Now and then – spotting the difference

How did the conditions differ between today and when the rock was formed?

During fieldwork, when you have worked out, with your pupils, how a rock was formed, ask them these questions, to help them to picture how different the conditions must have been in the past – and why.

Between now (today) and then (when the rock was formed) how have these things changed?:

- temperature
- humidity
- visibility
- pressure
- life – including shells, other invertebrates and vertebrates
- orientation
- altitude
- latitude
- age

Use a thermometer and map to give exact figures for temperature and altitude today, if you have them.

The example summarised in the table below, shows how the questions might be answered. It is based on a field visit to limestone exposures of Carboniferous age in Tor Woods, Wells, Somerset, UK in October at 4.00pm. The limestone contains fossils of corals and shellfish (brachiopods) with thick shells, which show that the deposits were laid down in a subtropical, shallow, clear marine environment, like the Caribbean Islands of today.

Tilted beds of Carboniferous limestone, as found near Tor Woods, Somerset, UK. The hammer lies along a bedding plane which once formed the sea floor.

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Aerial view of a tropical sea, the Virgin Islands, Caribbean Sea

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Feature - *approximate values*		**Now**	**Then – in Carboniferous limestone times**	**Difference**	**Reason**
Temperature		12°C	26°C	14°C	area near Equator when lime sand that later formed limestone was deposited
Humidity		75%	100%	25%	under water then
Visibility		10 km	5m	nearly 10 km	visibility much less under water, even in clear tropical seas
Pressure		one atmosphere	1.5 atmospheres	0.5 atmospheres	10m of water results in 1 atmosphere increase in pressure - the depth then was probably around 5m
Life	shells	snails with thin shells	shellfish with thick shells	amount of protection needed	protection from storms and predators needed in the sea, snails can hide on land
	other invertebrates	slugs, insects	sea slugs, coral polyps, very few insects	fewer marine insects	very few insects ever colonised the sea
	vertebrates	amphibians, reptiles, birds and mammals	fish	locomotion style	different movement methods needed in water, on land and in the air
Orientation of layers		45° to horizontal	sea bed was horizontal	45°	tilting caused by a mountain-building episode
Altitude		70m above sea level	5m below sea level	75m	uplift caused by a mountain-building episode
Latitude		51°N	0° – shown by palaeomagnetic measurements	51°	1° of latitude is 111km (69 mls) – there has been 5661km (3519ml) of northward movement between then and now, due to plate tectonics
Age		0 million years	340 million years	340 million years	Carboniferous limestone was deposited in the distant geological past

When your pupils understand the approach, you could ask them more complex questions, like how these features have changed:

- altitude of the Sun at midday
- orientation of Earth's magnetism

Use a Magnaprobe™ (a small magnet on gimbals) to show the orientation of the Earth's magnetism today, if you have one.

For the Carboniferous limestone exposure in Tor Woods, Somerset, the answers are in the table below.

This approach can be used for the formation of any sedimentary, metamorphic or igneous rock.

Feature - approximate values	**Now**	**Then – in Carboniferous limestone times**	**Difference**	**Reason**
Altitude of the Sun at midday in October at the latitude of Somerset	28º at Noon	data for the Equator - 79º at Noon	51º	calculated by adding data to an electronic form at: http://aa.usno.navy.mil/data/docs/AltAz.php ; the Sun was much higher in the sky and thus it was much warmer in Carboniferous times
Orientation (inclination) of Earth's magnetism	70º	0º	70º	read from graph given in the 'Context' section below; the area has moved away from the Equator through plate tectonic movement

The back up

Title: Now and then – spotting the difference.

Subtitle: How did the conditions differ between today and when the rock was formed?

Topic: A thought experiment, attempting to compare various aspects of the environment when the rock was formed, with conditions today.

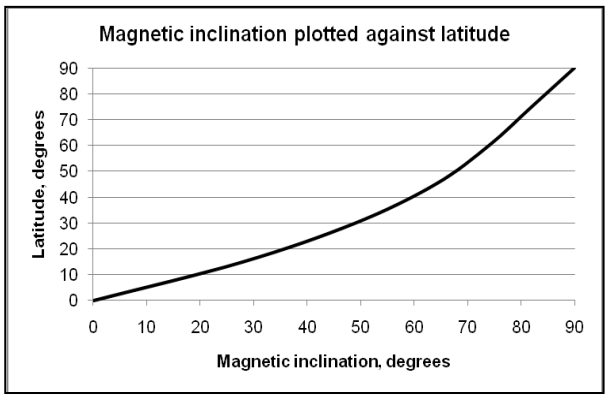
Age range of pupils: 9 years plus

Time needed to complete activity: 10 minutes

Pupil learning outcomes: Pupils can:

- describe and explain the differences between the conditions during the formation of a rock in the past and those of today;
- appreciate that the changes are linked to plate tectonic movement, and mountain-building within long passages of geological time.

Context:
This activity was designed for use in the field to consolidate and extend pupil understanding of the rocks they are studying. It can be used for any rock, although the conditions during the formation of metamorphic and igneous rocks will be more speculative. Changes of magnetic inclination with latitude can be measured on the graph below.



Following up the activity:
The same approach can be used for a wide variety of field sites or by using photographs.

Underlying principles:

- We can use the principle of uniformitarianism to work out the likely conditions of formation of rocks.
- We can gauge a range of environmental parameters at the Earth's surface today and use these for comparison with the conditions under which rocks were formed.

Thinking skill development:
Working out rock-formation conditions requires construction, whilst cognitive conflict is involved in comparing those conditions with the conditions of today.

Resource list:

- access to an exposure of rocks or photographs of rock exposures
- (optional) thermometer to measure today's temperature; map showing altitudes, to find today's altitude; Magnaprobe™ to show the magnetic inclination today

Useful links:
The electronic query form to discover the height of the Sun in the sky is found at:
http://aa.usno.navy.mil/data/docs/AltAz.php

A range of other field-based thought experiments can be found on the Earthlearningidea website, http://www.earthlearningidea.com/index.html

Source: Chris King of the Earthlearningidea Team.