

Sedimentary structures - graded bedding

Make your own graded bed – one depositional event, but with coarse to fine sediment

Some sediments are deposited in a “whoosh” from a current which is carrying a wide range of particle sizes. This can also happen when an explosive volcanic eruption ejects ash and “volcanic blocks” into the air, which then settle out in water. In each case, a bed is produced in which there is a gradual reduction in particle size from the base upwards, called graded bedding. This can be demonstrated as follows:

Prepare an empty coffee jar in advance by filling it about one third full of mixed sediment, topping up with water and then screwing on the lid tightly.

1. Swirl the jar vigorously until all the sediment is in suspension, then quickly stop it swirling. Ask pupils to observe the outcome and describe what they have seen and perhaps record it with their own photograph (Photograph 1) Repeat the activity, but now ask the pupils to time how long it takes for each fraction to settle, e.g. granules (i.e. particles of 2-4 mm diameter), coarse sand and finer sand. (It may take hours for all the mud to settle, but pupils will not need to watch continuously for this to happen!)
2. Now shake the jar up vigorously and then put it down quickly. Ask pupils to observe what happens this time: they will see that a bed has formed that is coarser at the bottom, becoming finer upwards, exactly like the last one. However this time the graded bed has formed by deposition from still water. Pupils could measure how long it takes for each fraction to settle this time too.

Ask pupils where, in the natural world, they would expect to see a large quantity of mixed sediment deposited so rapidly that there was no time for separate beds to form:

1. from a slowing current (*A. Graded beds like these are formed when turbidity currents flowing across ocean floors slow down and deposit sediment*).
2. in still water (*A. Graded beds form in still water after volcanic eruptions when mixed debris is erupted into the air and then settles through water*).



Photo 1: A coffee jar of mixed sediment after shaking and allowing to settle. (Photo: Peter Kennett)

The back up

Title: Sedimentary structures 1 – graded bedding

Subtitle: Make your own graded bed – one depositional event, but with coarse to fine sediment

Topic: A teacher demonstration (or a small group activity) showing the origins of graded bedding.

Age range of pupils: 11 - 18 years

Time needed to complete activity: Simple demonstrations – 5 minutes, but at least 20 minutes with follow up by pupils.

Pupil learning outcomes: Pupils can:

- observe the outcomes of simple demonstrations;
- measure the time taken for different sizes of sediment to settle out, whilst being aware of the approximations involved;
- understand how graded bedding may be formed in the natural world and its significance in interpreting past environments;

- appreciate that graded bedding may be used to determine if the beds are the “right way up”, or have been inverted by Earth movements (see ‘Following up the activity’).

Context: This activity can be used in any lesson dealing with the origin of sediments and the interpretation of past environments.

Following up the activity:

- Show pupils Photograph 2 and ask them to measure the average size of the particles at the levels marked by arrows (use the scale bar). The particles are all broken fragments of lava. How do they think the deposit formed? (*from an explosive volcanic eruption, where the rock fragments fell into a standing body of water, e.g. the sea. The average particle sizes are: a) 10mm; b) 3mm; c) 0.5mm*).



Photo 2: Volcanic agglomerate (locality unknown).
(Photo: Peter Kennett)



Photo 3: Graded bedding at Barmouth, Wales (coin is 2cm diameter)
(Photo: P008192, BGS. Contains public sector information licensed under the Open Government Licence v2.0)



Photo 4: Graded bedding at Barmouth, Wales (Photo: P008190, BGS. Contains public sector information licensed under the Open Government Licence v2.0)



Photo 5: Graded bedding in Torridonian sandstone, near Stac Pollaidh, Scotland (coin is 2cm diameter).
(Photo: P005849, BGS. Contains public sector information licensed under the Open Government Licence v2.0)

- In which of the Photographs 2 to 5 are the rocks the right way up? (*The rocks are the right way up in Photographs 2, 3, 4, since the coarsest particles are at the base in each case. In Photo 4, the rocks are steeply tilted to the right: if Earth movements had continued, they could very well have been inverted. In Photo 5, the rocks are shown upside down, by printing the photograph so that the coarsest particles are at the top.*)
- Look out for TV or video footage of explosive volcanic eruptions or swift underwater currents.

Underlying principles:

- A bed is defined as a layer of sediment which was formed in a single phase of deposition.
- A single phase of deposition may take a few seconds, or it may take many years.
- Badly sorted masses of sediment are carried by turbidity (density) currents, often triggered by earthquakes which shake up previously deposited loose sediment.
- Once a turbidity current stops, the larger particles overcome water resistance more quickly than the finer ones and therefore settle out first.
- An explosive volcanic eruption produces equally badly sorted rock fragments, which produce graded bedding when falling into a standing body of water.
- Graded bedding is often used to determine the "way-up" of a sequence of beds: when the bed is the right way up, the coarsest material is at the base." (Note: Inverse grading, where the bed coarsens upwards is a characteristic of some sediments, but this is relatively uncommon)

Thinking skill development:

Thought processes of construction are involved when observing the outcomes of the demonstration. Upside-down structures may involve cognitive conflict and metacognition is used when pupils discuss the activity. Bridging skills are needed to relate the coffee jar observations to the real world.

Resource list:

- empty transparent coffee jar or similar, with a close-fitting lid
- loose sediments, ranging from granule size (2 – 4 mm), down to mud, to fill the jar by about one third
- water
- rulers
- stop watch

hot, cold and particle-filled density currents as they flow in the atmosphere and ocean”, and “Sedimentary structures – sole marks Evidence from the base of a sedimentary bed”.
<http://www.nationalstemcentre.org.uk/elibrary/resource/2300/rock-formation-and-deformation>

Source: Written by Peter Kennett of the Earthlearningidea Team, from a widely-known class demonstration.

Useful links: www.earthlearningidea.com “High flow. Low flow? - atmosphere and ocean in a tank:

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