

## Sedimentary structures – cross-bedding and ‘way-up’ Using cross bedding to determine the way-up of a bed of sedimentary rock

When water flows over loose sand, small-scale dunes can form like those shown in photograph 1.



Photo 1: Subaqueous dunes formed on a beach; the dunes were formed by tidal currents flowing out to sea on a falling tide. (Photo: *Chris King*)

These subaqueous dunes are around half a metre high and several metres wide and so are much smaller than wind-formed dunes. After being formed by the tide, they are often destroyed, and so are not often seen on beaches, but the important thing is that they produce cross-bedding, as described below – and this is often preserved in sandstones.

As water currents flow across sand in beaches, rivers, etc., subaqueous dunes form and then are moved steadily forward. The water moves the sand up the dune until it reaches the top and then the sand avalanches down the other side in a sheet of sediment; this slopes downward in the same direction as the current, at around 20°. These sloping layers of sand are called cross-bedding.

The diagram below shows that a) the lower slopes of the subaqueous dunes are often gently curved upwards; b) as a new dune advances, it truncates (cuts off) the top of the previous one.

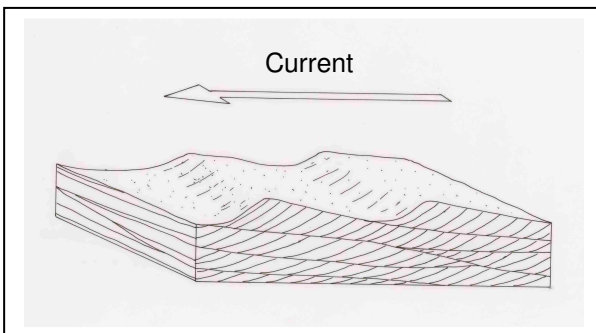


Diagram showing the relationship between current flow and the structure of the dunes.

We can use these observations to work out if a cross-bedded sandstone is the right way up, or if it has been turned upside down by Earth movements (or when it is used in a building). Explain this principle to the class, using Photograph 2.

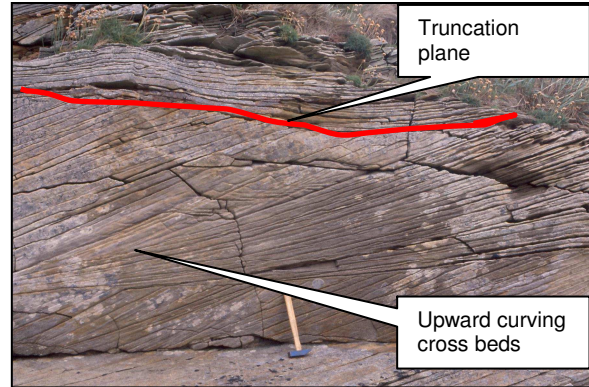


Photo 2: Cross-bedding in sandstones, Eday, Orkney Islands. The beds are the right way up. (Photo: *Peter Kennett*)

Now ask the class to say if the block of coarse sandstone in Photograph 3 is the right way up or if it is inverted. (*It is the right way up, since the truncation plane cuts sharply across above cross-beds*).



Photo 3: Cross bedding in a coarse sandstone, Burbage Edge, Sheffield (Photo: *Peter Kennett*)

This method can be practised on building stones. Show pupils Photographs 4 and 5, which show two different parts of the same building, constructed from red sandstone. Ask them to work out which block of sandstone is the right way up and which has been placed upside down by the builders. (*The block in Photo 4 is upside down – the truncation plane cuts downward-curving cross-beds, just below the coin. The block in Photo 5 is the right way up – the cross beds curve gently upwards*)



Photo 4: Red sandstone on the front of a building (Coin = 2cm)  
(Photo: Peter Kennett)



Photo 5: Red sandstone on the front of the same building  
(Coin = 2cm) (Photo: Peter Kennett)

## The back up

**Title:** Sedimentary structures – cross-bedding and ‘way-up’

**Subtitle:** Using cross bedding to determine the way-up of a bed of sedimentary rock

**Topic:** An introduction to the types of evidence which can be obtained from cross-bedding in sediments and in sedimentary rocks.

**Age range of pupils:** 14-18 years

**Time needed to complete activity:** 10 minutes

**Pupil learning outcomes:** Pupils can:

- identify cross-bedding in sediments and in sedimentary rocks from photographs;
- relate cross-bedding to the original conditions of deposition of the sediment;
- use cross-bedding to determine the way-up of a series of sedimentary rocks;
- understand that cross-bedding in building stones may be used to determine if the block has been placed upside down or the right way up.

**Context:** Cross-bedding is a common feature of sedimentary rocks. It can be formed by both subaqueous dunes (as described here) and dunes formed by wind (eg. in deserts and on coasts). As aeolian (wind-formed) dunes are metres in height and tens of metres across, the cross bedding formed by them is also larger, with single sets of cross-beds often being more than a metre thick.

Asymmetrical ripple marks have similar shapes to dunes, but are on a smaller scale of centimetres rather than metres. They are also formed by both water currents and air currents, but in a slightly different way to dunes (sand is deposited from the bottom up on the sloping surfaces, not from the

top down by avalanching, as in dunes). Their internal structure is similar to cross-bedding, but on a smaller scale, and is called cross-lamination.

The formation of these features may be observed in modern depositional environments and then related to similar structures in sedimentary rocks – an example of using the present to help understand the past.

Following up the activity: Use Earthlearningidea activity *Sedimentary structures – cross-bedding and ancient currents: using cross-bedding to determine the direction of ancient currents*, to show how cross-bedding may also be used to determine ancient current directions, with possible economic connotations. Look out for examples of cross-bedding in buildings and work out which way up the blocks are.

### Underlying principles:

- Sediment of grain size coarser than silt, such as sand, is not always deposited in horizontal layers.
- Currents wash sand grains along in the direction of the current.
- Variations in the current lead to underwater dunes forming at regular intervals on the river bed or the sea bed.
- Sand grains ride up the backs of these dunes and then avalanche down the front side, to come to rest at an angle from the horizontal, at 20° or so.

**Thinking skill development:** Identifying patterns in cross-bedding and relating them to the former current involves skills of construction. Metacognition is involved when pupils discuss which way up the sandstones are, as seen in the photographs. Linking observations from photographs to the real world involves bridging.

**Resource list:**

- copies of the photographs and the diagram
- (Optional) specimens of cross-bedded sedimentary rocks, or access to a building constructed from them.

<http://www.nationalstemcentre.org.uk/elibrary/resource/721/unit-4-building-sedimentary-structures>

**Source:** Written by Peter Kennett of the Earthlearningidea team.

**Useful links:**

<http://www.nationalstemcentre.org.uk/elibrary/resource/734/second-hand-rocks-introducing-sedimentary-processes> and

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