Siccar Point

Virtual field trip

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Welcome!

I am Dr Amanda Owen, a lecturer in Sedimentology in the School of Geographical and Earth Sciences at the University of Glasgow. Alongside my teaching I conduct research on the deposits of river systems from modern day to deep time (100 millions of years ago) with a focus on understanding how they adapt and change to external forces such as tectonic processes and climate change. I also try to understand how and where ancient river deposits host societally important resources (e.g. act as water aquifers, minerals such as gold and uranium, oil and gas as well as be Carbon Capture and Storage and geothermal sites). Alongside satellite imagery analysis, field work has formed an integral part of my data collection.

This workbook aims to give you all a virtual field experience where we will explore an exceptional geologic outcrop, Siccar Point, which is located on the east coast of Scotland.

I have designed this workbook, along with a series of accompanying short videos (https://www.youtube.com/playlist?list=PLqtFz4wUN3IM_MmrntsaGXofjGDnm7WDK), to help you gain an understanding of how we observe, record and interpret geologic outcrops. Key concepts will be covered through video content, with questions and short exercises helping you devise a geological history of the area, to understand how and why the environments have changed through time.

Siccar Point is an excellent site to begin training geoscientists as it demonstrates core underpinning geoscience principles. In fact, it was at this site in 1788 that James Hutton realised the concept of geological time.

We will be exploring this outcrop via a freely available three-dimensional virtual outcrop model, high resolution gigapan imagery and photographs, showcasing some of the latest technology. Although fieldwork forms an important part in geoscience degree programmes an increase in the availability of affordable technology has allowed field experiences to become more accessible, bringing geological sites from across the globe to your local computer environment.

I hope you enjoy working through this workbook, if you have any questions or comments relating to this workbook please do not hesitate to get in contact with me.

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To begin with watch the first introductory clip:

Video 1:
https://youtu.be/3X8tvPFJxl8

Exercise 1:
When you first arrive at a new field location, it is best practice to explore your outcrop to understand its extent and the variety of rock types and features present.

Take a few minutes to explore this outcrop (using a digital outcrop model and gigpan imagery) and become familiar with it.

-> Digital outcrop model:

Digital outcrop models are generated by taking many overlapping images of a surface/object, from a range of perspectives. A mesh is then created of the object/surface and the photographs draped over. This technology has become increasingly popular to generate datasets in the last ~5 years.

You access the three-dimensional digital outcrop model at the following link: https://skfb.ly/6vIUz or search for 'Siccar Point' at www.Sketchfab.com. This digital outcrop has been provided by eRock (https://www.e-rock.co.uk/)

Top tip!
You can zoom in and out but also pan right and left in sketchfab. To pan left and right (or up and down) you will need to do this by either pressing in the scroll wheel on your mouse, or press the shift button and pan the image around if you are using a laptop track pad (or do not have a scroll wheel on your mouse). It may take a little bit of practice but it is worth the practice to explore these packages.

-> Gigapan imagery

Gigapan imagery is effectively many high resolution photographs stitched together. A SLR camera is mounted on to a Gigapn tri-pod which then moves the camera around taking the appropriate images to create a large, high resolution panorama. Although Gigapan imagery is two-dimensional, the clarity and resolution of the images are extremely high in quality.

You can access the high resolution image of Siccar point at the following link: http://gigapan.com/gigapans/188522. This imagery has been collected by Callan Bentley (Piedmont Virginia Community College (Charlottesville, VA, USA)).

Top tip!
Once you arrive at the webpage, it is a simple zoom in and out and panning left and right with your mouse.

Q1. How many rock types (units) do you think are present? How did you distinguish them?

Now watch video 2.

Video 2:

https://youtu.be/FJ-X2hRq9nU

Exercise 2:

We have now determined the presence of two rock units

Unit 1) Silurian aged (425 million years) interbedded mudstones and very fine sandstone.
Unit 2) Devonian aged (345 million years) coarse sandstone and conglomerates.

Q2. Using the below descriptions, observations from the gigapan and virtual outcrop models, as well as example images overleaf, determine the depositional environments for each unit?

Top tip!

Use the images overleaf to help you visualise what the different sedimentary environments look like. Some key things to think about are

- Are they high or low energy?
- Will that environment have the capacity to carry coarse (large) sediment?
- Will fine-grained material be easily settle from the water column if the flow is fast? Or is a quite, low energy environment needed?
- Are there any biota (animals/vegetation) in the rocks that will help you determine the depositional environment?

Unit 1 (Silurian rocks)

Unit 1 is composed of two principle rock types. Rock type 1 is thinly bedded mudstones (up to 20cm thick) where individual grains are no larger than 0.0625 mm in size. These rocks are dark coloured and have horizontal banding present. In nearby location graptolite fossils have been found. Rock type 2 is a fine sandstone (grains are less than 2mm in size) which has some small scale ripples and an erosional base. Beds reach up to 45 cm in thickness).

Example graptolite fossil BGS.ac.uk

Close up image of the mudstone. Photo credit Callan Bentley (see extra resources)

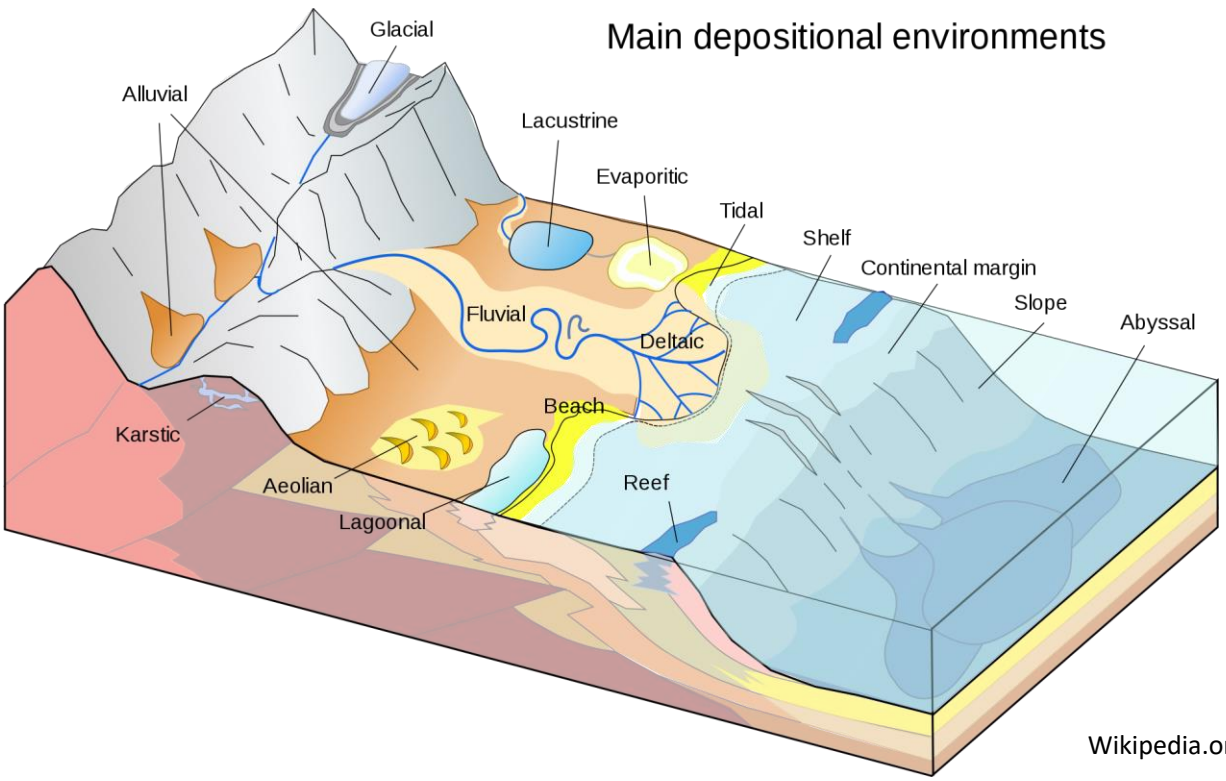
Unit 2 (Devonian rocks)
Unit 2 is distinctively red in colour. The unit is poorly-sorted and dominated by medium to coarse sandstone (grains are 0.3-0.8 mm in size), however large (up to 10 cm in size) angular clasts are present. The large clasts are composed of both volcanic rocks and mudstones that are similar to unit 1 lithologies. Freshwater armoured fish have been observed in nearby locations.

Example armoured fish Nhm.ac.uk

Photograph of large clasts from Siccar Point (photo credit Callan Bentley, see extra resources)

Top tip!

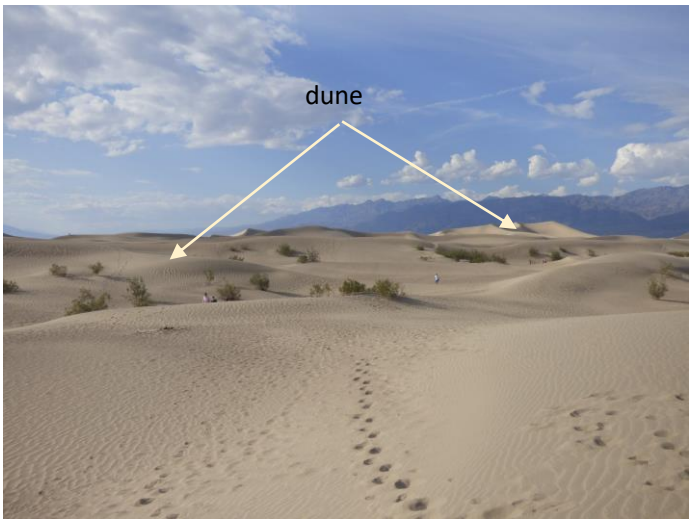
Here is a schematic image summarising the depositional environments we see on our planet. See overleaf for example images of a selection of environments.

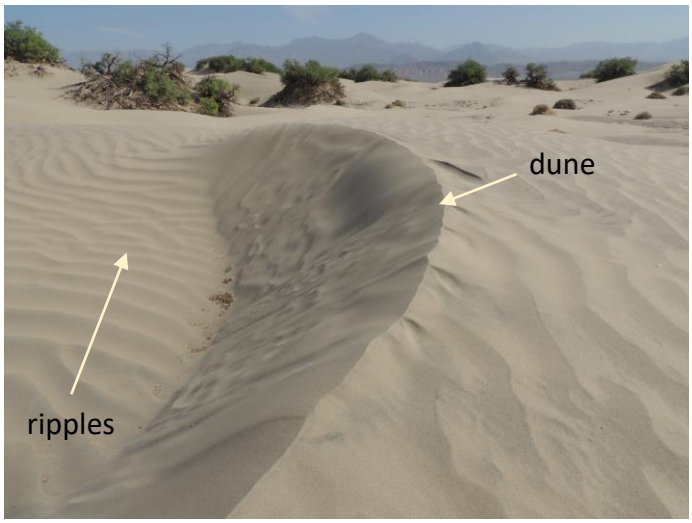


Wikipedia.org

Aeolian desert dunes

Medium sand with ripples and dunes (cross-bedding). Well-sorted. Very little vegetation present.





Fluvial (river)

Fine to coarse sand, large clasts (boulders) transported close to source area. Poorly sorted near source. Channel bars (sediment islands) present, often contain coarse material.

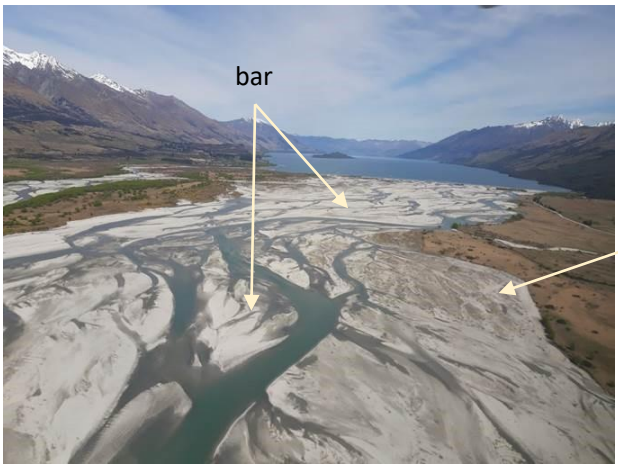
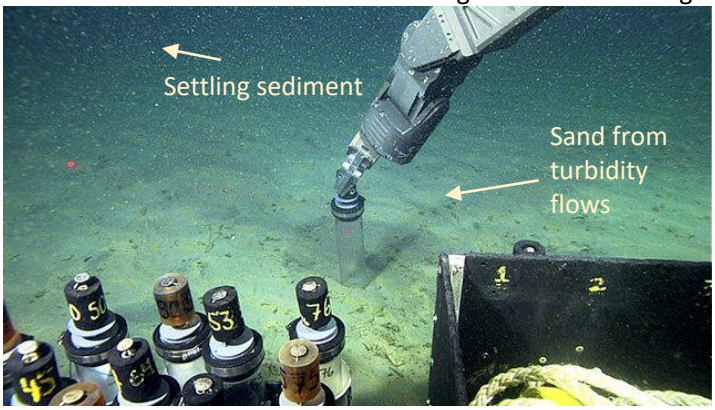


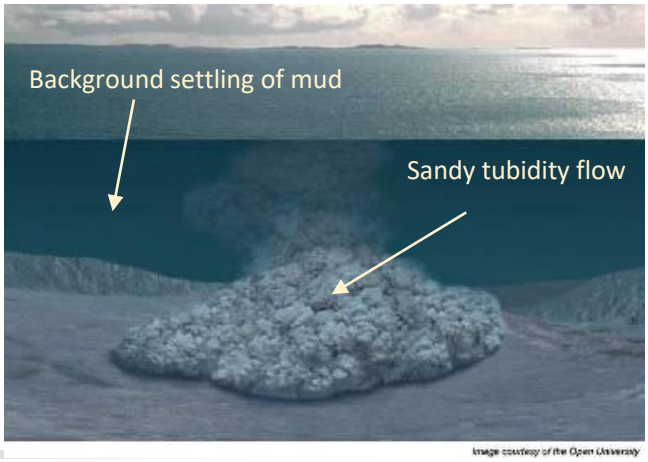
Image credit: Richard Williams

Deep marine

Quite waters with intermittent sediment flows (fine sand with current ripples) coming from the continent through turbidity currents (underwater density currents). Majority of the time mud grade material settles from quiet waters.

Image credit: MBARI.org



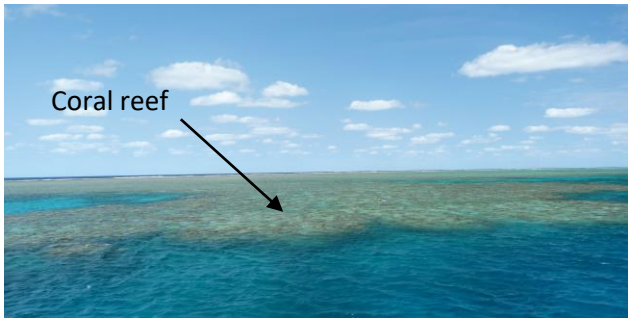


Beach

Medium sand, well sorted. Wave-ripples present and shallow dipping surface representing beach surfaces. Marine shells commonly present.

Shallow marine: coral reef

Composed of carbonate shells. May be broken due to wave activity. Form in warm shallow seas.



Glacial environments

Striations (scratches formed by material in a glacier cutting into a rock) present on rock. Dropstones also present (material falls from glacier into muddy material below)

striations

dropstone

Photo credit: Marie Busfiled

Now watch video 3.

Video 3:

https://youtu.be/u1tscHZg8xI

Exercise 3:

Draw a sketch of the Siccar Point outcrop (field of view to be sketched can be seen below. Remember all the hints and tips on how to draw a sketch from the video.

We would love to see your final sketch, so please do take a photograph of your sketch and post it social media, tagging our school channels (see front cover).
That concludes our virtual field trip. I hope this exercise has given you a flavour of what field work might involve, how we approach and make observations of an outcrop, as well as how we formulate interpretations.

Further resources:

If you want to find out more about James Hutton you can watch a BBC documentary on him at https://www.bbc.co.uk/programmes/b00wkc23 .
Callan Bentley also provides a blog on his trip to collect Gigapan data from Siccar point:
https://blogs.agu.org/mountainbeltway/2016/06/30/virtual-field-trip-siccar-point-scotland/