

Sedimentary structures – cross-bedding and ancient currents

Using cross-bedding to find the directions of ancient currents

This activity links with the Earthlearningidea activity *Sedimentary structures – cross-bedding and 'way-up': Using cross-bedding to determine the way-up of a bed of sedimentary rock.*

The diagram shows how one type of cross-bedding is formed, where sand piles up into underwater dunes, as it is moved along by a current as on the bed of a river.

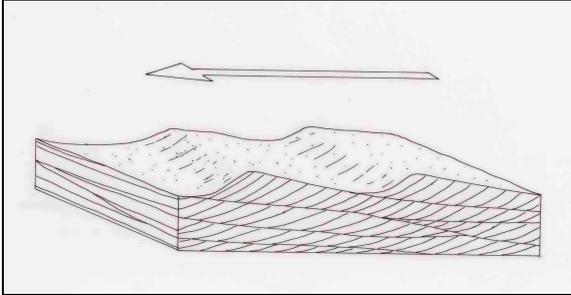


Diagram showing the relationship between current flow and the structure of the dunes it forms.

The diagram shows that the underwater dunes are asymmetrical, and that the steep face is on the side towards which the current is flowing. If we could cut into a dune, we would see layers of sand lying at the same angle to the horizontal: this angle, too points in the direction of the current. The sloping layers are often preserved as cross-beds in sedimentary rocks, and the slope can be used to find out the direction in which the ancient current was flowing.

Use Photo 1 to ask which way the current was flowing when this sandstone was deposited (*A. from right to left*).



Photo 1. Jurassic-age cross-bedded sandstone in Swaziland. (Photo: *Chris King*).

Photo 1 was taken by a geologist prospecting for diamonds in Swaziland in southern Africa who found sandstones like the ones in photographs 1 and 2. The sandstones also contained minerals from a diamond deposit many miles away. Using Photo 2, decide which way the geologist would have driven to see if the source of the diamonds could be found.



Photo 2. Cross-bedded sandstones in Swaziland containing diamonds.

The geologist used these cross-beds to find the direction the ancient current had come from (*from the West*) – and collected samples in that direction until the source of the diamonds was found – a diamond 'pipe' coming up from deep below ground. Later a mine was opened up to extract the diamonds and is still running today.

Show pupils Photo 3 and ask them to use the cross-bedding near the top of the specimen to work out the ancient current direction (*from right to left*).



Photo 3: A small block of sandstone with cross bedding (Photo: *Peter Kennett*).

Now show them Photograph 4 which gives a view of the same block turned through 90° and ask them to state the ancient current direction again.



Photo 4: The same block of sandstone as in Photograph 3, turned through 90°. (Photo: *Peter Kennett*).

The answer in this case is *from left to right*. How can this be? It is important to realise that cross-bedding is a three dimensional property. Now show pupils Photo 5 and ask them to state the direction of the cross-bedding, now that they can see the three dimensional view (*towards the camera*). Finally, if the arrow is showing the direction of North, in what compass direction was the ancient river flowing? (*to the West, i.e. from the East*).

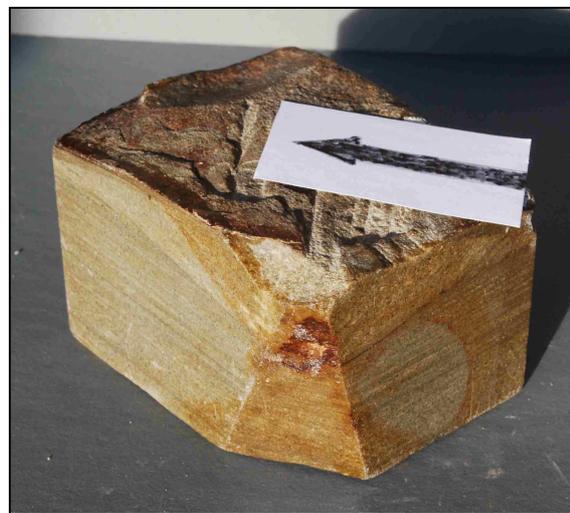


Photo 5: A three dimensional view of the same block of sandstone. (Photo: Peter Kennett).

The back up

Title: Sedimentary structures – cross-bedding and ancient currents

Subtitle: Using cross-bedding to determine the direction of ancient currents

Topic: An introduction to the evidence from cross-bedding in sediments and sedimentary rocks used to determine current directions.

Age range of pupils: 14 – 18 years

Time needed to complete activity: 15 minutes

Pupil learning outcomes: Pupils can:

- identify cross-bedding in sedimentary rocks from photographs;
- relate cross-bedding to the original conditions of deposition of the sediment;
- understand the relationship between current direction and cross-bedding;
- use cross-bedding to determine the directions of the ancient currents which deposited the sediments in a sequence of sedimentary rocks.

Context: Cross-bedding is a common feature of sedimentary rocks. The formation of cross-bedding can be seen in modern depositional environments and then related to similar structures in sedimentary rocks – an example of using the present to help us to understand the past. Cross-bedding can be used as part of prospecting in the minerals or hydrocarbon industries.

Following up the activity: Use Earthlearningidea activity *Sedimentary structures – cross-bedding and 'way-up': Using cross bedding to determine the way-up of a bed of sedimentary rock* to show how cross-bedding may be used to determine the way-up of a series of rocks. Look out for examples of cross-bedding in buildings and work out in which directions the ancient currents might have flowed.

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 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.
- Owing to fluctuations in current directions in natural flowing water, many measurements of ancient current directions are required, to be reasonably certain of the overall direction of the ancient current flow.
- Ancient currents are usually referred to as *palaeocurrents*.

Thinking skill development:

Identifying patterns in cross-bedding and relating them to the former currents involves skills of construction. The fact that one block of rock may show two different apparent palaeocurrent directions introduces cognitive conflict. Metacognition is involved when pupils discuss the palaeocurrent directions 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.

Useful links:

<http://www.nationalstemcentre.org.uk/elibrary/resource/734/second-hand-rocks-introducing-sedimentary-processes> and <http://www.nationalstemcentre.org.uk/elibrary/resource/721/unit-4-building-sedimentary-structures>

Source: Written by the Earthlearningidea team.



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