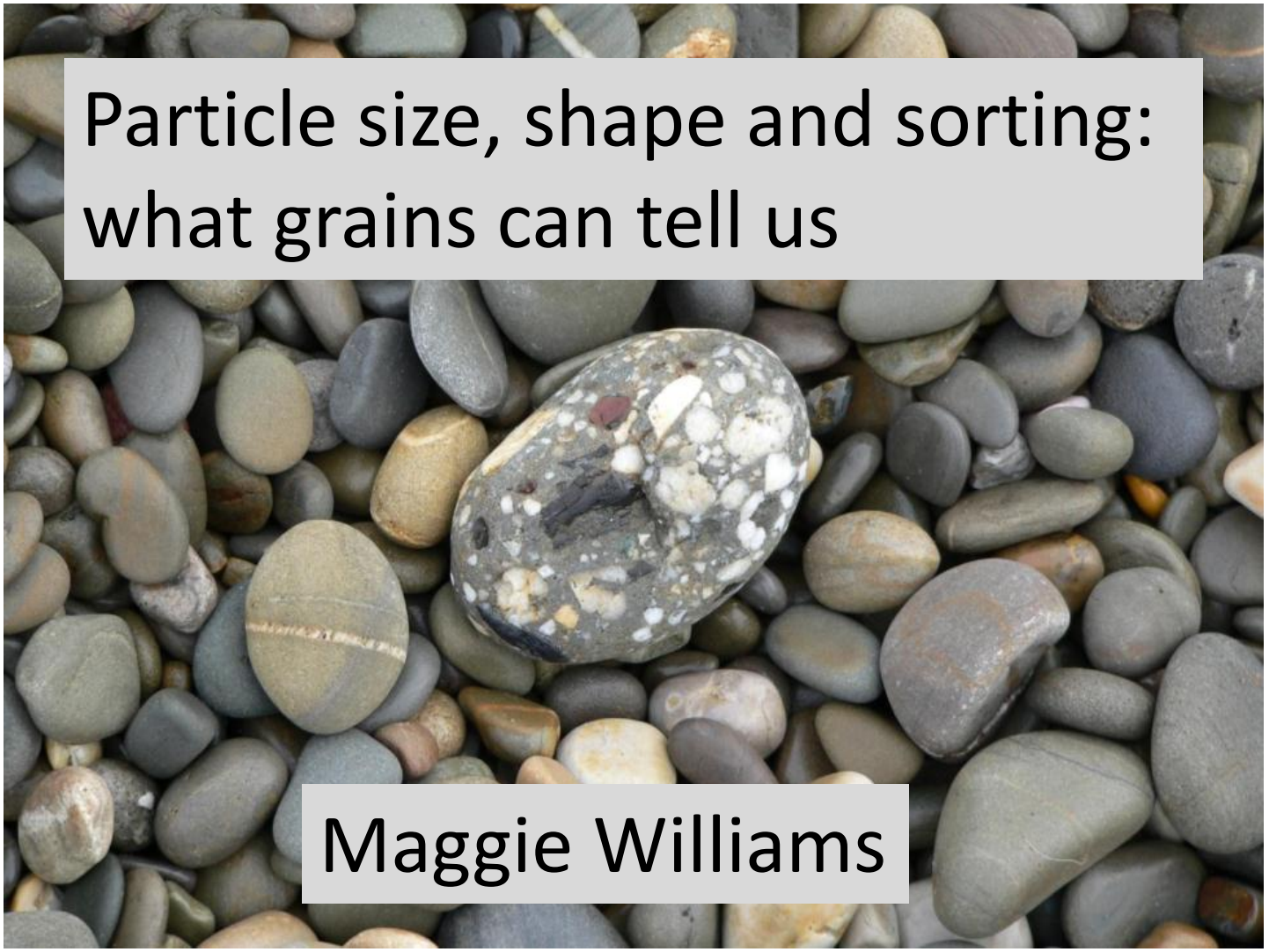


Particle size, shape and sorting: what grains can tell us

Maggie Williams

Most sediments contain particles that have a range of sizes, so the mean or average grain size is used in description.

The Wentworth-Udden grade scale for clastic sediments.
Particle diameters in mm are correlated with the ϕ scale. Sediment and rock names are shown.
What names are given to clastic rocks with the following grain sizes: 6ϕ; 1.5ϕ; 3ϕ; 77mm; 0.1mm?

ϕ values	Particle diameter (mm diam.)	Wentworth grades	Rock name
-8	256	Boulders	Conglomerate
-6	64	Cobbles	
-2	4	Pebbles	
-1	2	Granules	Granulestone
0	1	Very coarse sand	Sandstone
1	0.5	Coarse sand	
2	0.25	Medium sand	
3	0.125	Fine sand	
4	0.0625	Very fine sand	
8	0.0039	Silt	Siltstone
		Clay	Claystone

Mean grain size of loose sediments is measured by size analysis using sieves

Grain size

>2mm Coarse grain size (Granules<pebble<cobbles<boulders)

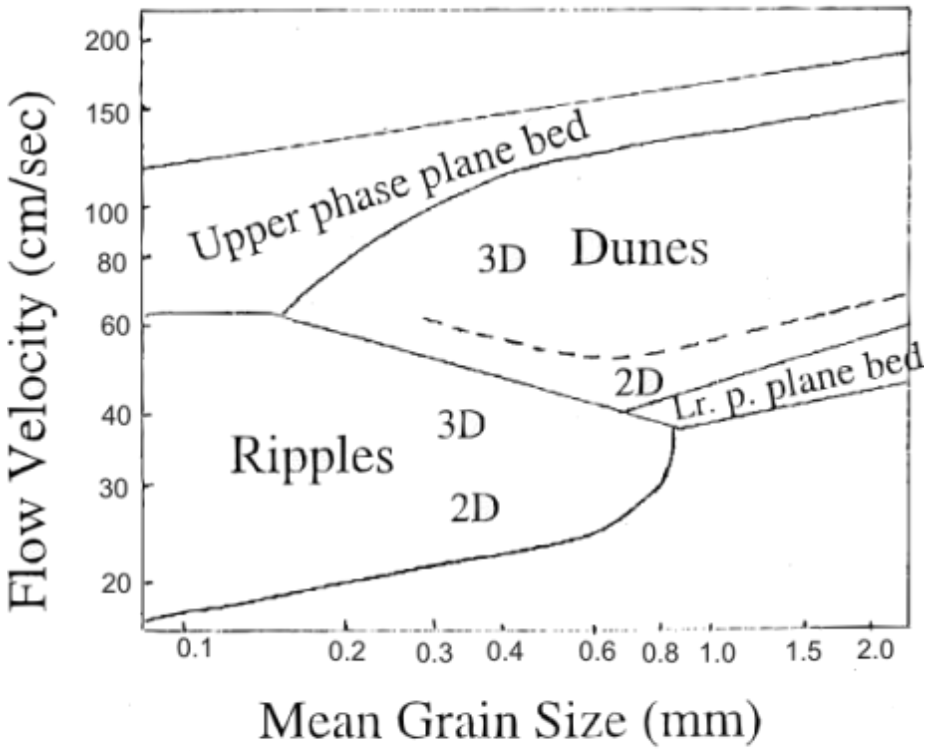
0.06 to 2mm Medium grain size Sand: very coarse-coarse-medium-fine-very fine)

<0.06mm Fine grain size (Clay<silt) Difficult to see

Remember that for sediment sizes > fine sand, the coarser the material
the greater the flow velocity needed to erode, transport & deposit the grains

Bedform Phase Diagram - for unidirectional flow

Relates mean flow velocity, grain size and occurrence of different bedforms



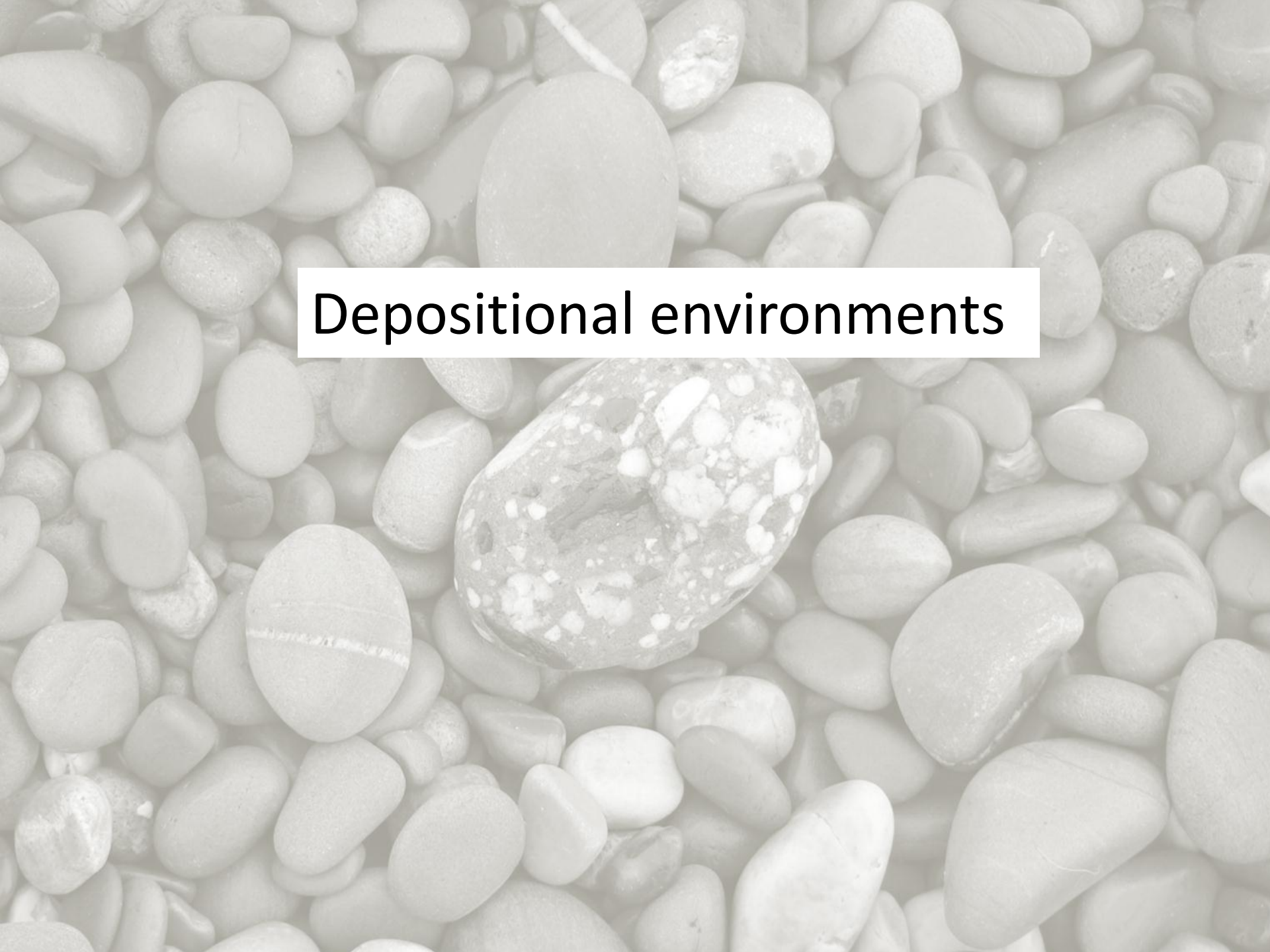
2D - straight
3D linguoid (ripples)
lunate (dunes)

Are the grains the same size of different?

What does this tell you?

If grains are the **same size** this tells you that the sediment was sorted out during longer transportation (perhaps moved a long distance by a river or for a long time by the sea.

If grains are of **different sizes** the sediment was probably deposited close to its source or deposited quickly (e.g. by a flood or from meltwater).

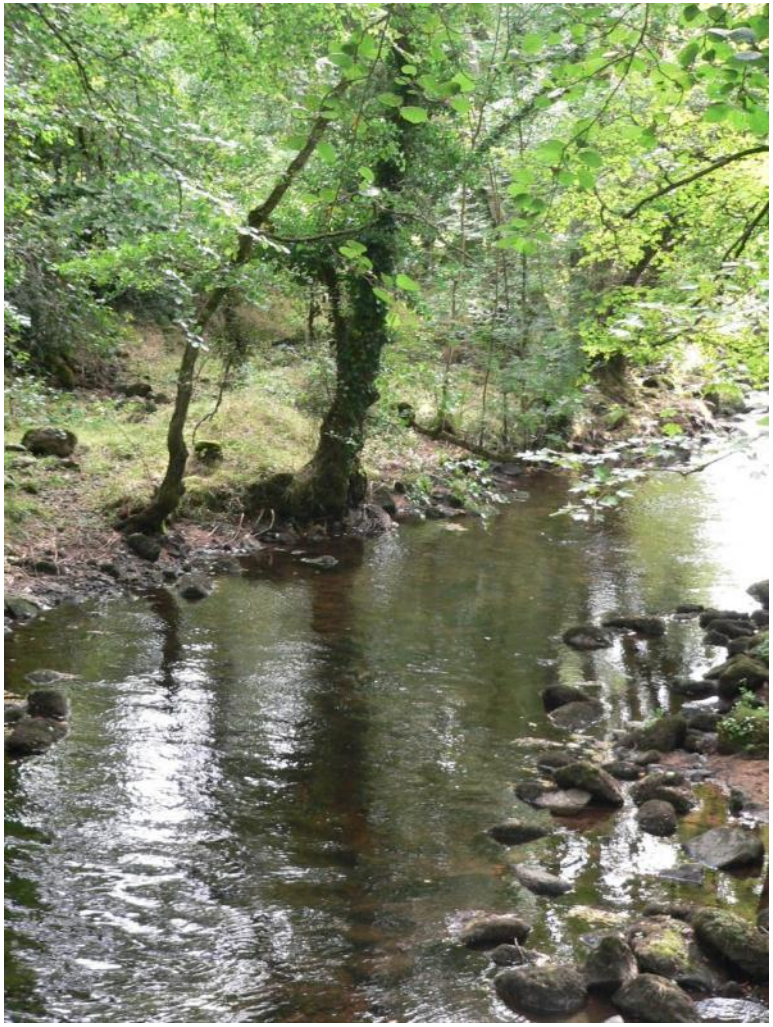


Depositional environments

Environment 1

Environment 2

Environment 3



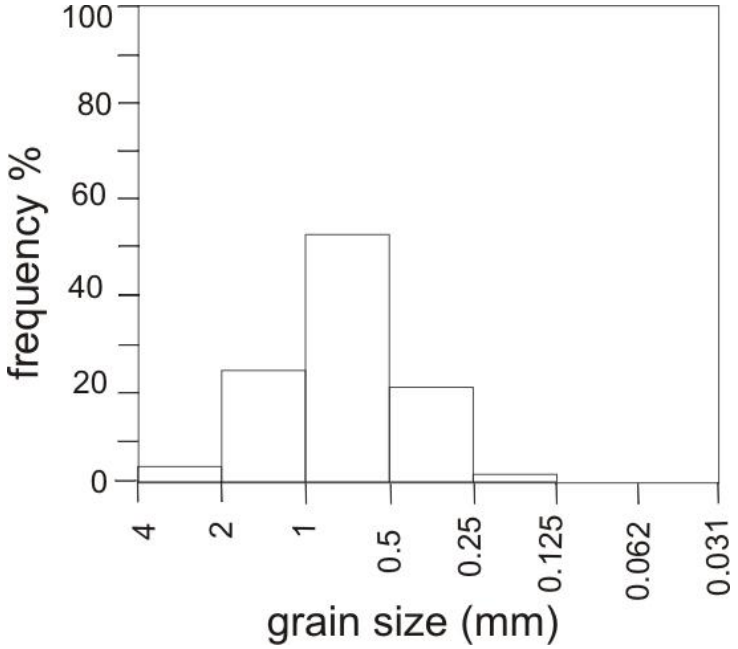
Environment 4

Environment 5

Environment 6

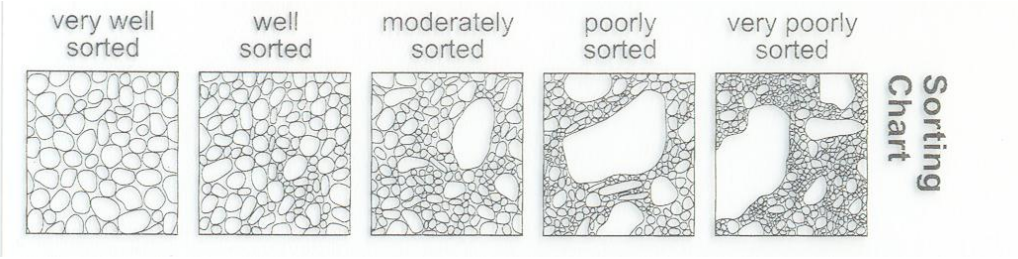
Sediment size frequency plots from different depositional environments

- When loose sediment collected from a sedimentary environment is washed and then sieved it is possible to measure the grain sizes in the sediment accurately.
- The grain size distribution may then be plotted as a histogram or as a cumulative frequency curve.
- Sediments from different depositional environments give different sediment size frequency plots.



This shows the grain size distribution for a **river sand**.
This sand is described as fairly well sorted.

Grain sorting



What is sorting?
Very well-sorted sediments - grains all the same size

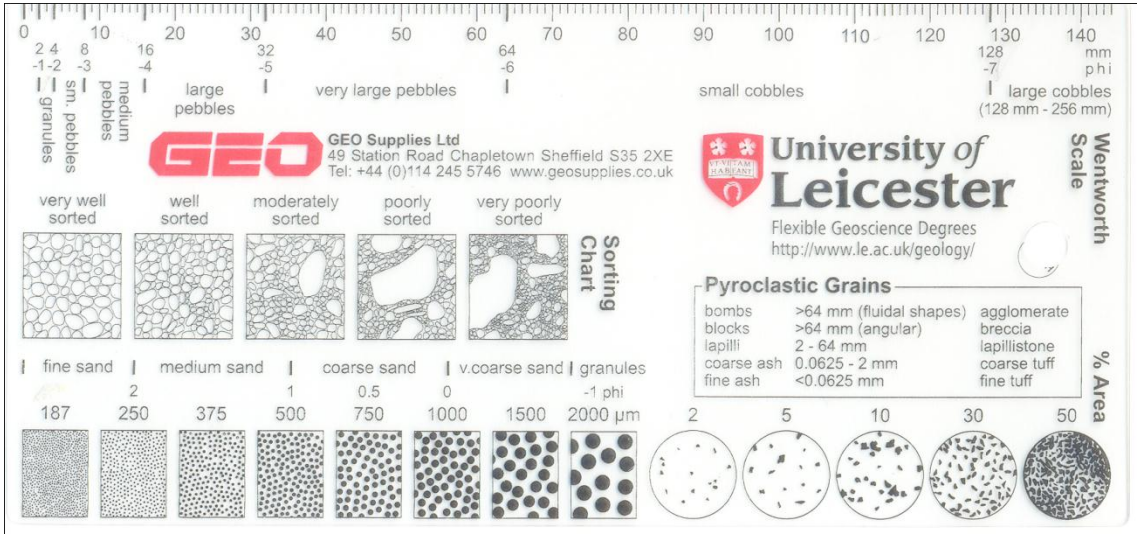
Very poorly-sorted sediments - grains with a wide range of sizes

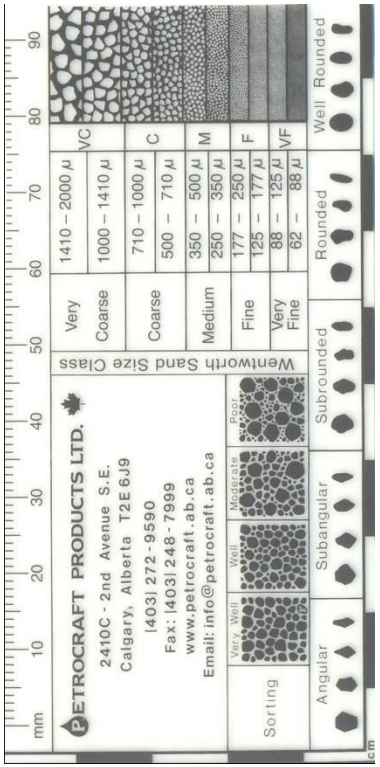
What does sorting tell you?
Generally, sediment sorting improves along the sediment transport path.

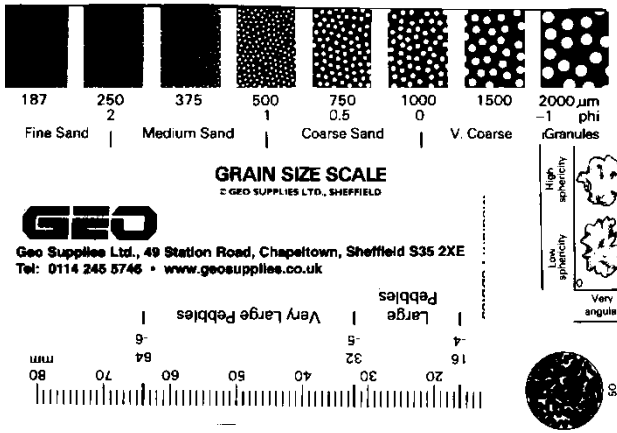
Poorly sorted sediments were usually deposited quickly (e.g. in storm beds or from flows/mudflows. Better sorted sediments may have been reworked by wind or water. (e.g. Sand deposits on beaches, in shallow seas or in deserts)

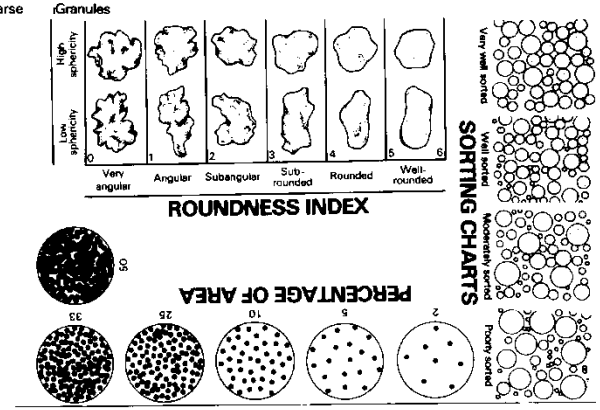
Studying sedimentary rocks

Mean grain size and sorting - more difficult to analyse in consolidated sedimentary rocks

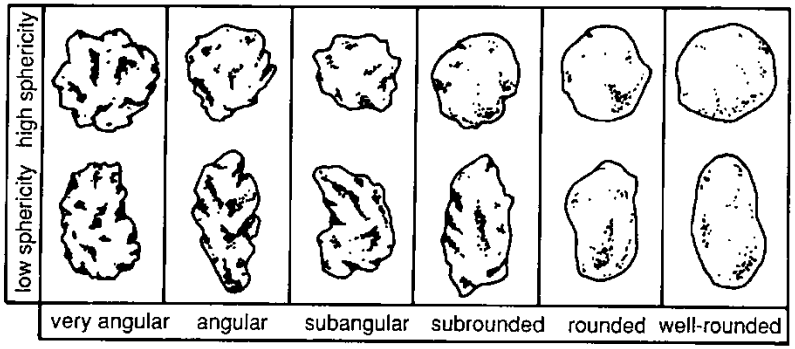








Grain shape



What does high or low sphericity tell you?
Not much! Sphericity of grains mainly depends on the physical properties of the source material. (Sphericity is little changed by transport)

What does the degree of rounding tell you?
Generally – the more rounded the grains are the more they have been moved around (i.e. the longer the length of time or distance they have moved). Angular grains cannot have travelled far.

1. For each of the following four rocks:

a) describe the grain size and sorting of the grains,

b) name the rock.

Rock A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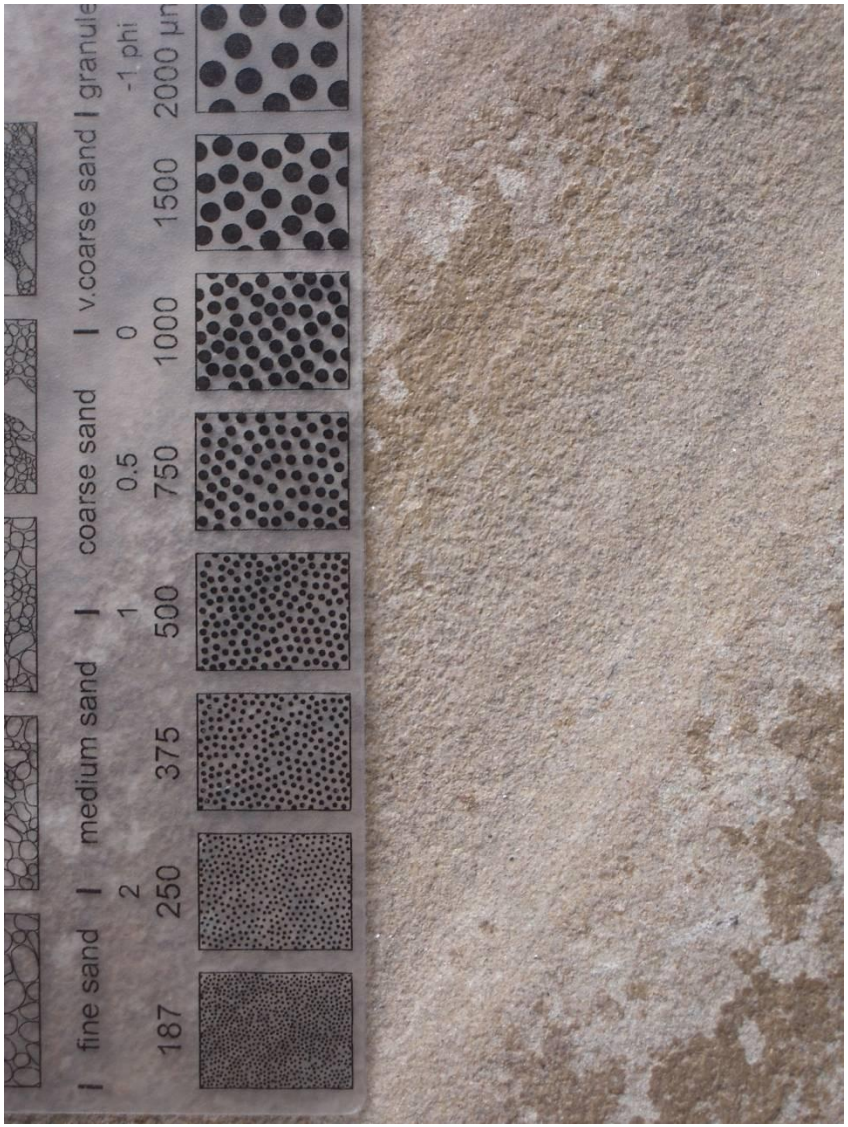
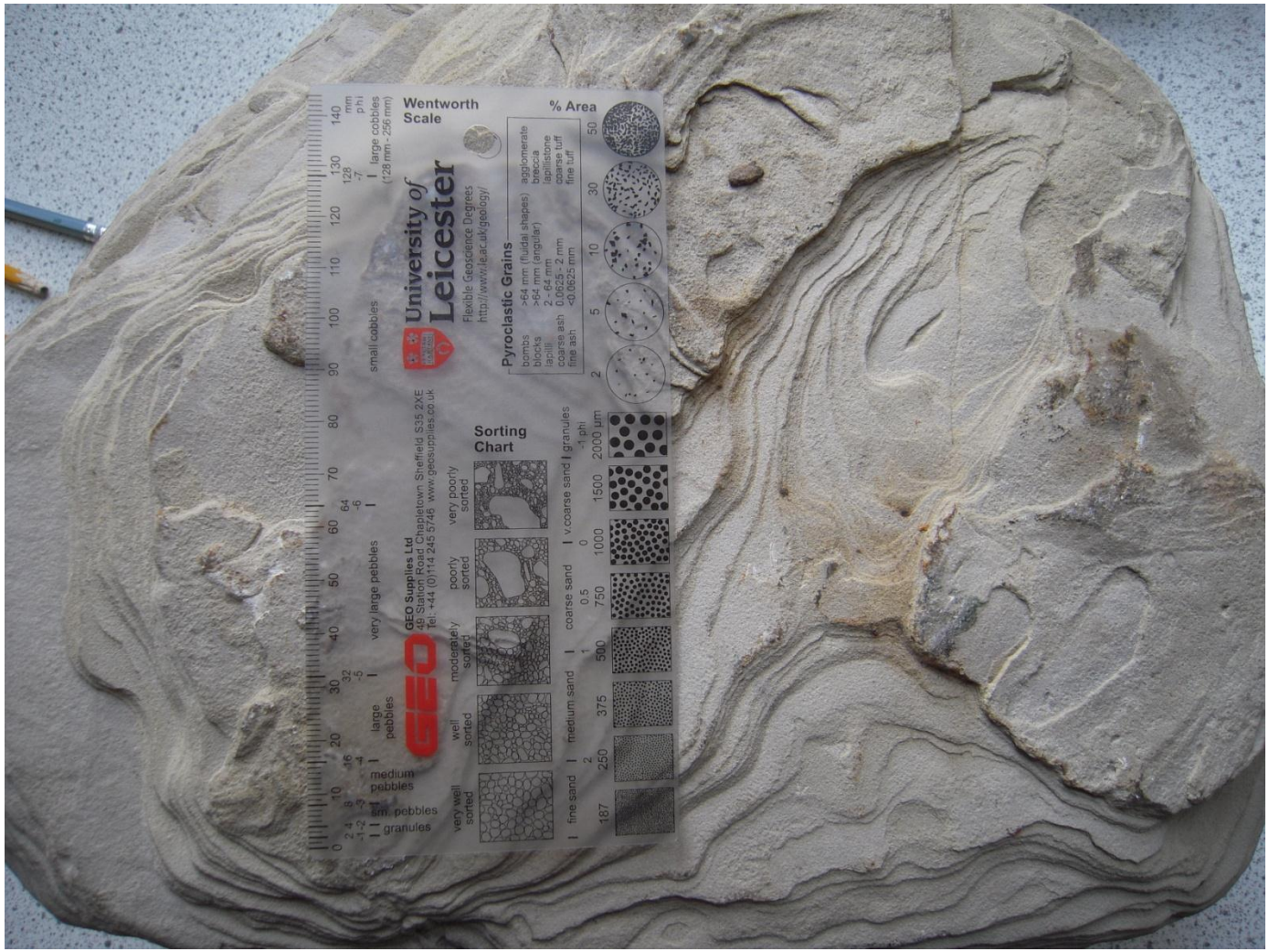
Wentworth Scale
% Area
Sorting Chart
very well sorted
well sorted
moderately sorted
poorly sorted
very poorly sorted
fine sand
medium sand
coarse sand
v.coarse sand
granules
small cobbles
large cobbles
very large pebbles
large pebbles
medium pebbles
sm. pebbles
granules
Pyroclastic Grains
bombs
blocks
lapilli
coarse ash
fine ash
agglomerate
breccia
coarse tuff
fine tuff

Detail of rock A



Rock B


Wentworth Scale
% Area
University of Leicester
Flexible Geoscience Degrees
http://www.le.ac.uk/geology/
Pyroclastic Grains
bombs
blocks
lapilli
coarse ash
fine ash
>64 mm (fluidal shapes)
>64 mm (angular)
2-64 mm
0.0625 - 2 mm
<0.0625 mm
agglomerate
breccia
lapillistone
coarse tuff
fine tuff
GEO Supplies Ltd
Sorting Chart
very well sorted
well sorted
moderately sorted
poorly sorted
very poorly sorted
very large pebbles
large pebbles
medium pebbles
sm. pebbles
granules
small cobbles
large cobbles
fine sand
medium sand
coarse sand
v.coarse sand
granules

Detail of rock B

Rock C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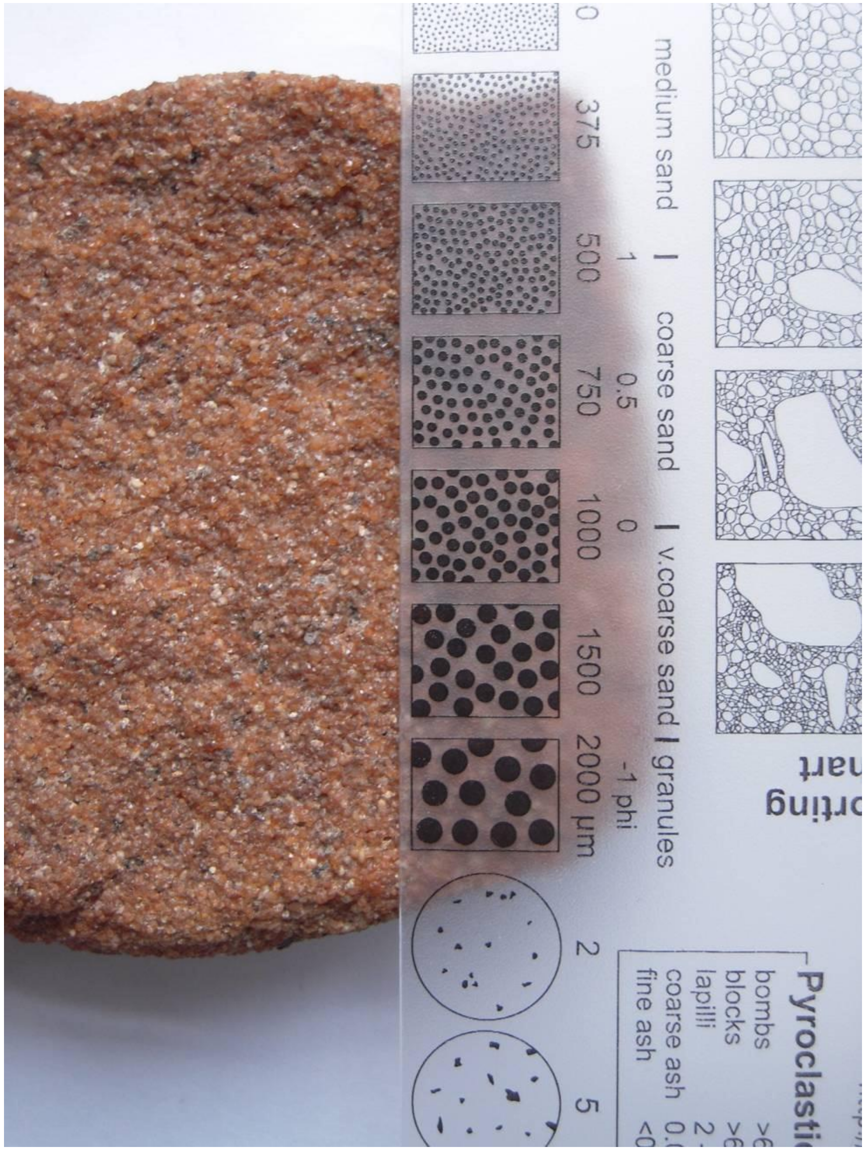
Wentworth Scale
Sorting Chart
Pyroclastic Grains
% Area

Detail of rock C



Rock D


Wentworth Scale
University of Leicester
Flexible Geoscience Degrees
http://www.le.ac.uk/geology/
Pyroclastic Grains
bombs >64 mm (fluidal shapes) agglomerate
blocks >64 mm (angular) breccia
lapilli 2 - 64 mm lapillistone
coarse ash 0.0625 - 2 mm coarse tuff
fine ash <0.0625 mm fine tuff
% Area
50 30 10 5 2
Sorting Chart
very well sorted
well sorted
moderately sorted
poorly sorted
very poorly sorted
fine sand | medium sand | coarse sand | v.coarse sand | granules
187 250 375 500 750 1000 1500 2000 µm
2 1 0.5 0 -1 phi
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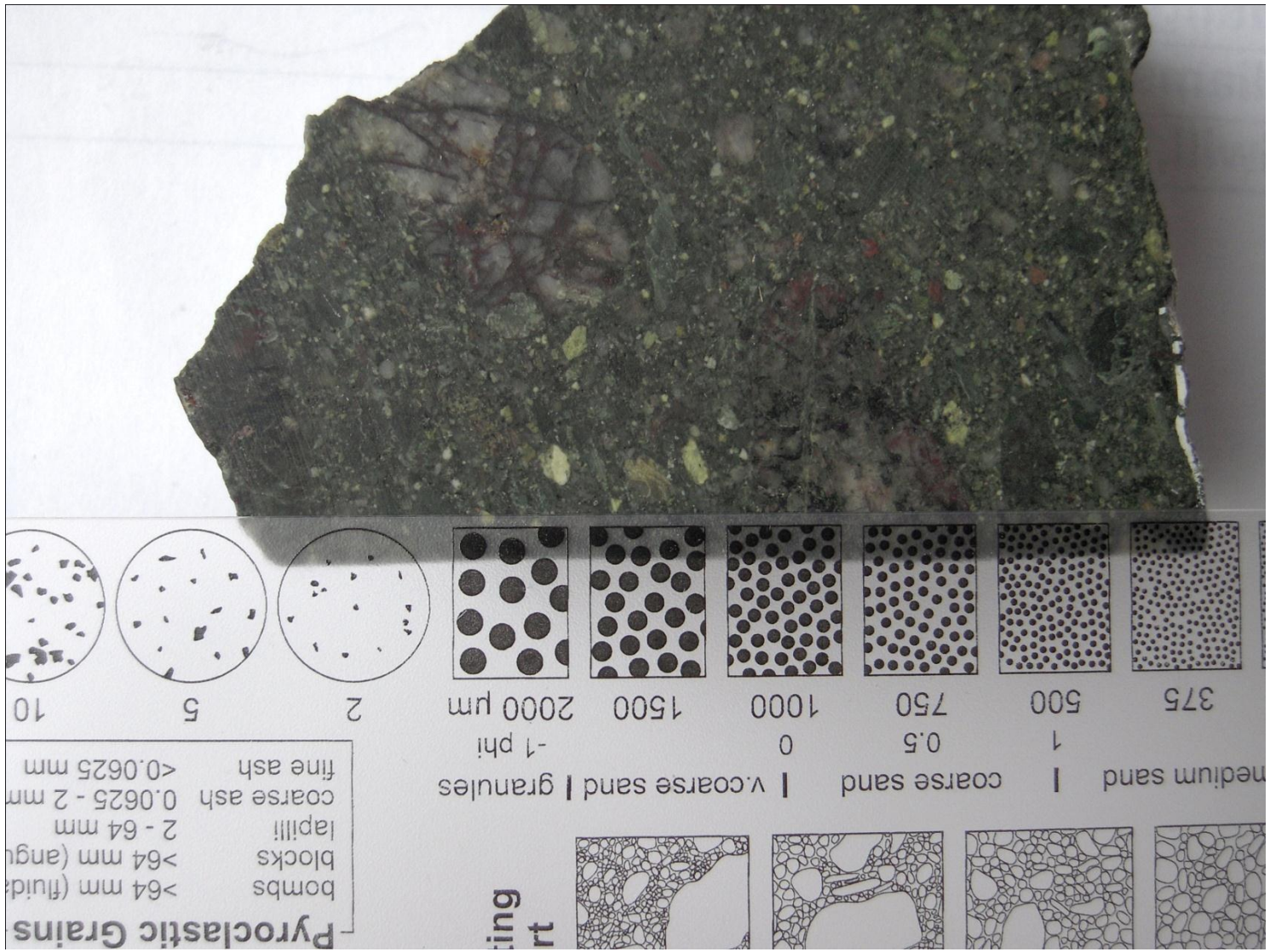
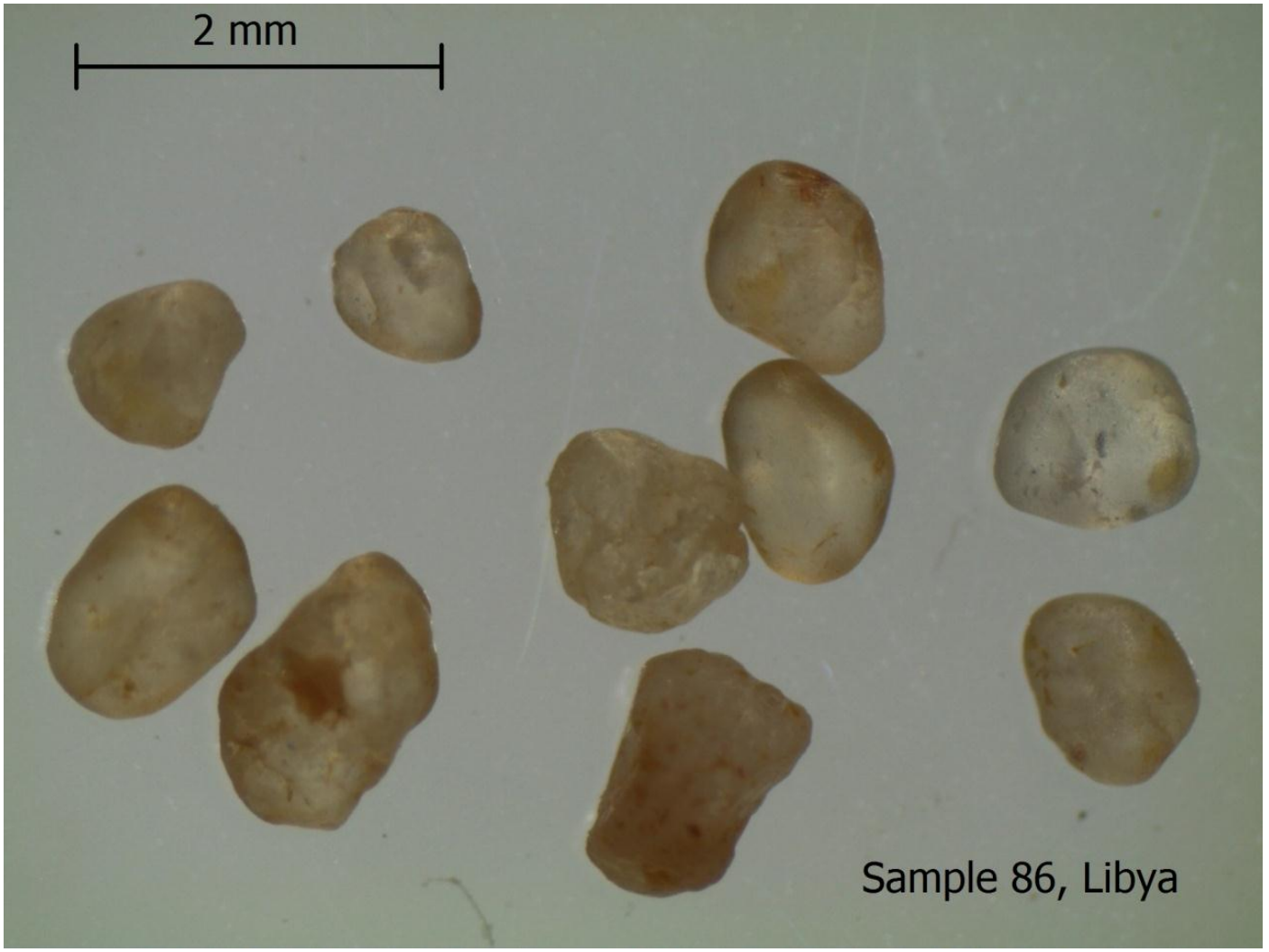
pebbles
(128 mm - 256 mm)

Detail of rock D

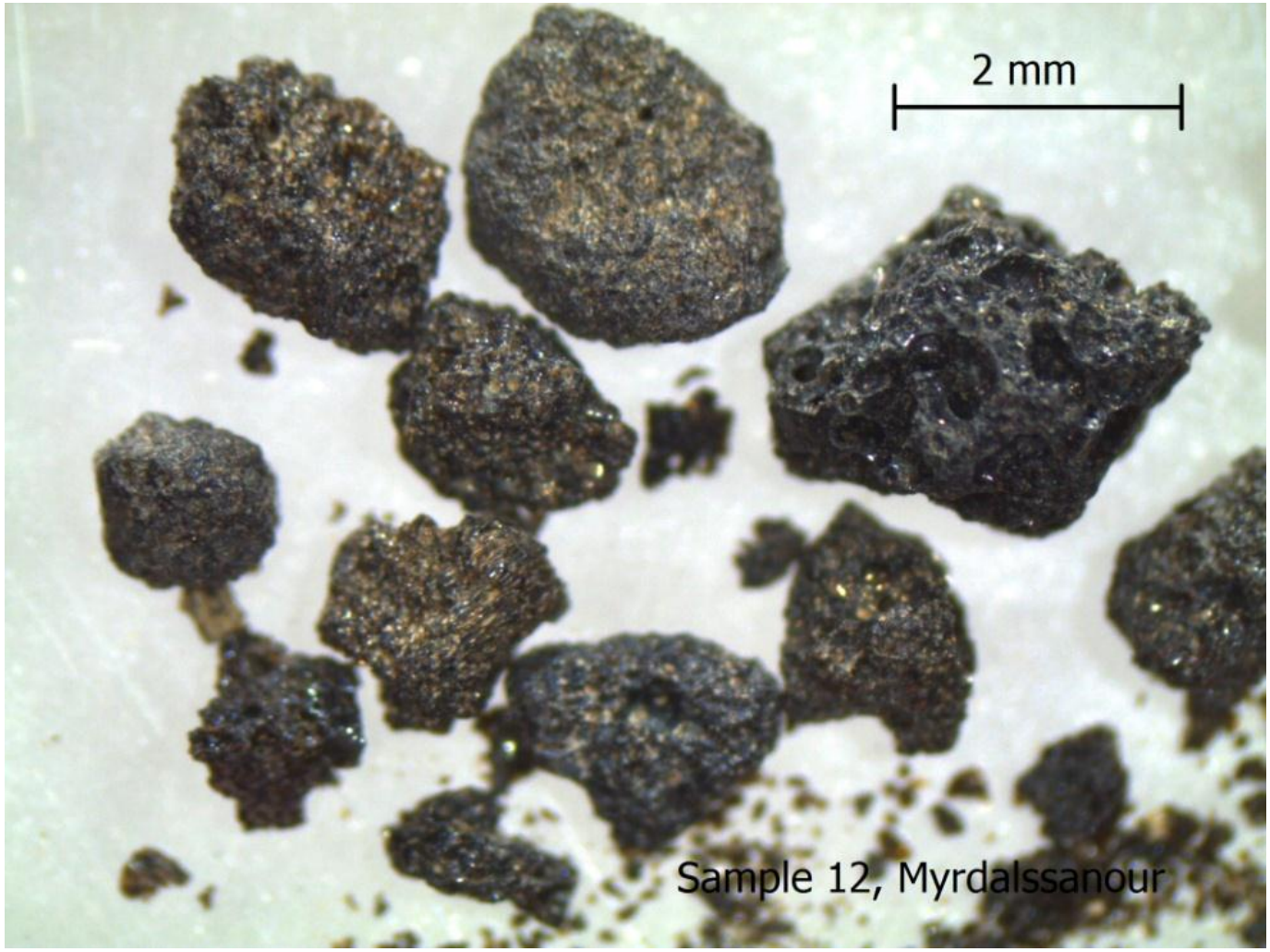


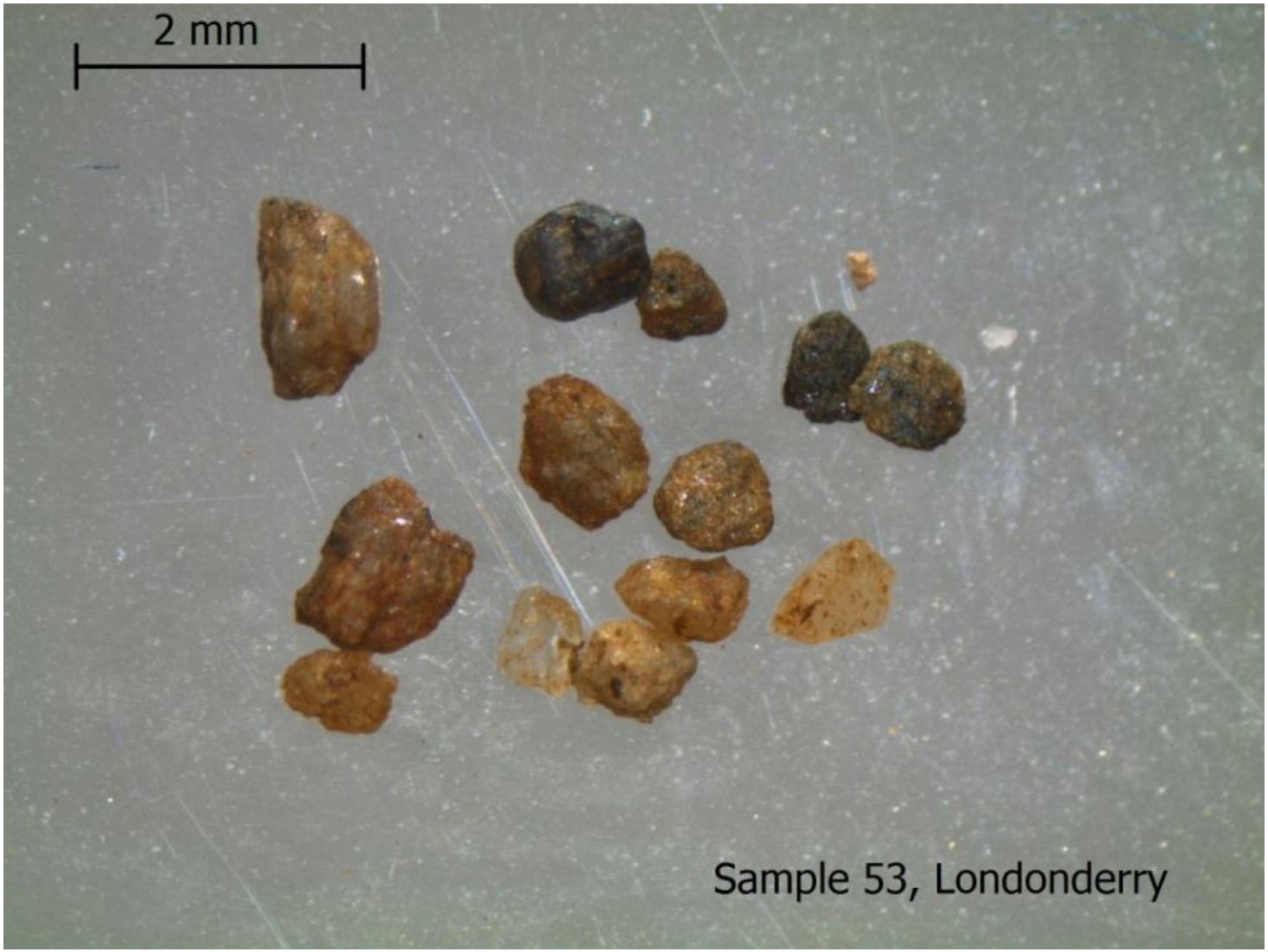
2. For each of the following sediments describe the :

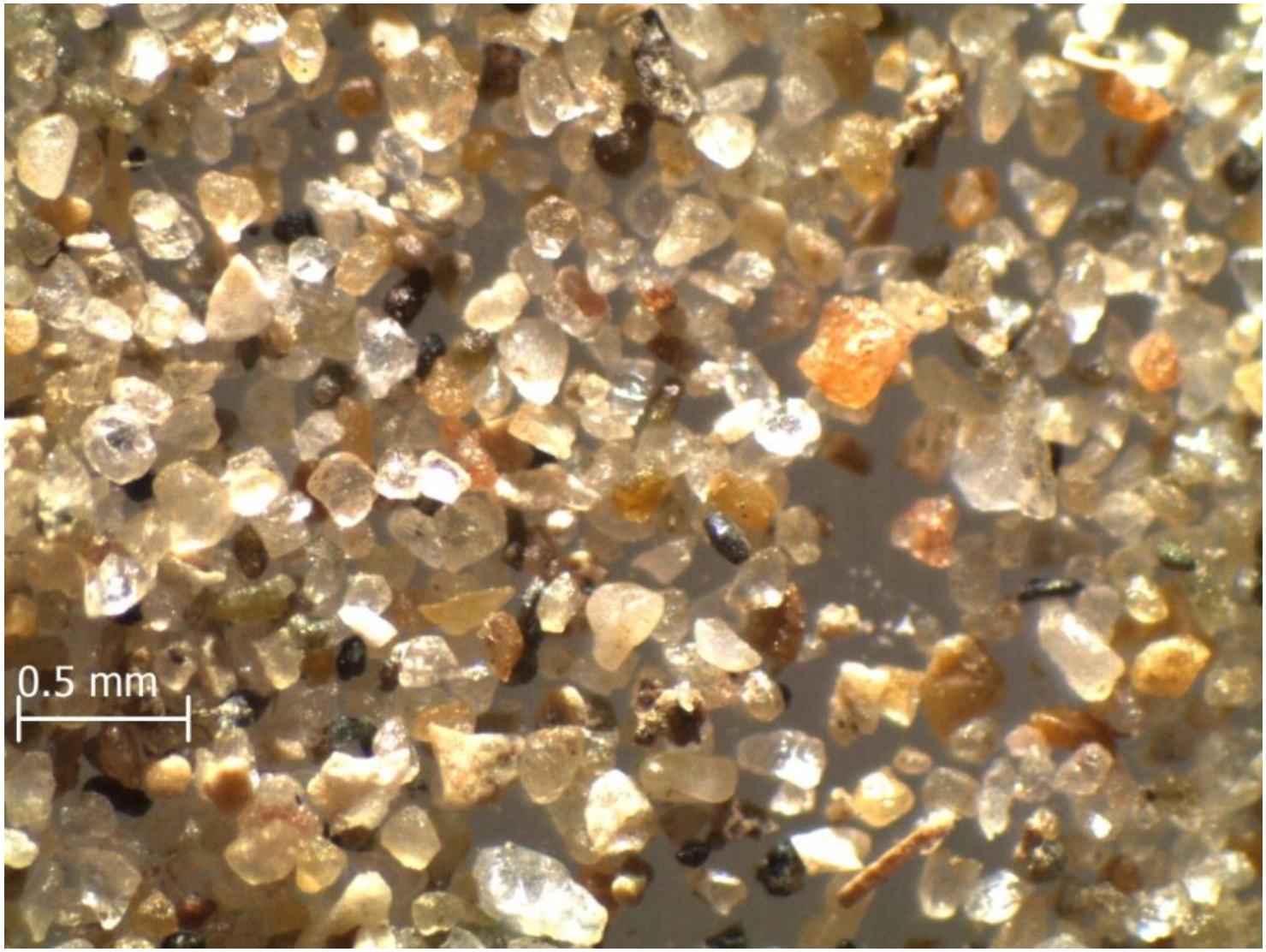
a) **grain size,**
b) **grain sorting,**
c) **rounding of the grains.**


2 mm
Sample 86, Libya


2 mm
Sample 13, Skegness


2 mm
Sample 12, Myrdalssanour


2 mm
Sample 53, Londonderry

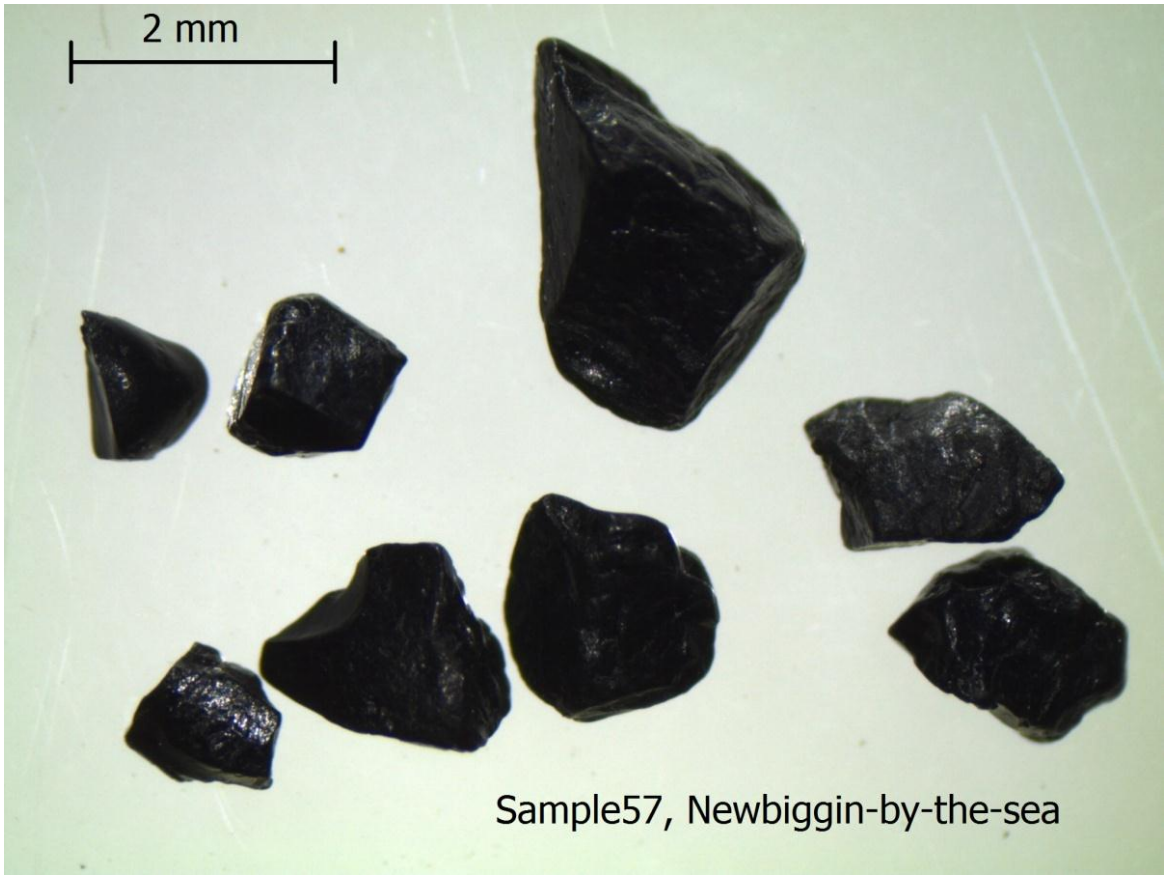


Sample 2, Towy

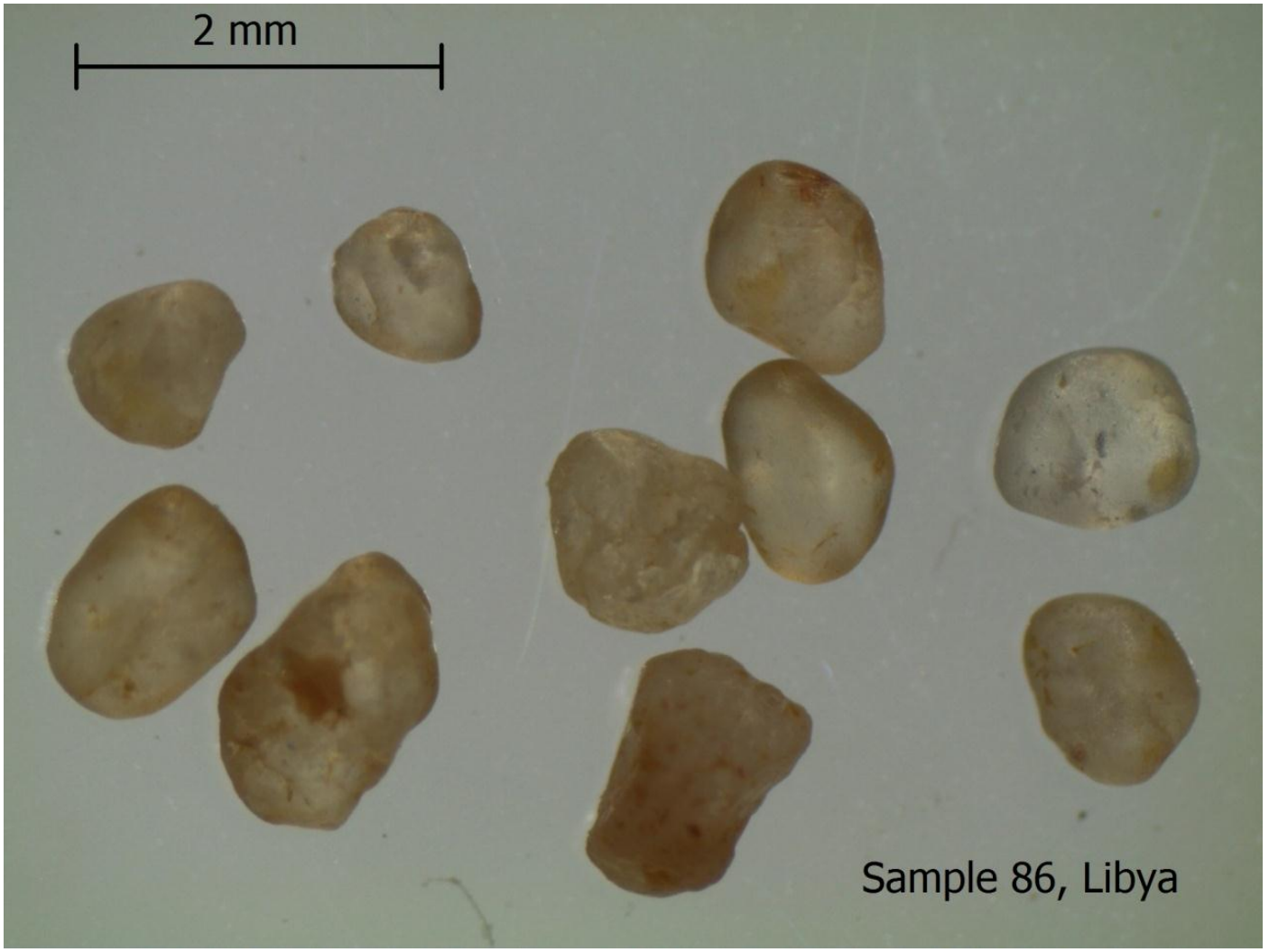
Sample 10, Flamborough Head

3. Which of the following sediment samples contains:

a) **only quartz grains,**
b) **mostly rock fragments (lithic grains)**
c) **mostly skeletal remains?**


2 mm
Sample57, Newbiggin-by-the-sea

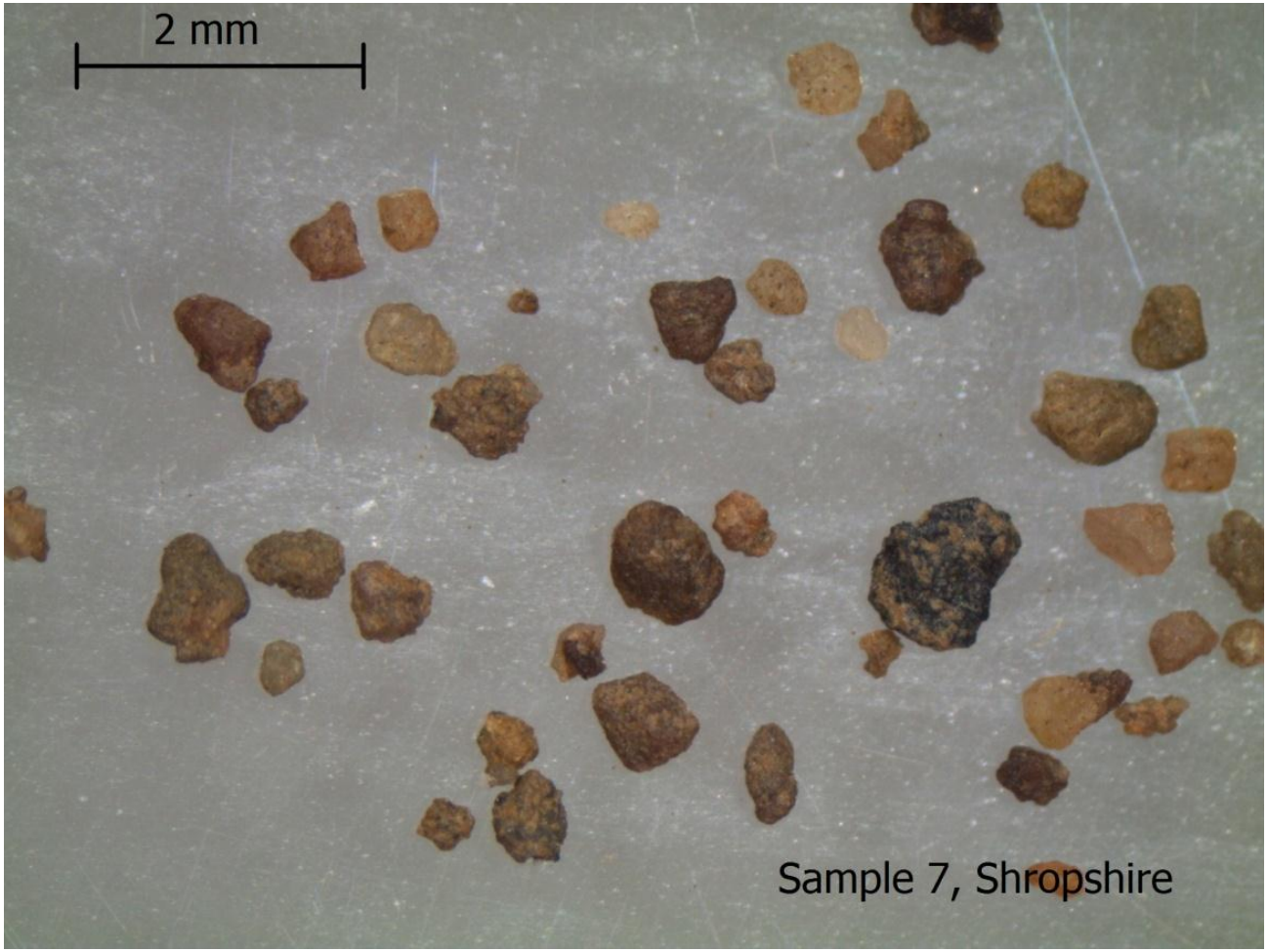

2 mm
Sample 50, Bahamas


2 mm
Sample 86, Libya

4. For the following four slides answer the question given on each slide.

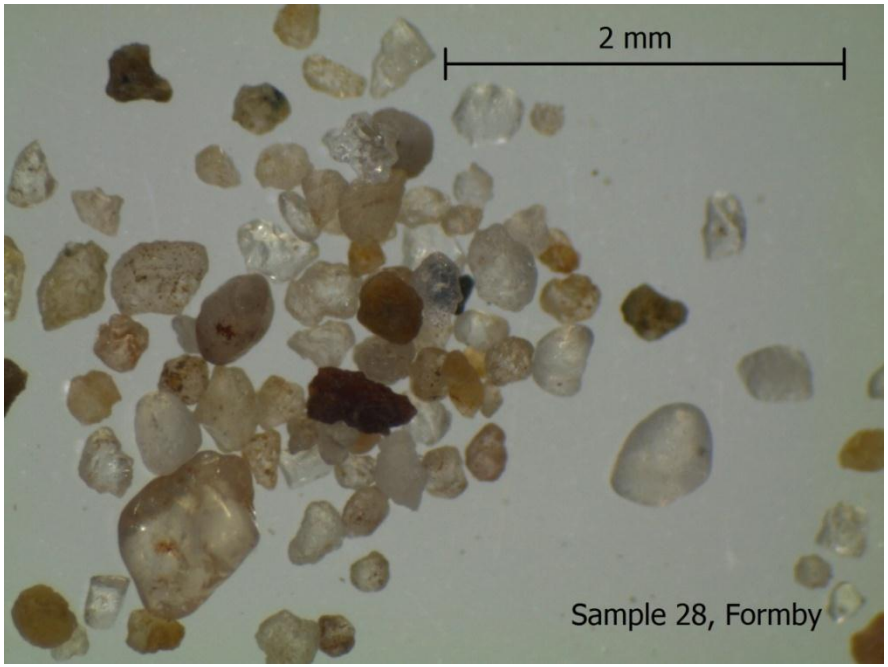
Sample 1

This sediment was collected from the beach at Vik, Island.
What evidence does it show that has been reworked by water?



This sediment was collected on the banks of the River Severn in Shropshire.
What evidence does it show that it was not transported a long distance?

Which of these two sediment samples shows evidence that it was probably deposited as a glacial outwash deposit? Give reasons for your answer.



Which of these two sediment samples was most likely to have been deposited as a wind-blown beach sand? Give a reason for your answer.