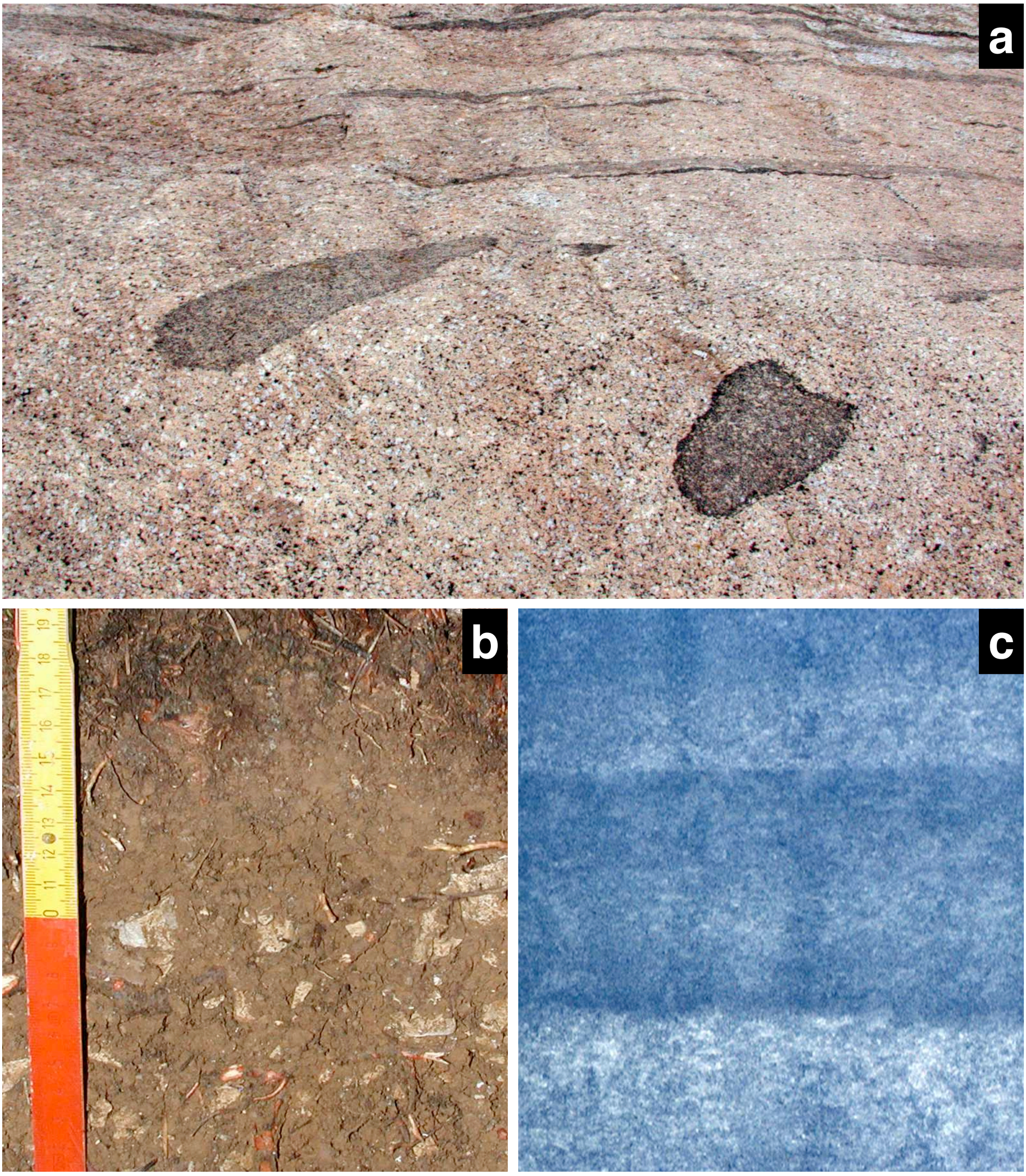


**Figure 2.1**
Photographs of outcrops.
(a) Outcrop showing ductile shear zone, pocket knife for scale; note, uneven surface producing uneven lighting in spite of diffuse day light conditions;
(b) soil profile of rendzina (Image courtesy Christine Alewell); picture taken with flash; note central perspective and even illumination;
(c) snow profile; picture taken in transmitted light; scale is missing.

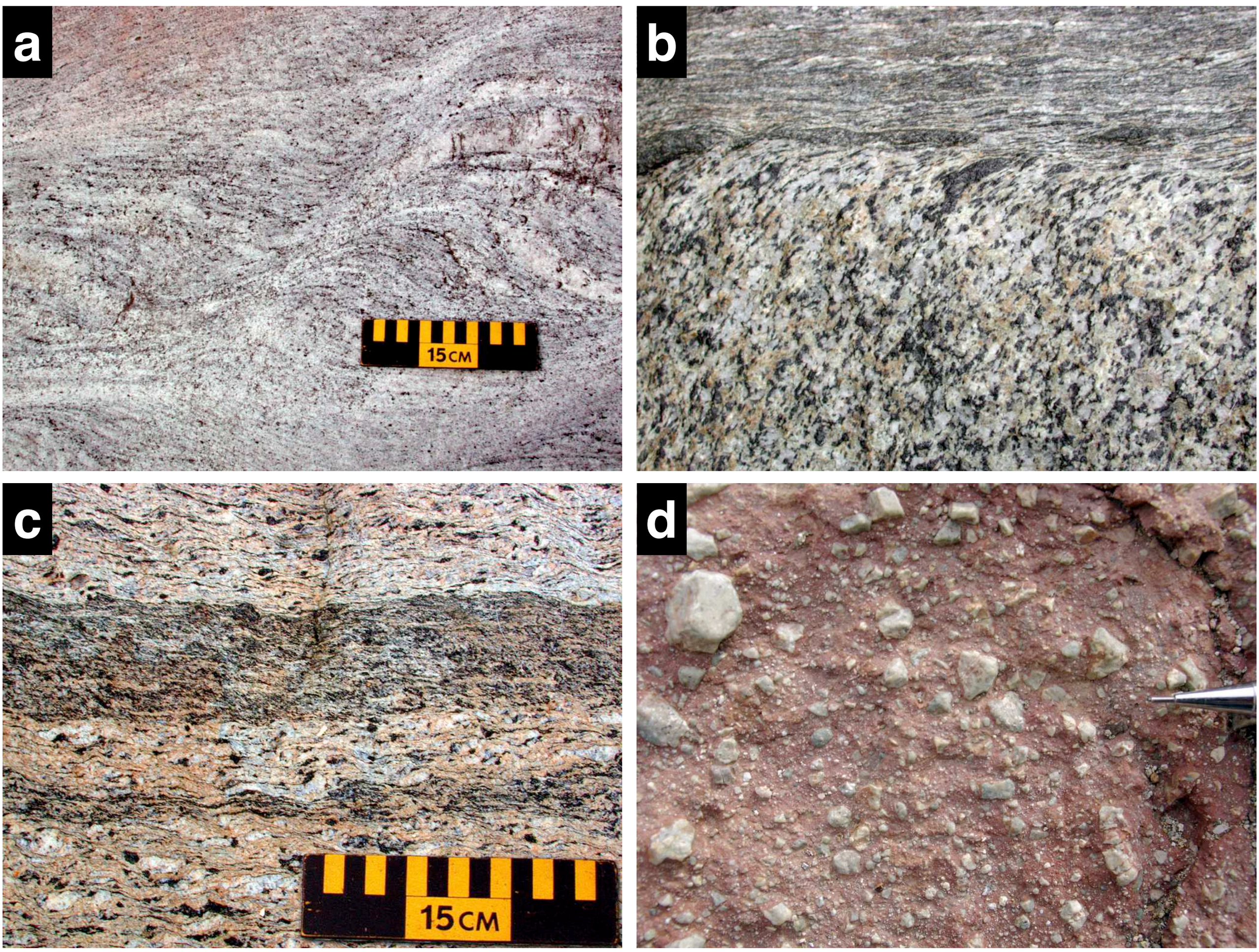


**Figure 2.2**
Photomacrography in the field.
(a) Glacially polished outcrop;
(b) detail of ductile shear zone;
(c) foliated granitic rock (light) with highly stretched enclaves (dark);
(d) fault rock, tip of pencil for scale (Image courtesy Holger Stünitz).
Note central perspective and diffuse lighting conditions.

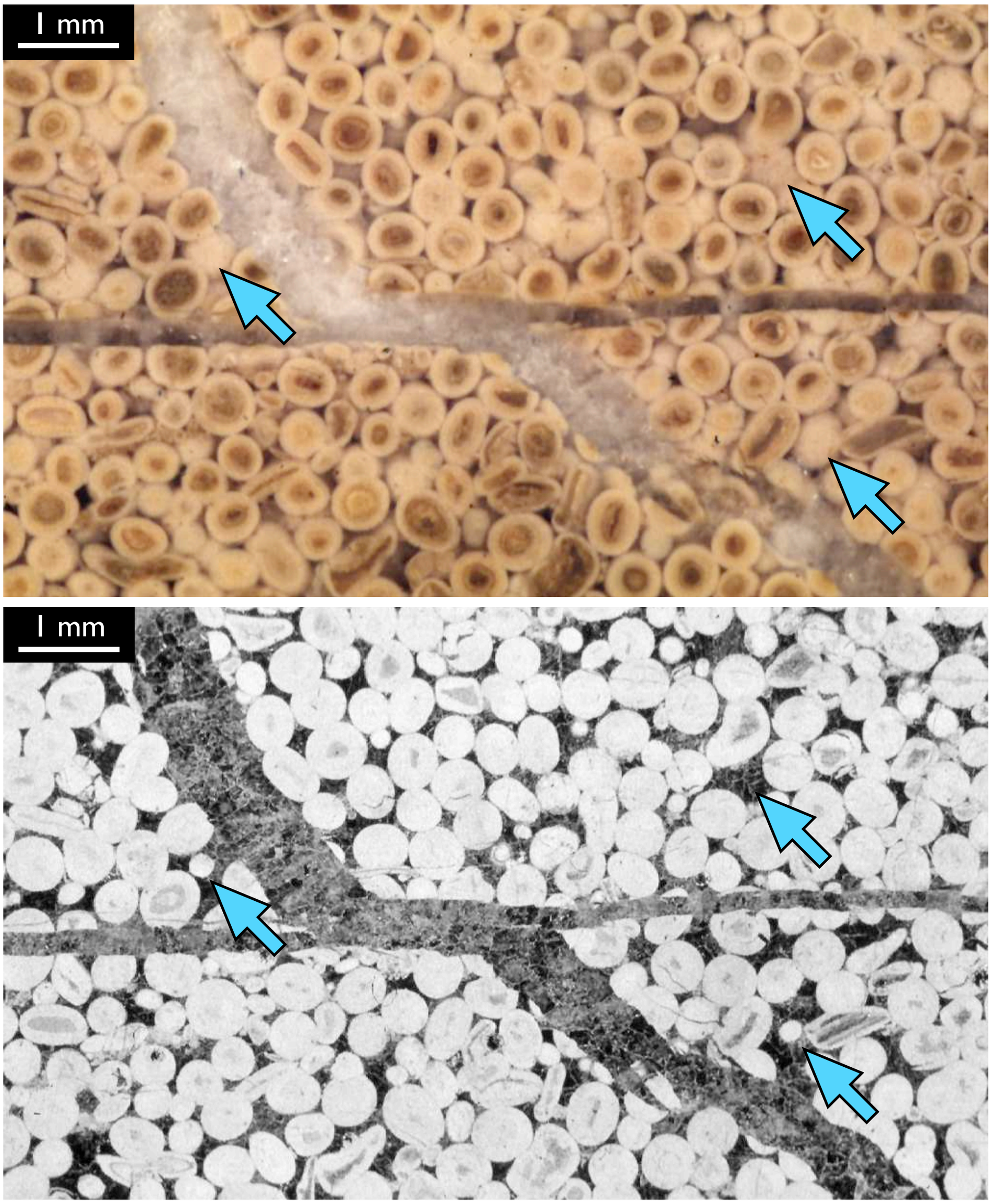


**Figure 2.3**
Two dimensions ?
(a) Polished surface of oolithic limestone;
(b) acetate foil replica of surface shown in (a).
Arrows point to identical sites.

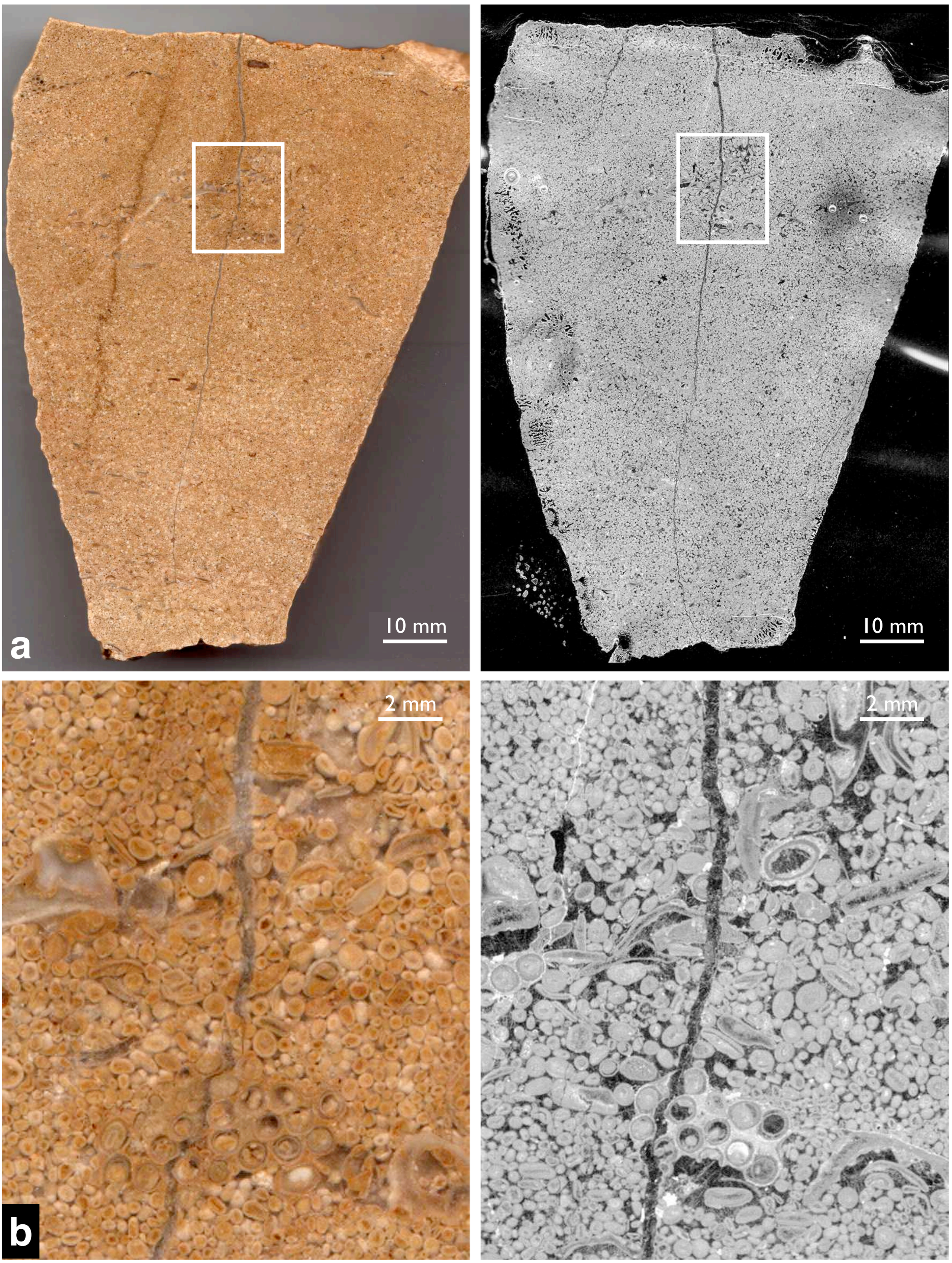


**Figure 2.4**
Acquiring images with a flatbed scanner.
(a) Polished surface of oolithic limestone and acetate foil are scanned on a A4 scanner at its maximum resolution (600 ppi);
(b) enlarged details (see frames in (a)).

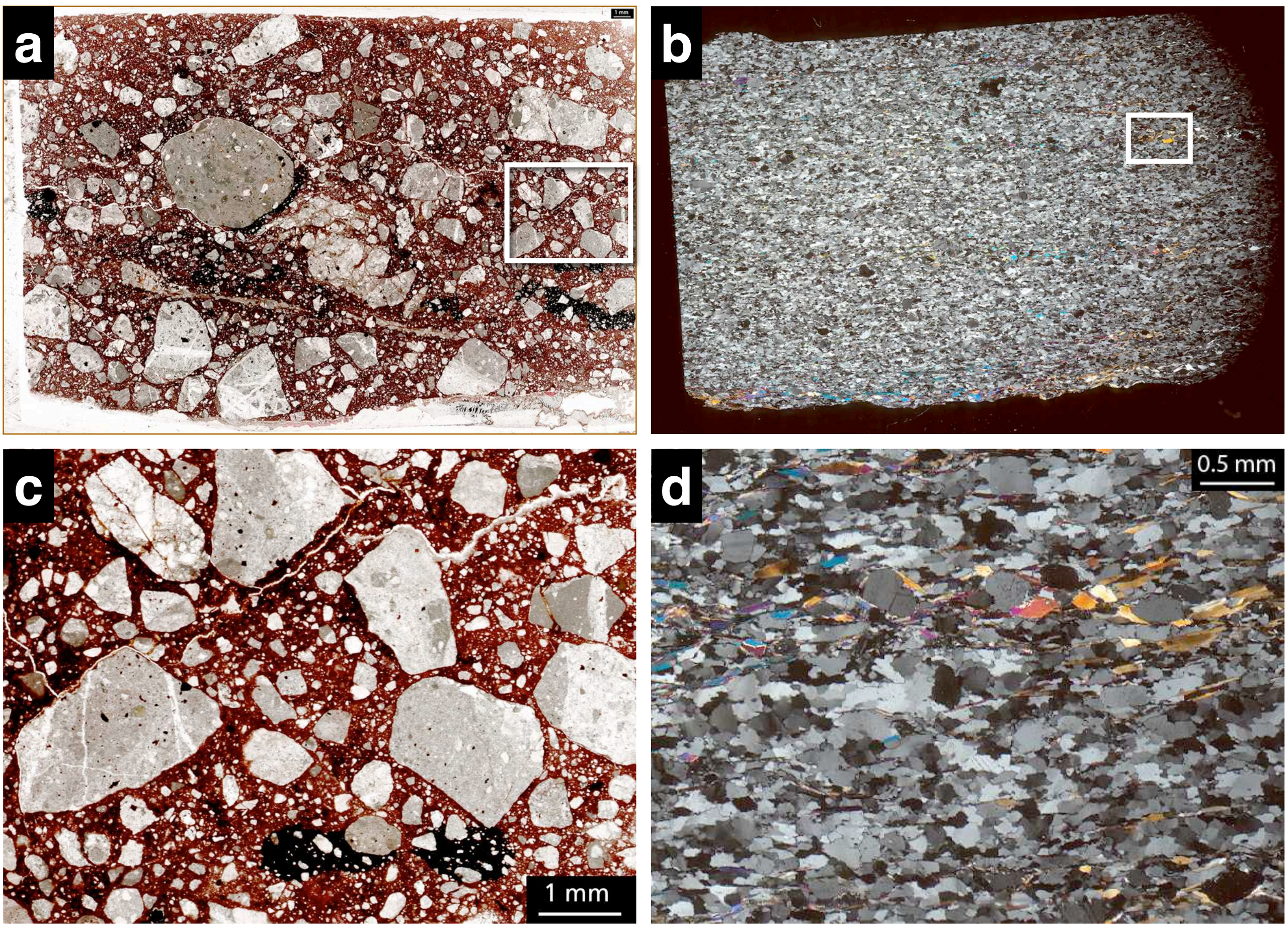


**Figure 2.5**
Acquiring images with a slide scanner.
Thin sections are scanned using special slide holders at high resolution (4000 ppi); white frames in (a) and (b) indicate enlarged details (c) and (d):
(a) and (c) consolidated fault rock, plane polarization;
(b) and (d) quartz mylonite, cross polarization.

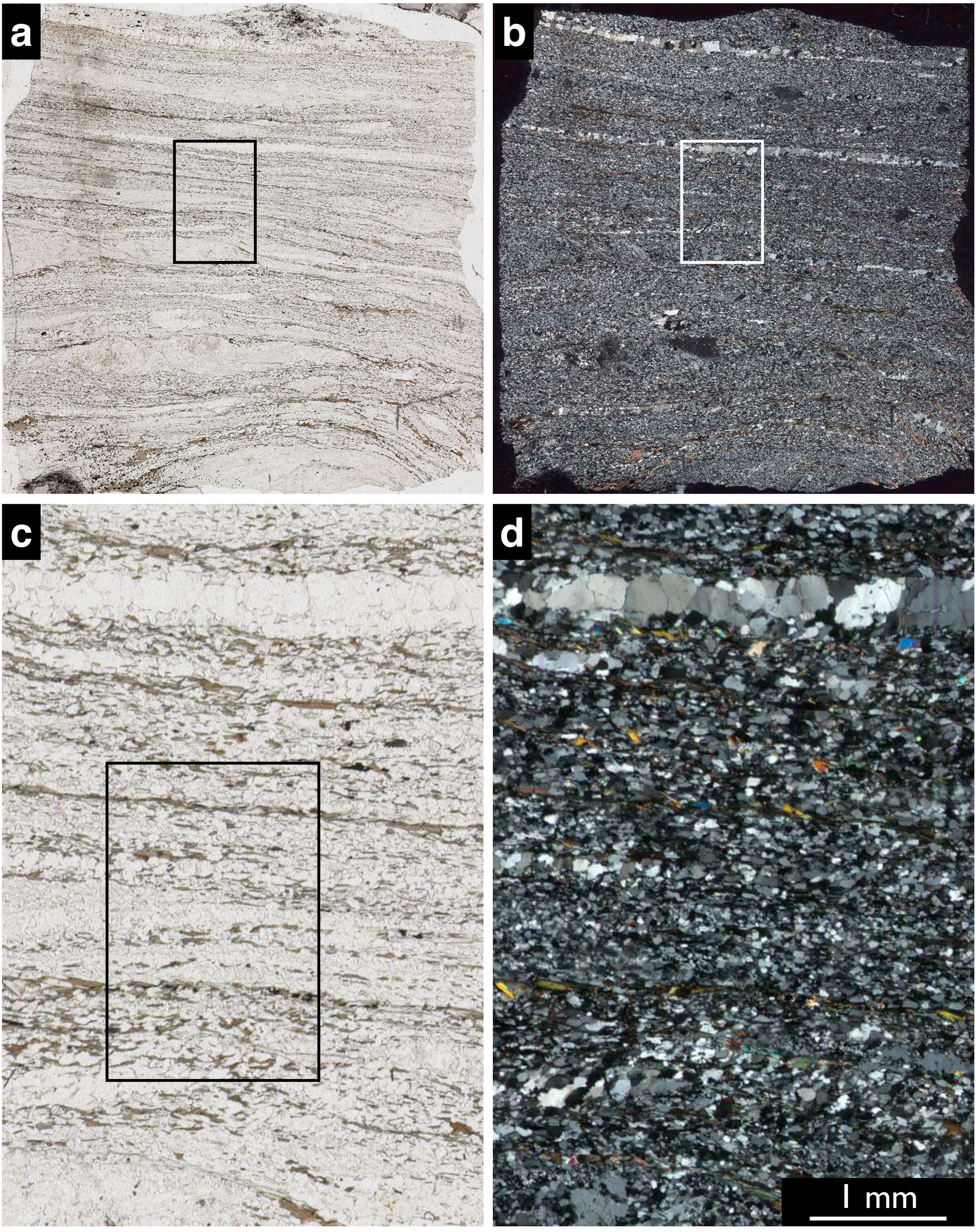


**Figure 2.6**
Resolution of slide scanner.
(a) Entire thin section of foliated granitoid rock in plane polarization;
(b) entire thin section in cross polarization;
(c) detail of (a), area in rectangle is shown enlarged in Figure 2.9;
(d) detail of (b).

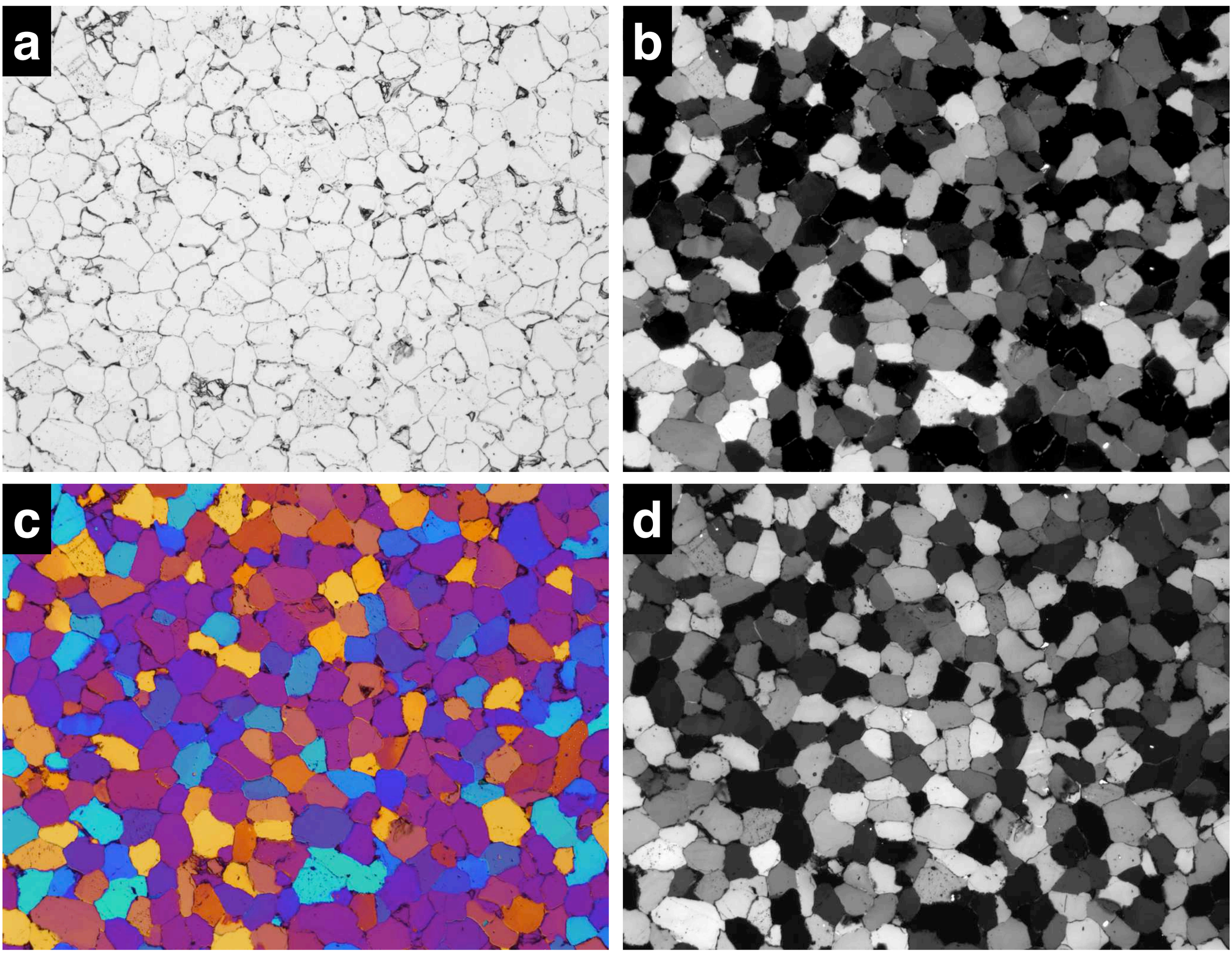


**Figure 2.7**
Light microscopy.
Thin section of quartzite shown in different modes:
(a) plain transmitted light;
(b) cross polarization;
(c) cross polarization and wave plate;
(d) circular polarization.

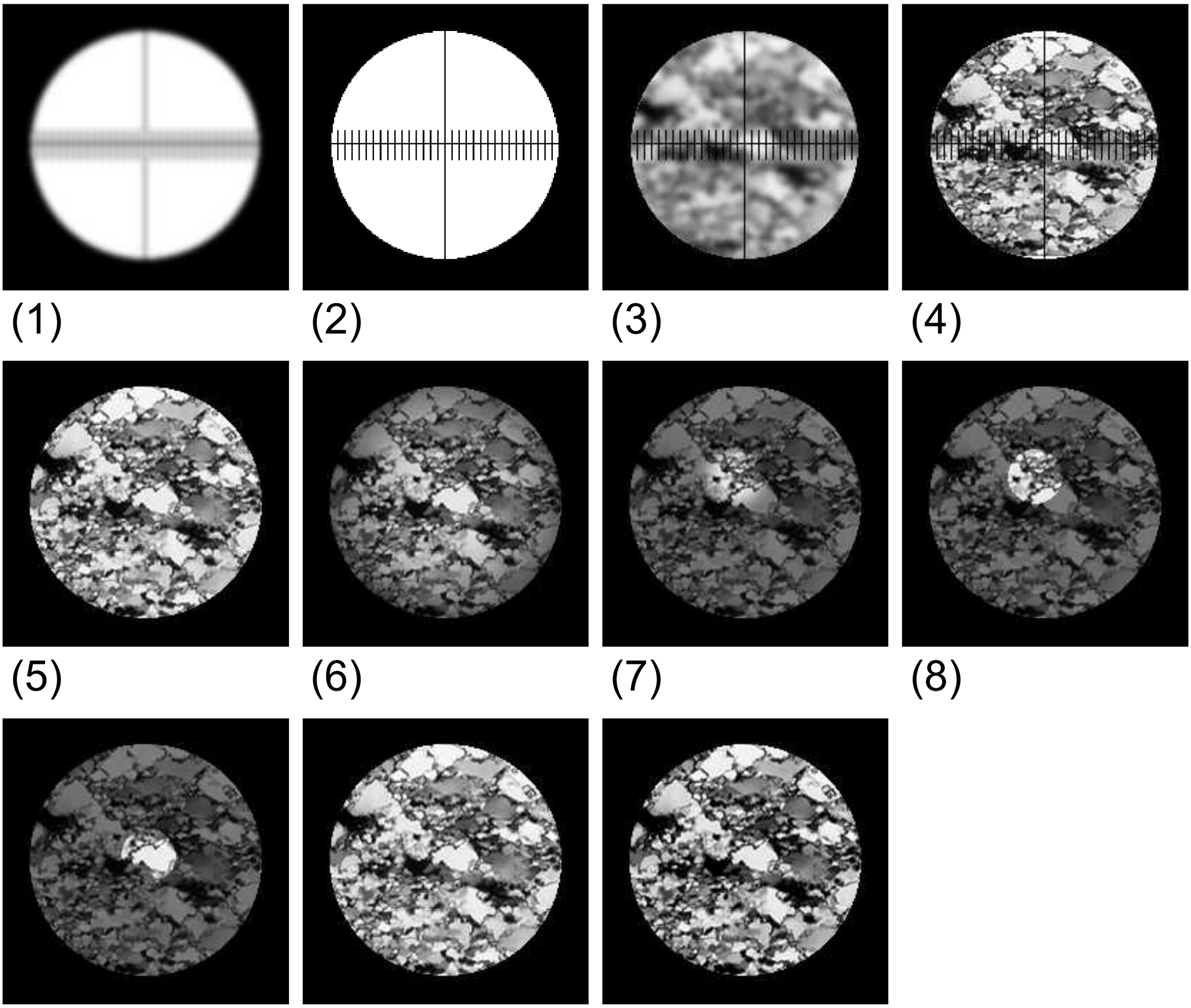


**Figure 2.8**
Köhler illumination.
Procedure: (1) observe cross hair in eye piece; (2) focus cross hair; (3) observe thin section; (4) bring image of thin section into same plane of focus as cross hair of eyepiece; (5) start with well focused image; (6) install appropriate condenser (with numerical aperture matching that of objective) and open condenser diaphragm completely; (7) close illumination diaphragm; (8) focus image of closed diaphragm by moving the condenser up and down; (9) center image of illumination diaphragm using condenser screws; (10) open illumination diaphragm until the rim of the opening barely disappears from the field of view; (11) stop down condenser.

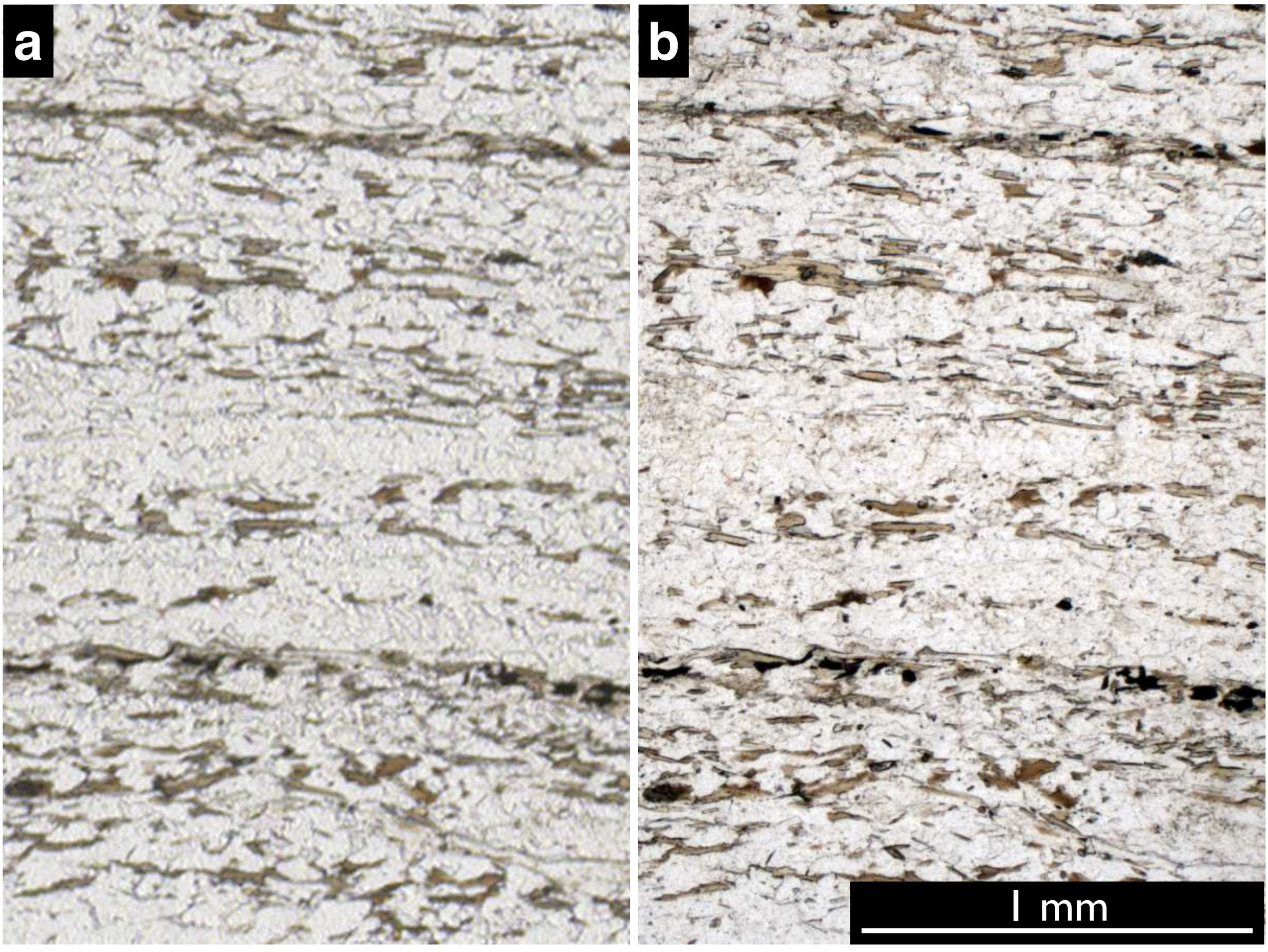


**Figure 2.9**
Comparison between slide scanner and low magnification microscopy.
(a) Detail of scanned thin section of foliated granitoid rock (see Figure 2.6.c);
(b) same area taken with light microscope, ZEISS NEOFLUAR Epiplan 2.5x / 0.075, plane polarized condition, area in frame is shown at higher magnification in Figure 2.14.

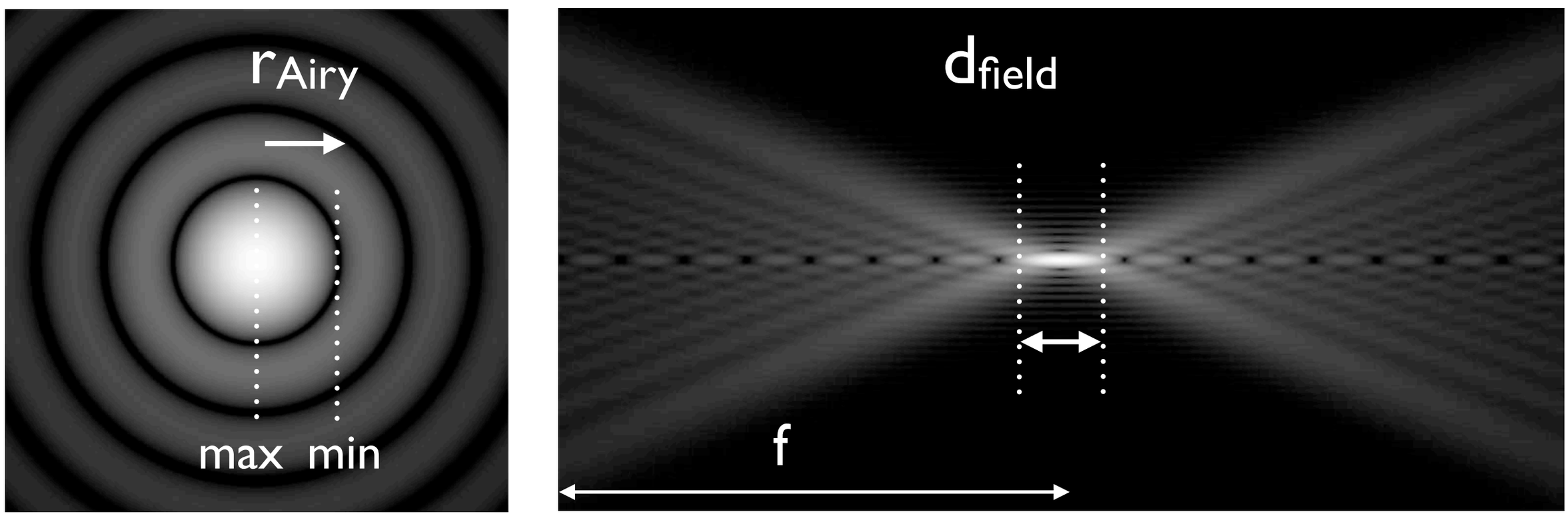


**Figure 2.10**
Point spread function (PSF).
(a) lateral resolution in image plane (x-y plane) determined by radius of Airy disk;
(b) depth resolution determined by constant size (magnification) of Airy disk along the z-axis of the optical system; longitudinal section, f = focal length, direction of optical axis.

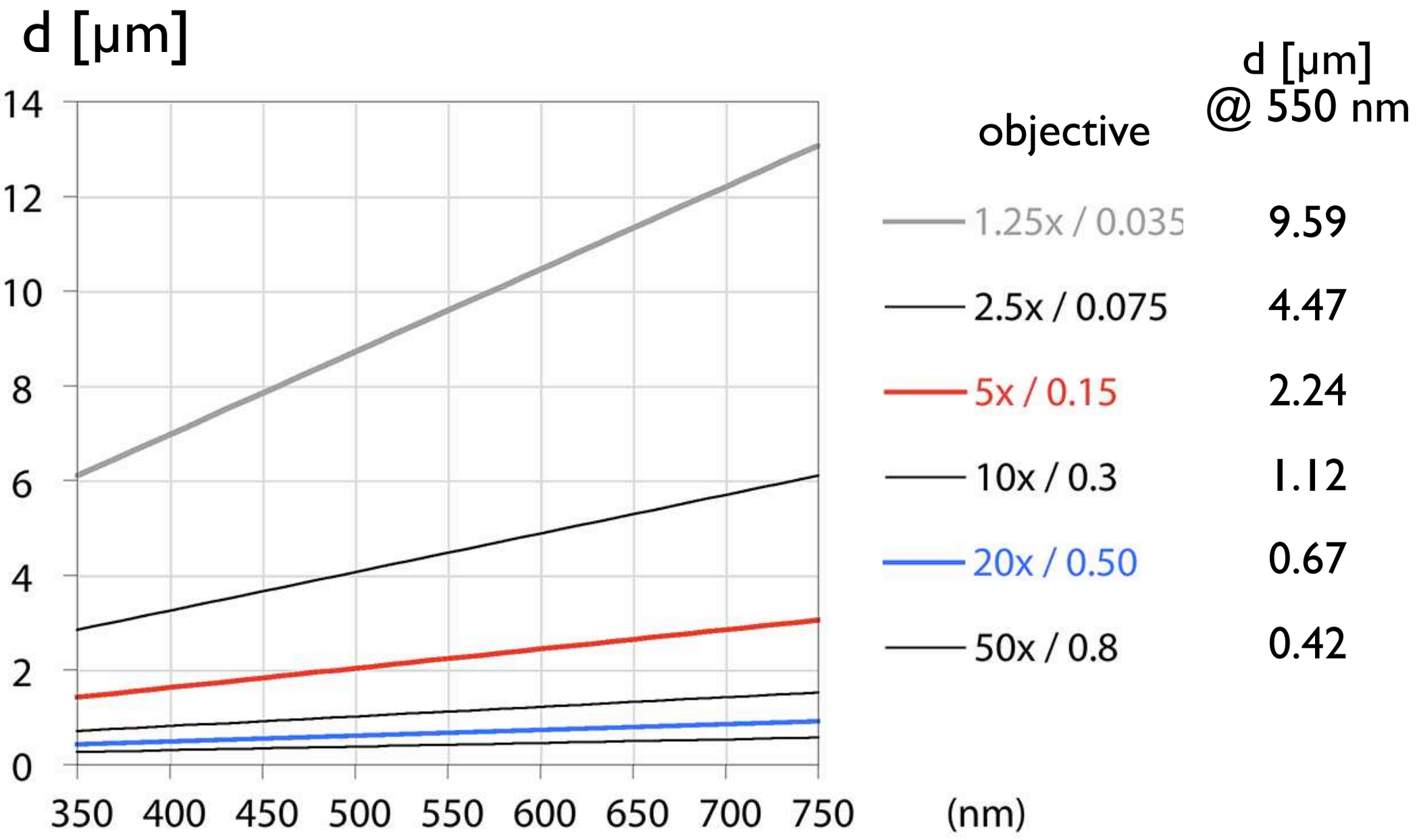


**Figure 2.11**
Lateral resolution.
Resolved length, d, as function of wavelength, λ, for different microscope objectives; values of d at 550 nm wavelength are indicated.

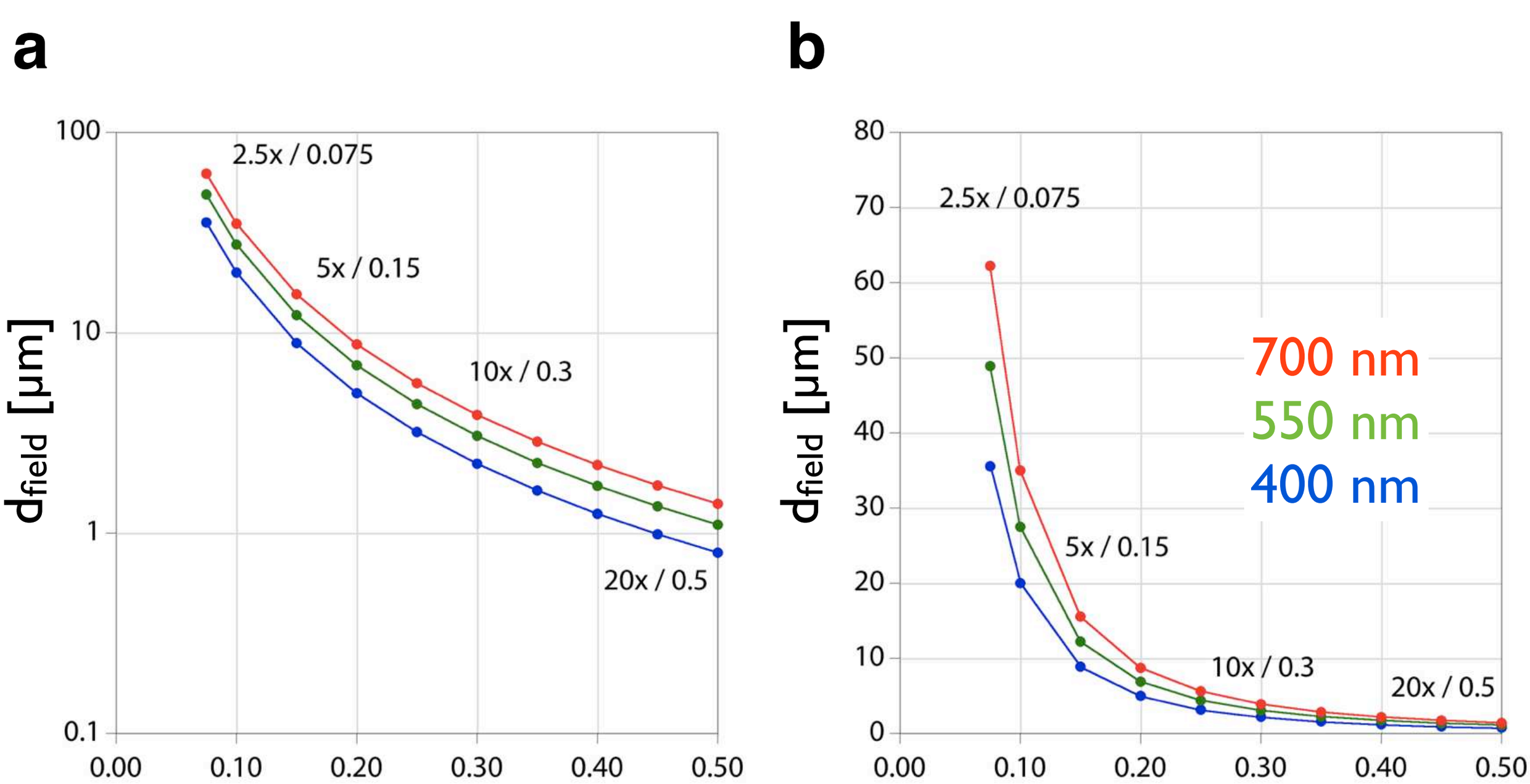


**Figure 2.12**
Depth resolution.
Depth of field, $d_{field}$, as a function of numerical aperture is shown for 3 different wavelengths:
(a) logarithmic plot;
(b) linear plot.

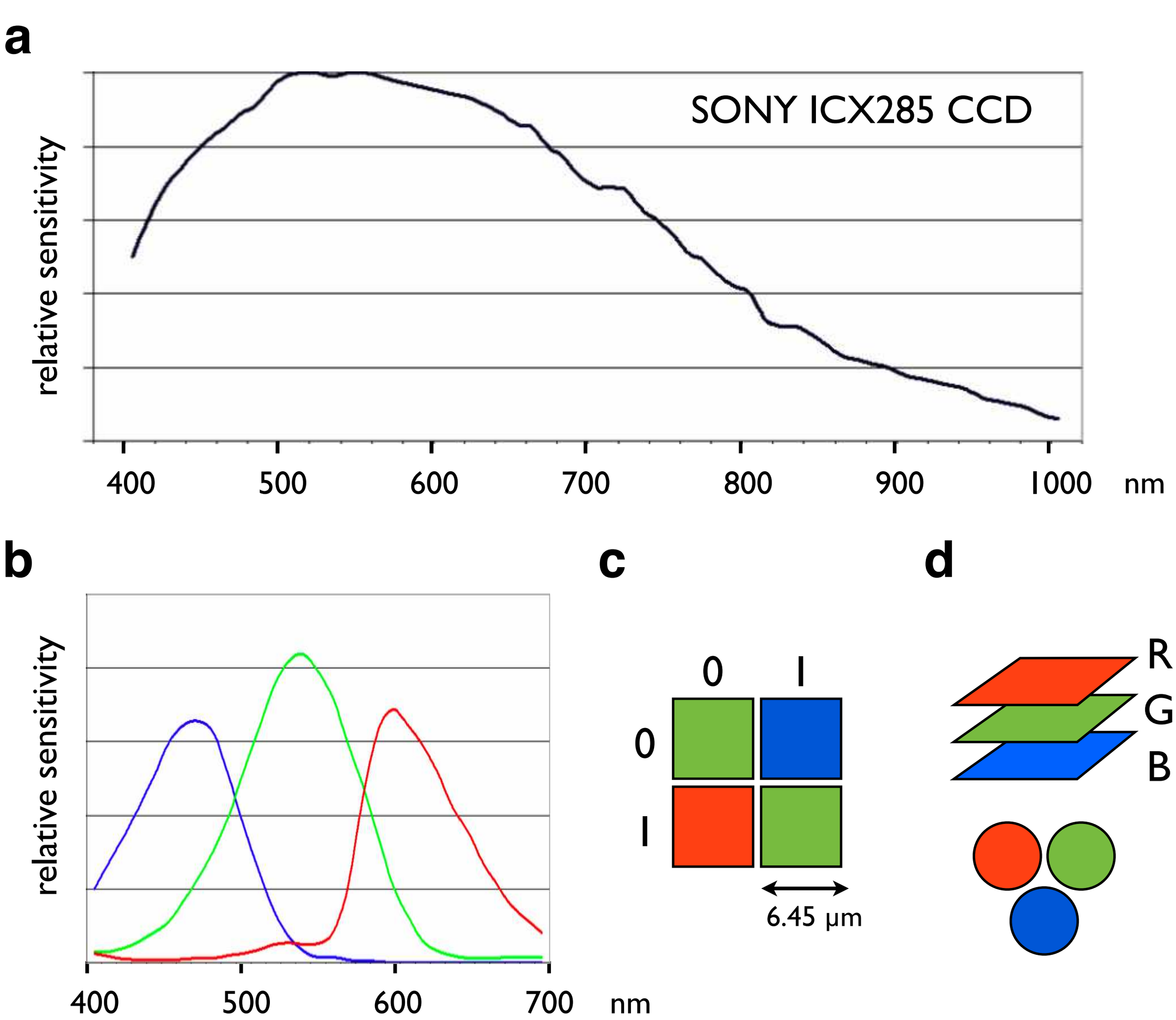


**Figure 2.13**
Example of image sensor.
(a) Spectral sensitivity of CCD image sensor without filter;
(b) spectral sensitivity of CCD image sensor with Bayer filters for red, green and blue pixels;
(c) recording color through Bayer filter, typical width of pixel is 6 to 7 µm, position of two green, one red and one blue filter in the even (0) and odd (1) columns and rows of the chip are indicated;
(d) rendition of color as three color channels (RGB) in color images and three fluorescent spots on the monitor.

| objective | no. of pixels | true length [µm] | true size of pixel [µm] | resolved length [µm] |
|---|---|---|---|---|
| 2x | 205 | 500 | 2.44 | 4.47 |
| 5x | 79 | 100 | 1.27 | 2.24 |
| 10x | 156 | 100 | 0.64 | 1.12 |
| 20x | 155 | 50 | 0.32 | 0.67 |
| 50x | 158 | 20 | 0.13 | 0.42 |

**Table 2.1**
True size represented by one pixel in image compared to resolved length of objective; values measured for Axiocam camera and ZEISS Axioplan microscope; note that the true pixels size is approximately one half of the resolved length.

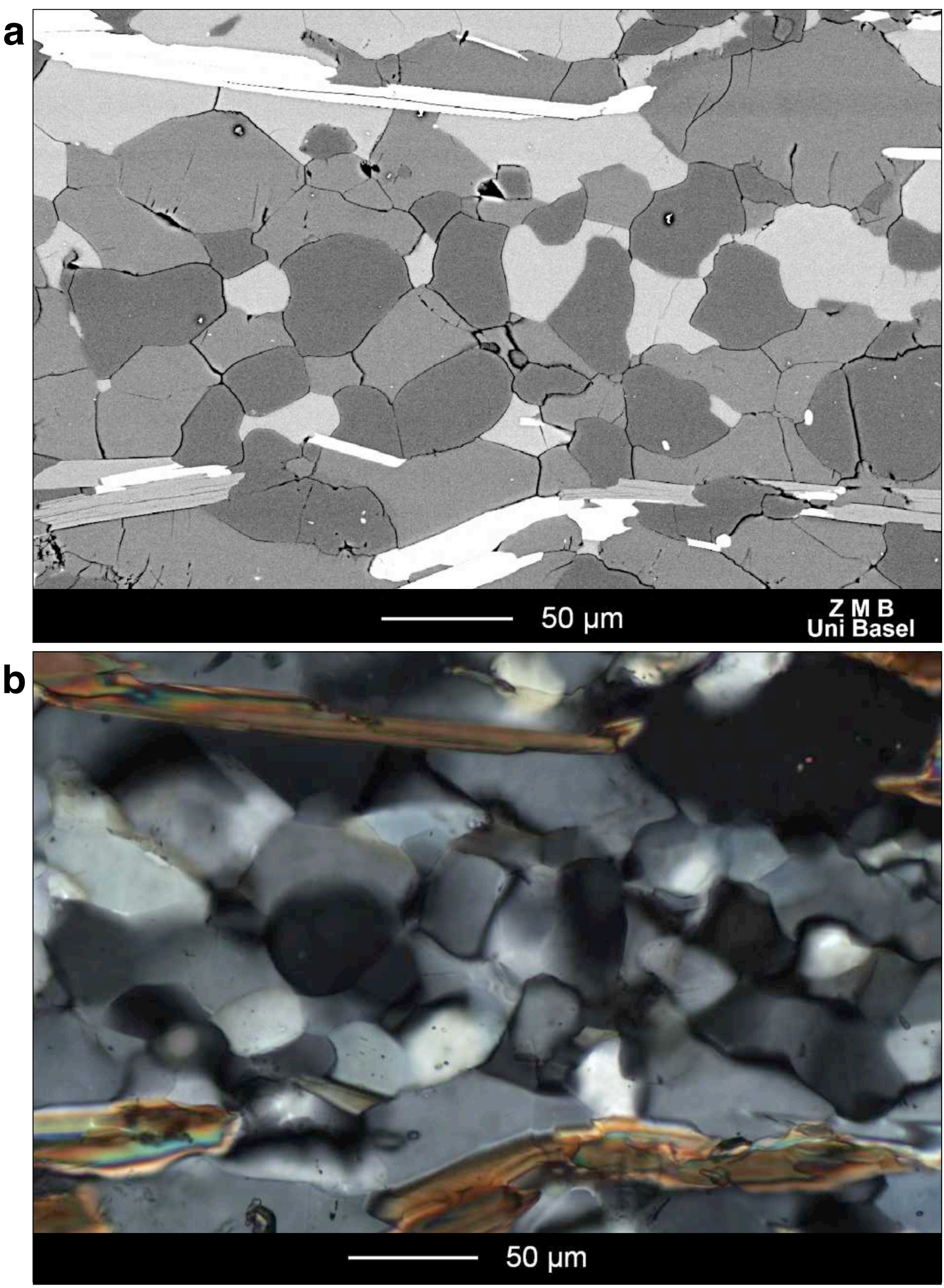


**Figure 2.14**
Scanning electron microscopy.
(a) Micrograph of polished surface of foliated granitoid rock (Image courtesy Rüdiger Kilian), backscatter electron contrast (BSE) showing different mineral phases: white = biotite, very light gray = K-feldspar, light gray = muscovite, gray = plagioclase, dark gray = quartz;
(b) same area taken with optical microscope, circular polarization (see Fig. 2.9b): here contrast is mainly due to orientation of crystals with respect to polarizers.

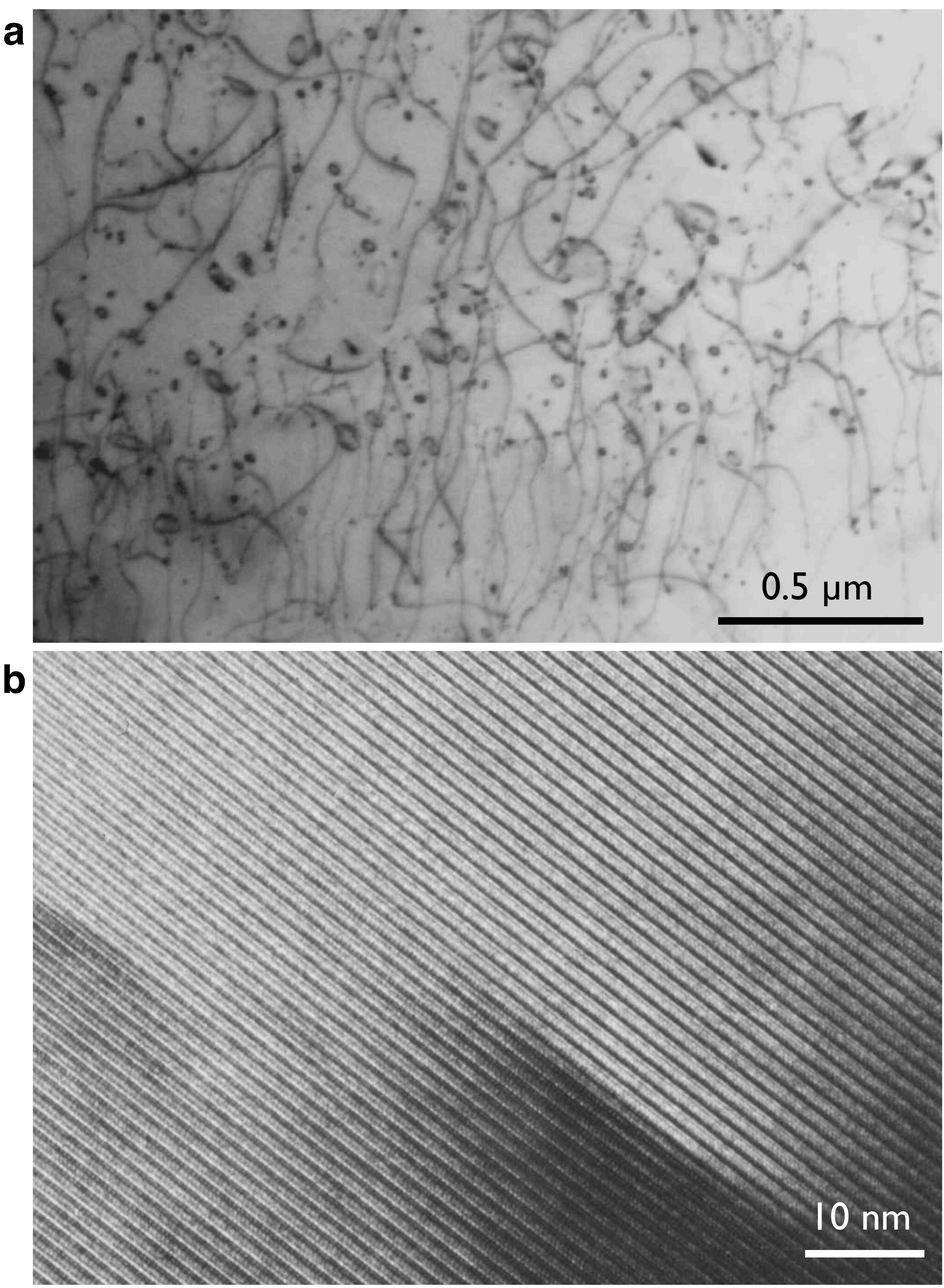


**Figure 2.15**
Transmission electron microscopy.
(a) Free dislocations in quartz, bright field contrast (Image courtesy John Fitz Gerald);
(b) Chlorite, lattice planes, high resolution image (Image courtesy Andreas Kronenberg).