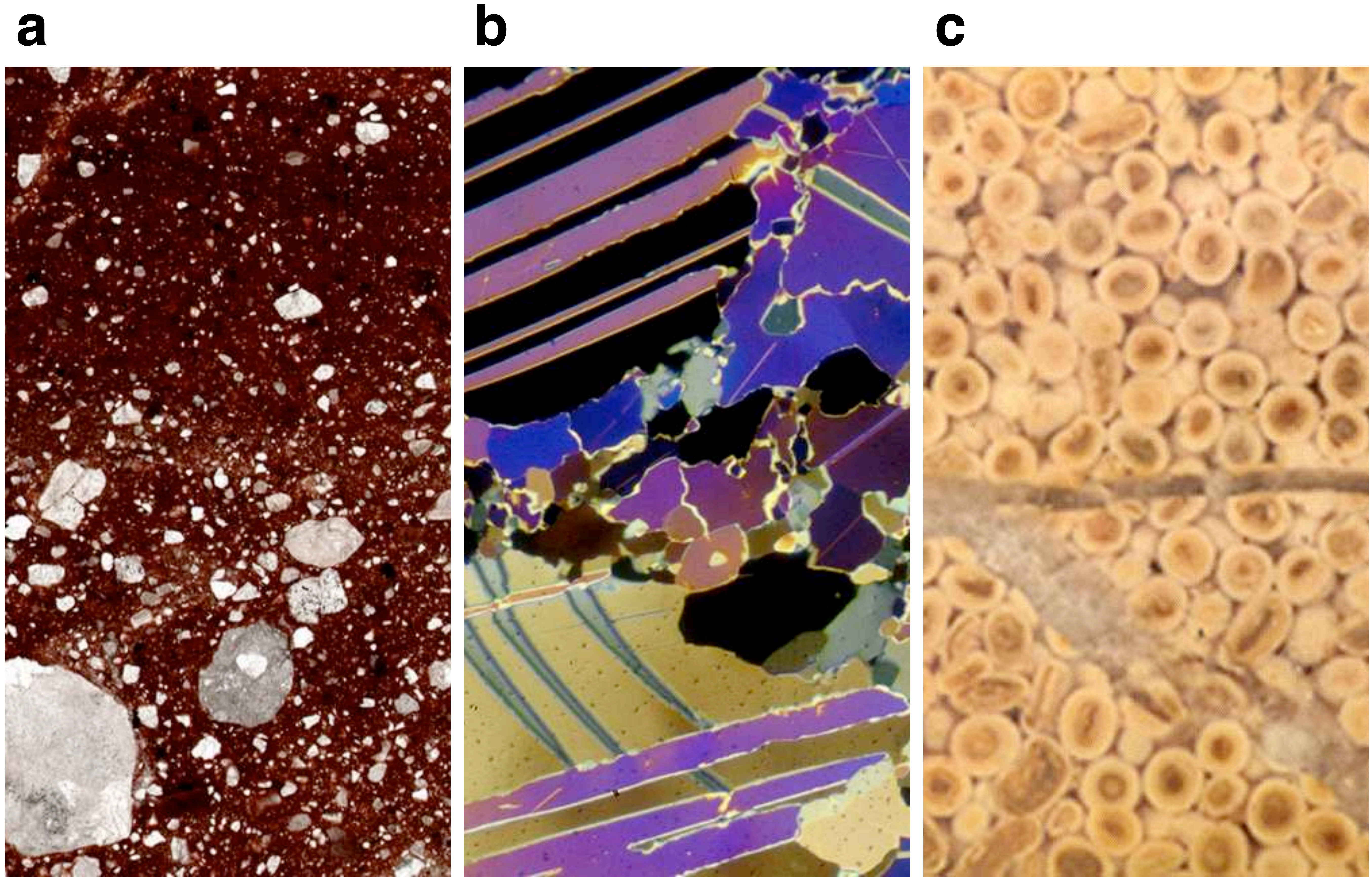

Figure 11.1
Grain size and physical processes.
(a) Grain size distribution in cataclastic rock relates to fragmentation, comminution;
(b) mean grain size in dynamically recrystallized marble relates to flow stress;
(c) grain size distribution of oolithic limestone relates to environment of deposition.

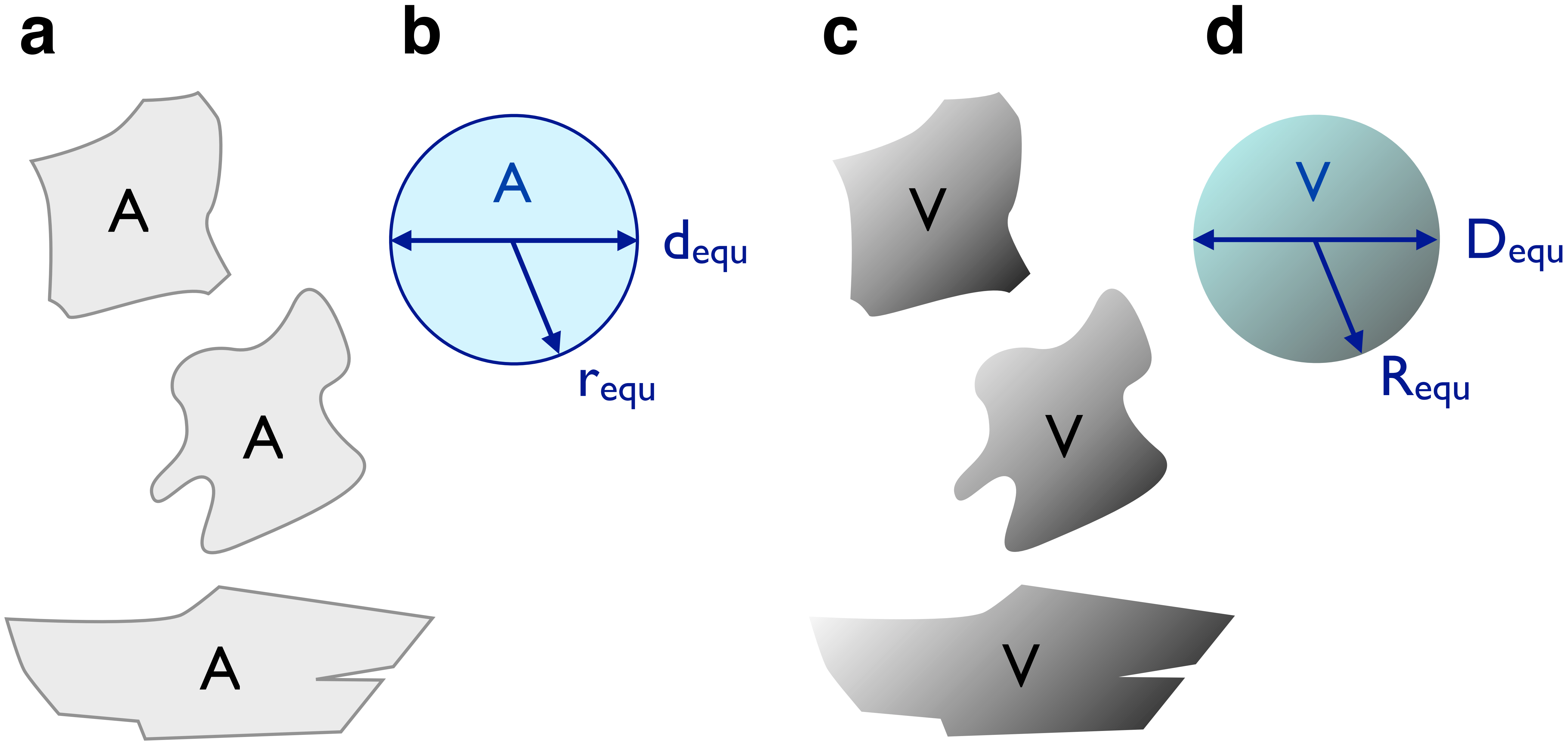

Figure 11.2
The size of a grain in two and three dimensions
(a) Different cross sections of grains, all with same area A;
(b) circle with same area as shapes in (a); r_{equ} = radius, d_{equ}= diameter of area equivalent circle;
(c) different 3-D grains, all with same volume V;
(d) sphere with same volume as grains in (c); R_{equ} = radius, D_{equ}= diameter of volume equivalent sphere.

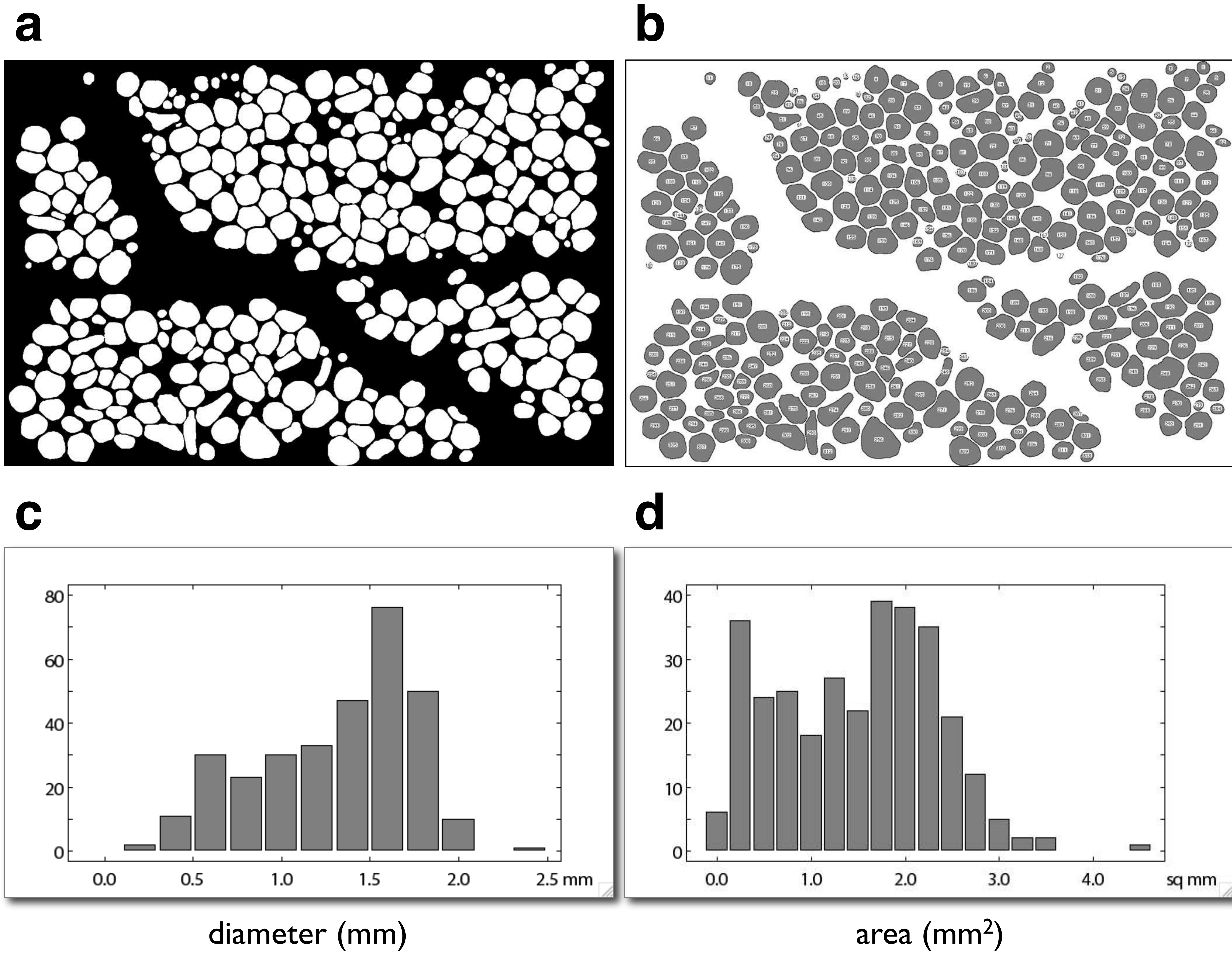

Figure 11.3
Image SXM grain size analysis.
(a) Segmented image of oolithic limestone (for polished section, see Figure 2.3);
(b) bitmap after evaluation;
(c) histogram of diameters;
(d) histogram of areas of cross sections.

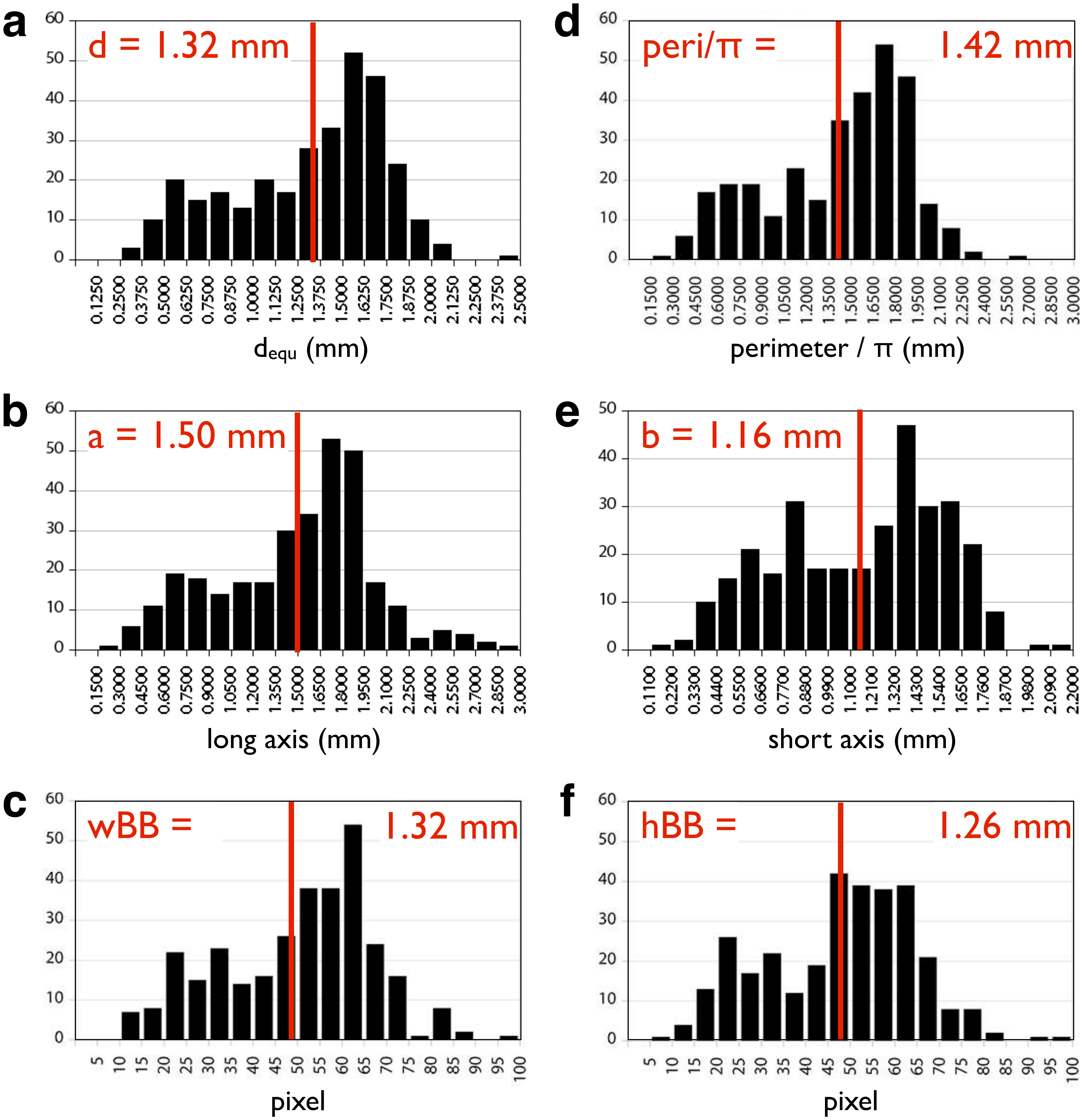

Figure 11.4
Linear grain size measures for oolithic limestone.
Results are shown as histograms for:
(a) equivalent diameters, d_{equ};
(b) perimeter divided by π;
(c) long diameters of best-fit ellipses, a;
(d) short axes of best-fit ellipses b;
(e) width of bounding box;
(f) height of bounding box;
arithmetic means are indicated (red).

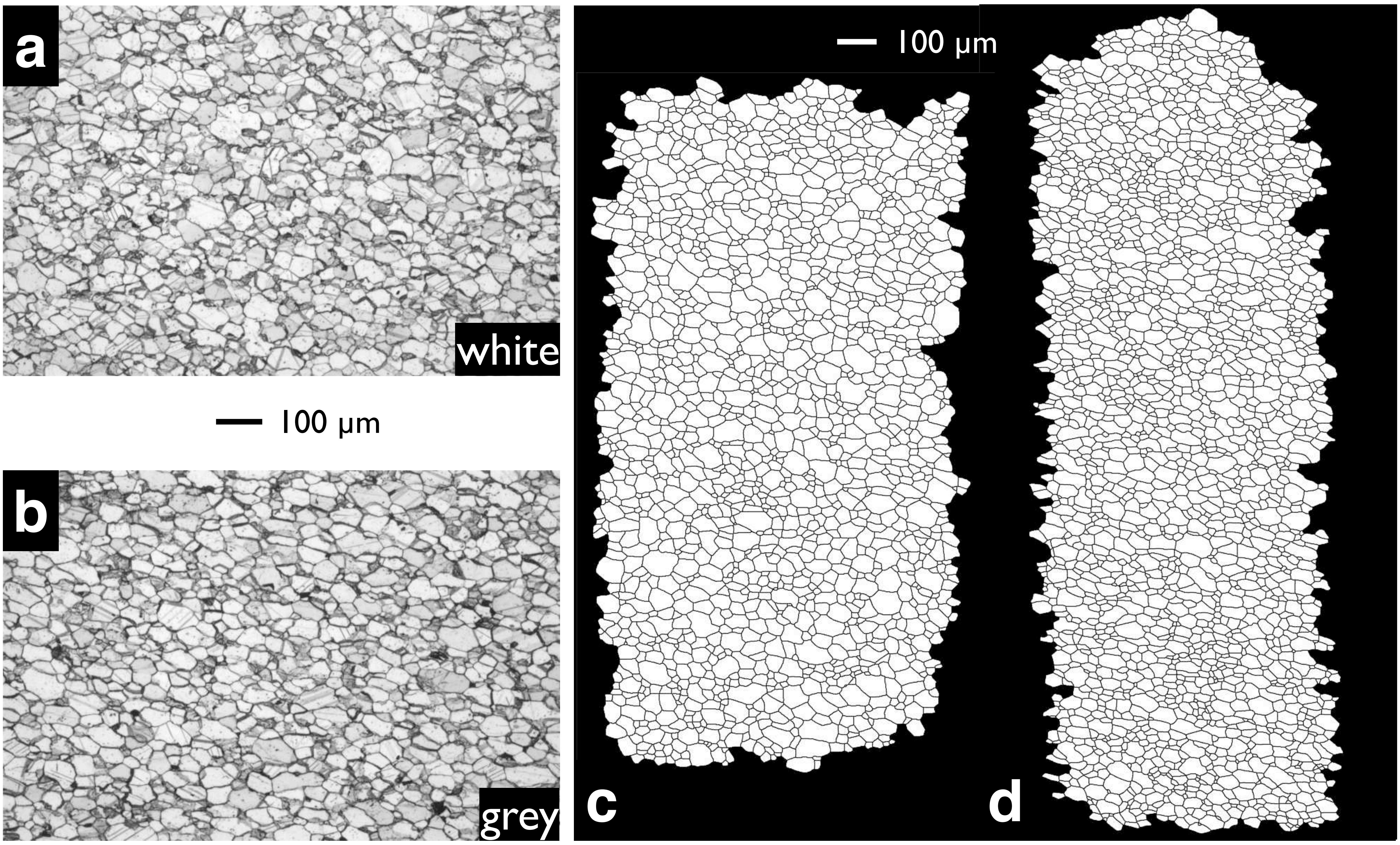

Figure 11.5
White and gray variety of Carrara marble.
(a) Micrograph of white variety in plane polarized light, scale applies to (a) and (b);
(b) micrograph of gray variety in plane polarized light;
(c) grain boundary map of white variety, scale applies to (c) and (d);
(d) grain boundary map of gray variety (grain boundary maps courtesy Giancarlo Molli).

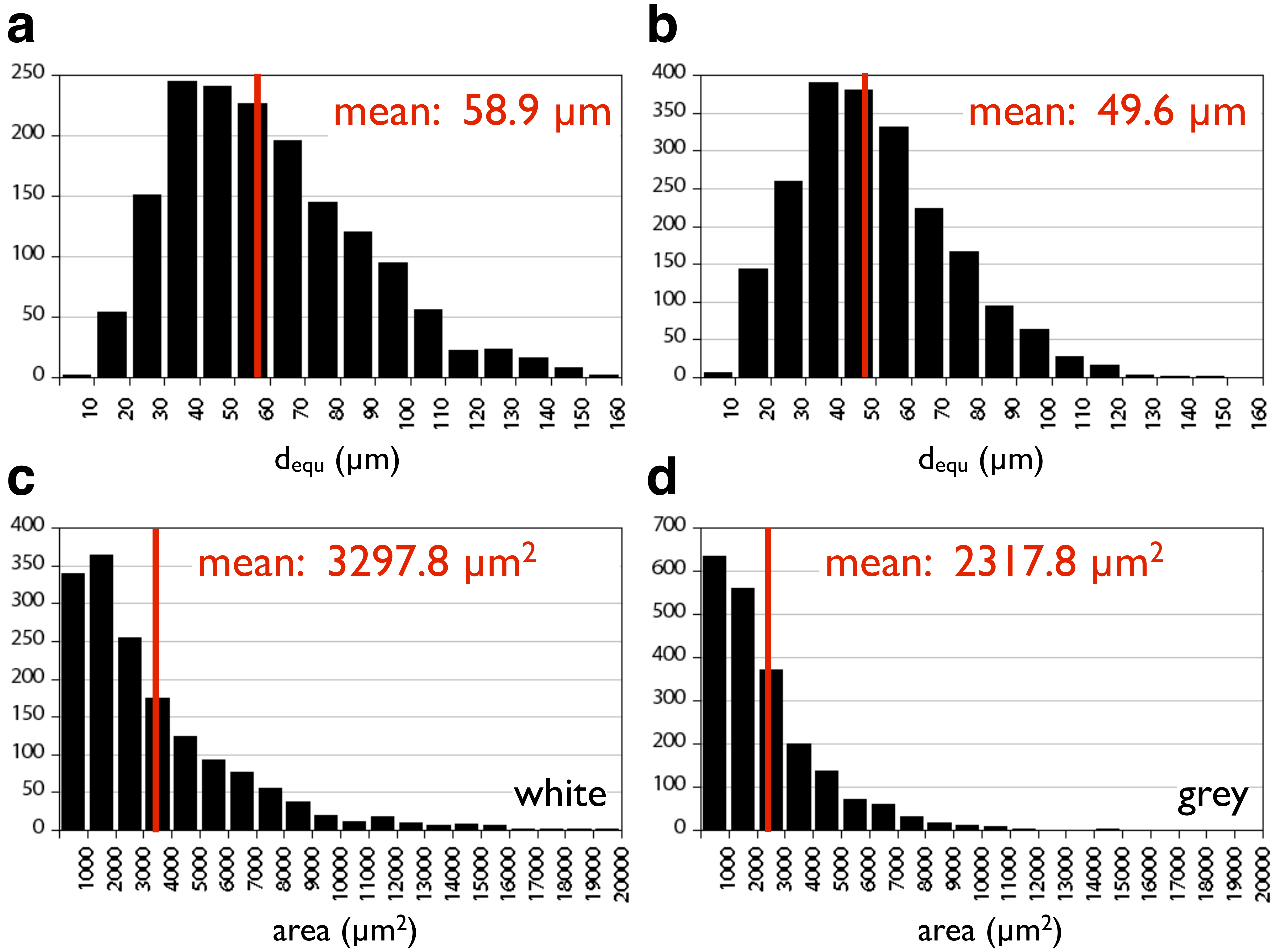

Figure 11.6
Grain size of white and gray Carrara marble.
Results are shown as histograms for:
(a) equivalent diameters, d_{equ}, of white variety;
(b) equivalent diameters, d_{equ}, of gray variety;
(c) areas, A, of white variety;
(d) areas, A, of gray variety;
arithmetic means are indicated (red).

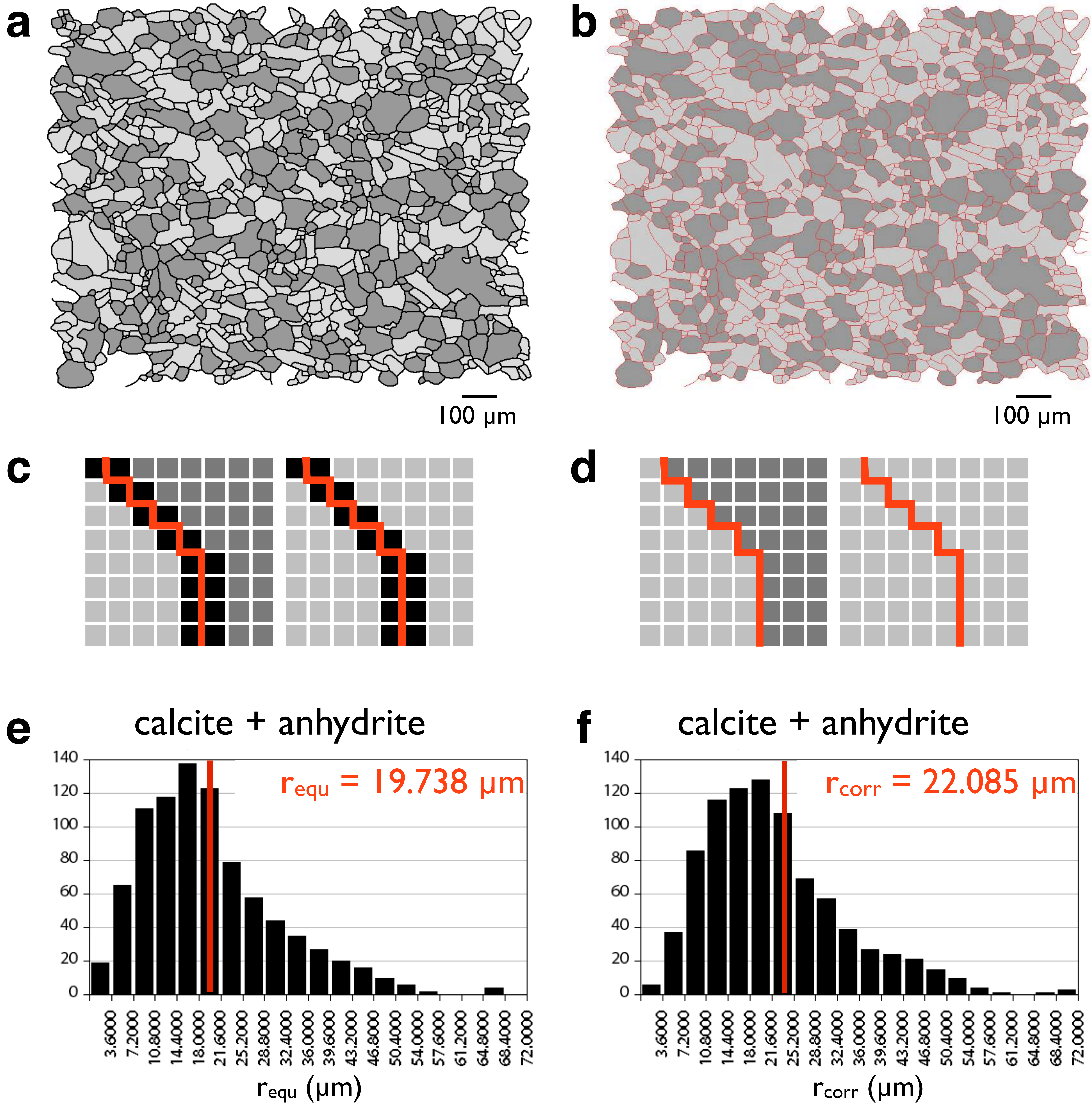

Figure 11.7
Grain size analysis of two-phase aggregate of calcite and anhydrite.
(a) Grain map of 50:50 anhydrite calcite mixture: anhydrite (light gray), calcite (dark gray) and grain boundaries (black) (line drawing courtesy David Bruhn);
(b) phase map of same material, showing 2 mineral phases, locations of phase and grain boundaries are marked (red);
(c) detail of (a) showing a phase boundary (left) and a grain boundary (right);
(d) detail of (b) showing a phase boundary (left) and a grain boundary (right).
(e) r_{equ} = radius of measured cross sectional areas (equation 8.1);
(f) r_{corr} = radius of corrected cross sectional areas (equation 8.4);
arithmetic means are indicated in red.

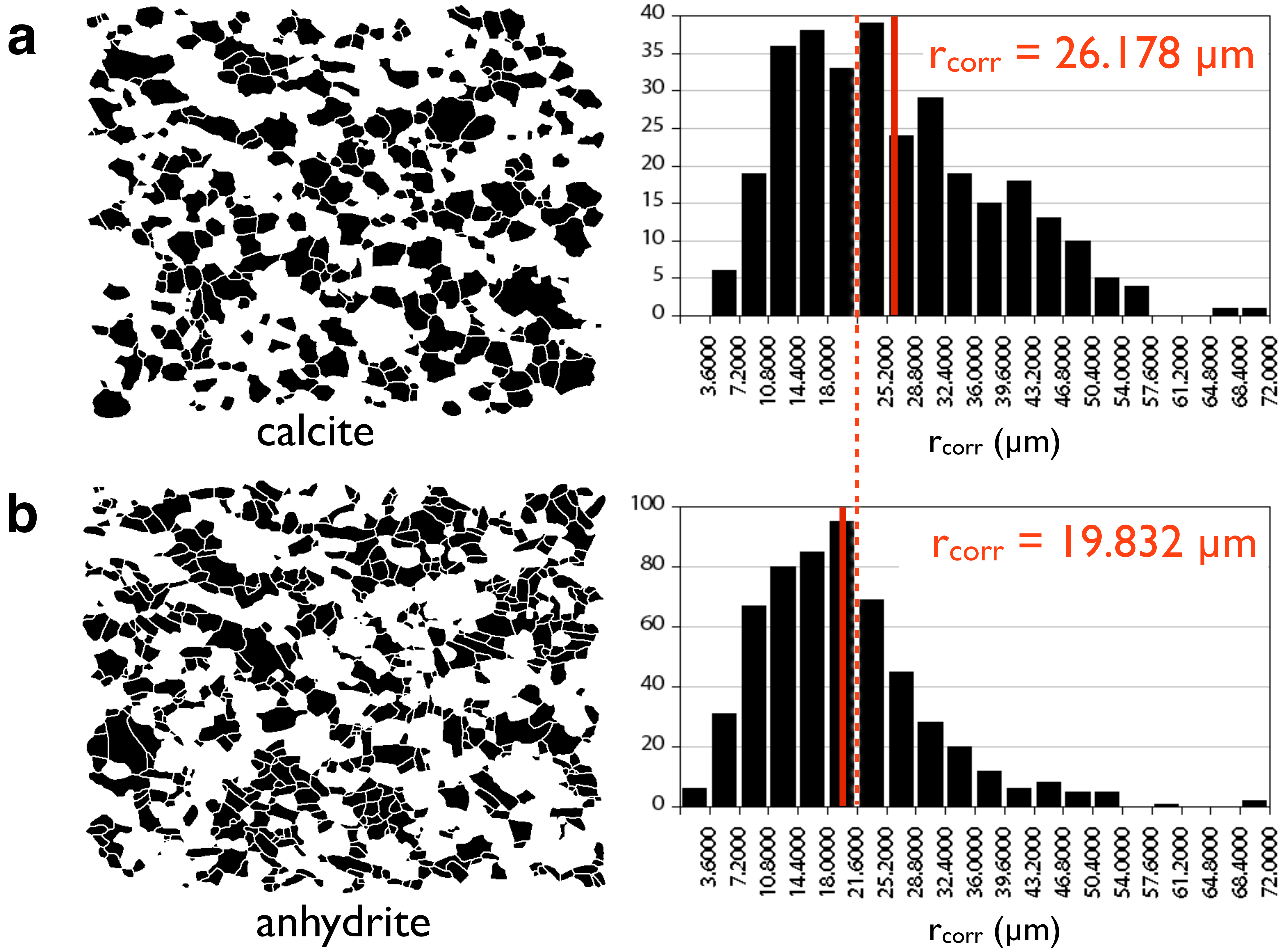

Figure 11.8
Grain size analysis of calcite and anhydrite in 50:50 mixture.
(a) Grain map and histogram of corrected radii, r_{corr}, for calcite;
(b) grain map and histogram of corrected radii, r_{corr}, for anhydrite;
solid red lines = arithmetic means; stippled line = mean for (calcite+anhydrite) (from Figure 11.7.f).

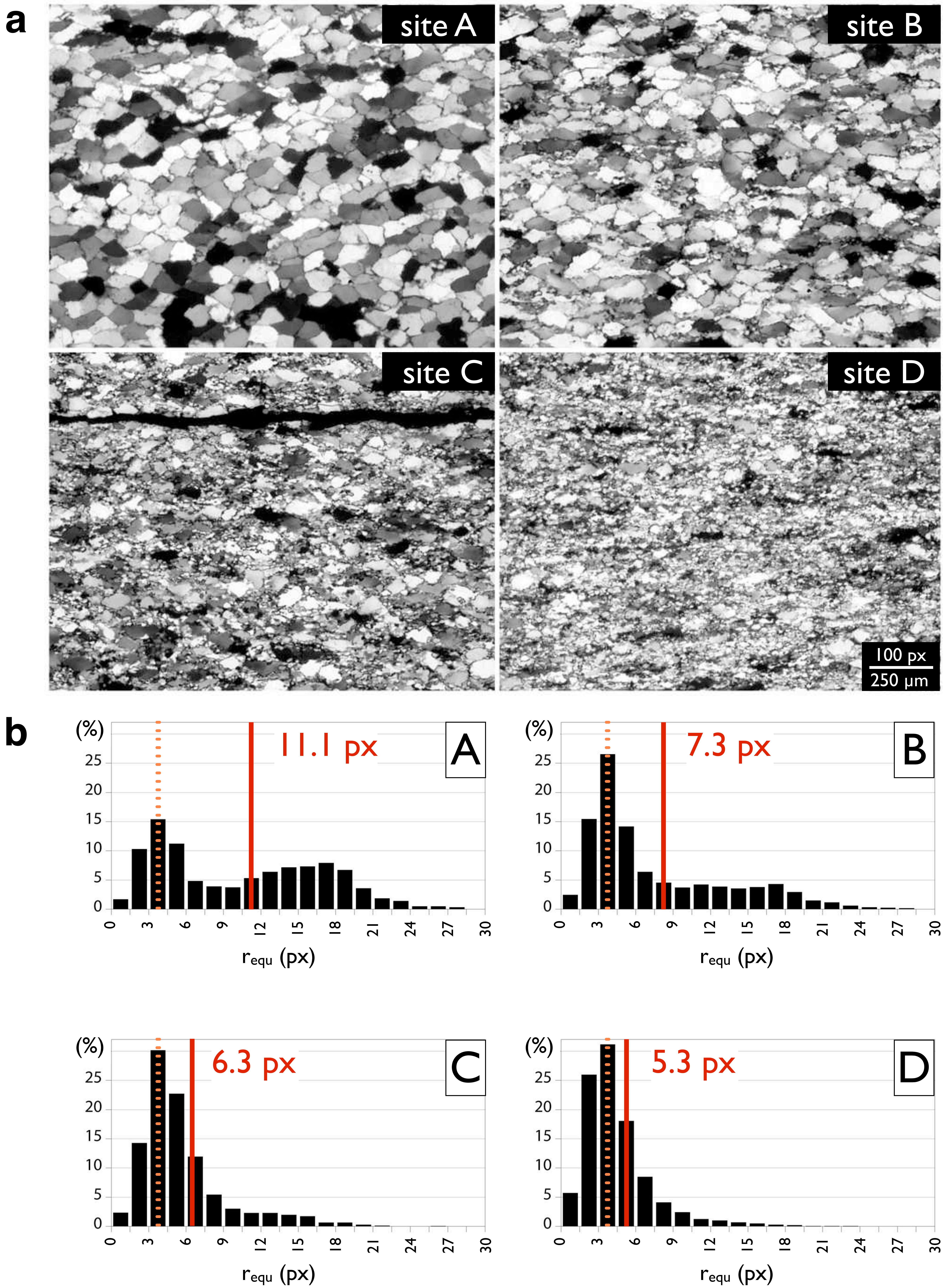

Figure 11.9
Grain size analysis of dynamically recrystallized quartzite.
(a) Micrographs (circular polarization) showing sites of increasing recrystallization: A ~10 %, B ~25 %, C ~55 %, D ~75 %; scale applies to all (samples courtesy Jan Tullis); (b) histograms of equivalent radii, r_{equ}, for samples A to D; stippled lines = modal values; solid lines = mean values.

```
macro 'Grain size map by area           [A]';
var
  i,j,n,mean,mode,min,max, maxarea, number:integer;
  xx,yy,dummy:integer;
begin

PutMessage('Use grain map (=INVERSE grain boundary map)');
SetScale(0,'pixel');
ResetCounter;
SetCounter(0);
SetOptions('x-y center,area');
SetParticleSize(1,99999);
AnalyzeParticles('reset');
number:=rCount;
maxarea:=0;

for i:=1 to number do begin
if rarea[i] > maxarea then maxarea:=rarea[i];
end;
------------------------------------------------------------
maxarea:= GetNumber('area ? measured max (sq px = ',maxarea);

SetDensitySlice(1,250);
MakeBinary;

for i:= 1 to number do begin
xx:=Xi[i];
yy:=Yi[i];
AutoOutline(xx,yy);
Measure;
GetResults(n,mean,mode,min,max);
dummy:= 254*n/maxarea;
if dummy > 254 then dummy:=254;
SetForegroundColor(dummy);
if GetPixel(xx,yy) > 0 then Fill;
end;
------------------------------------------------------------
SetPalette('rainbow',0);
SelectAll;

end;
```

```
grain size map by area       [A]
grain size map by radius     [B]
```

```
maxrad:=sqrt(maxrad/3.14159);
maxrad:= GetNumber('radius ? measured max (px) = ',maxrad);

SetDensitySlice(1,250);
MakeBinary;

for i:= 1 to number do begin
xx:=Xi[i];
yy:=Yi[i];
AutoOutline(xx,yy);
Measure;
GetResults(n,mean,mode,min,max);
dummy:= 254*sqrt(n/3.14159)/maxrad;
if dummy > 254 then dummy:=254;
SetForegroundColor(dummy);
if GetPixel(xx,yy) > 0 then Fill;
end;
```

Software box 11.1
Lazy grain size map.

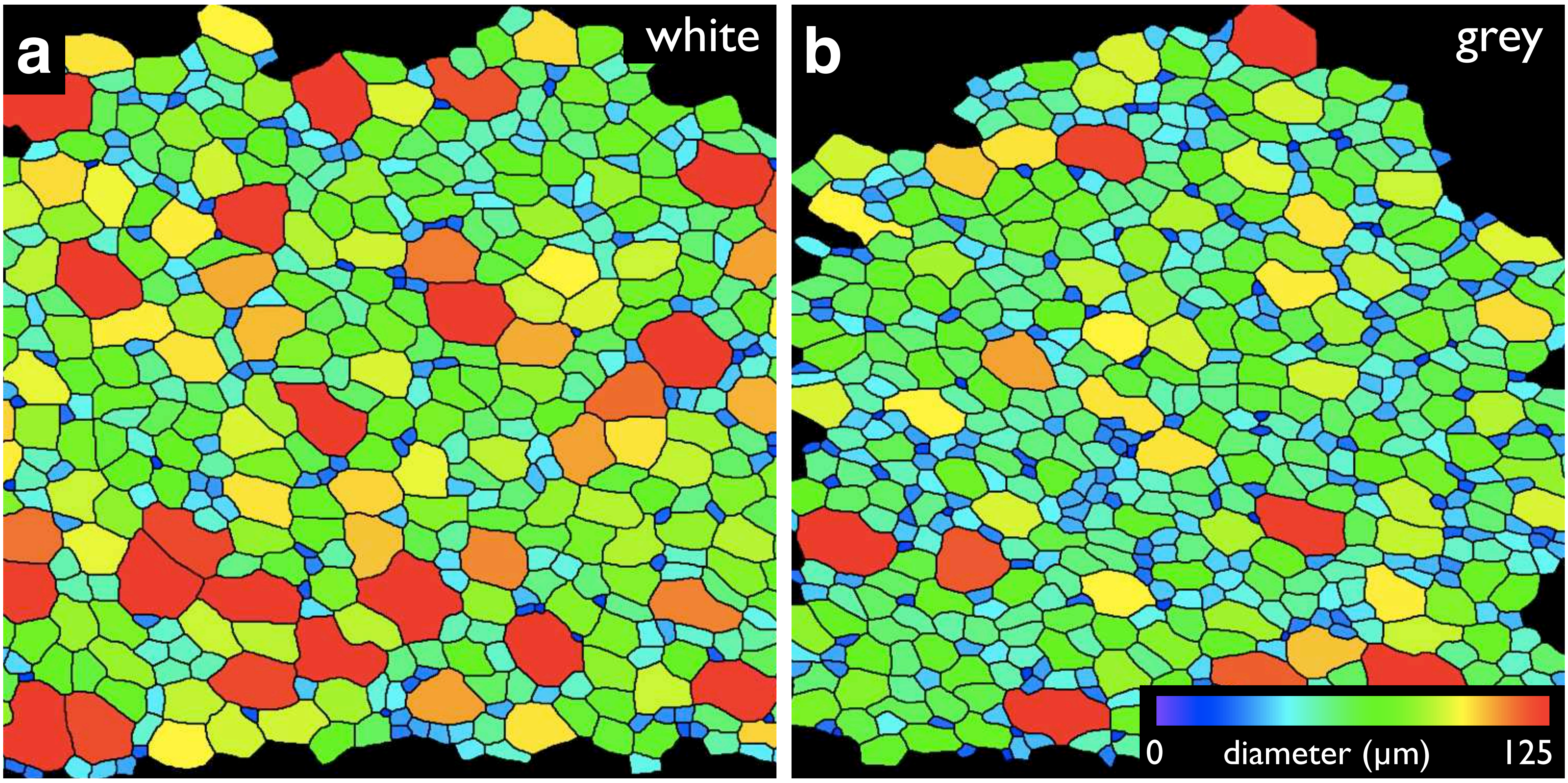

Figure 11.10
Grain size mapping for Carrara marble.
Grain maps of white and gray variety (from Figure 11.5) with cross sectional areas colored according to linear size, color code applies to both.
(a) Grain size map of white variety;
(b) grain size map of gray variety.

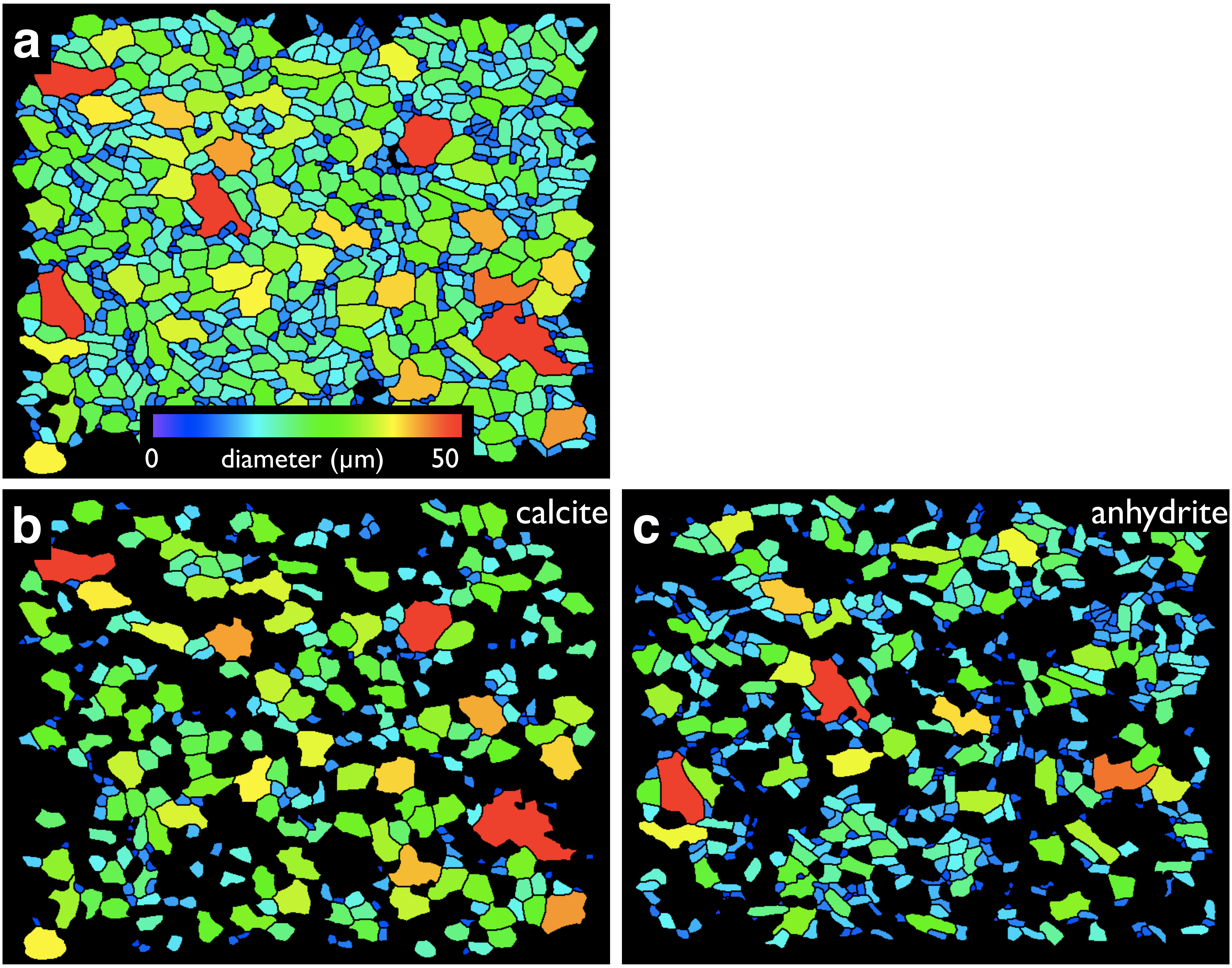

Figure 11.11
Grain size mapping for calcite - anhydrite mixture.
Cross sectional areas are colored according to size, color code applies to all.
(a) Grain size map of mixture (from Figure 11.7.a);
(b) grain size map of calcite;
(c) grain size map for anhydrite.

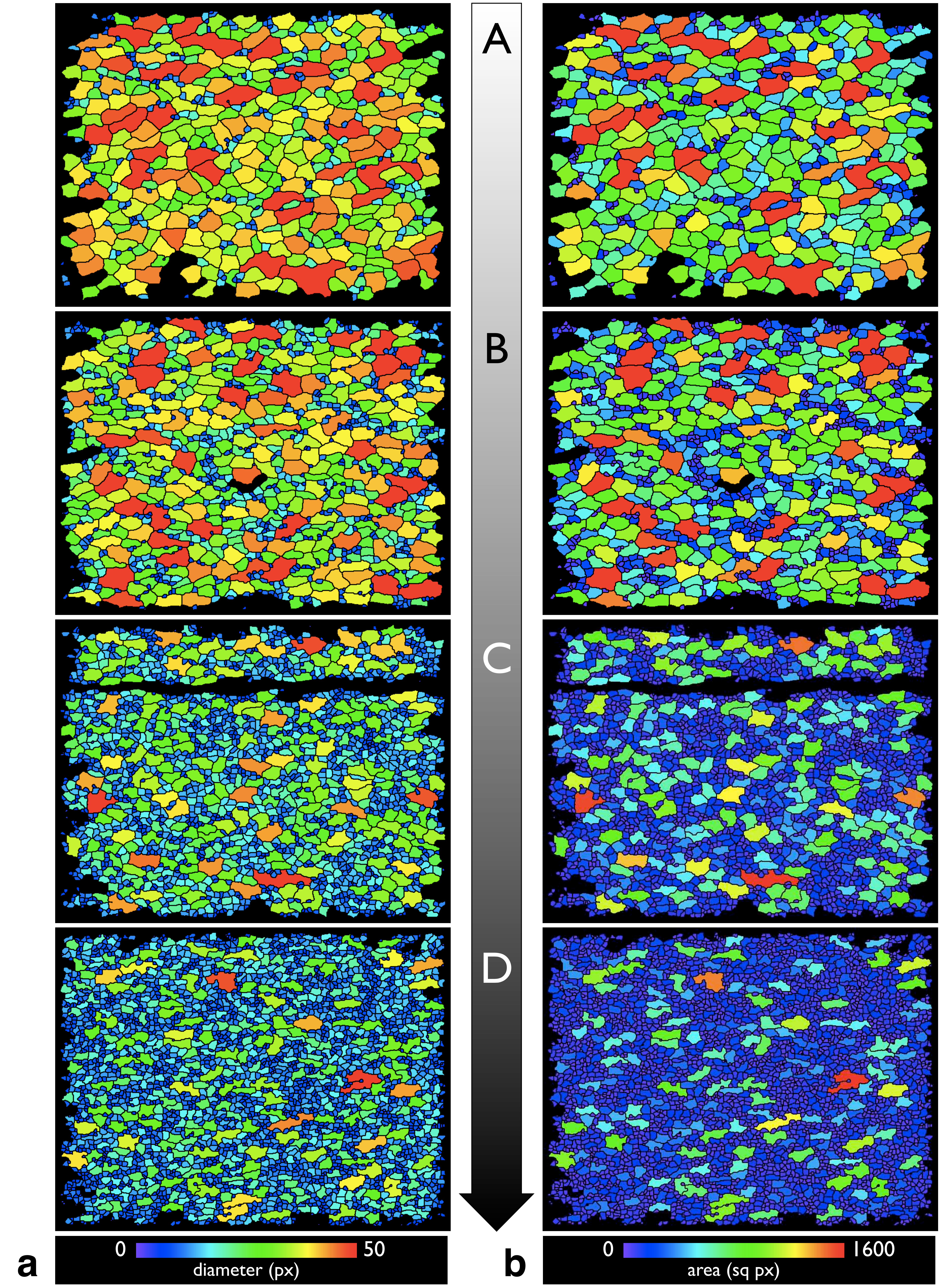

Figure 11.12
Grain size mapping.
Sample sites A to D correspond to (a) to (d) in Figure 11.9;
(a) linear scale for diameter (pixels); (b) linear scale for area (square pixels).