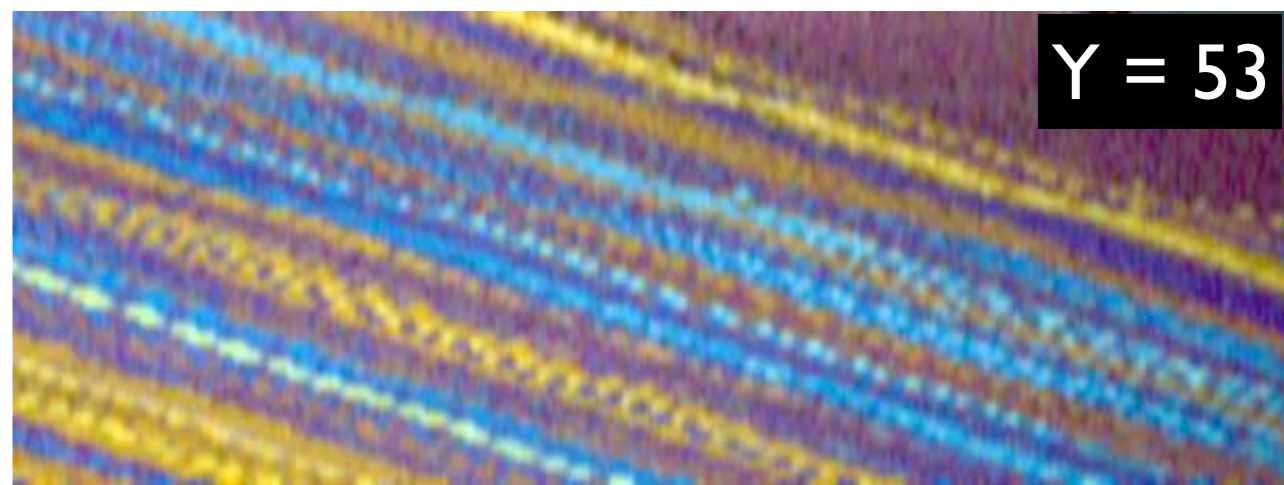


Figure 3.8

Volume stacks.

X-Y-Z stack representing the volume of rock of which a thin section consists (see inset), stacked micrographs are misorientation images from an incrementally thinned thin section (see text); stippled lines = traces of vertical sections; arrows point to corresponding location in image.

a**b****Figure 3.9**

Time stacks.

(a) Three frames of film of deformation experiment on norcamphor (experiment by Marco Herwegh), left-lateral shear, traces for time slices in yellow;

(b) time slices in moving upper block (top), center of shear zone (center) and fixed lower block (bottom).

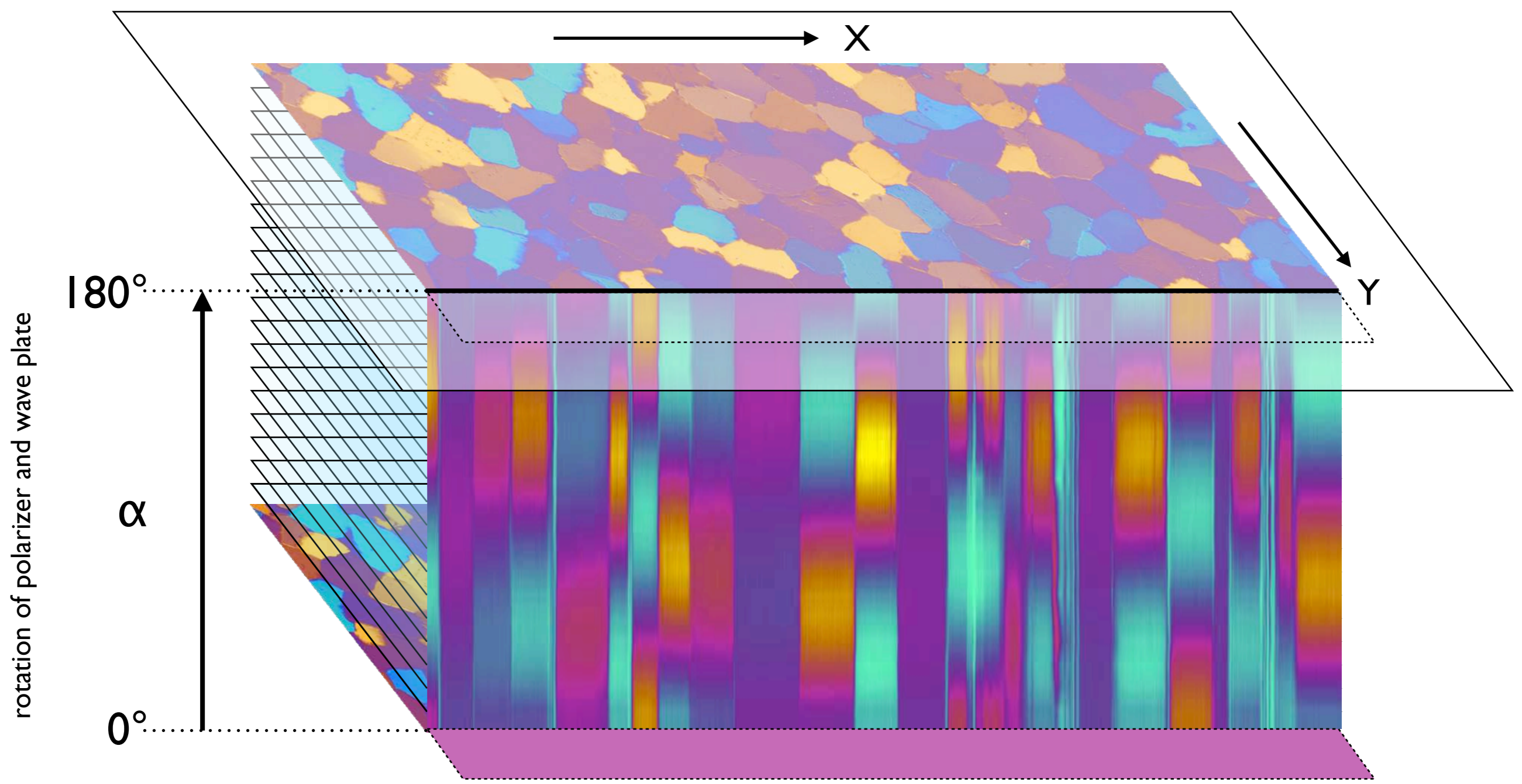
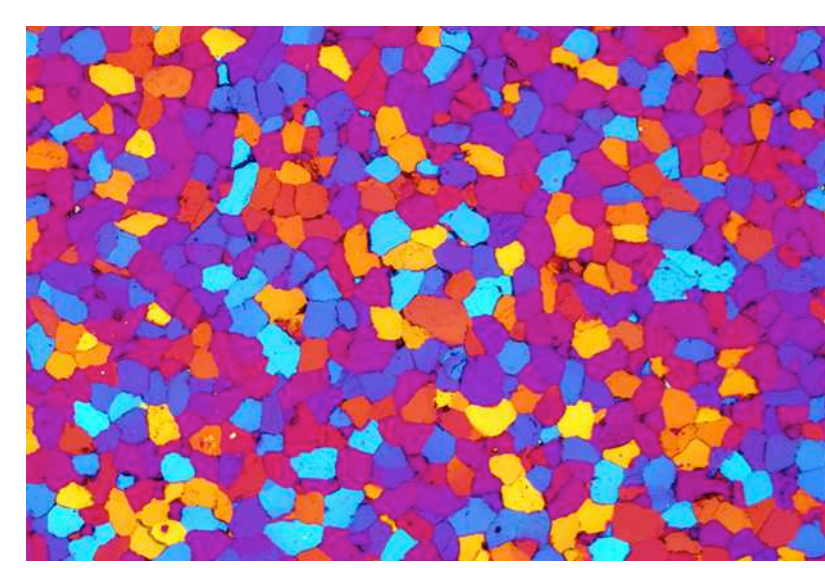


Figure 3.10

Crystal orientation stacks.

Stack of micrographs taken with rotating polarizer and wave plate shown as X-Y- α stack. The change of interference colors as function of rotation are seen on vertical sections.



900 · 600 RGB
1,620,000 byte

format	compression (mode)	type	size (bytes)
RAW	-	lossless	1,725,219
TIFF	-	lossless	1,754,034
TIFF	LZW	lossless	1,350,657
PICT	(32bit/pixel)	lossy	1,643,887
PICT	(16bit/pixel)	lossy	1,047,630
JPEG	max quality	lossless	838,804
JPEG	max compression	lossy	144,218
PNG	-	lossy	1,073,214

Table 3.3
JPEG compression of 900 · 600 RGB image.

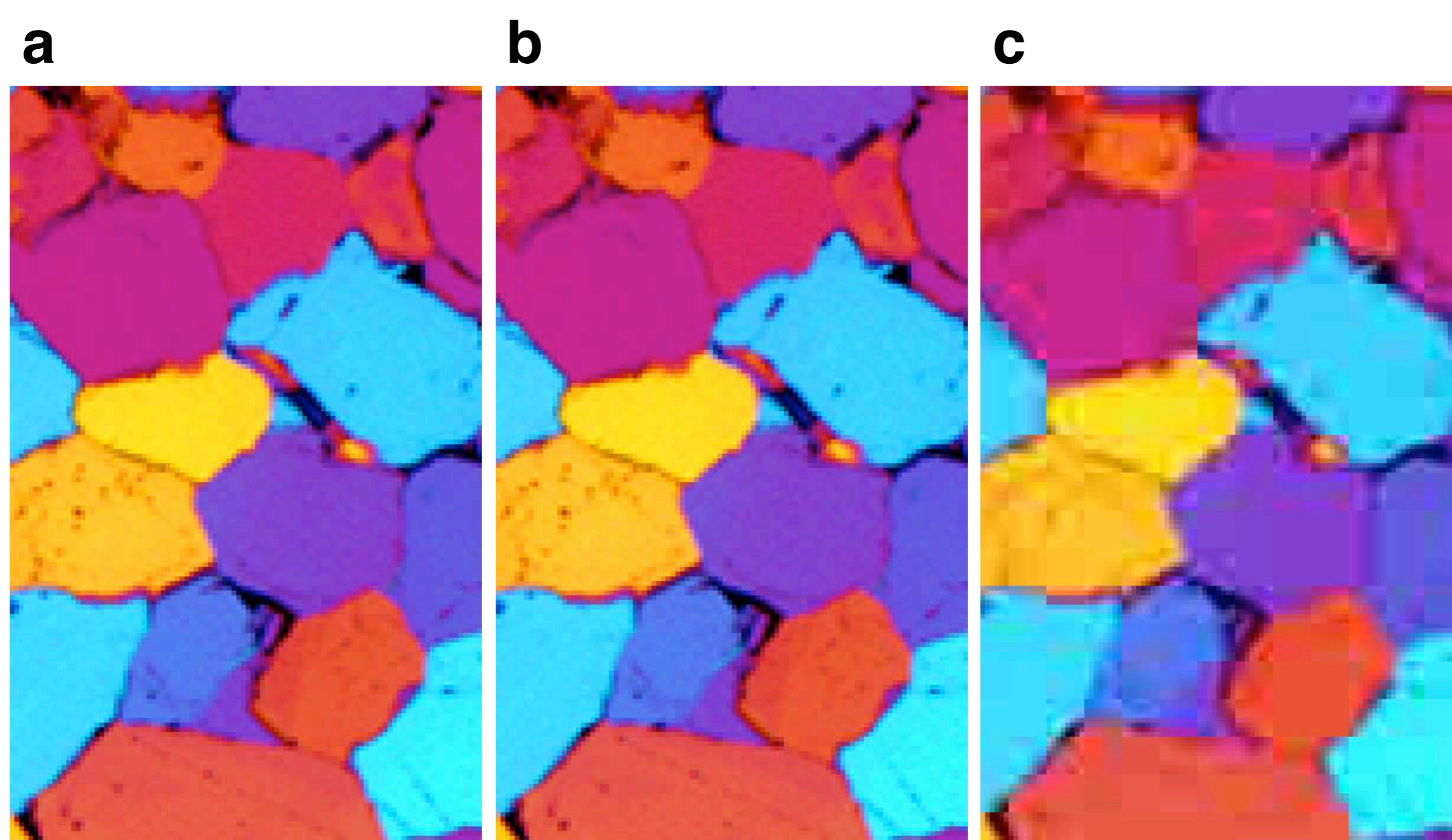


Figure 3.12
JPEG compression.
(a) Detail of original RGB image;
(b) JPEG, maximum quality;
(c) highly compressed JPEG; note $8 \cdot 8$ pixel blocks.

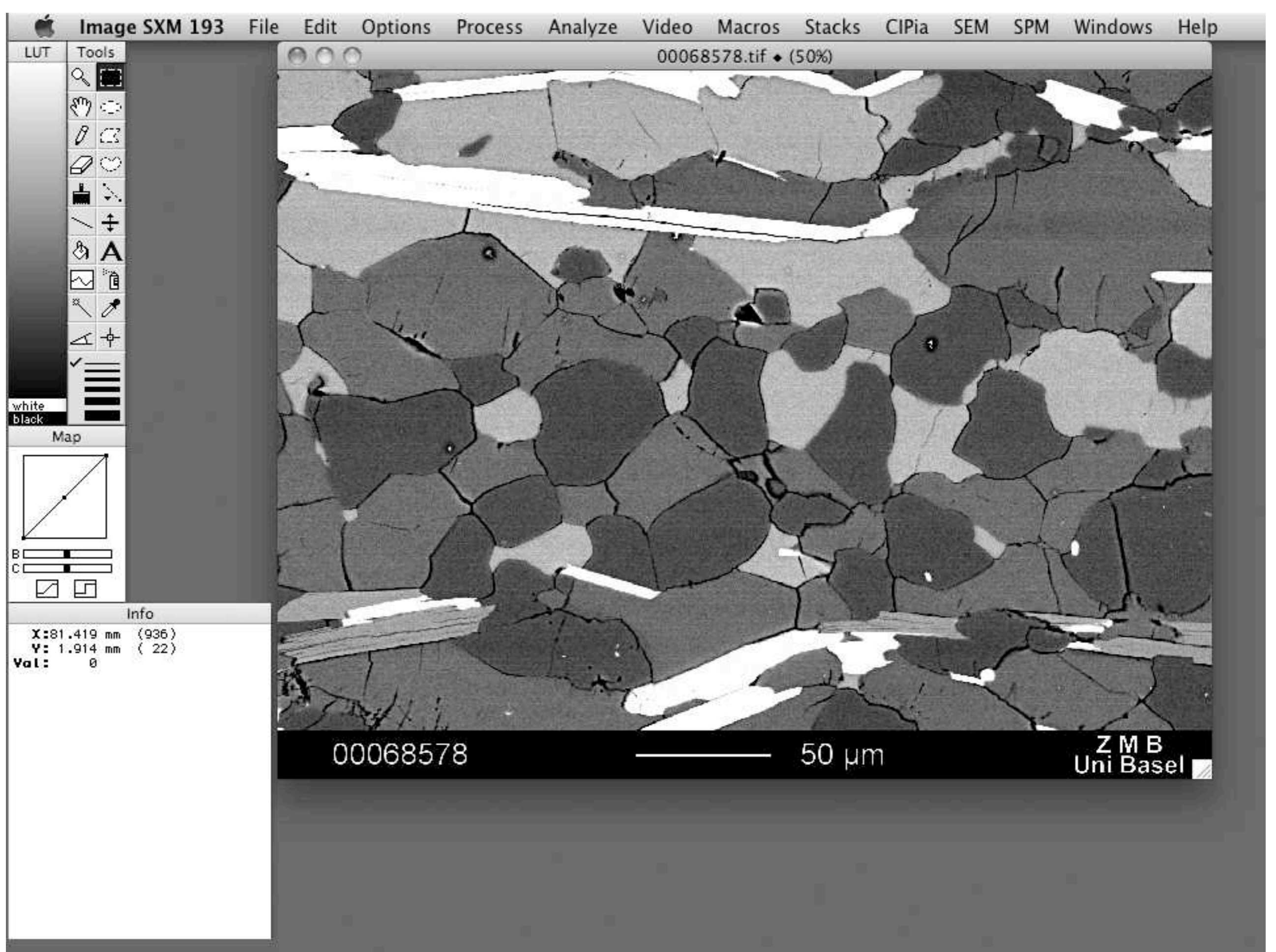


Figure 3.13
Desktop of Image SXM (Version 193 PrinCIPIa, June 2012)

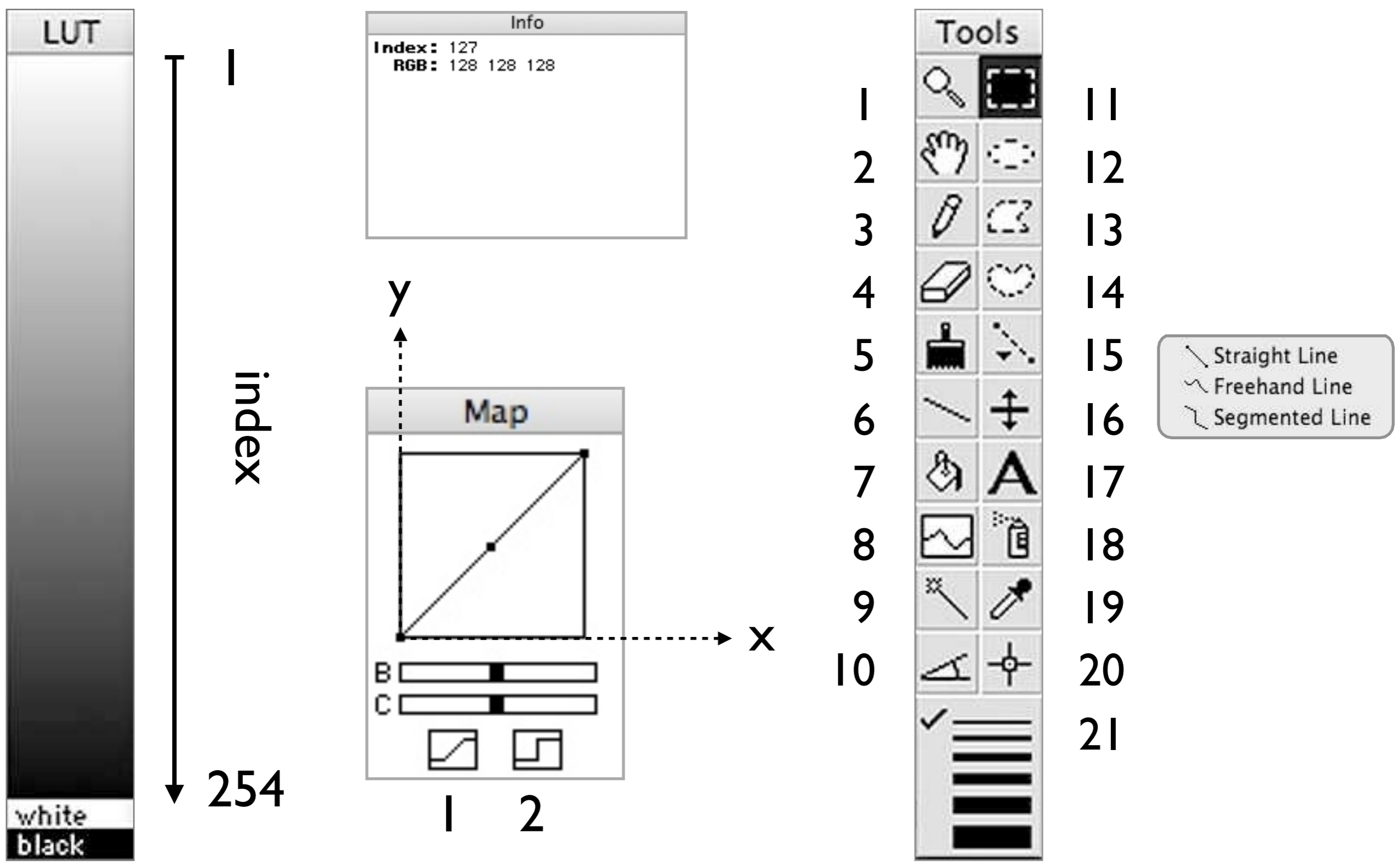


Figure 3.14

Image SXM windows: LUT, Info, Map and Tools.

LUT: Grayscale representation of look-up table.

Info: Display of information and measurements

Map: Representation of look-up table as (transfer) curve: x-axis = index (input value); y-axis: gray value (output); sliders B and C modify brightness (offset) and contrast (slope) respectively; click on field 1 restores 1:1 LUT; field 2 invokes thresholding.

Tools: (see text for description).

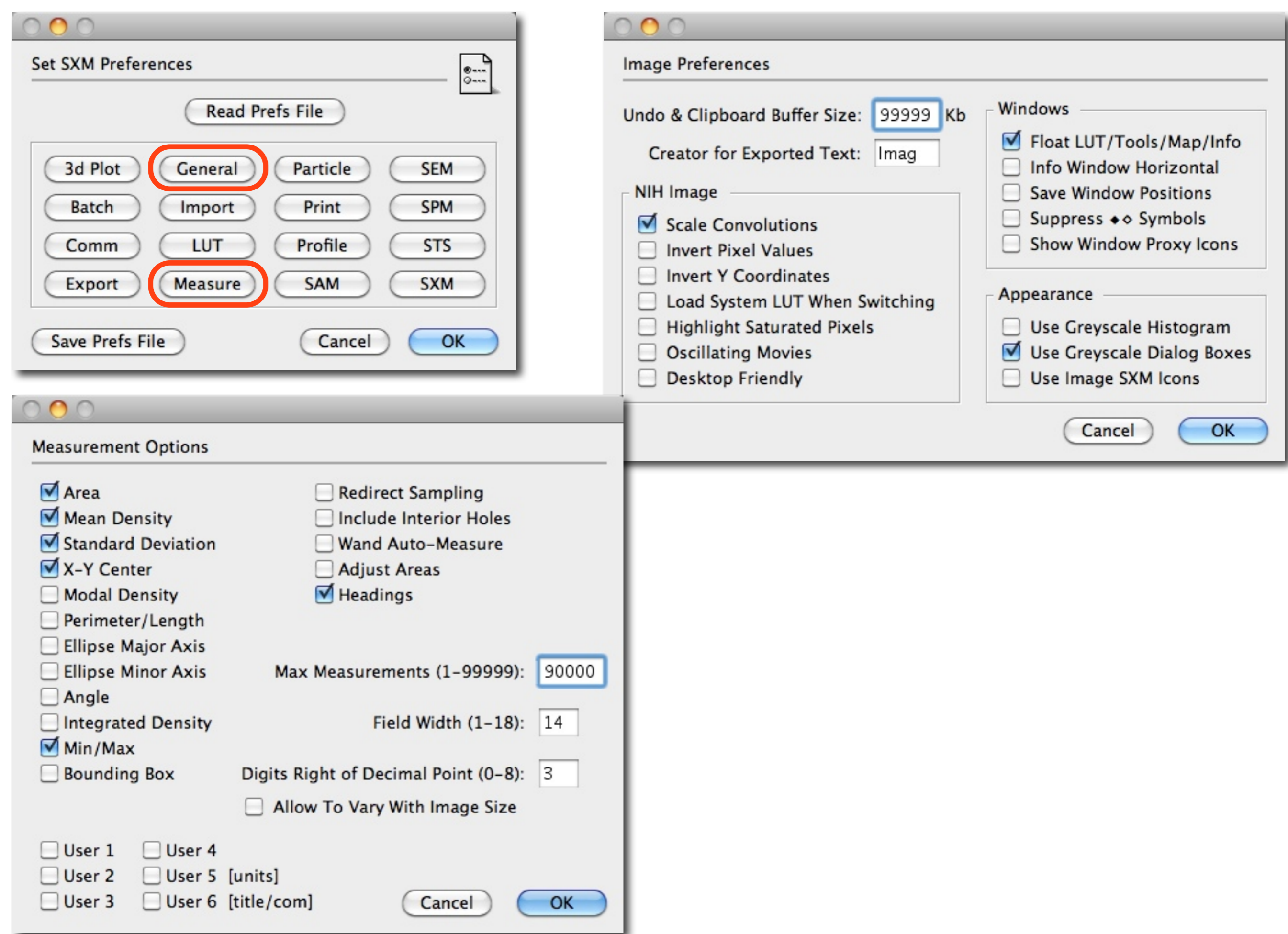


Figure 3.15

Image SXM Preferences.

Top right: settings for Image Preferences; lower left: settings in Measurement Options.

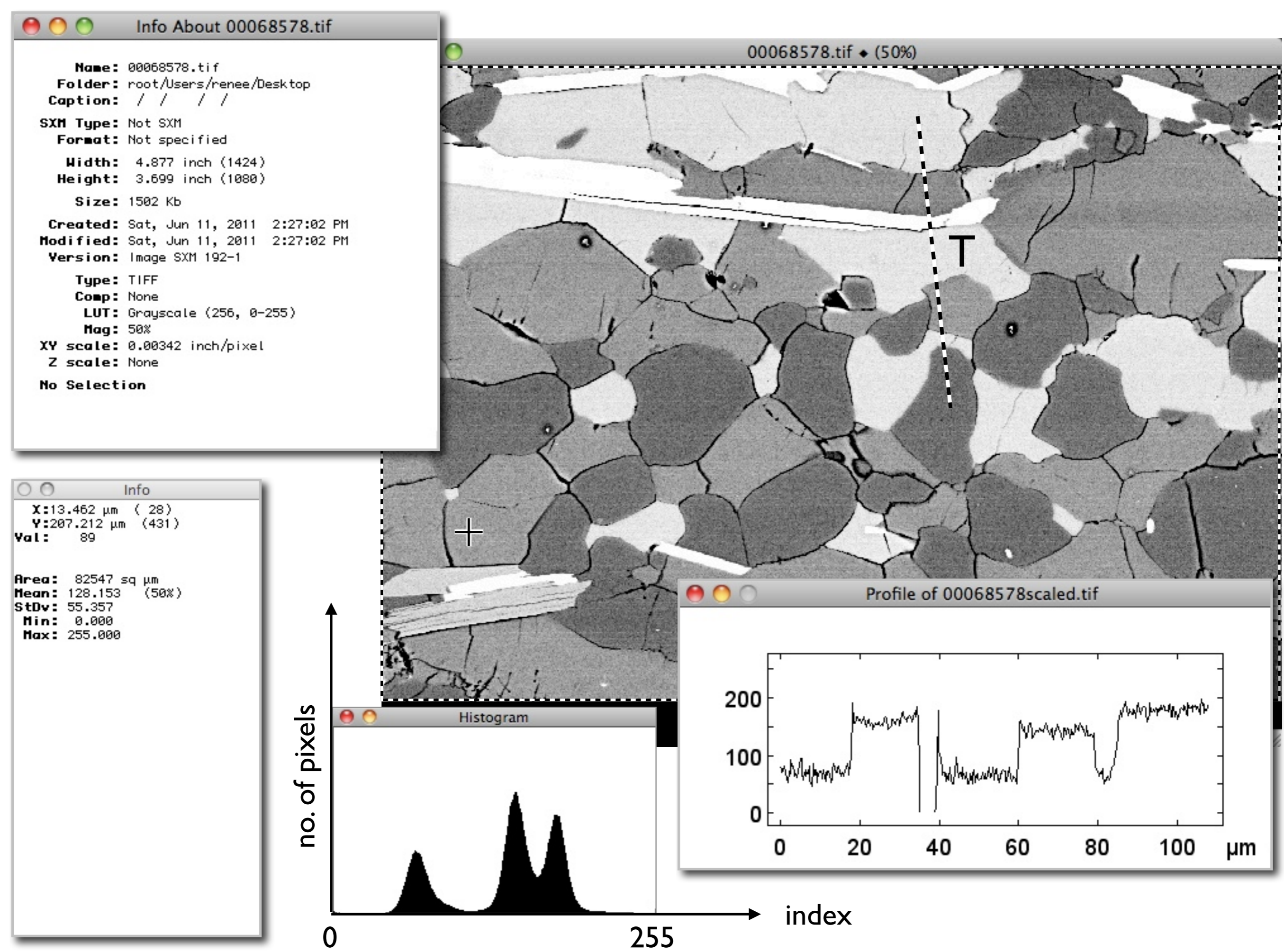


Figure 3.16

Information about image.

Info About (image file name): Information displayed by command 'Get Info'.

Info: Position (X and Y) and gray value (Val) of cursor, measurement value for histogram.

Histogram: Number of pixels as function of index (0 to 255).

Profile: Gray values along traverse (T).

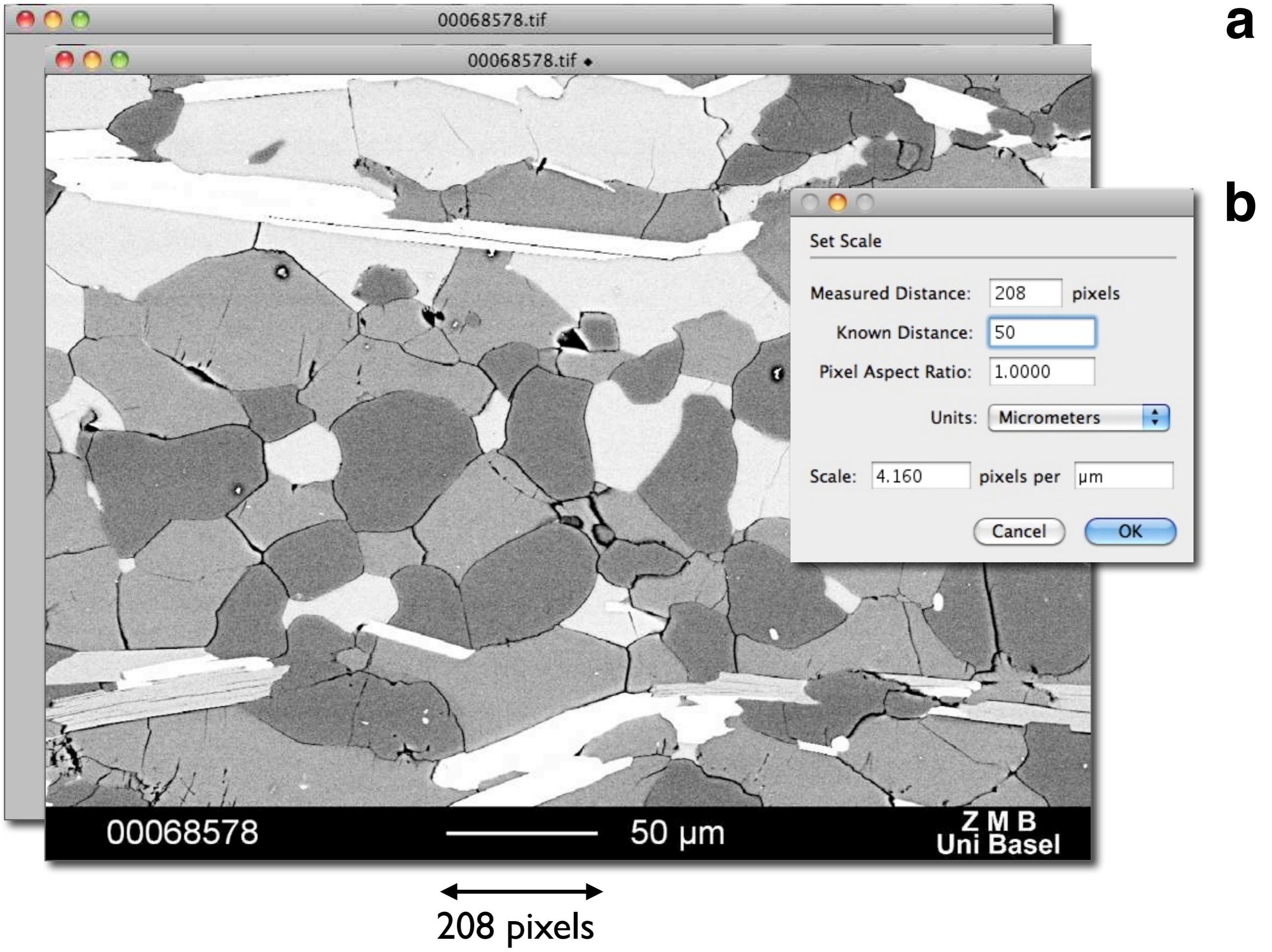
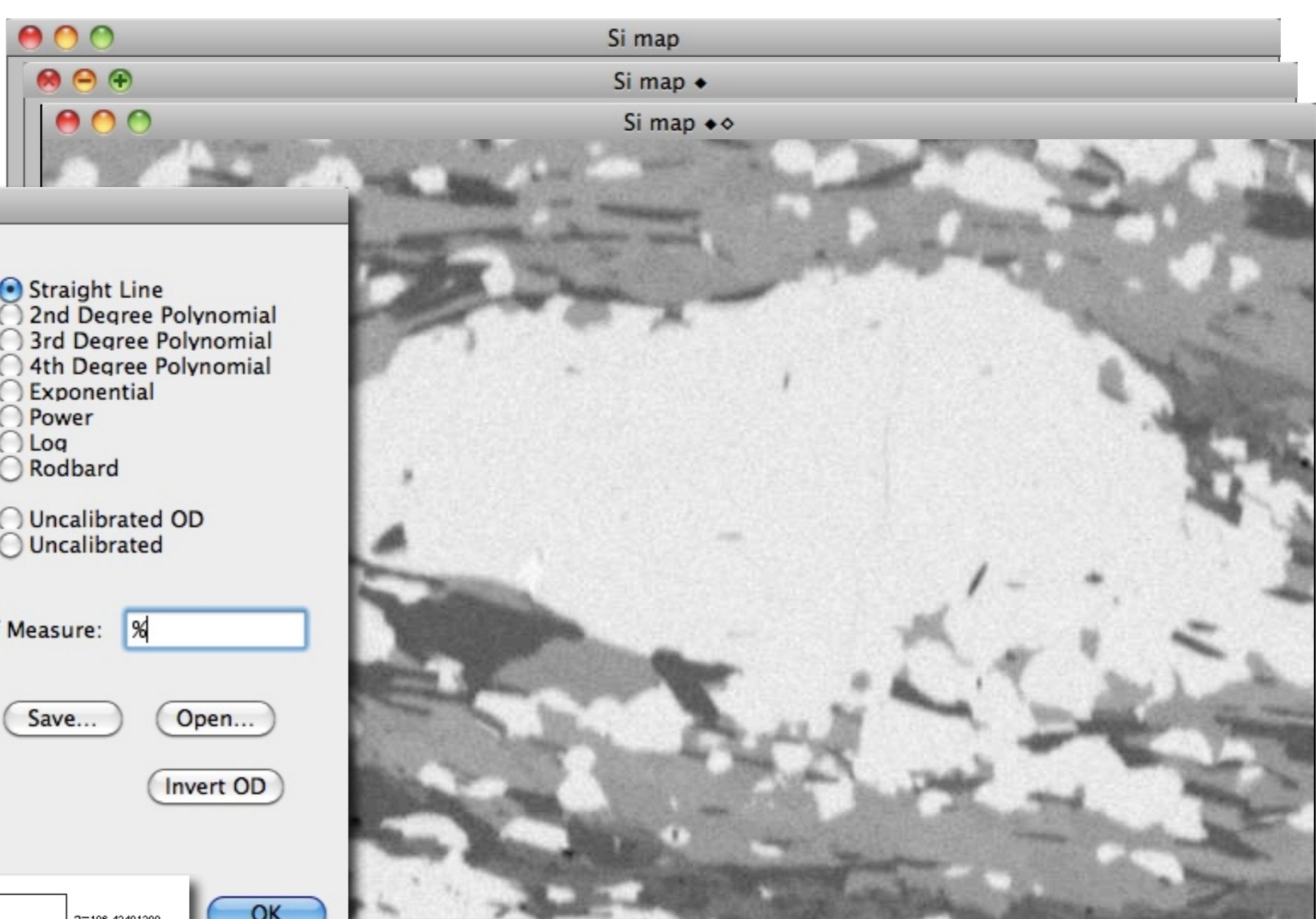


Figure 3.17

Scaling the image.

(a) Original image (SEM micrograph): window title with name only, if unscaled and uncalibrated; with black diamond, after scaling;

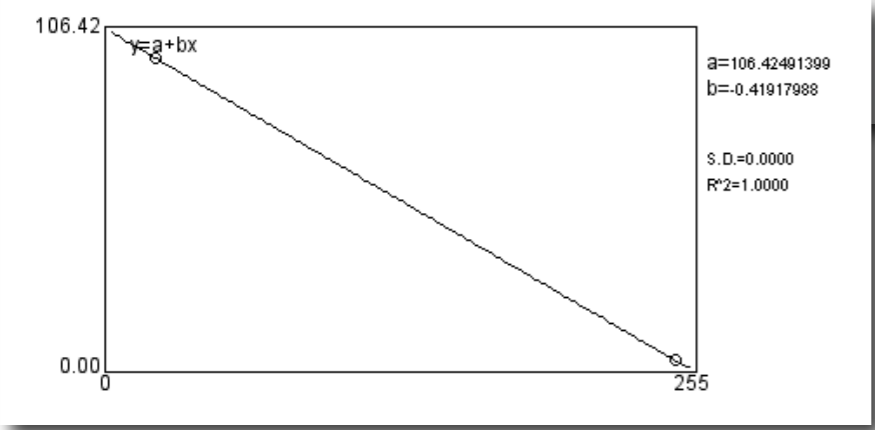
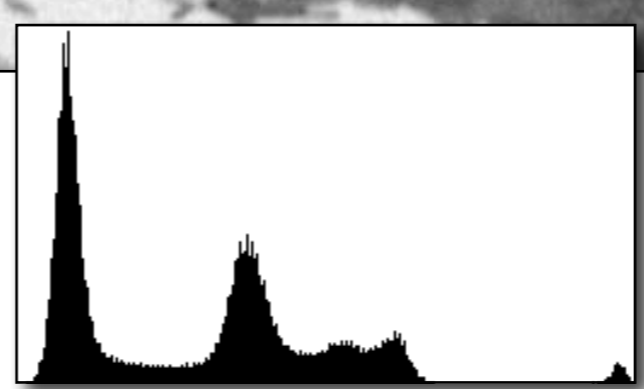
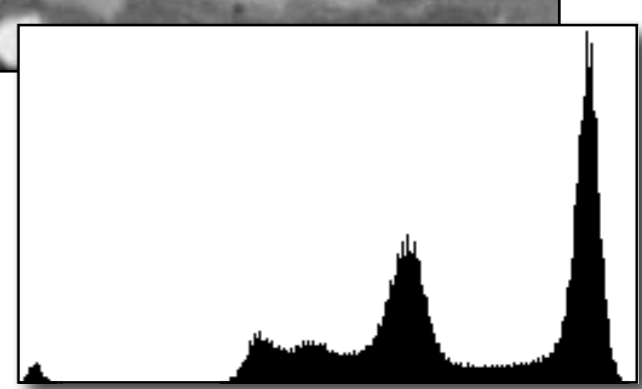
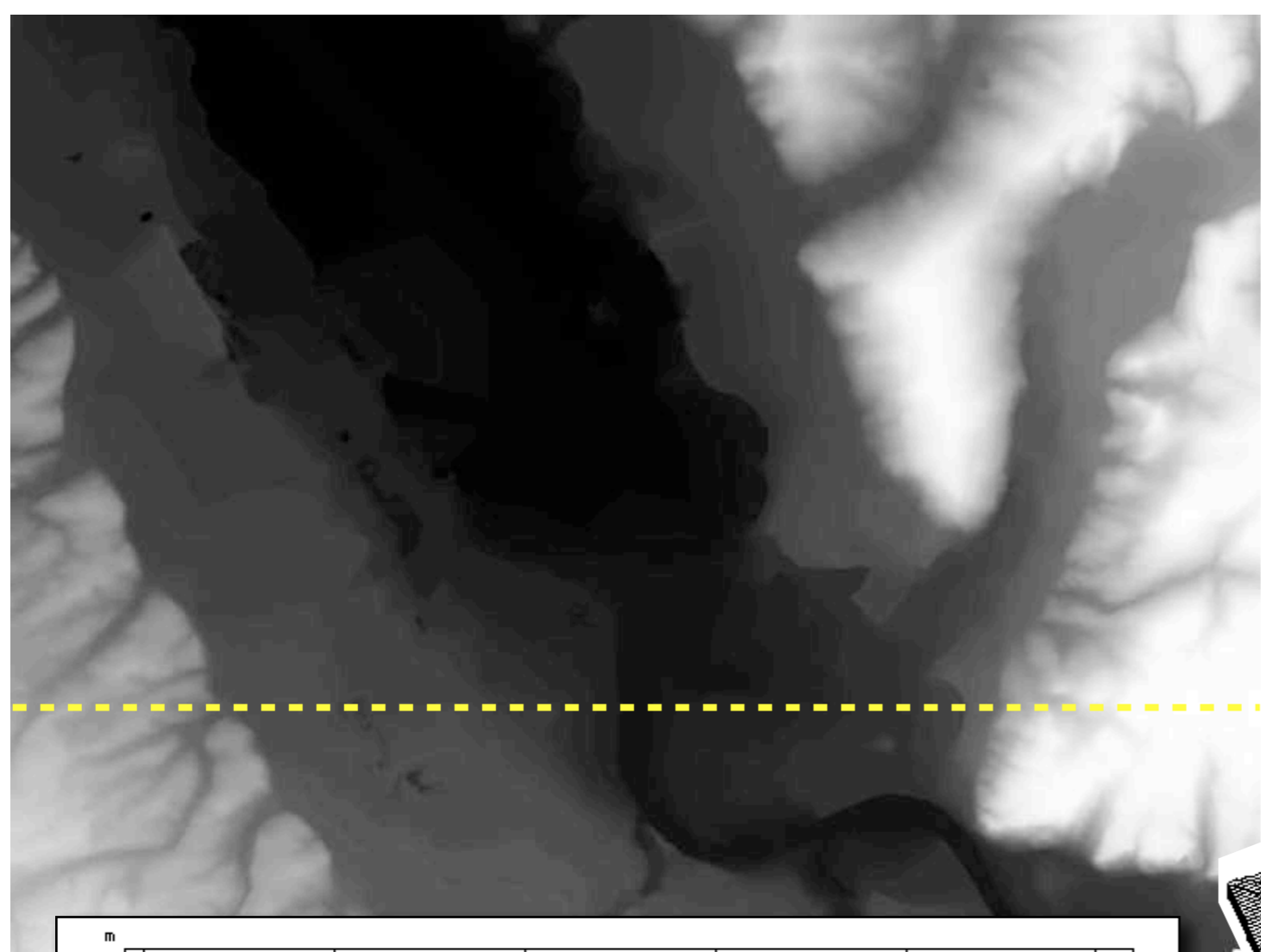
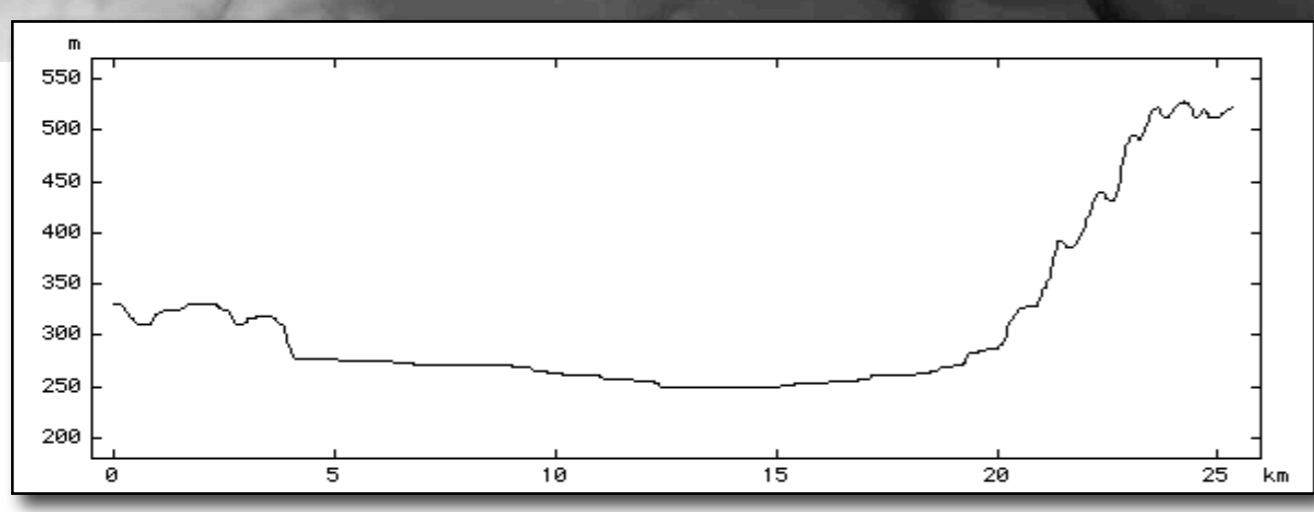
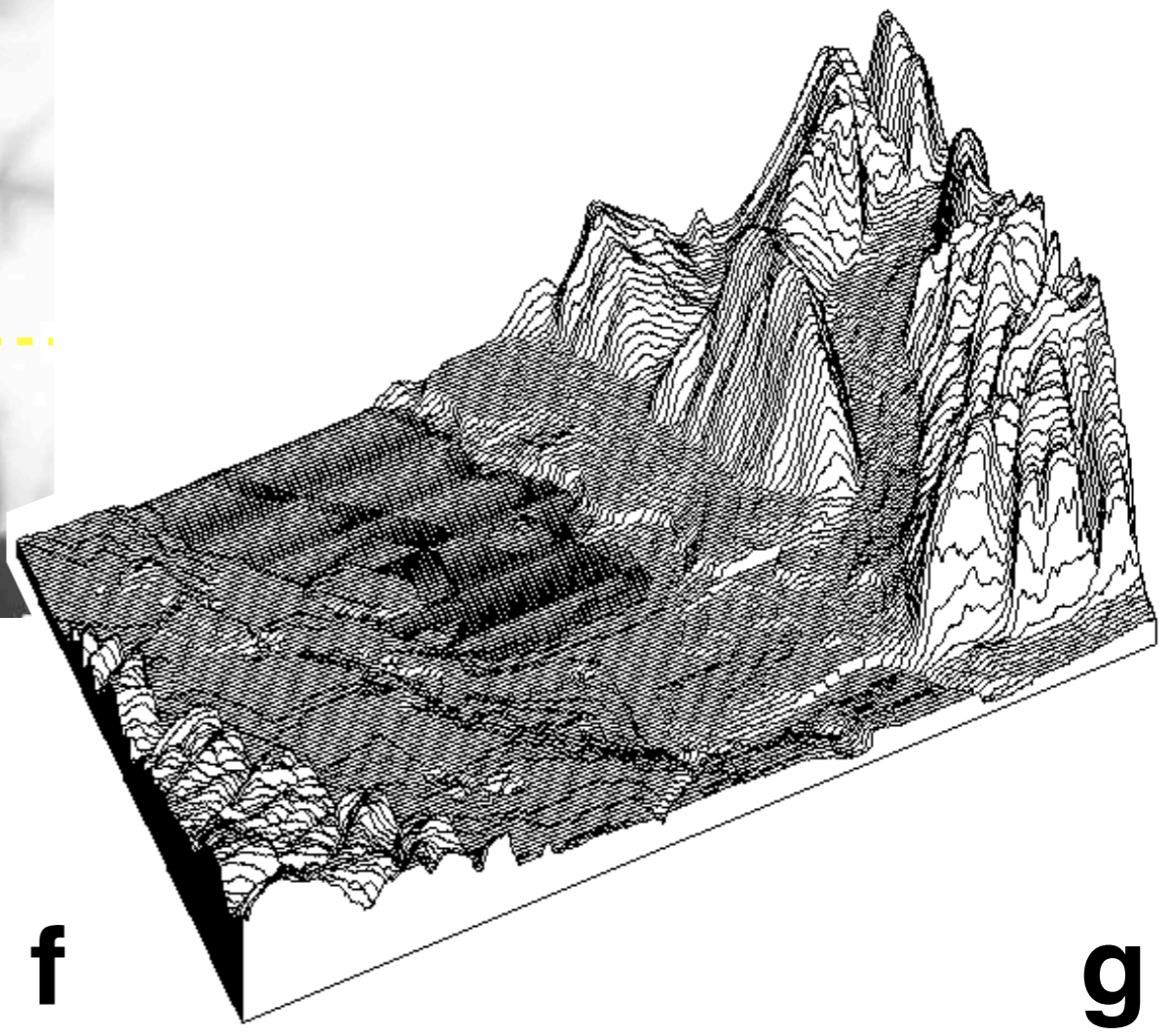
(b) dialog window for scaling.

a

	Measured	Known
1	20.10	98
2	249.12	2
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		

Straight Line
 2nd Degree Polynomial
 3rd Degree Polynomial
 4th Degree Polynomial
 Exponential
 Power
 Log
 Rodbard
 Uncalibrated OD
 Uncalibrated

Unit of Measure:

**b****c****d****e****f****g****Figure 3.18**

Calibrating images.

- (a) Image 1 (element map): window title with name only, if unscaled and uncalibrated; with black diamond, after scaling, with empty diamond after calibration;
- (b) dialog window for calibration with resulting calibration curve;
- (c) histogram before calibration;
- (d) histogram and profile after calibration, note scaled and calibrated axes in profile;
- (e) image 2 (digital elevation model);
- (f) profile, note scaled and calibrated axes;
- (g) topographic representation.

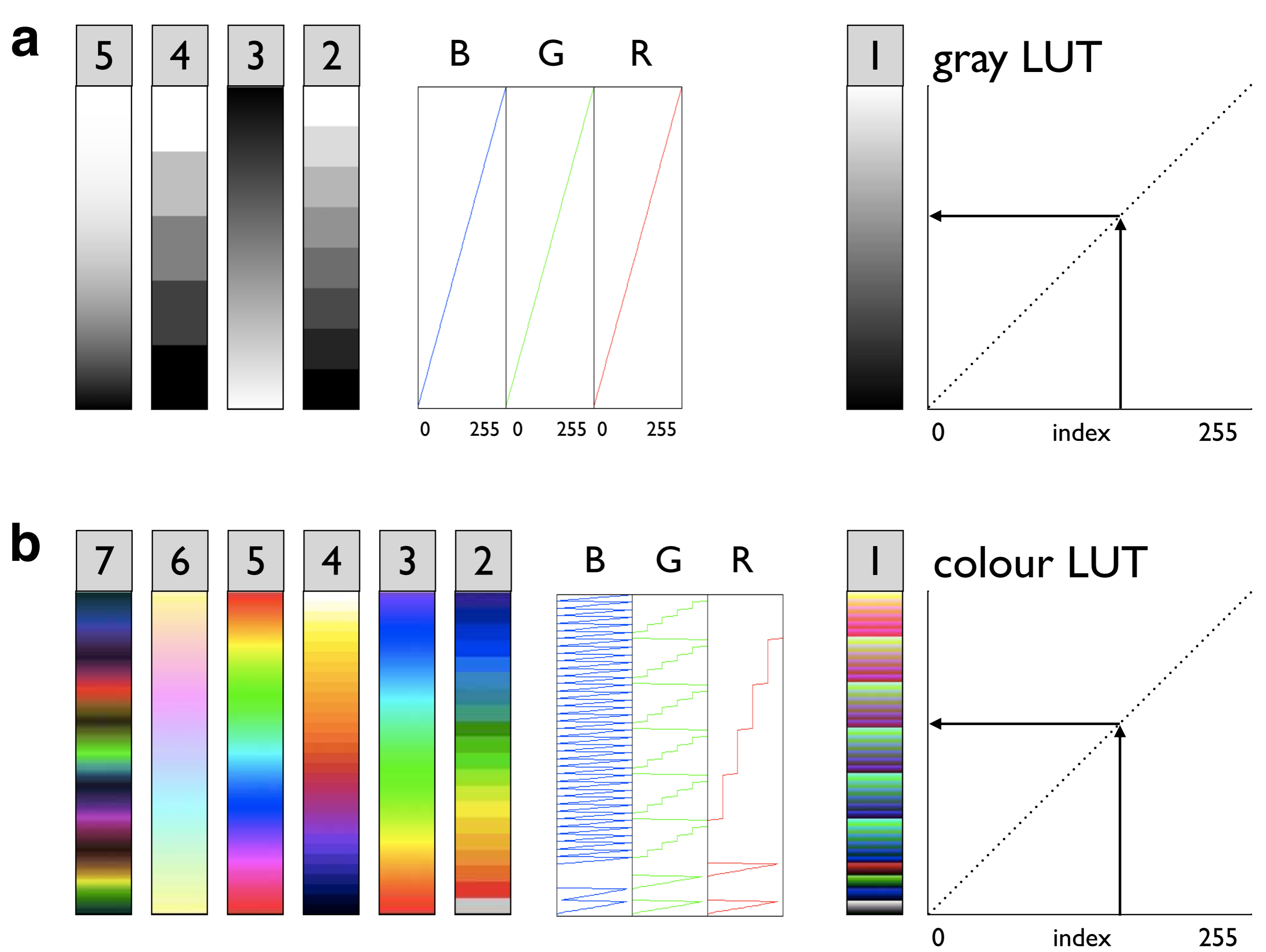


Figure 3.19

Look-up Table.

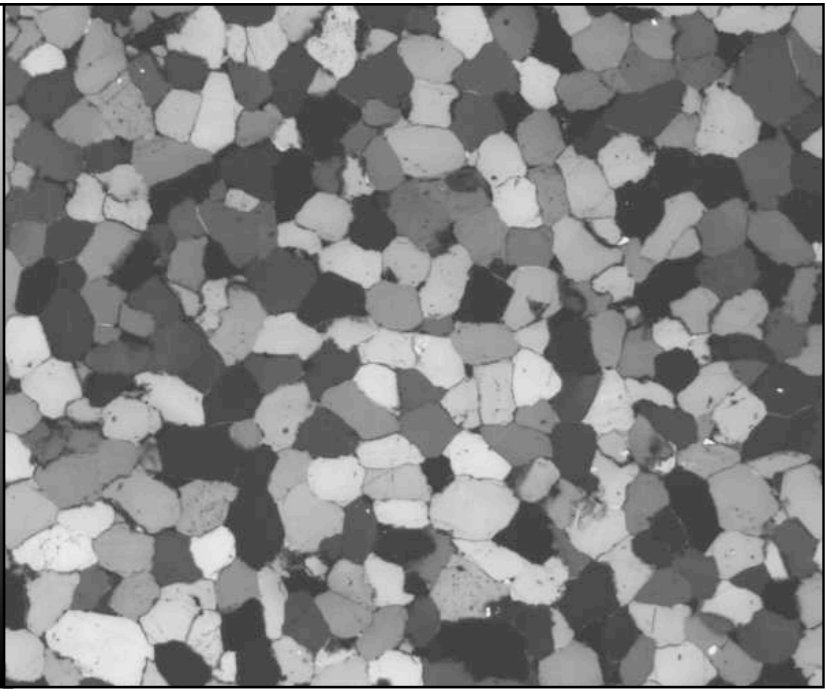
LUT window is shown along y-axis; on a plot, values of the blue LUT (B), green LUT (G) and red LUT (R) intensity are shown for LUT (I), intensities increase from 0 (black) to 255 (white); on the x-axis the index runs from 0 (white) to 255 (black)

In the case of monochromatic LUTs, for a given index, the red, green and blue LUT values are always the same; in the case of color LUTs, R, G, and B differ.

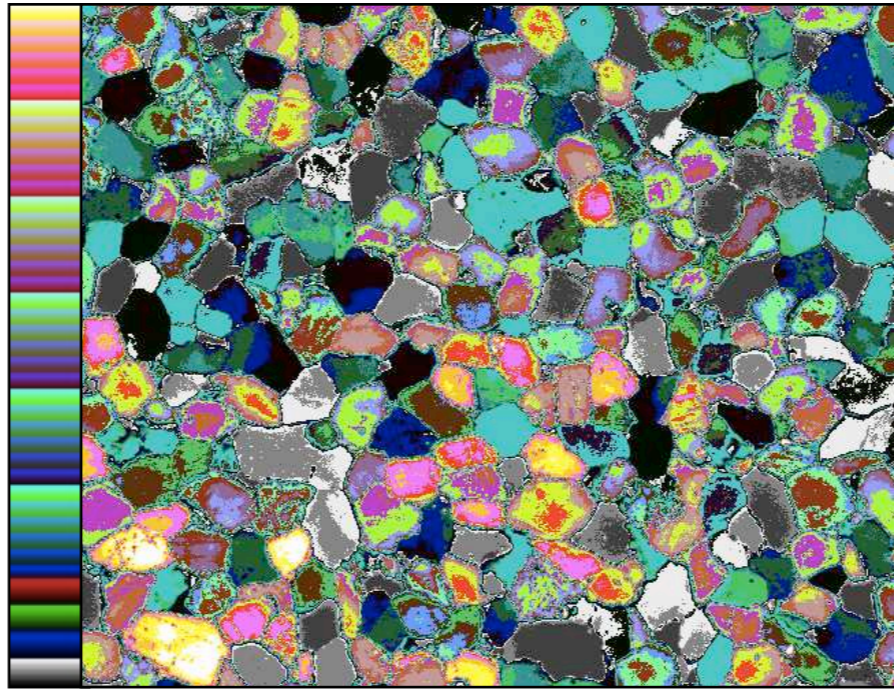
(a) Gray LUTs: (1) 'Grayscale', (2) '8 Grays', (3) Inverted, (4) LUT Setting of 5 Colors, (5) Gamma = 2.58;

(b) Color LUTs: (1) System LUT, (2) '20 Colors', (3) 'Rainbow', (4) 'Fire-2', (5) 'Spectrum', (6) 'Pastel Shades', (7) 'Mandelbrot'.

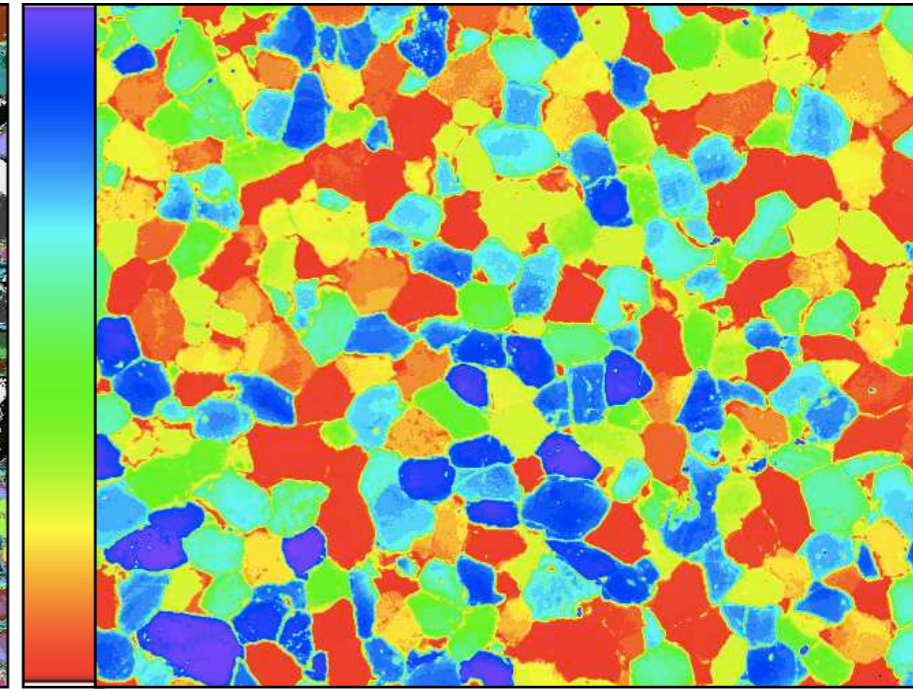
Grayscale



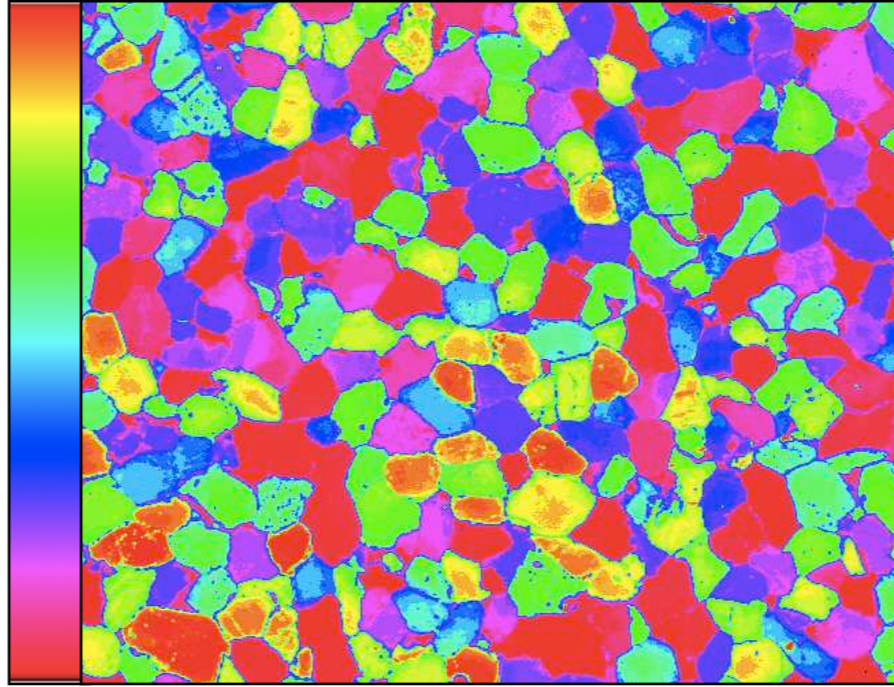
System LUT (Mac OS)



Rainbow



Spectrum



Fire-2

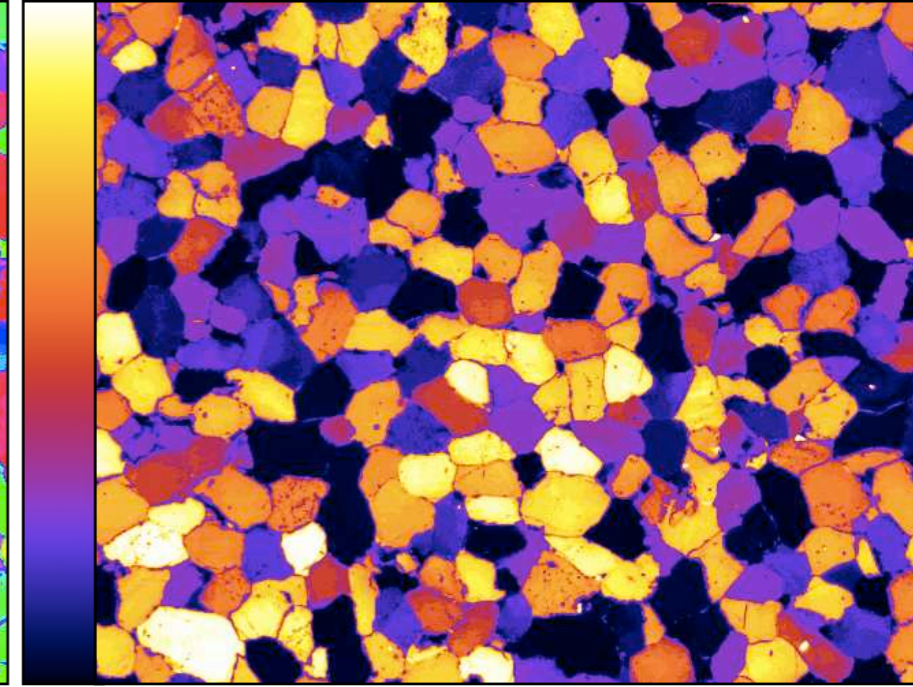


Figure 3.20
Effect of color look-up tables (LUT).

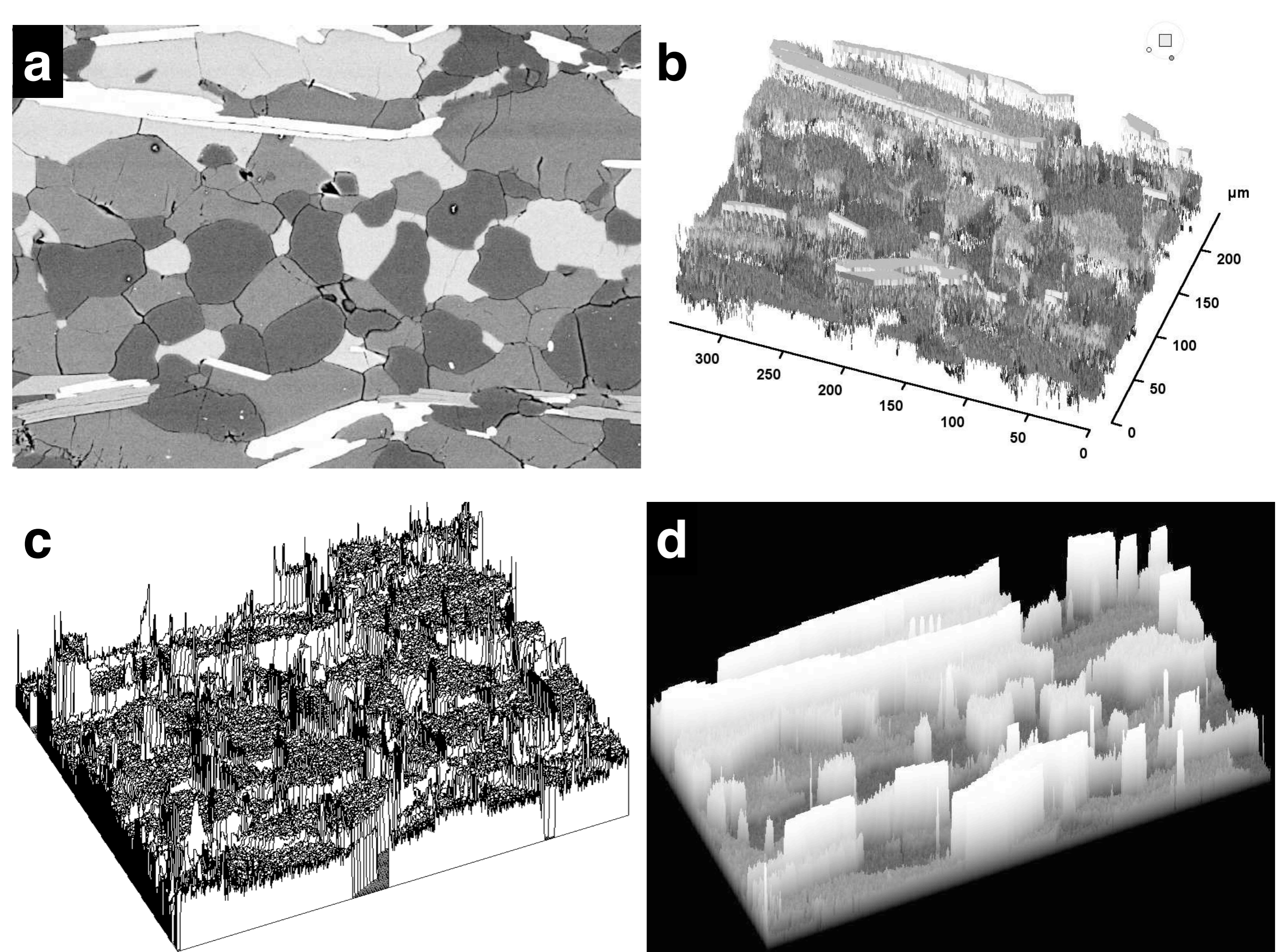


Figure 3.2I

Visualization of image topography.

(a) Gray value representation of image (SEM micrograph);

(b) interactive 3-D diagram invoked by the command '3d Plot...';

(c) density based surface plot shown as wireframe;

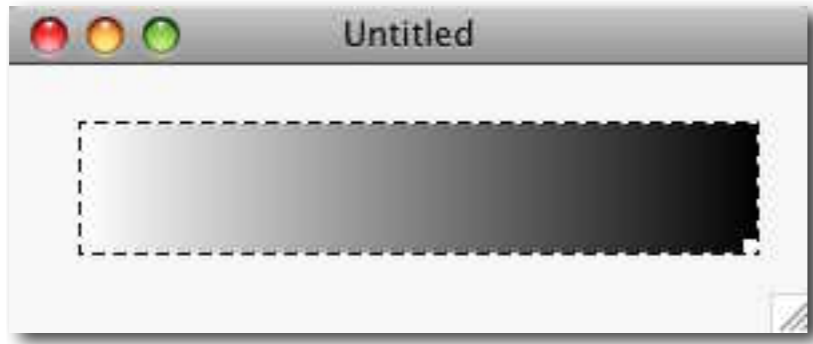
(d) brightness based surface plot.

1, 2

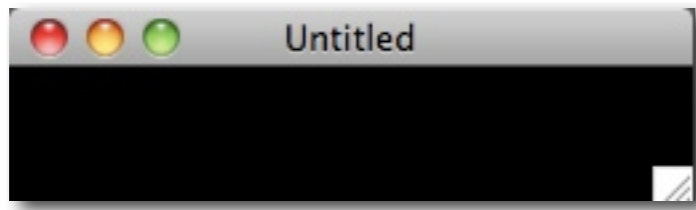


white 254 GV black

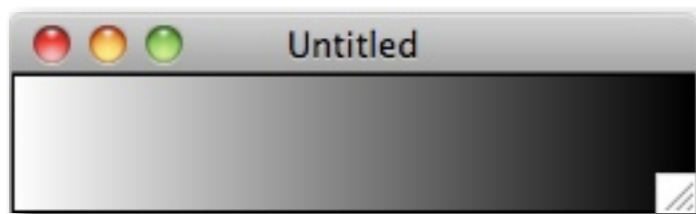
3



4



5



6

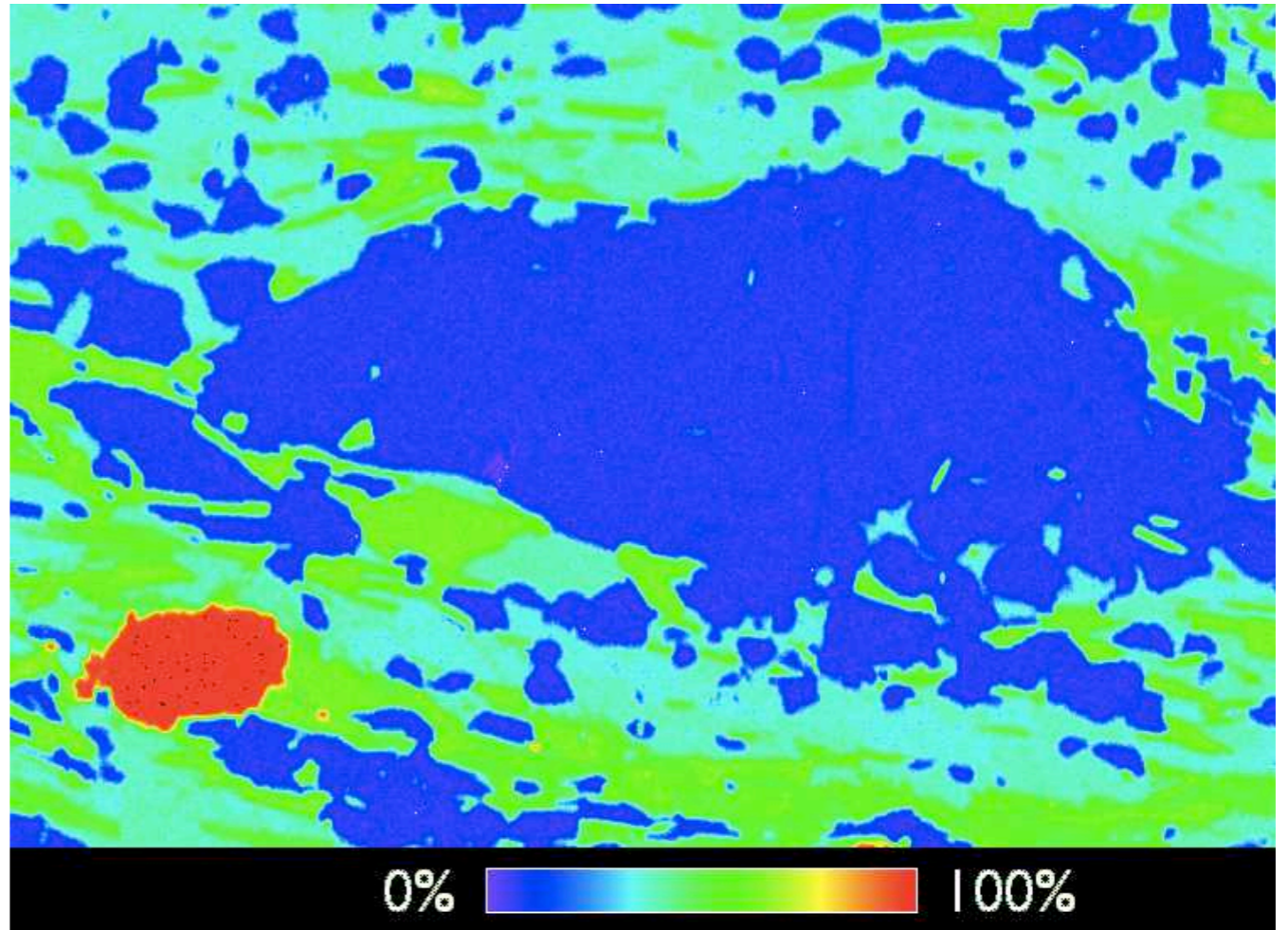


Figure 3.22

Making a grayscale.

- (1) Make new file using 'New' command (⌘N) in File menu;
- (2) select region of interest (ROI) of 254 · 50;
- (3) create grayscale using 'Draw Scale' command in Edit menu;
- (4) optional for boundary: make new file of 256 · 52, fill black for black boundary, leave white for white boundary;
- (5) paste grayscale into new file
- (6) paste grayscale into image (element map from Figure 3.18) or propagate LUT from image to grayscale.

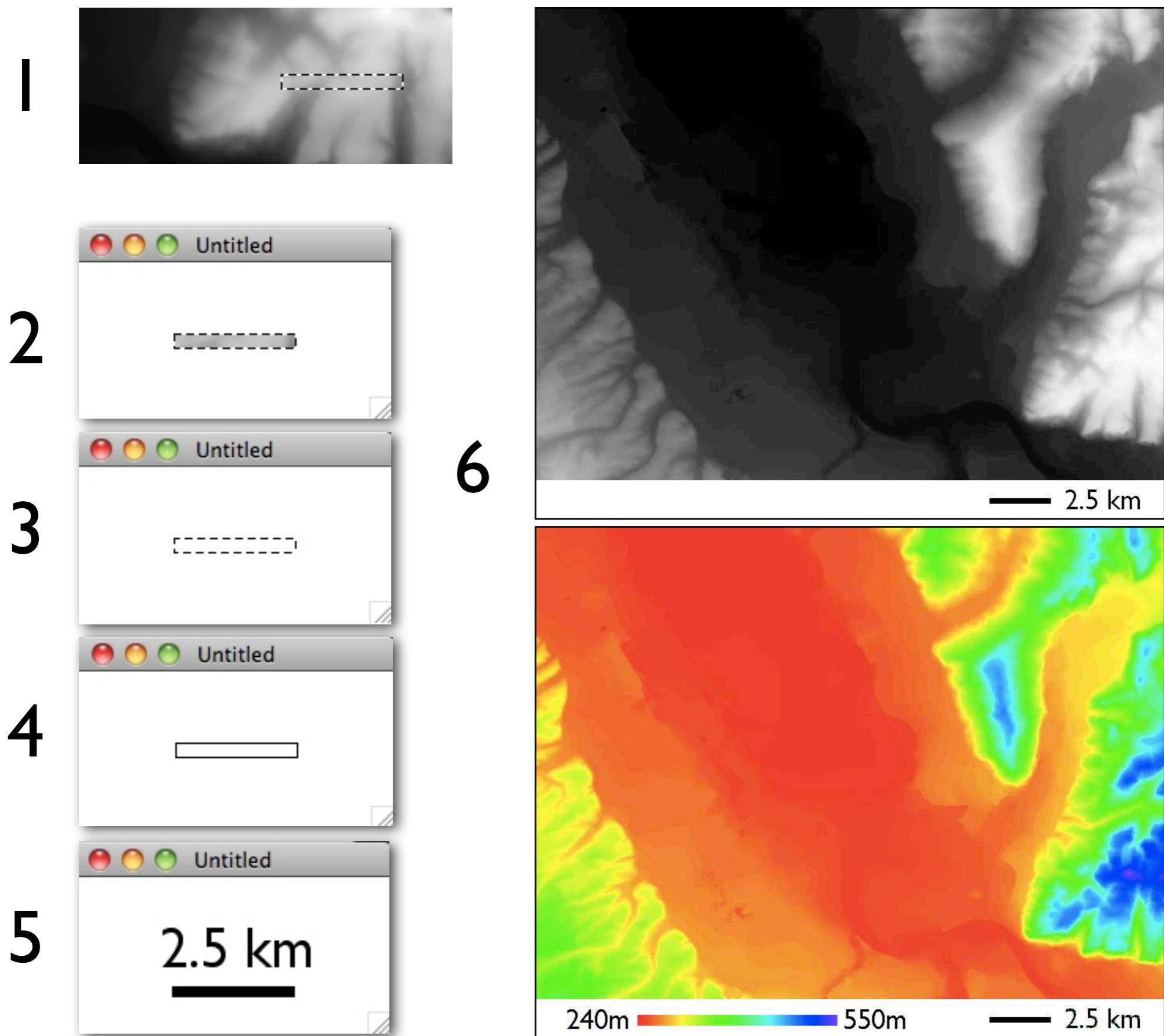


Figure 3.23

Making a scale bar.

- (1) select region of interest (ROI) of known true width (map from Figure 3.18.e); copy (⌘C);
- (2) create new file (⌘N); paste scale (⌘V);
- (3) with selection still active; clear ROI and draw boundary using delete key and 'Draw Boundary' command in Edit menu;
- (4) fill, using Paint Bucket tool (7, Figure 3.14);
- (5) label (use sans-serif font, e.g., Gill Sans)
- (6) copy (⌘C) and paste (⌘V) into image (top); same with color LUT and calibration added (as in Figure 3.22) (bottom).