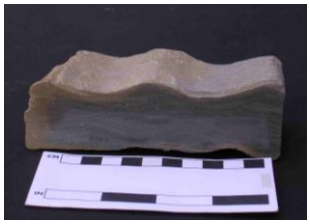
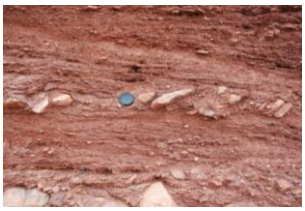
What was it like to be there? – clues in sediment which bring an environment to life

Bringing a depositional environment to life using evidence from sedimentary structures

Ask pupils to imagine themselves to be there at the time when the sediments at the sedimentary exposure (or in the photographs) were forming, and to think what the conditions would have been like at the time.

Sedimentary structure	**Photo**	***Land or water? If water, how deep?***	***Moving water or wind? If so, how fast?***	***What might you see, hear, taste, smell, sense?***
Bedding		Nearly all beds of sediment are formed in water, of lake or river depth, down to deep sea depth	Flow of 0.01 to 1 metre per second (ms^{-1}) to bring sediment into the area, slowing down to deposit it (see Hjulström-Sundborg diagram below)	The muddy/sandy water has poor visibility; normal underwater sounds; fresh or salt water; no smell; difficult to stand on the new sediment layer
Small-scale cross bedding		Formed in underwater dunes by currents in rivers and the sea	The underwater dunes that form cross bedding develop at water speeds of 0.4 to 1 ms^{-1}	The flowing water contains sand with poor visibility; rushing sound of flowing water; fresh or salt water; no smell; difficult to stand up in these flows
Large-scale cross bedding		Formed in wind-formed sand dunes on land in deserts and coastal areas (less commonly in rivers and the sea)	Wind speeds of at least 3 ms^{-1} are required to move sand and form sand dunes, producing large-scale cross bedding	You could see across the desert or coastal dunes, and hear the wind blow, the sand might be gritty between your teeth with desert or coastal smells; difficult to walk in loose sand
Asymmetrical ripple marks		These can form wherever water flows at the right speed, in rivers, shallow and deep seas. They are also formed as wind blows over loose sand	Form at water speeds of 0.2 to 0.6 ms^{-1} and wind speeds of more than 3 ms^{-1}	The water might be fairly clear or muddy with poorer visibility; normal underwater sounds; fresh or salt water; no smell; easy to stand in flows of this speed
Symmetrical ripple marks		Formed by waves in lakes or the sea, where the water is less than 200m deep	Produced by the gentle to and fro movement of water as waves pass overhead	Clear or cloudy water; normal underwater sounds; fresh or salt water; no smell; easy to stand in flows of this speed
Graded bedding		Graded bedding forms underwater, most commonly from turbidity currents that flow across the deep ocean floor	Turbidity currents flow at up to 30 ms^{-1} down continental slopes and across the ocean floor, slowing down as they flow	No visibility in this turbulent cloudy flow, which is much too fast to survive, let alone use your other senses

Imbricated pebble bedding		Shallow fast-flowing water currents carry pebbles and can deposit them in overlapping layers, dipping upstream; waves can imbricate beach gravel too	Pebbles are deposited at flows between 0.1 and 1 ms^{-1}) (see Hjulström-Sundborg diagram below), but faster flows are needed to carry the pebbles	Fast shallow flows are likely to be turbulent and cloudy and noisy. They are most common in freshwater floods that would be impossible to stand up in
Mudcracks (desiccation cracks)		These are formed by a drying land surface where mud has been deposited	Water would have brought mud into the area, but has now flowed away or dried up	Views of dried out pools, lake beds or tidal flats with their characteristic sounds and smells; easy to stand on the cracked surface
Footprints		Animals leave prints in muddy sediment on land before it dries out as casts of the base of the foot	Water would have brought mud into the area, but has now flowed away or dried up	Views of dried out pools, lake beds or tidal flats with their typical sounds and smells; easy to stand on the surface which is now hard
Trails and burrows		Animals leave these in muddy sediment on the beds of pools, lakes, tidal flats and quiet sea floors.	Formed and usually preserved underwater, but unusually can be retained on dried out mud surfaces	Water above the muddy floor can be clear or cloudy, fresh or salt with normal underwater sounds; difficult to stand on this muddy layer

All photos by Peter Kennett, apart from the large scale cross bedding (File is licenced by Roy Luck (roy.luck on Flickr) http://www.flickr.com/people/royluck/ under the Creative Commons Attribution 2.0 Generic licence) and the dinosaur footprints (with permission from Dr. Oliver Wings, http://dinosaurhunter.org).

Then, for each environment, ask, 'If you were there, how would you be feeling? – scared? – happy – amazed?'

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The back up

Title: What was it like to be there? – clues in sediment which bring an environment to life

Subtitle: Bringing a depositional environment to life using evidence from sedimentary structures

Topic: Asking 'deep questions' about sedimentary structures to help pupils to visualise the environment in which they formed.

Age range of pupils: 9-90 years

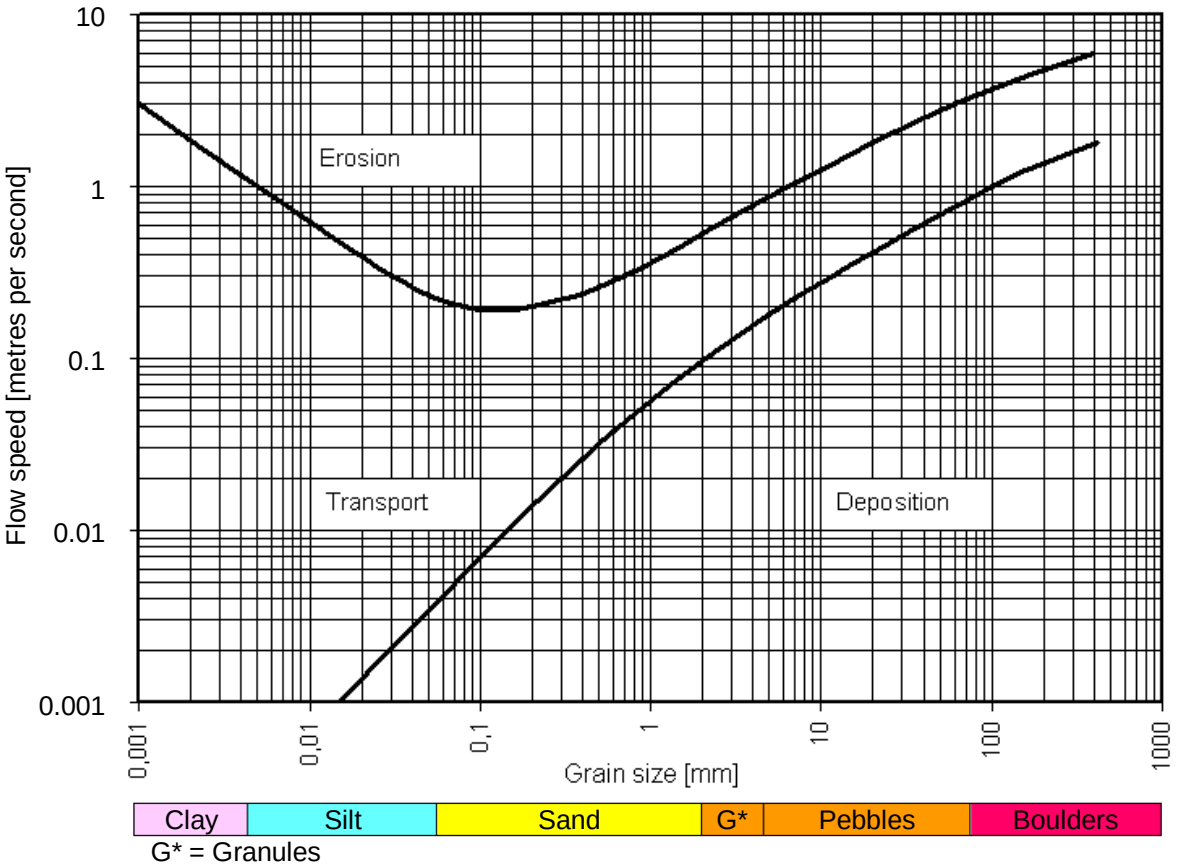
Context:
You can read the flow speed at which different sizes of sediment are deposited from the Hjulström-Sundborg diagram on page 3.

Time needed to complete activity: depends on the numbers and types of structures

Pupil learning outcomes: Pupils can:
- describe how different sedimentary structures formed;
- explain how the evidence from them can be used to help reconstruct past environments;
- describe likely past environments using all their senses.

Following up the activity:
Try using the 'Questions for any rock face' Earthlearningideas or the '*What was it like to be there? – in the rocky world*' or the '*What was it like to be there? – bringing a fossil to life'* Earthlearningideas.

Hjulström-Sundborg diagram



G* = Granules

Note: 10 ms^{-1} is 22 miles per hour or 36 kilometres per hour, so 1 ms^{-1} is 2.2 mph and 3.6 kph, etc.

Underlying principles:

- Sedimentary structures preserve evidence of the processes that formed them, often with clues about the rates and directions of flows.
- They therefore provide valuable evidence for the reconstruction of ancient sedimentary environments.

Thinking skill development:

Creative and imaginative skills are needed to translate the evidence from sedimentary structures into mental pictures of the depositional environments in which they formed.

Resource list:

- the resources needed for pupil fieldwork listed in the '*Planning for fieldwork: preparing your pupils before setting out to "ask questions for any rock face"*

Useful links:

A graph of the flow speeds at which asymmetrical ripples and subaqueous dunes form can be found at:
http://opencourseware.kfupm.edu.sa/colleges/cs/es/geol307/files%5C5-_Handouts_Lec_7.pdf

Source: Chris King of the Earthlearningidea Team.