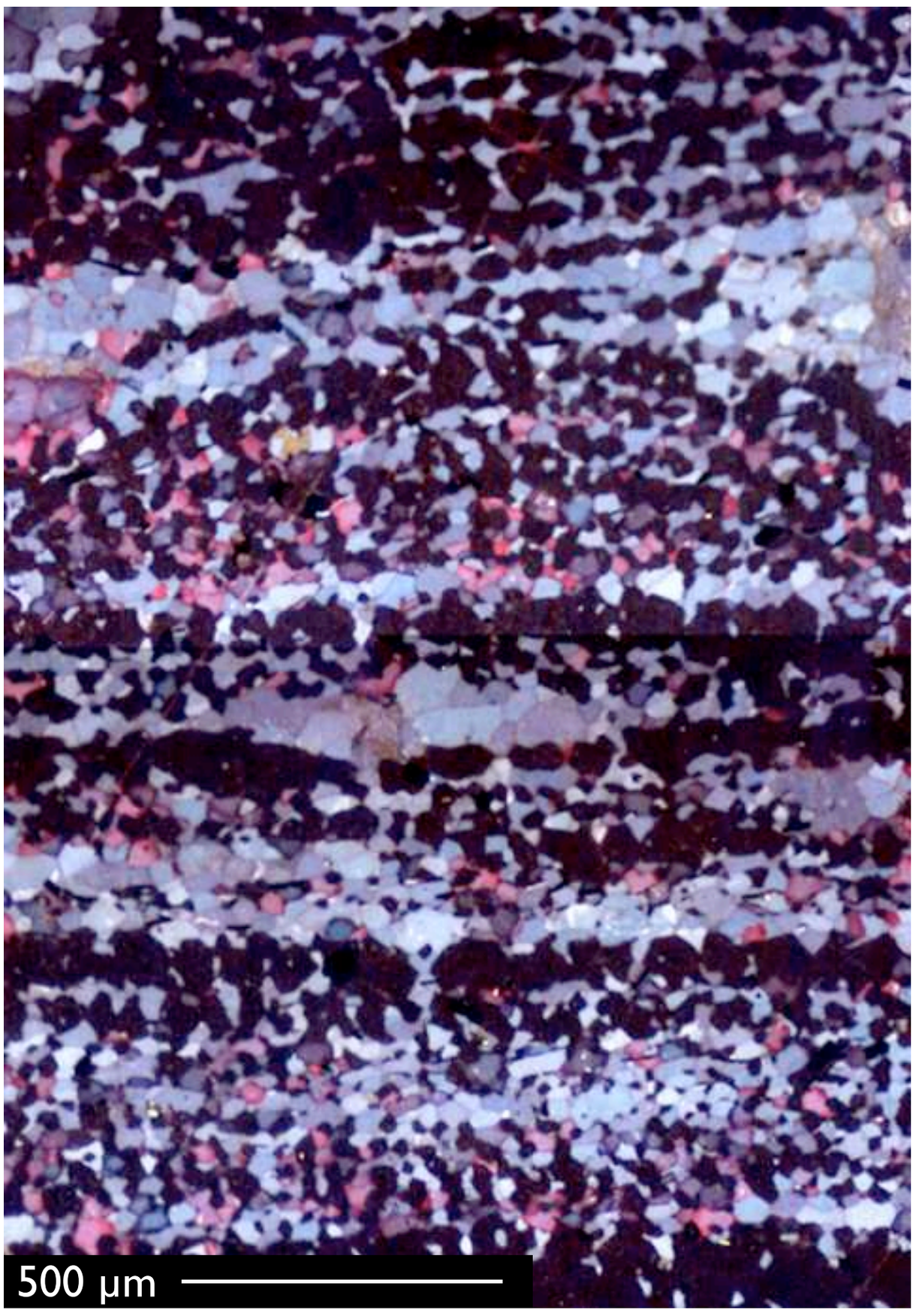


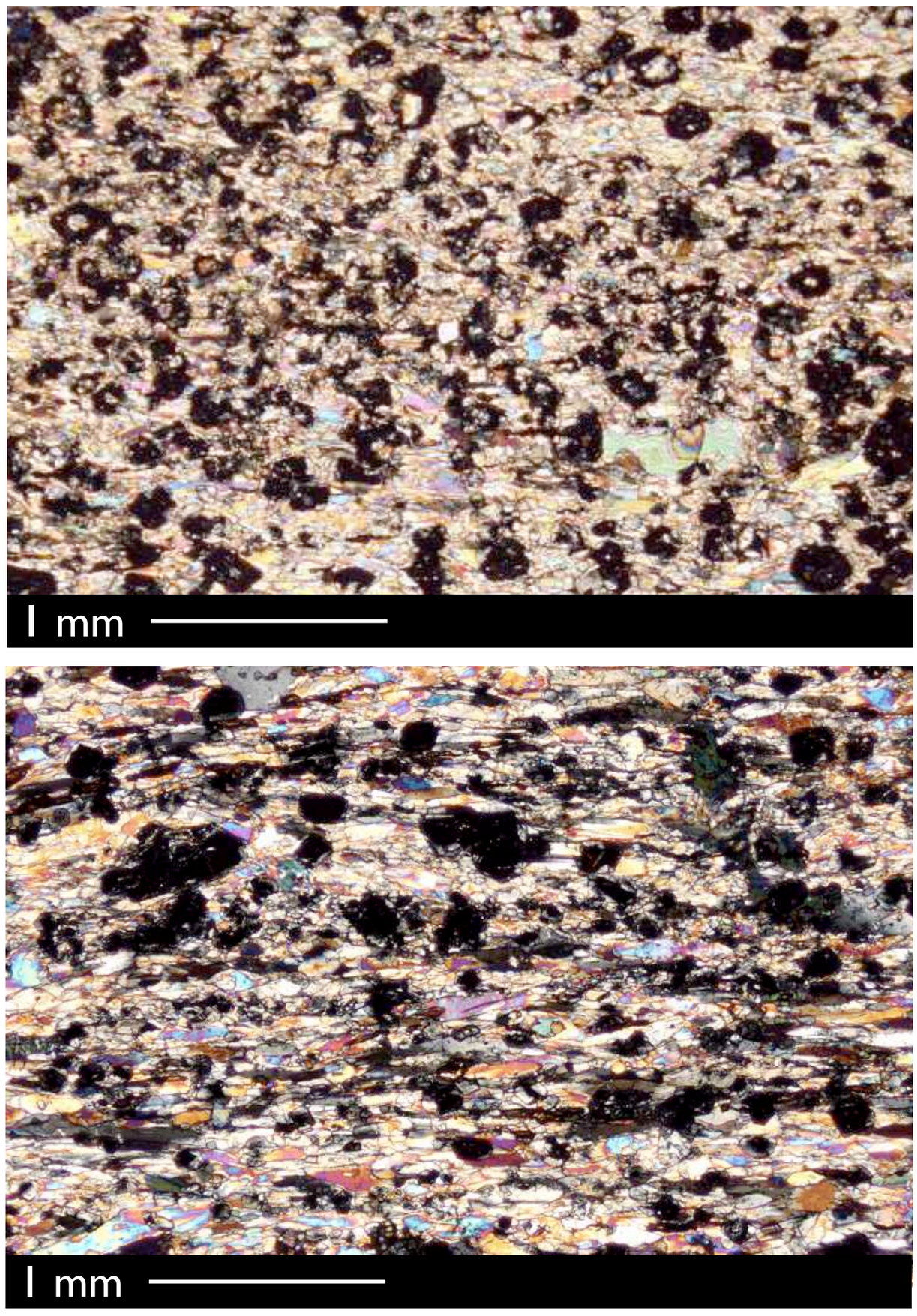


Figure 18.1
Spatially dispersed mineral grains.
(a) Micrograph of quartz-feldspar mylonite in cathodo-luminescence contrast (image courtesy Sina Marti): light blue = K-feldspar; pink = plagioclase, black = quartz;
(b) micrograph of eclogite (image courtesy James MacKenzie), cross polarized light, showing dispersed (top) and clustered (bottom) garnet grains in black.

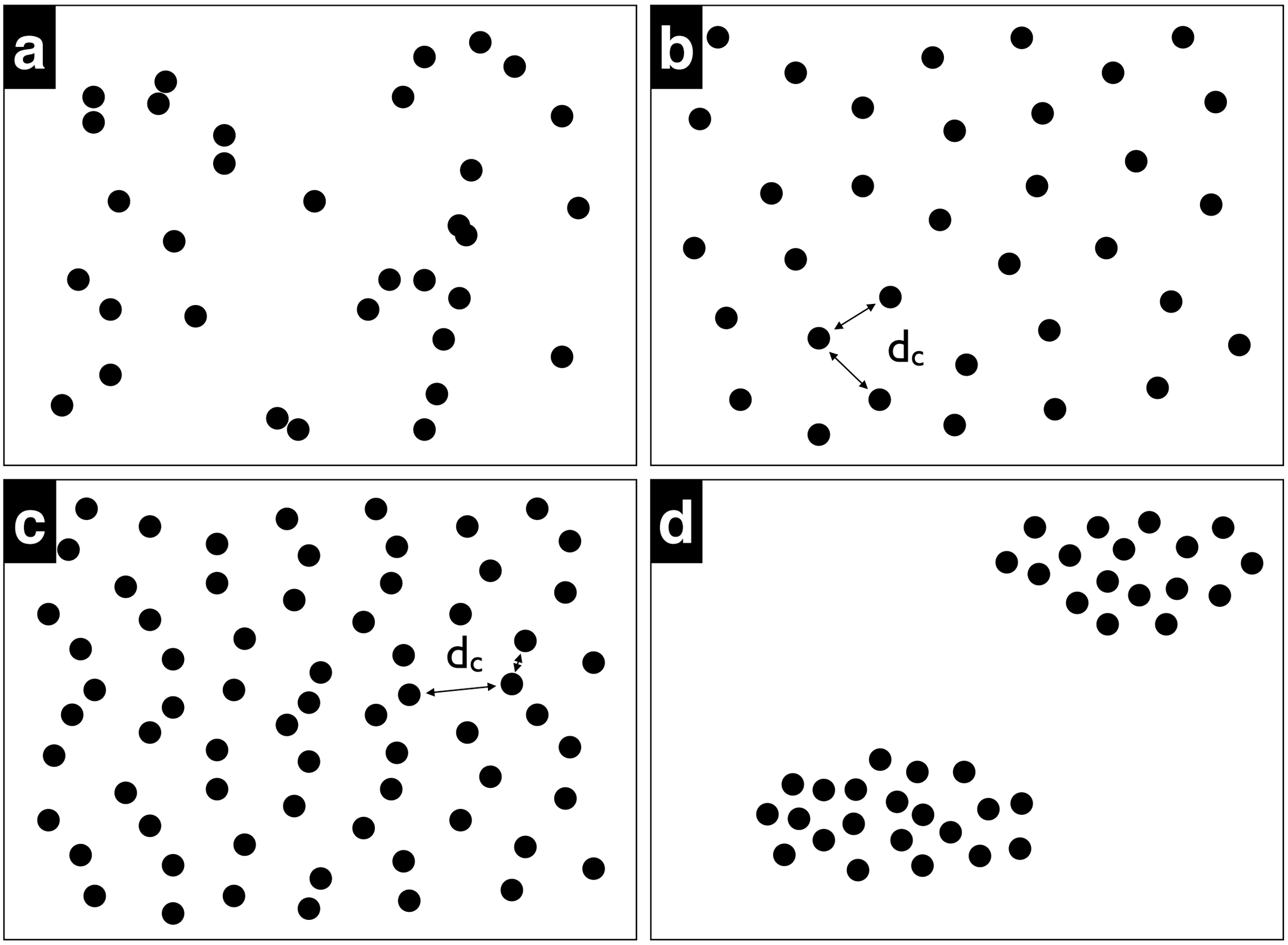


Figure 18.2
Concept of spatially dispersed center points.
(a) Random distribution of points in plane (Poisson distribution);
(b) anti-correlated distribution of points (d_c = minimal distance between points);
(c) same as (b) with anisotropic correlation length, $d_c = d_c(\alpha)$, where α = angle with horizontal direction;
(d) clustered distribution of points.

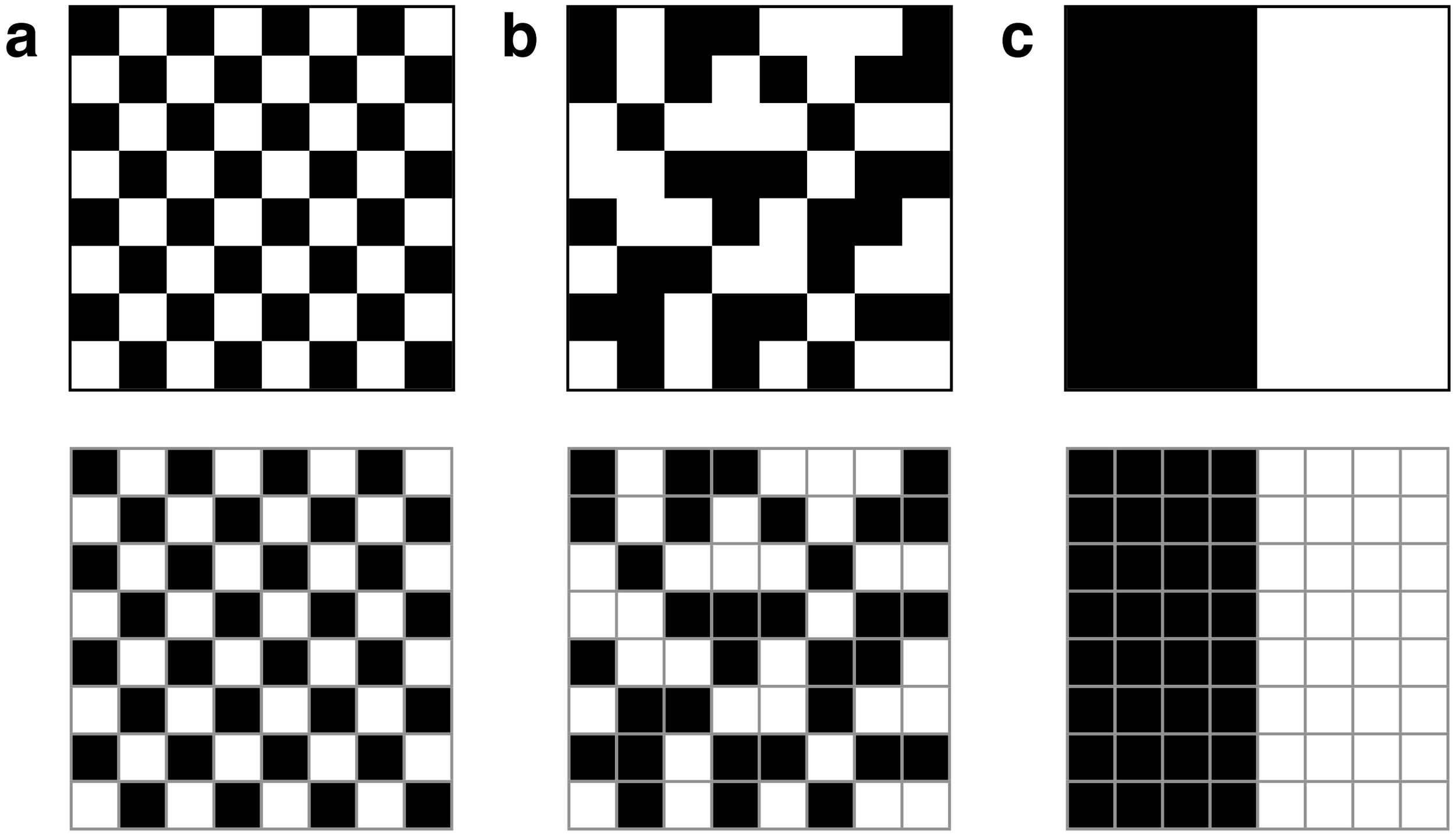


Figure 18.3
Chess board model for spatial distribution of phases.
Type distribution of phases (black, white) are shown, without boundaries (top), with boundaries (bottom):
(a) perfectly ordered (= anti-clustered) distribution;
(b) random distribution;
(c) perfectly clustered distribution of phases.

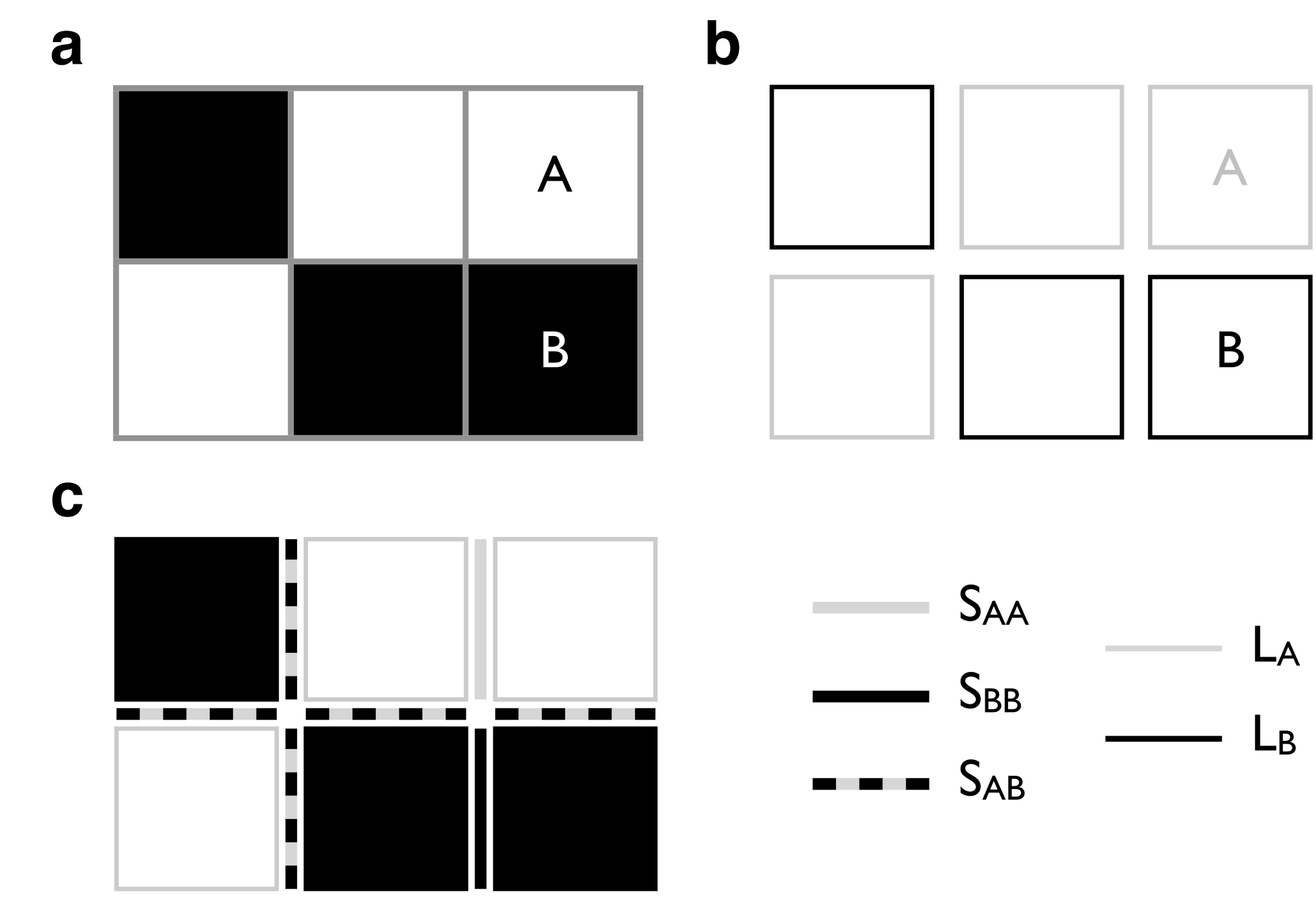


Figure 18.4
Phases, boundaries and contacts.
Six grains with two phases, A and B, are shown.
(a) White areas = phase A; black areas = phase B;
(b) L_A = grain boundaries of phase A; L_B = grain boundaries of phase B;
(c) S_{AA} = contact surfaces of phase A with phase A; S_{BB} = contact surfaces of phase B with phase B; S_{AB} = contact surfaces of phase A with phase B.

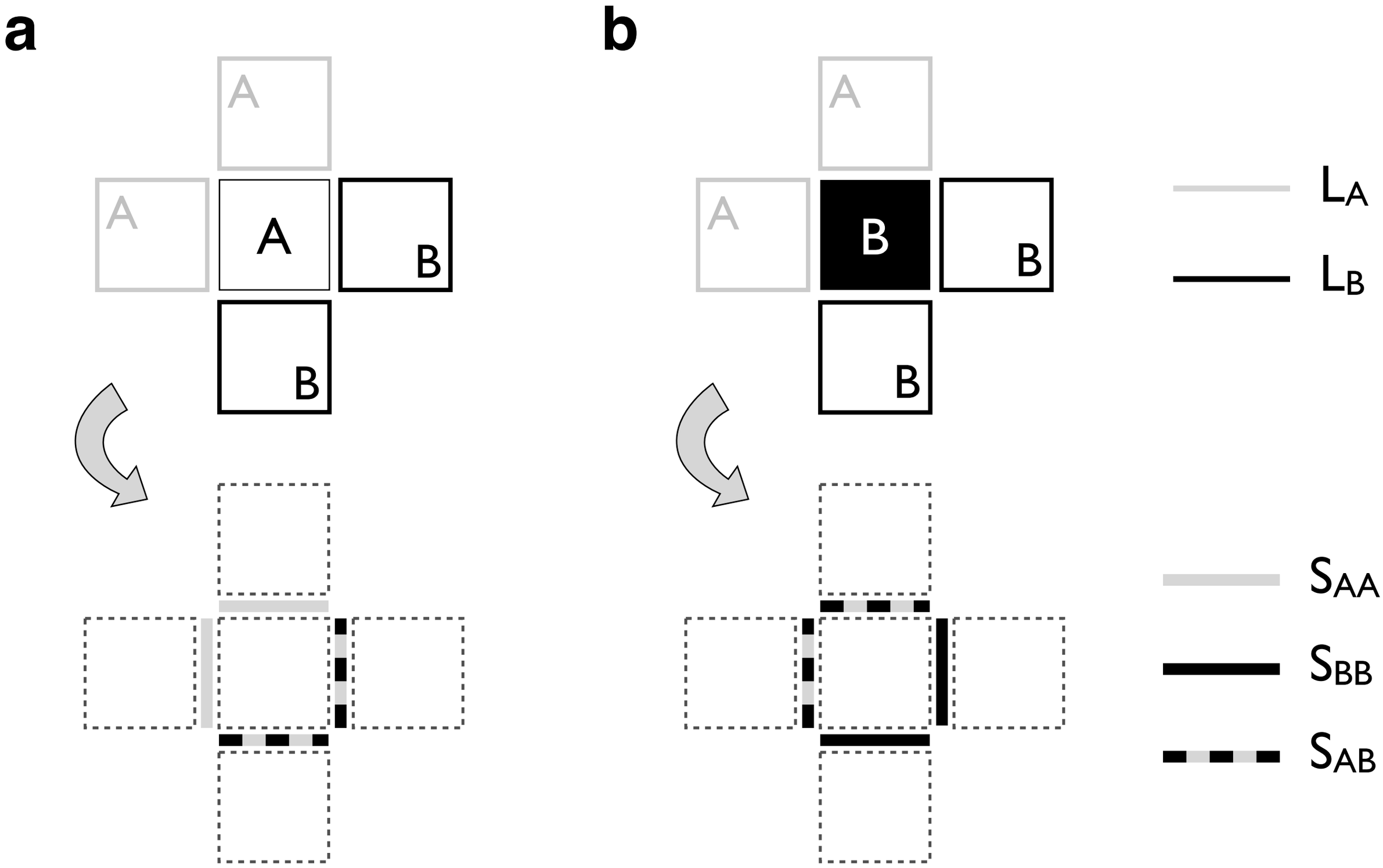


Figure 18.5
Conceptual model for contact probabilities.
(a) Possible contact surfaces for phase A: S_{AA} and S_{AB};
(b) possible contact surfaces for phase B: S_{BB} and S_{BA} (=S_{AB}).

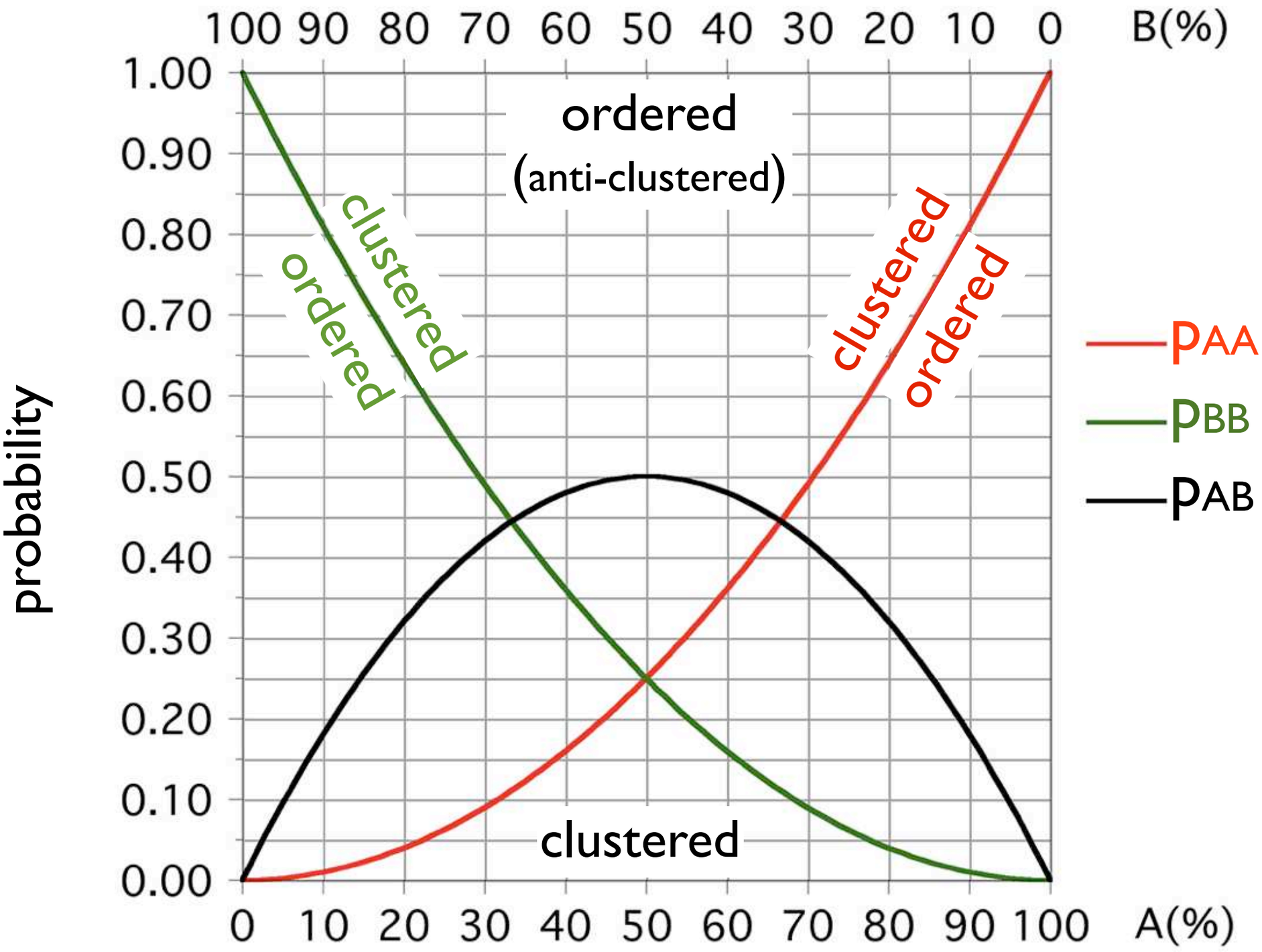


Figure 18.6
Binomial distribution.
Probabilities of contact types, A-A, B-B or A-B, for random mixing of phases A and B are shown for varying percentages of A or B. If measured proportions of A-A or B-B are higher than the theoretical values for p_{AA} or p_{BB}, respectively, the spatial distribution is clustered; if measured proportions of A-B are higher than the theoretical values for p_{AB} the spatial distribution is ordered (anti-clustered).

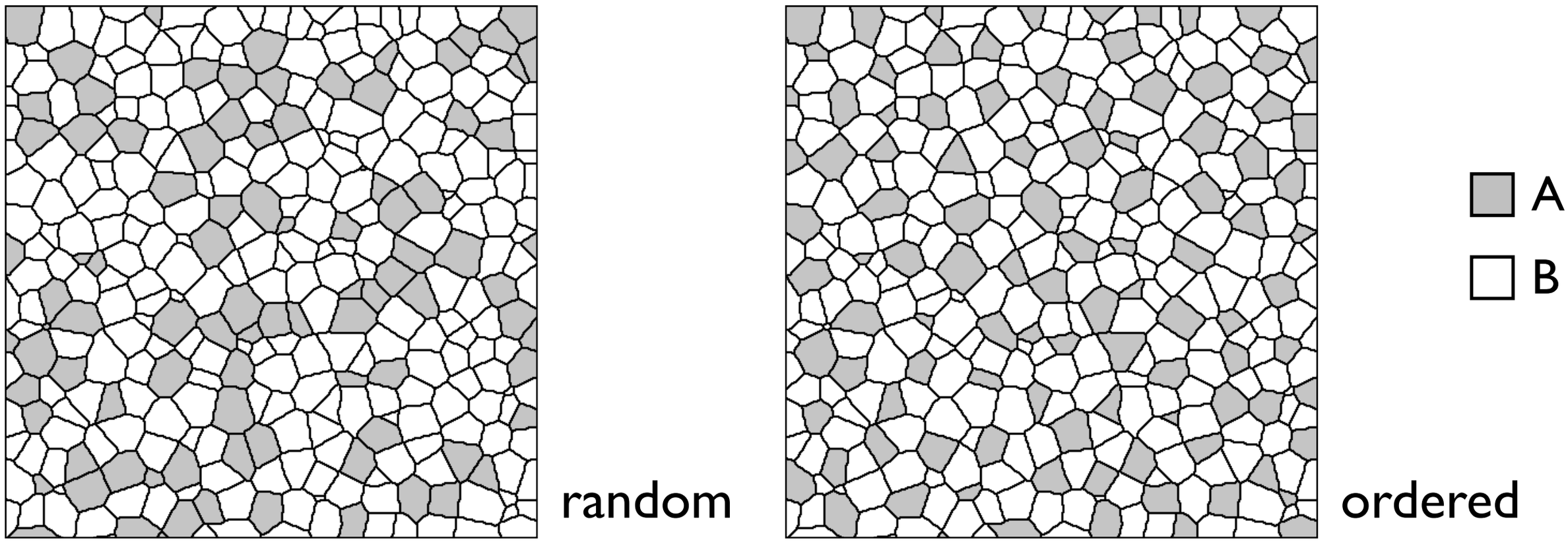
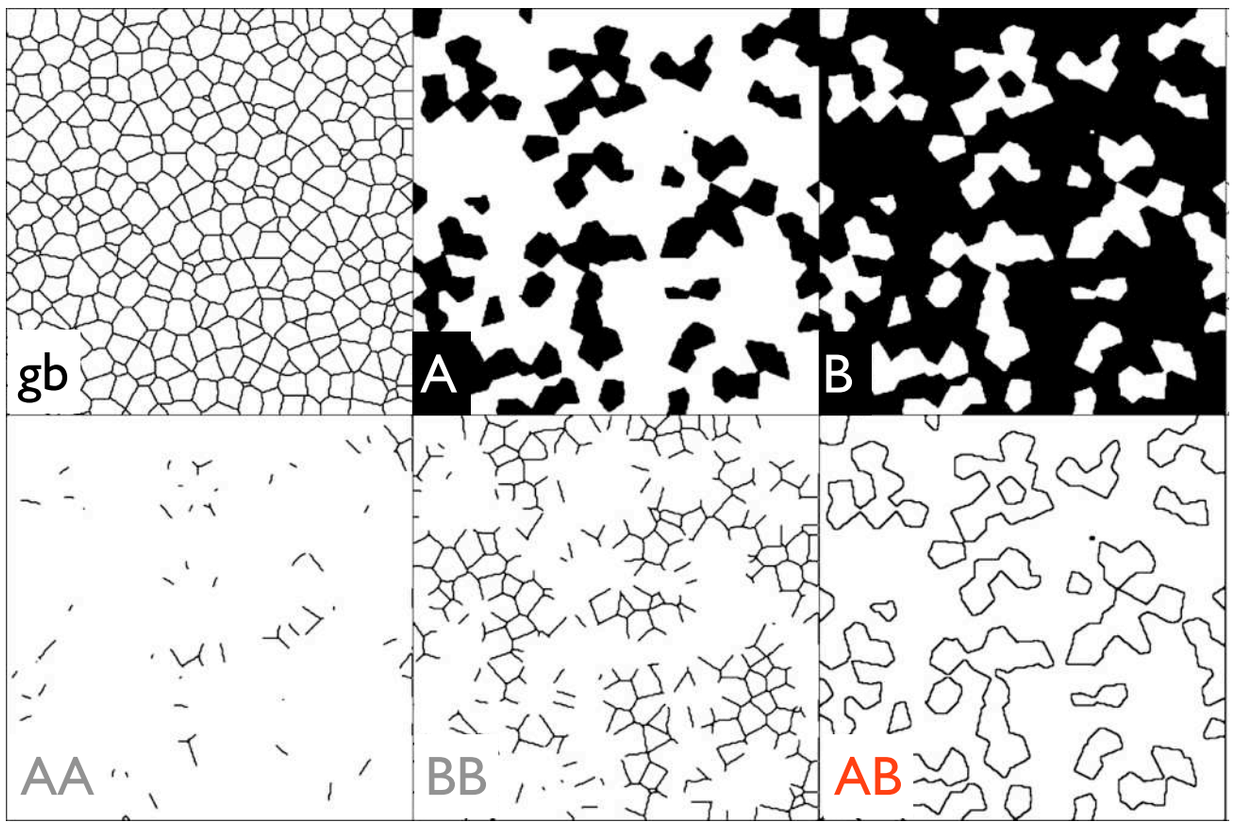
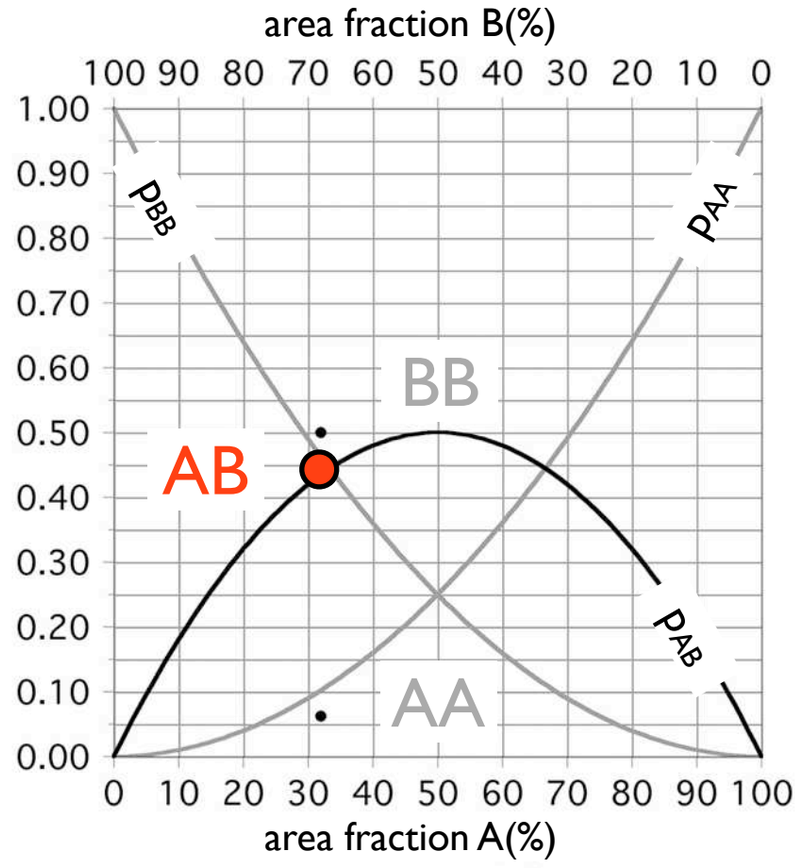


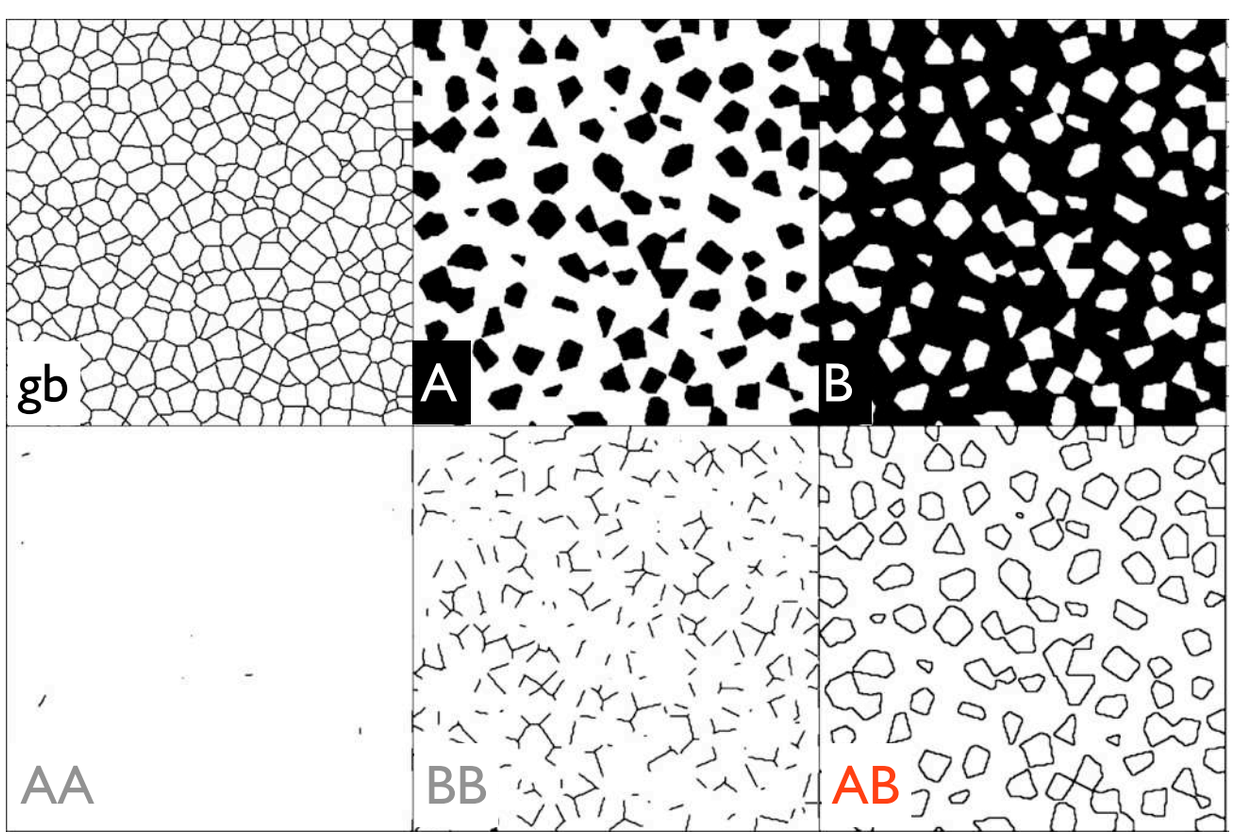
Figure 18.7
Four examples of spatial distributions.
In each case, the ratio of phase A : phase B $\approx$ 0.3 : 0.7.

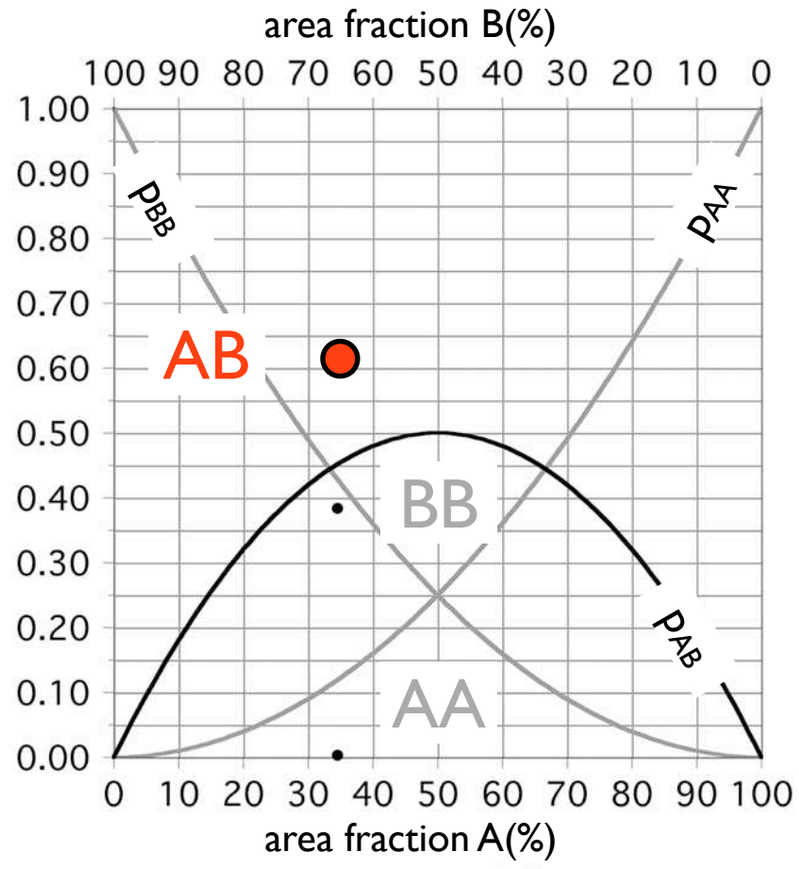
a


gb
A
B
AA
BB
AB


area fraction B(%)
100 90 80 70 60 50 40 30 20 10 0
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
pBB
pAA
pAB
BB
AB
AA
0 10 20 30 40 50 60 70 80 90 100
area fraction A(%)

b


gb
A
B
AA
BB
AB

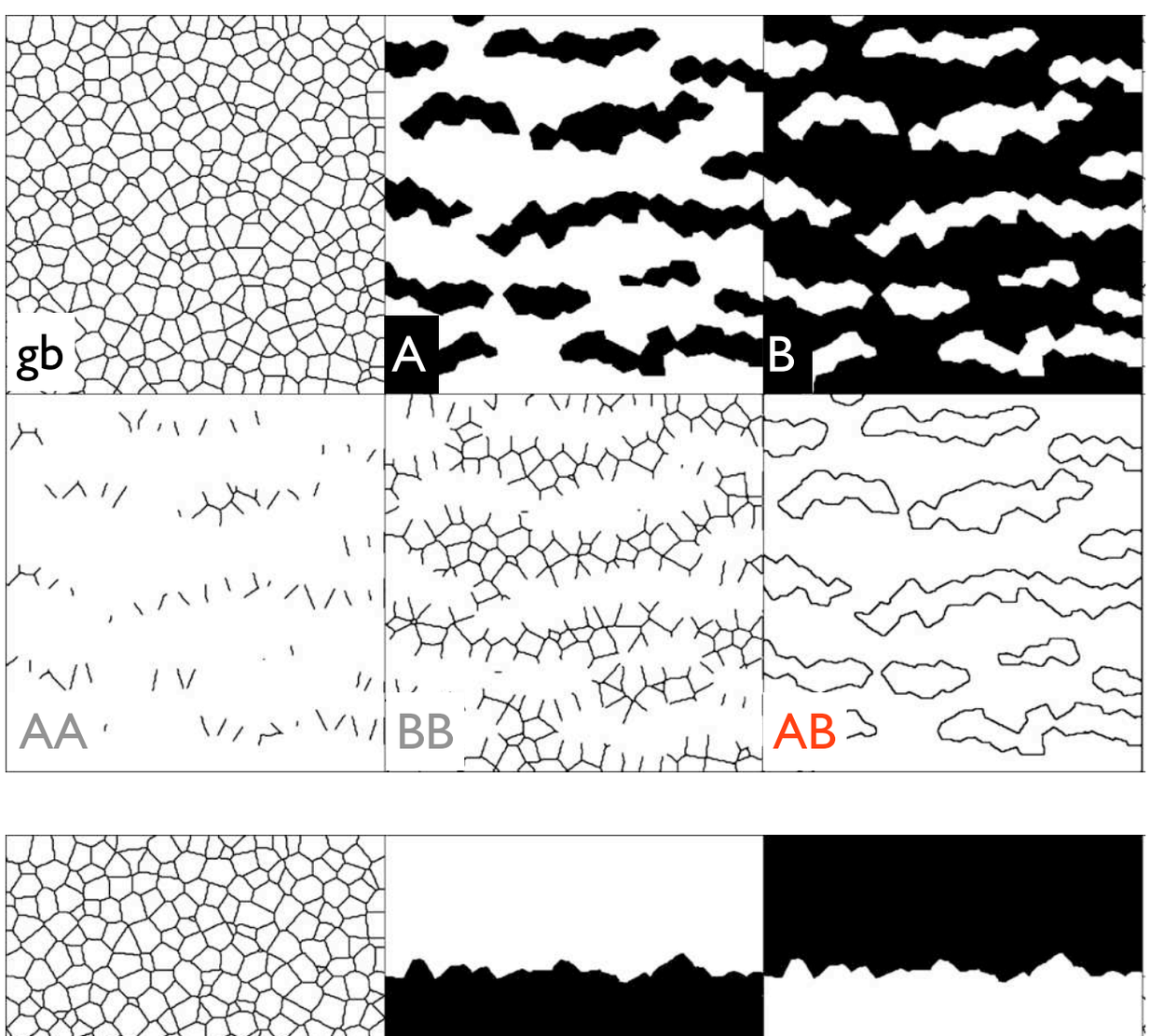

area fraction B(%)
100 90 80 70 60 50 40 30 20 10 0
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
pBB
pAA
pAB
AB
BB
AA
0 10 20 30 40 50 60 70 80 90 100
area fraction A(%)

c

gb
A
B
AA
BB
AB

area fraction B(%)
100 90 80 70 60 50 40 30 20 10 0
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
pBB
pAA
pAB
BB
AB
AA
0 10 20 30 40 50 60 70 80 90 100
area fraction A(%)

d


gb
A
B
AA
BB
AB

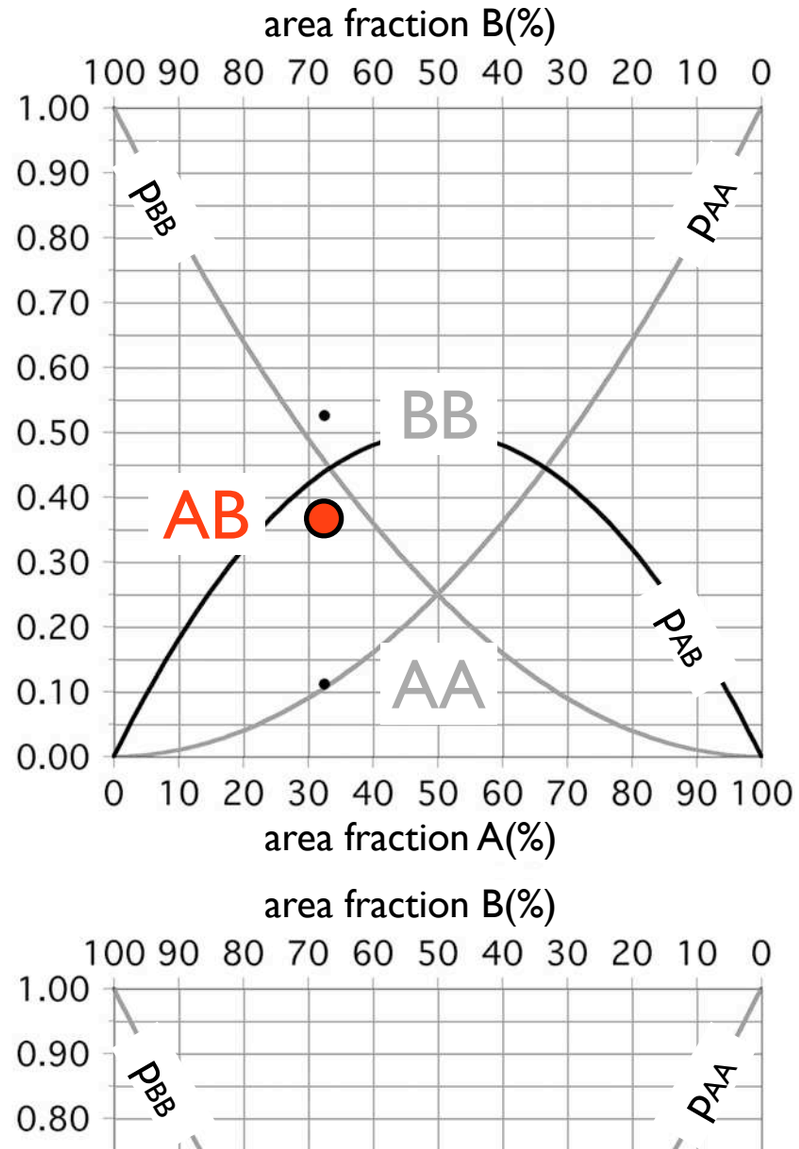

area fraction B(%)
100 90 80 70 60 50 40 30 20 10 0
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
pBB
pAA
pAB
BB
AA
AB
0 10 20 30 40 50 60 70 80 90 100
area fraction A(%)

Figure 18.8
Spatial distributions and contact probabilities.
(a) Random distribution;
(b) ordered distribution;
(c) clustered distribution;
(d) highly clustered distribution.
Left: mosaic showing gb = all grain boundaries, A = phase map of A, B = phase map of B, AA = contact surfaces between A and A, BB = contact surfaces between B and B, AB = contact surfaces between A and B.
Right: curves p_{AA}, p_{BB} and p_{AB} of probabilities of A-A, B-B and A-B contacts, respectively, for a random distribution of phases; measured values of AA, BB and AB are plotted against area fraction of phases, phase boundaries (AB) are highlighted in red. Note that AA + BB + AB = 1.00.

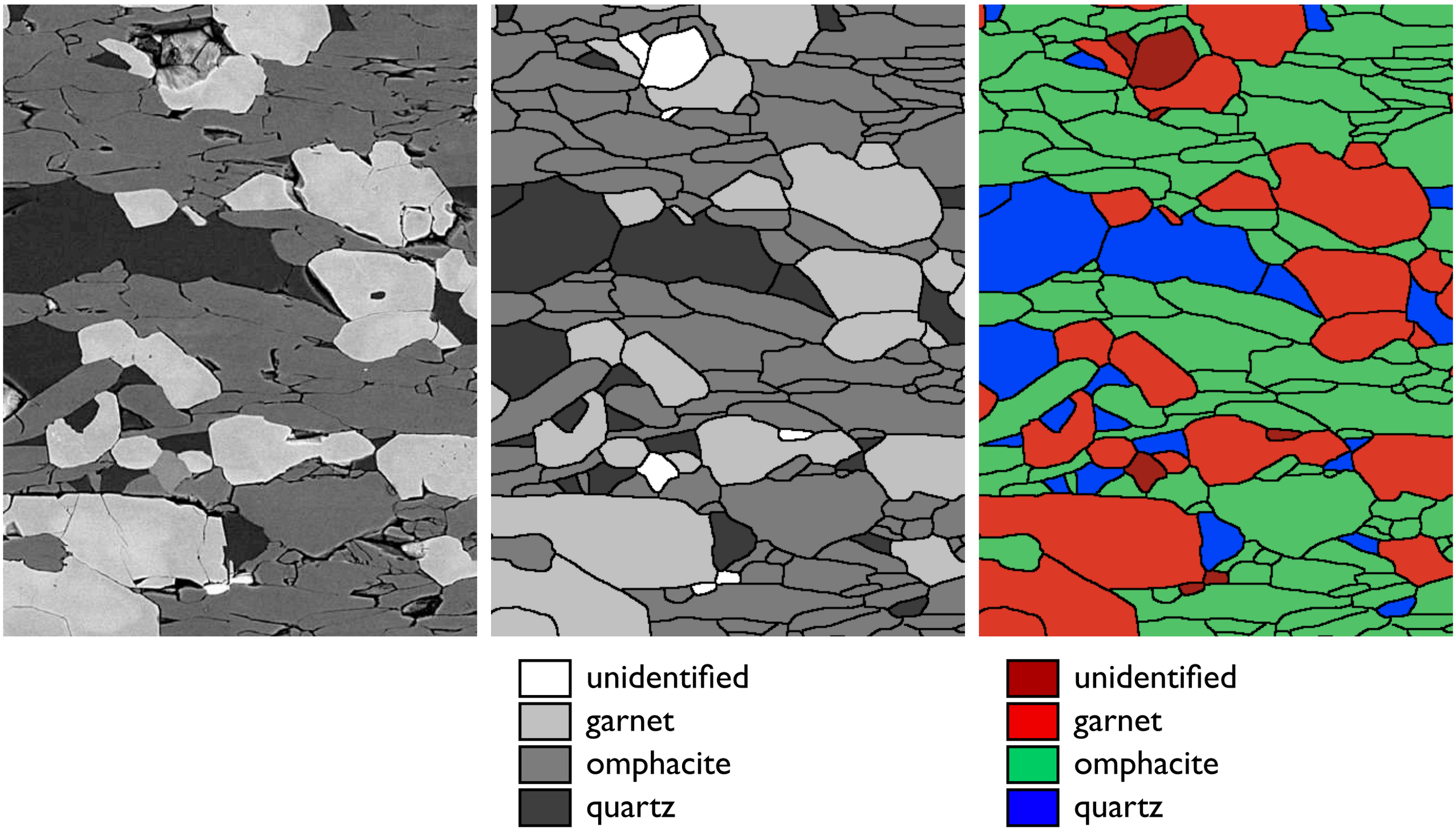


Figure 18.9
Segmentation of eclogite.
(a) Original SEM micrograph of eclogite, BSE contrast;
(b) bitmap showing 4 mineral phases and grain boundaries;
(c) color version of (b).

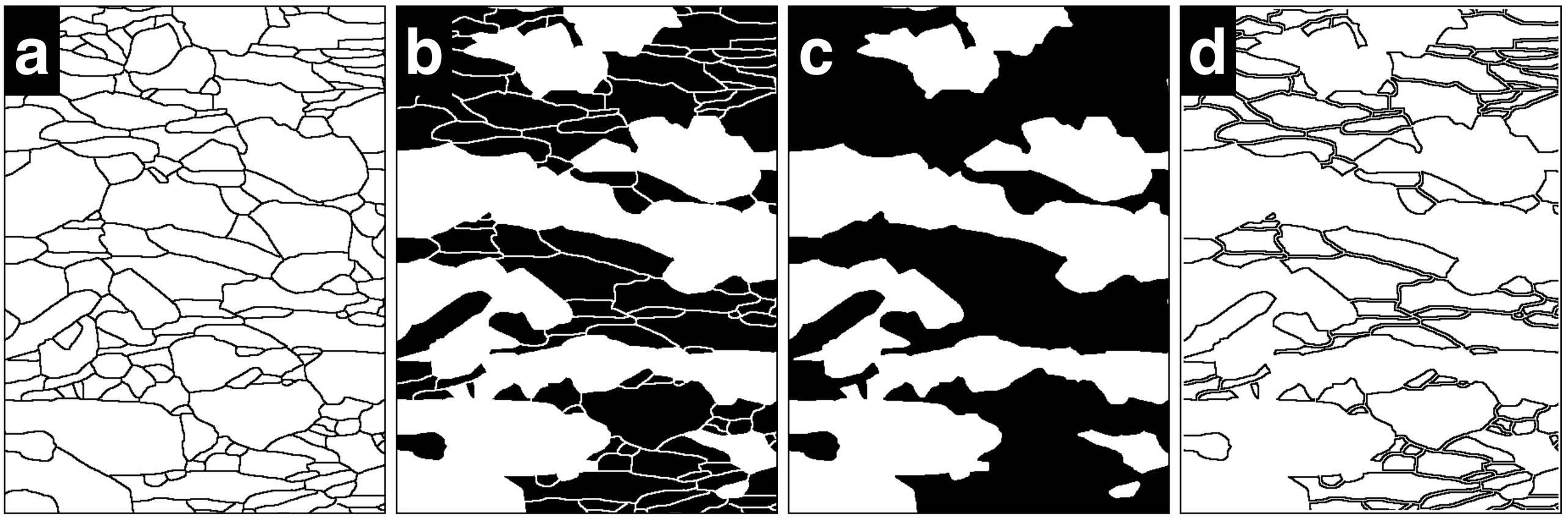


Figure 18.10
Deriving phase and grain boundaries.
Procedure is shown for omphacite (= phase A, green in Figure 18.9).
(a) Grain boundary map of entire fabric;
(b) grain map of phase A;
(c) coherent areas of phase A aggregate, obtained by dilating (b);
(d) outlines of phase A grains, using 'Outline' command (Process > Binary menu);
(e) outlines of phase A aggregates, obtained from (c);
(f) A-A contacts, obtained by AND-adding grain boundaries (a) and phase map A (c);
(g) vertical parts of A-A contacts, obtained by AND-adding a copy of (f) onto itself and shifting vertically;
(h) horizontal parts of A-A grain boundaries, obtained by AND-adding a copy of (f) onto itself and shifting horizontally.

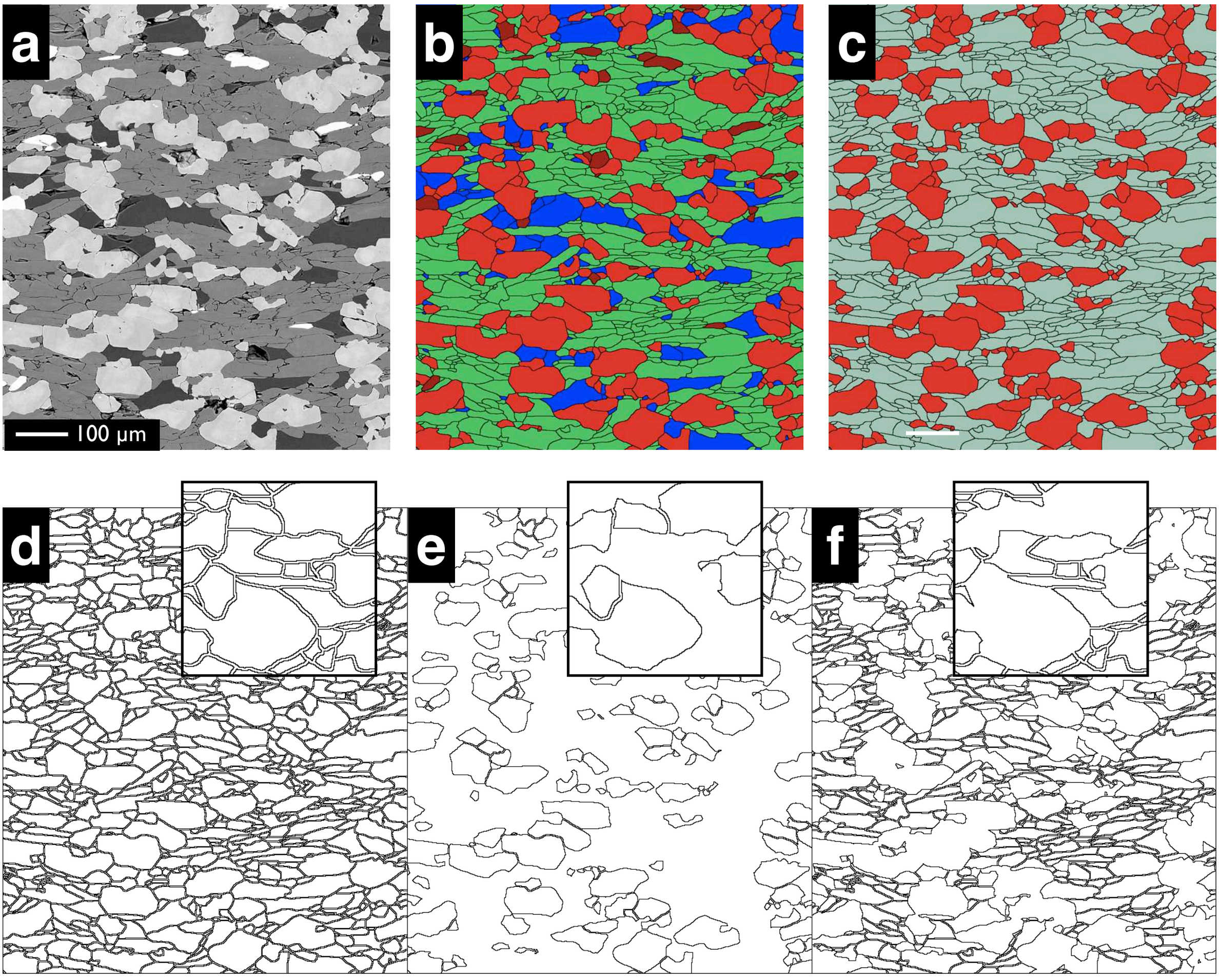
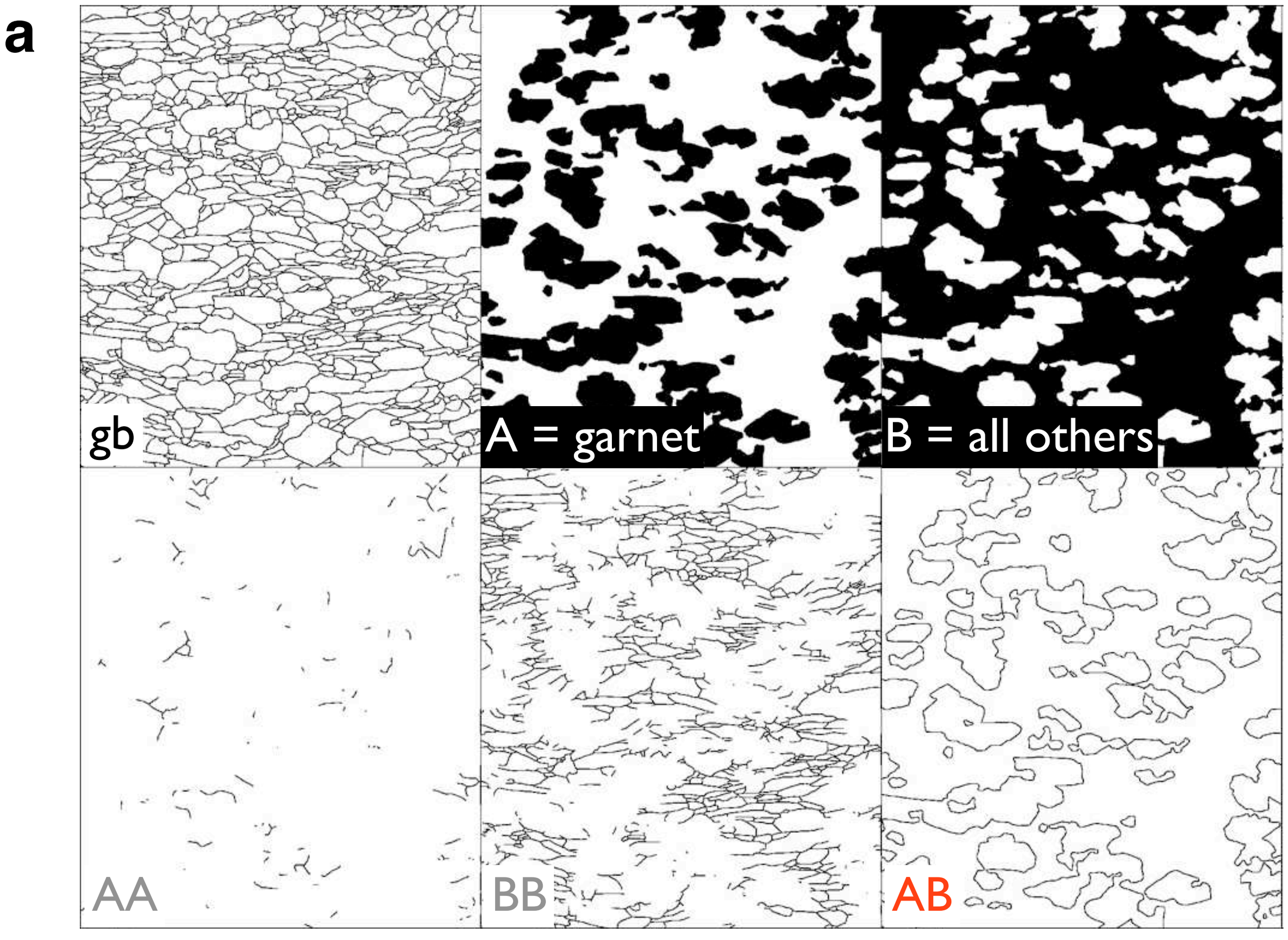
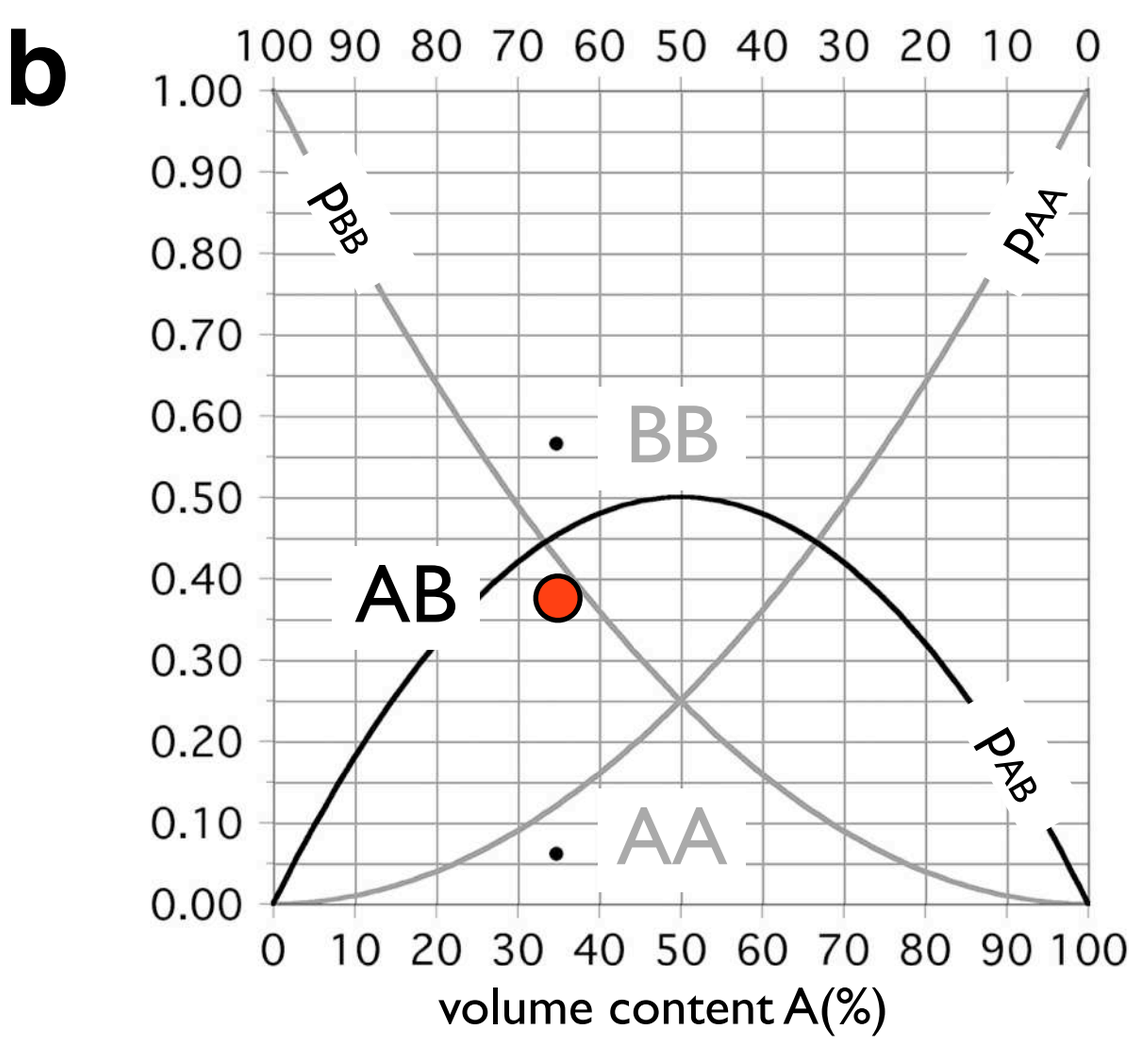


Figure 18.11
Distribution of garnet in eclogite.
(a) SEM micrograph: light gray = garnet, medium gray = omphacite, dark gray = quartz.
(b) phase map of eclogite: red = garnet, green = omphacite, blue = quartz, brown = rest, black = boundaries (map by James MacKenzie);
(c) reduced phase map: red = garnet, gray = all others;
(d) map of all boundaries;
(e) map of garnet boundaries;
(f) map of all non-garnet boundaries;
insets show enlarged sites.





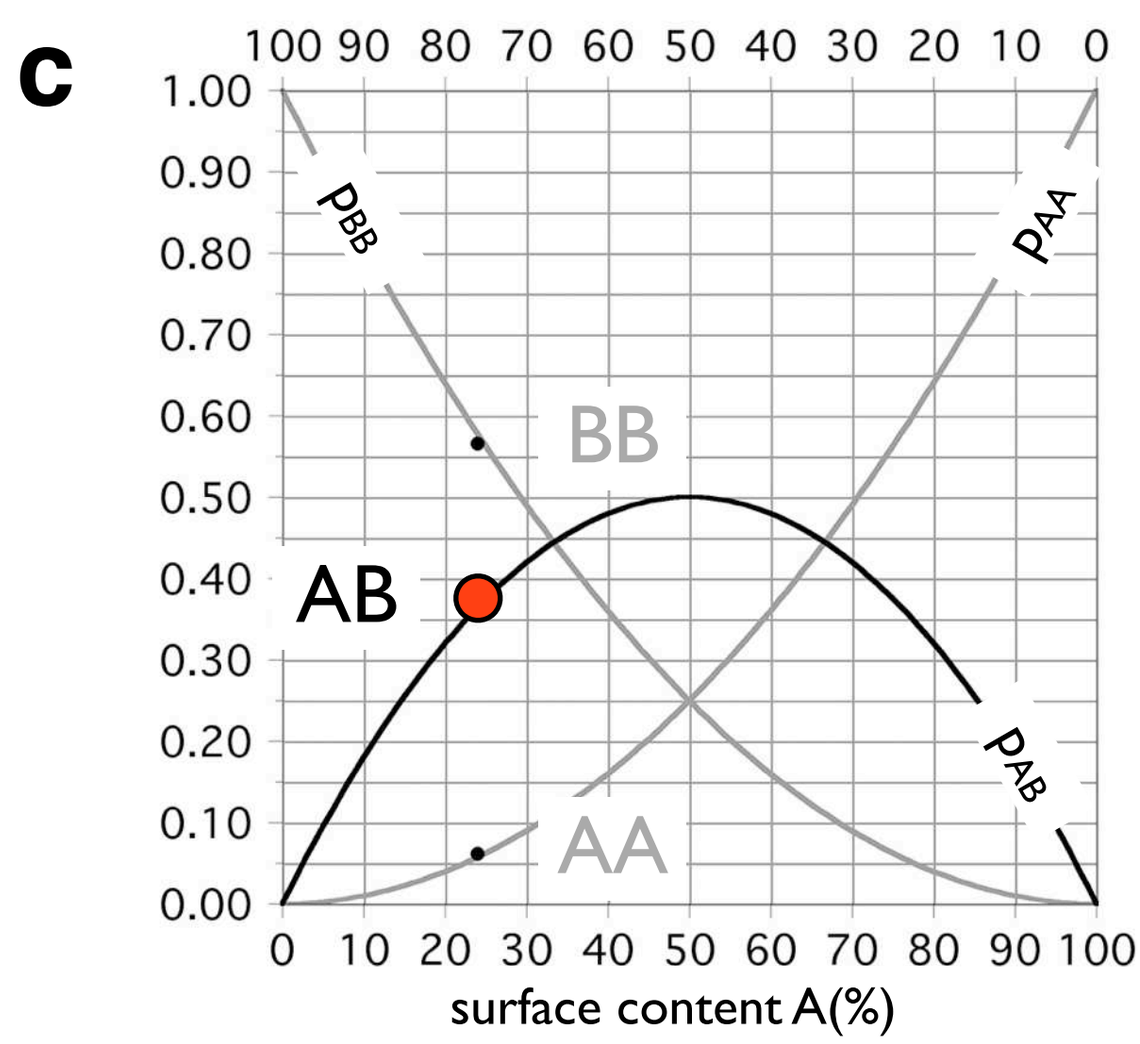


Figure 18.12
Analysis of distribution of garnet in eclogite.
Phase map shown in Figure 18.11.
(a) Mosaic showing gb = all grain boundaries, A = phase map of garnet, B = phase map of all others, AA = contact surfaces between garnet and garnet, BB = contact surfaces among all others, AB = contact surfaces between garnet and any other.
(b) plot of theoretical values p_{AA}, p_{BB} and p_{AB} for a random distribution of phases; measured values for (a) are inserted as functions of volume fractions (= area fractions) of phases;
(c) same as (b), measured values are plotted as functions of surface fractions (= length fractions) of boundaries.

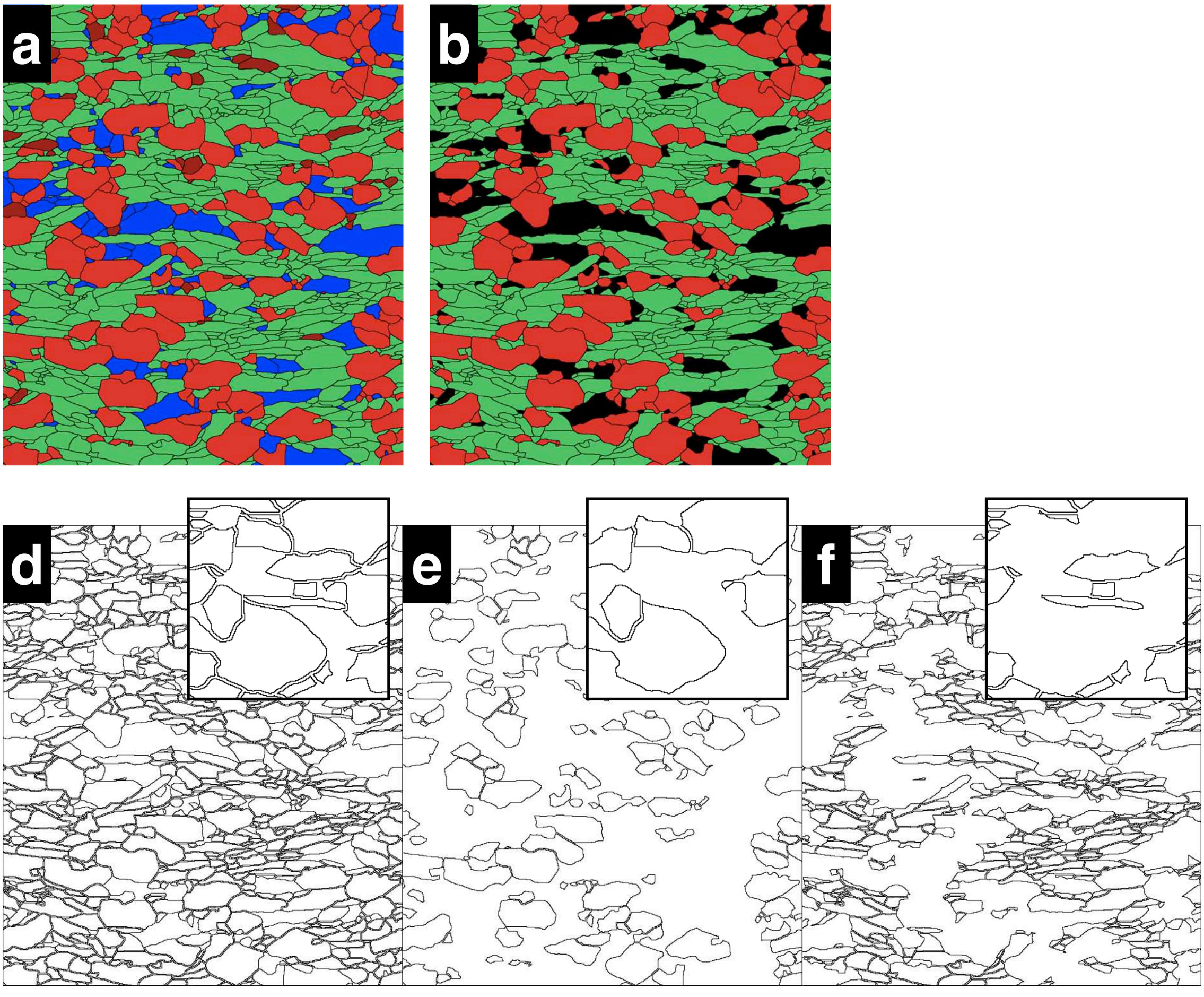


Figure 18.13
Distribution of garnet and omphacite in eclogite.
(a) Phase map of eclogite: red = garnet, green = omphacite, blue = quartz, brown = rest, black = boundaries (map by James MacKenzie);
(b) reduced phase map: red = garnet, green = omphacite, black = boundaries + quartz + rest;
(c) map of all garnet and omphacite boundaries;
(d) map of garnet boundaries;
(e) map of omphacite boundaries;
insets show enlarged sites.

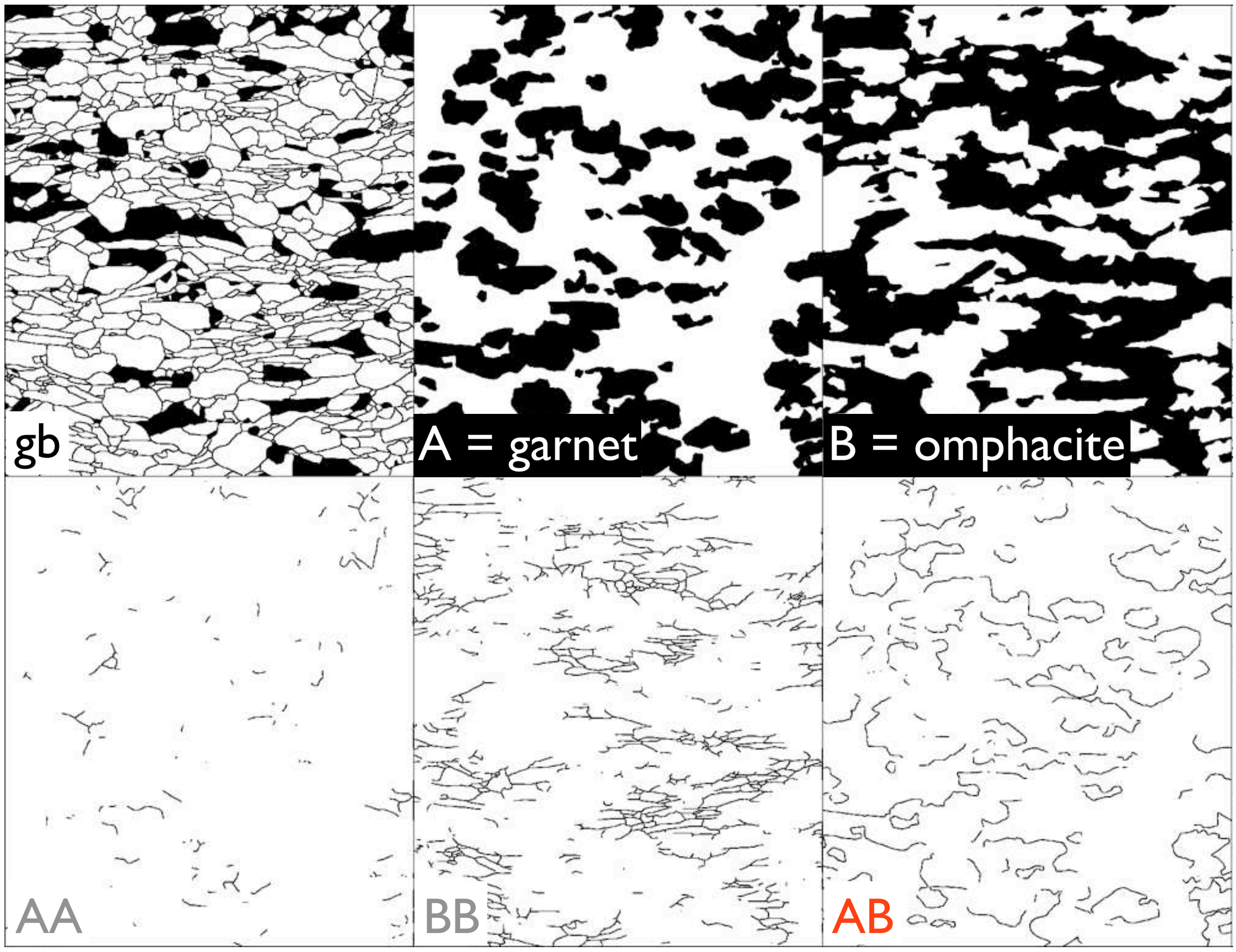


Figure 18.14
Analysis of distribution of garnet and omphacite in eclogite Phase map shown in Figure 18.13.
(a) Mosaic showing gb = all grain boundaries + quartz + rest, A = phase map of garnet, B = phase map of omphacite, AA = contact surfaces between garnet and garnet, BB = contact surfaces between omphacite and omphacite, AB = contact surfaces between garnet and omphacite.
(b) plot of theoretical values p_{AA}, p_{BB} and p_{AB} for a random distribution of phases; measured values for (a) are inserted as functions of volume fractions (= area fractions) of phases;
(c) same as (b), measured values are plotted as functions of surface fractions (= length fractions) of boundaries.

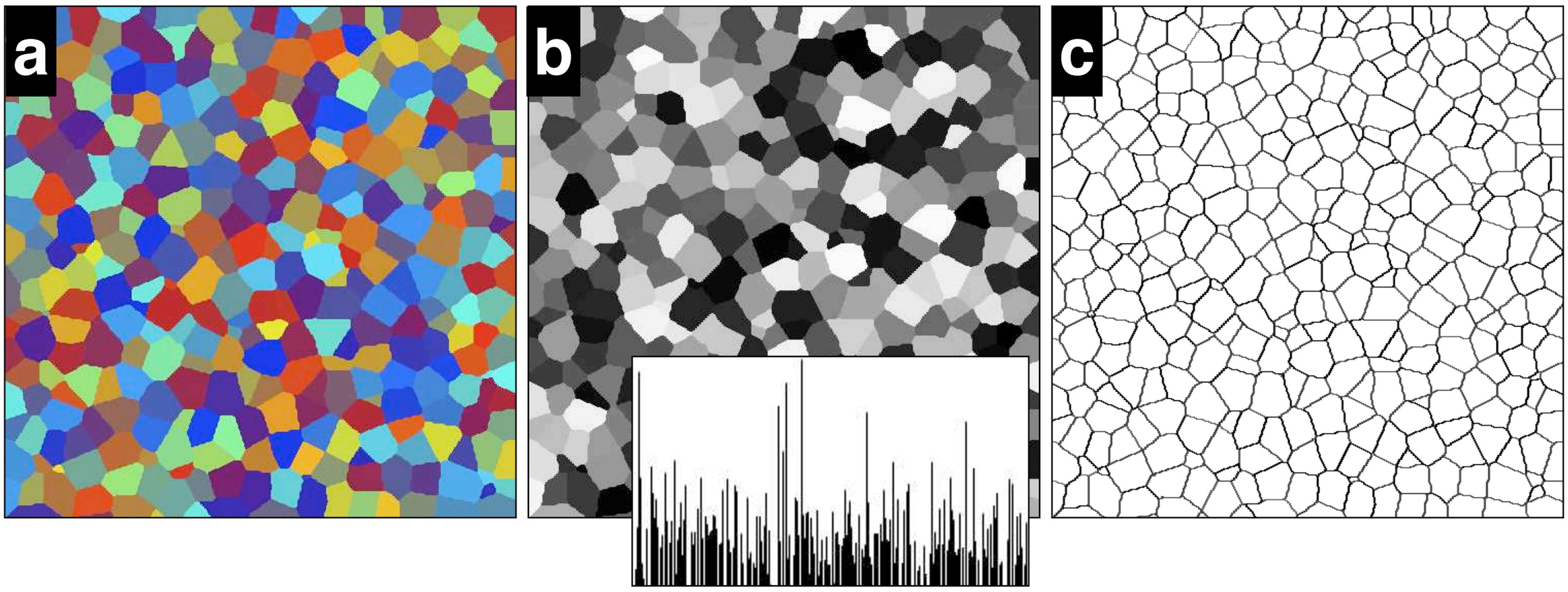


Figure 18.15
Preparing random spatial distributions of random phases.
(a) Section of 3-D Voronoi tessellation (software for numerical simulation by Hugo Ledoux, maps prepared by James MacKenzie);
(b) red channel of (a) showing random distribution of gray values (random phases);
(c) grain boundary map of (b).

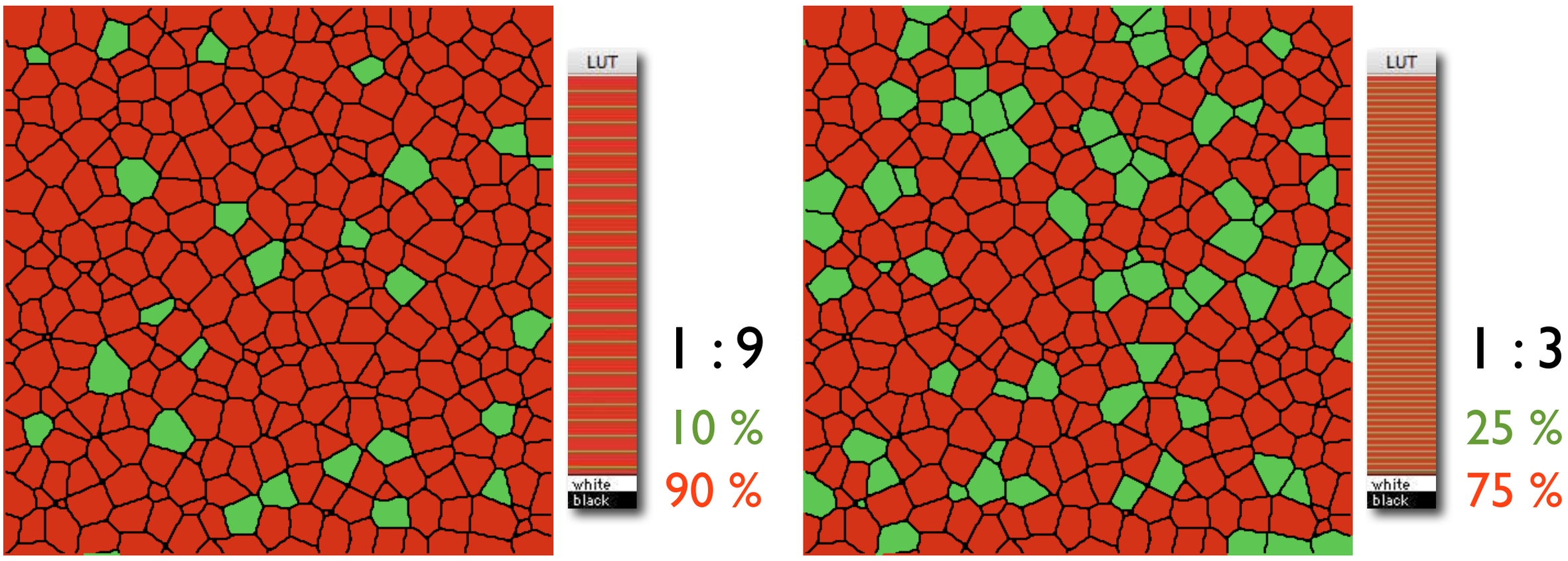


Figure 18.16
Random phase distributions.
Applying special LUTs to a random phase maps (such as Figure 15.b), different fractions of red and green phase are created. Four examples with different phase ratios are shown; LUTs are shown on the right. Note that the grain boundary map is the same in all four examples.

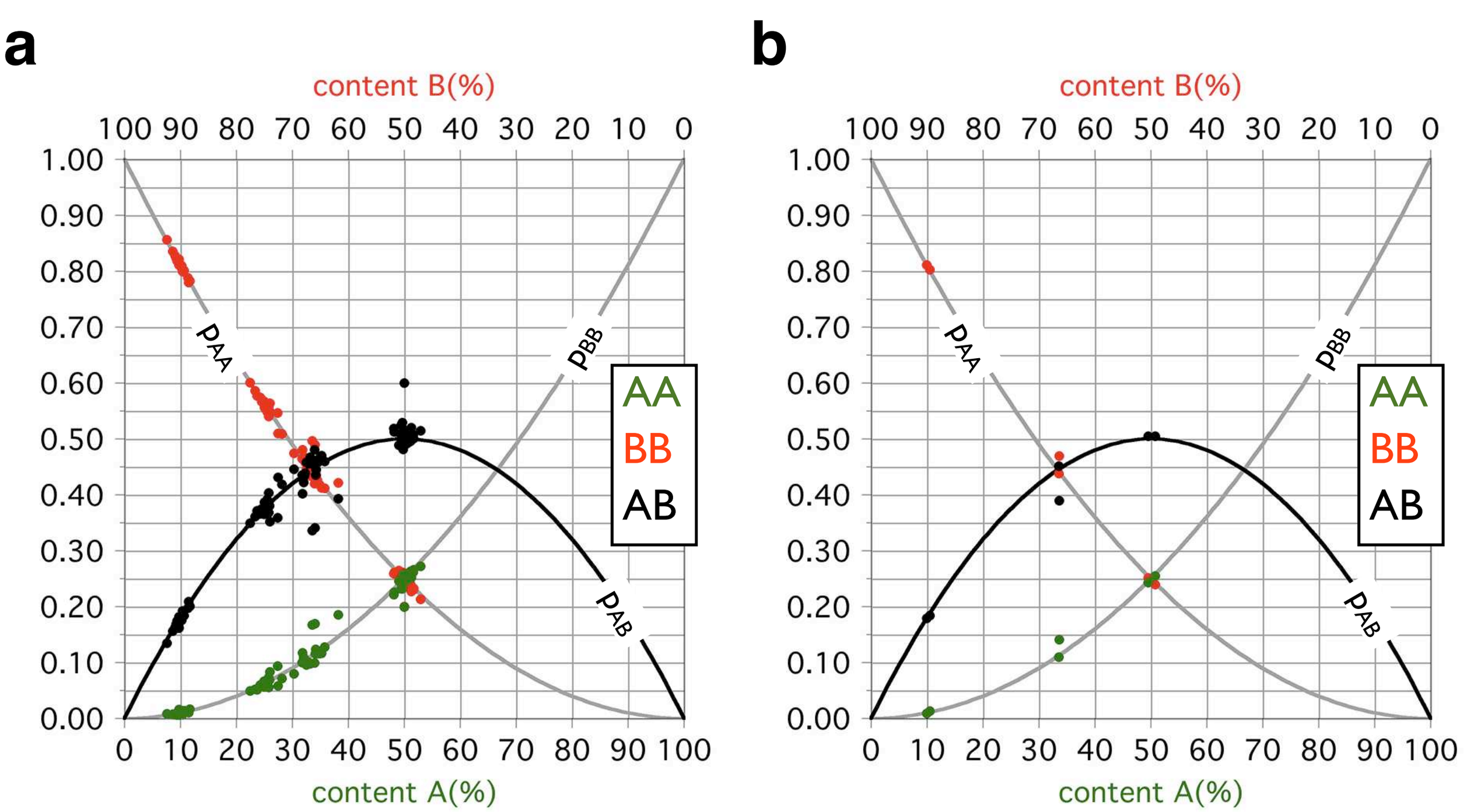


Figure 18.17
Influence of sample size.
(a) Curves of theoretical values p_{AA}, p_{BB} and p_{AB} for a random distribution of phases; measured values of numerical simulations (Figure 18.16) are plotted, sample size = 380;
(b) same as (a) using a samples size = 1520;
numerical simulations by Hugo Ledoux, analyses by James MacKenzie.

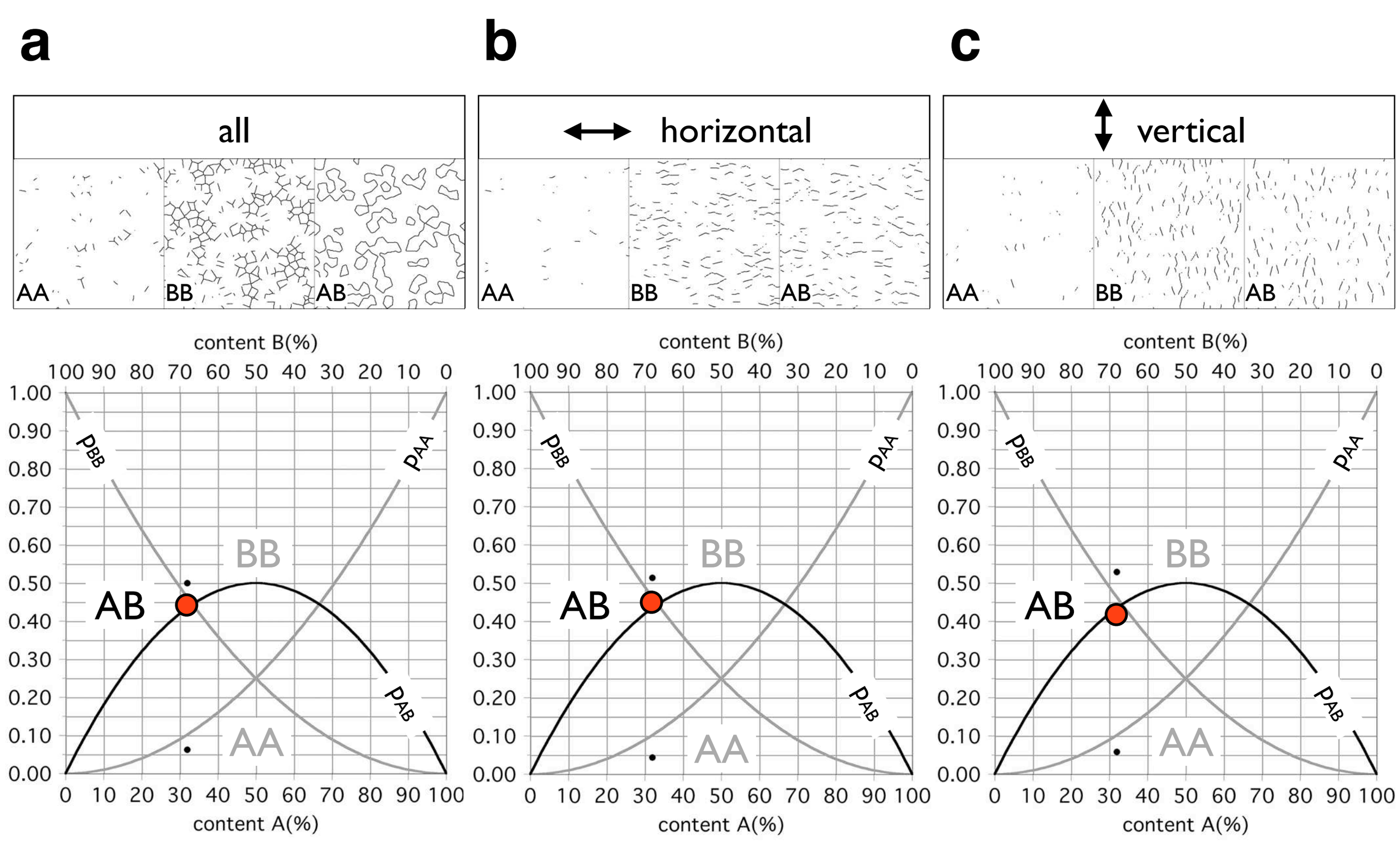


Figure 18.18
Influence of orientation on random distribution.
(a) Evaluation of contact surfaces for random spatial distribution (Figure 18.8.a);
(b) evaluation of horizontal surface fraction;
(c) evaluation of vertical surface fraction.

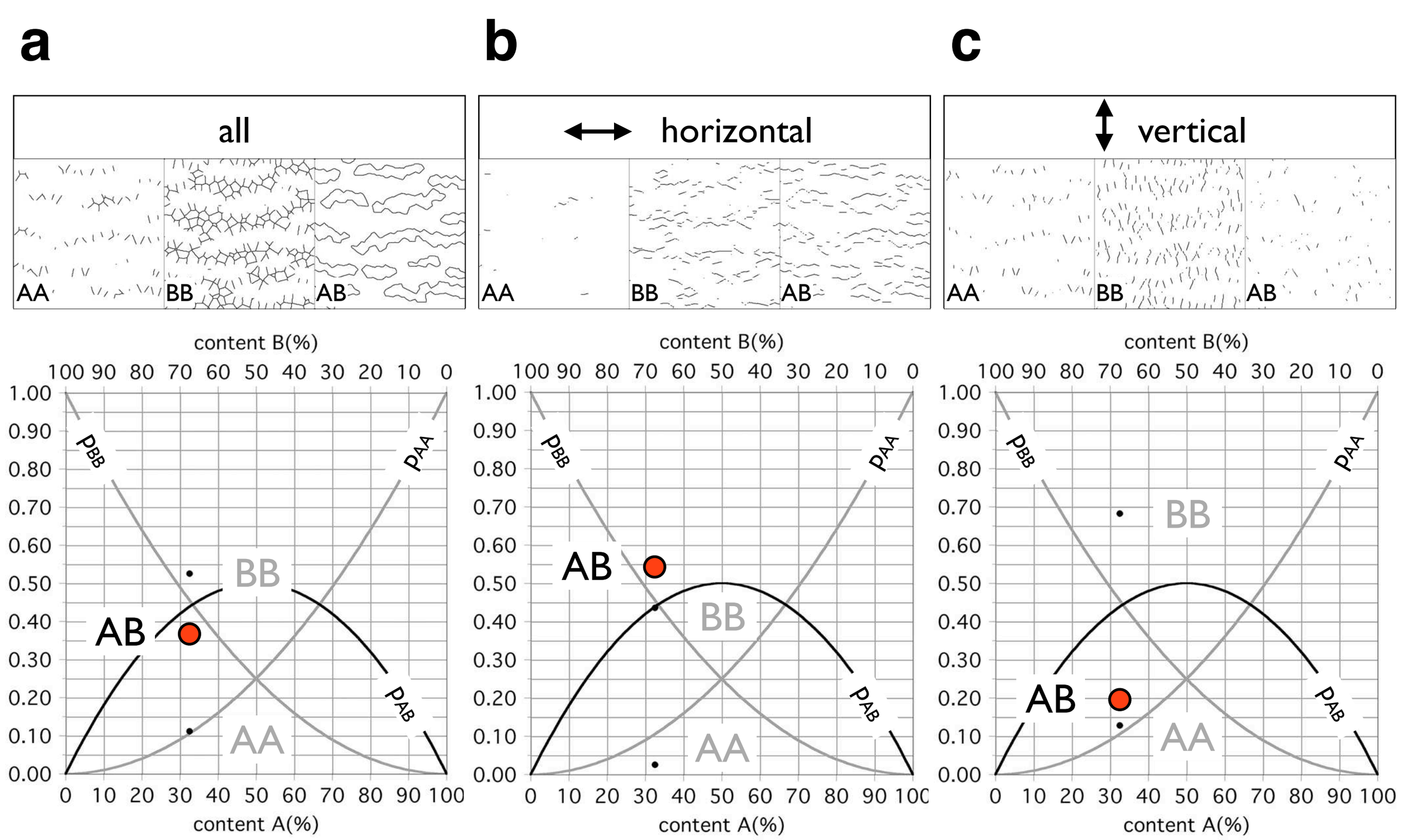


Figure 18.19
Influence of orientation on clustered distribution.
(a) Evaluation of contact surfaces for clustered spatial distribution (Figure 18.8.c);
(b) evaluation of horizontal surface fraction;
(c) evaluation of vertical surface fraction.