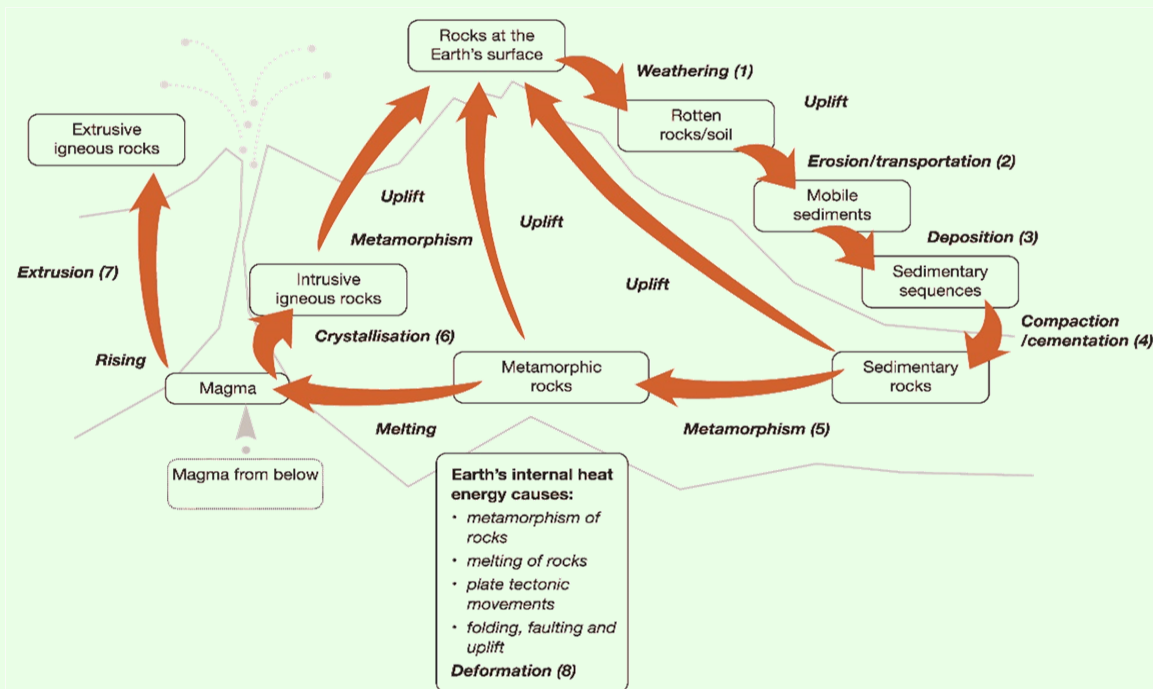


The dynamic rock cycle – online

Earth Science for science and geography – video workshop



Developed from
the Earth
Science
Education Unit
'The dynamic
rock cycle'
workshop, with
permission

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Earthlearningidea online video workshops

Purpose – ESEU background

- Most Earthlearningidea online video workshops are based, with permission, on workshops originally developed by the Earth Science Education Unit (ESEU)
- These were designed as interactive workshops for teachers and trainees, involving interaction, discussion and presentations by participants to others
- Global research into professional development workshops shows that these aspects are critical to success
- ESEU research shows that this workshop approach is highly successful in changing teaching in schools; evaluation feedback has also been very strong

Earthlearningidea online video workshops

Purpose – Earthlearningidea development

- The Earthlearningidea Team has developed the ESEU workshops into online video workshops for those unable to take part in face to face interactive workshops
- Each workshop is led by a PowerPoint presentation and has an accompanying booklet that contains all the activity background details, resource lists, risk assessments, etc.
- The individual workshop activities have been published for open access online at the website:
<https://www.earthlearningidea.com/>
- Each workshop activity has a question script and a video keyed into CASE principles, that can be accessed through the PowerPoint hyperlinks
- The aim is to facilitate online Earth science learning

The dynamic rock cycle – using CASE

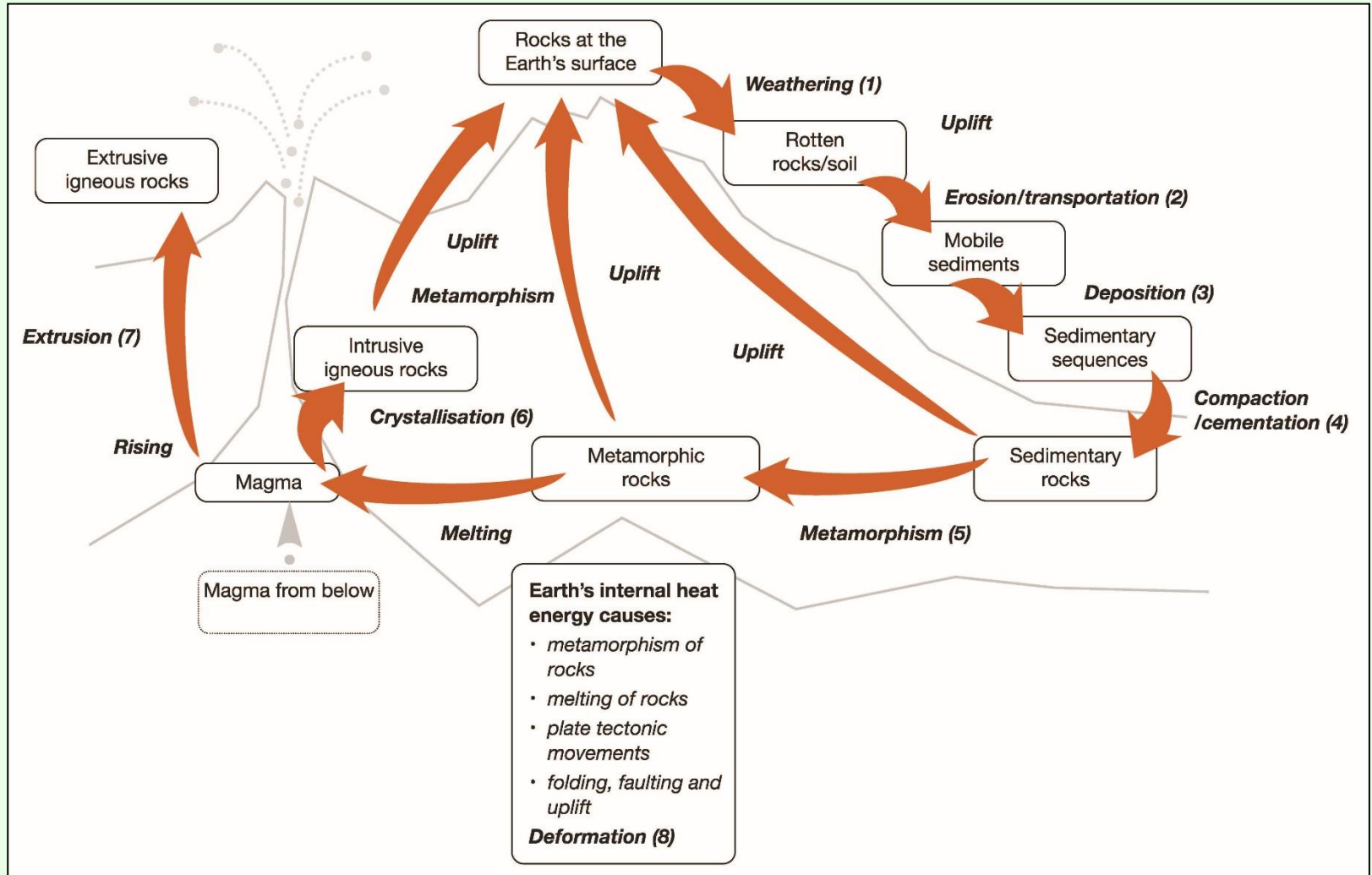
Teaching Earth science using the Cognitive Acceleration through Science (CASE) approach

- The activities in this workshop are keyed into the CASE approach – to develop thinking skills while teaching key Earth science material
- If you are unfamiliar with the case approach, you can access a video introduction at:
<https://www.earthlearningidea.com/Video/CASE.html>
- An exemplar Earth science teaching activity with a question script using the CASE approach is at:
https://www.earthlearningidea.com/Video/Atmosphere_ocean.html

The dynamic rock cycle

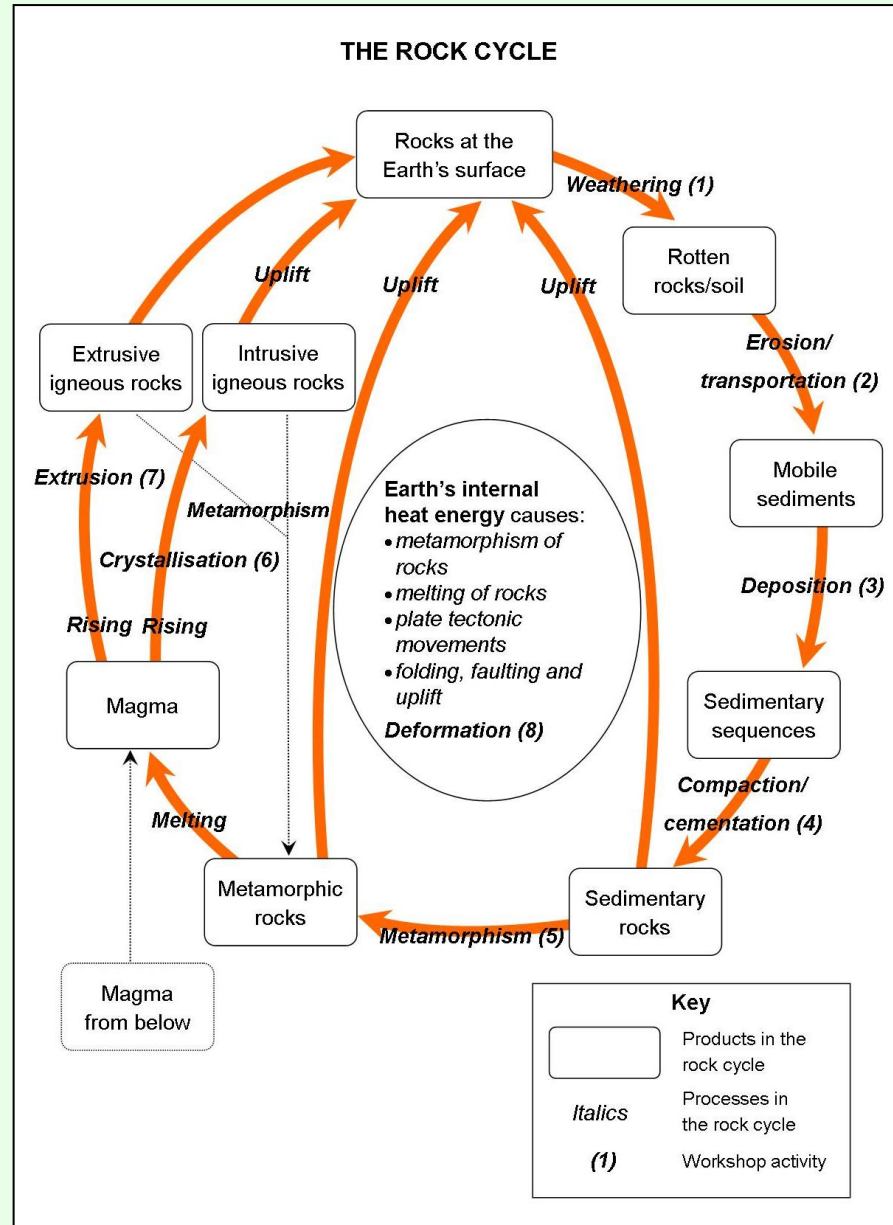
Workshop video run times			m	s	m	s
CASE – Cognitive Acceleration through Science Education					21	51
Using CASE			6	24		
Atmosphere and ocean			15	27		
The dynamic rock cycle					90	18
Laying out the rock cycle	introduction	5	27	13	43	
	mobile sediments	0	29			
	rock names	3	04			
	processes	4	43			
Weathering	heating and cooling	5	29	13	04	
	freeze-thaw	2	40			
	weathering limestone	4	55			
Erosion					6	28
Transportation and deposition	transportation and deposition 1	4	44	10	06	
	transportation and deposition 2	5	22			
Compaction and cementation					7	05
Metamorphism	squeezed out of shape	3	50	5	57	
	change of shape	2	07			
Crystallisation					9	27
Extrusion					9	26
Deformation and uplift	deformation	4	23	5	33	
	extension	1	10			
Rock cycle review	wax volcano	4	17	9	29	
	rock cycle in wax	2	41			
	rock cycle at your fingertips	2	31			

The dynamic rock cycle



'Diagrammatic version of the rock cycle'

The dynamic rock cycle



The dynamic rock cycle

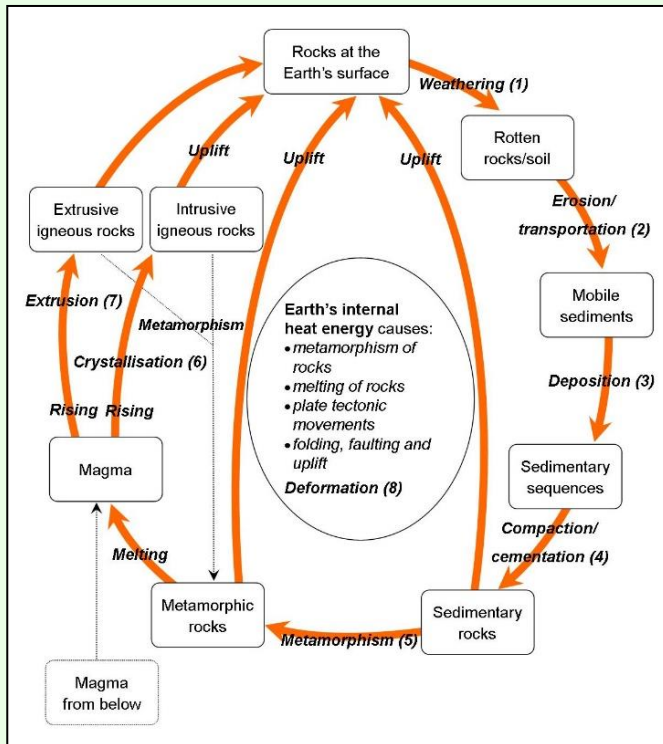
Pre- warning

If you would like to take part in the **‘Starter Activity: Rock cycle products and processes’** instead of just watching it on video – you will need to:

- Print off an A4 version of the rock cycle diagram, from the following slide or page 9 of the booklet
- Print off an A4 version of the ‘Rock reference sheet’ from the following slide or from p11 of the booklet and cut it up into small cards, one for each rock – with or without the rock name and description (your choice)
- Print off photographs of ‘Rocks at the Earth’s surface’ and ‘Sedimentary sequence’ (next slide or p8) and photos of the small bags of a) soil, b) sand (next slide)

The dynamic rock cycle

Pre- warning – to take part in the starter activity print these off, first two at A4 size:



Hand specimen		Close up	Hand specimen	Close up
				<p>Conglomerate - pebble-sized grains cemented/compressed together - a coarse-grained sedimentary rock.</p> <p>Sandstone - sand-sized grains cemented/compressed together, often with layers (bedding) - a medium-grained sedimentary rock.</p>
				<p>Mudstone - mud-sized grains compressed together, often with fine layers (bedding) - a fine-grained sedimentary rock.</p> <p>Limestone - fine grains cemented/compressed together; fine (calcium carbonate) rocks with dilute acid.</p>
				<p>Coal - plant material compressed together - a black sedimentary rock.</p> <p>Basalt - dark-coloured, fine-grained (too small to be seen) interlocking crystals (dark-coloured crystals are usually rich in iron/magnesium) - a fine-grained, dark-coloured, iron/magnesium-rich igneous rock, often with gas holes.</p>
				<p>Gneiss - pale-coloured, coarse-grained (clearly visible) interlocking crystals (pale-coloured crystals are usually rich in silica) - a coarse-grained, pale-coloured, siliceous igneous rock.</p> <p>Pentinite - very dark-coloured, coarse-grained (clearly visible) interlocking crystals (dark-coloured crystals are usually rich in iron/magnesium) - a coarse-grained, very dark-coloured, very iron/magnesium-rich igneous rock.</p>
				<p>Slate - mud-sized (too small to be seen) interlocking crystals parallel with each other; can break into sheets (slating) - a fine-grained, low-grade metamorphic rock.</p> <p>Schist - clearly visible interlocking crystals parallel with each other - a medium-grade metamorphic rock.</p>
				<p>Gneiss - clearly visible interlocking crystals in bands - a high-grade metamorphic rock.</p> <p>Marble - clearly visible interlocking crystals - formed when limestone is metamorphosed; the calcium carbonate crystals react with dilute acid.</p>

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The dynamic rock cycle

Summary

Try a series of 'hands-on' activities experimenting on and simulating the processes involved in the rock cycle.

Use the integrating model of the rock cycle as a means of encountering common rocks and Earth-processes in a practical, investigative way.

The dynamic rock cycle

Workshop outcomes

The workshop and its activities provide the following outcomes:

- identification and terminology of rock cycle products, including soils, sediments and rocks;
- knowledge and understanding about rock cycle processes and timescales, including weathering, erosion/transportation, deposition, compaction/cementation, metamorphism, melting, crystallisation, extrusion and deformation;
- methods of teaching the abstract concept of the rock cycle, using a range of teaching approaches;

The dynamic rock cycle

Workshop outcomes – continued

- introduction to a range of Earth science laboratory activities, from simple modelling to more complex investigations;
- approaches to activities designed to develop the thinking and investigational skills of pupils;
- links between laboratory models and planetary processes, some of which are locally active and therefore relevant to pupils;
- an integrated overview of the geological Earth science commonly taught to 11 – 14 year olds

The dynamic rock cycle

The workshop integrates all these 'rock cycle' activities:

- Laying out the rock cycle, starter activity
- Weathering – breaking up, or breaking down material at the Earth's surface
- Erosion – investigating the resistance of rock samples to “erosion”
- Transportation and deposition – investigating the movement of sand in water
- Compaction and cementation of sediments
- Metamorphism - detecting the distortion
- Crystallisation – with salol
- Extrusive igneous rocks – simulating magma flow
- Deformation and uplift – make your own folds and faults
- Rock cycle review, plenary activities

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Starter Activity: Rock cycle products and processes

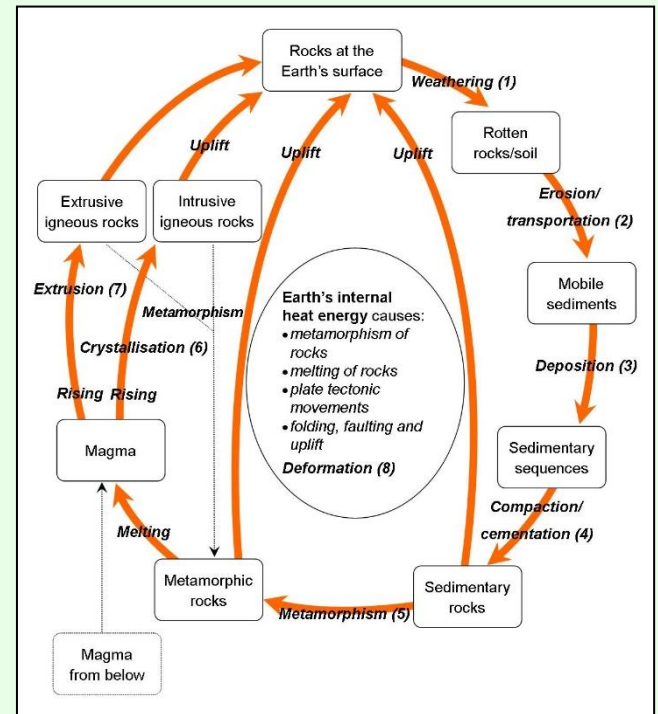
Place a series of rock cycle products in the correct places on a diagram of the rock cycle, then consider how all these are linked by rock cycle processes.

See how this is done through the question script and videos at:

https://www.earthlearningidea.com/Video/Rock_cycle1.html

See details of all the rocks used, in the 'Virtual Rock Kit' at:

https://www.earthlearningidea.com/virtual_rock_kit/START.htm



The dynamic rock cycle

Starter Activity: Rock cycle products and processes

See details of all the rocks used:

- in the 'Virtual Rock Kit' at: https://www.earthlearningi.dea.com/virtual_rock_kit/S_TART.htm
- on the rock reference sheet on page 11 and the lists on pages 41/42 of the booklet

Virtual Rock Kit
View sandstone, granite, marble and many more...

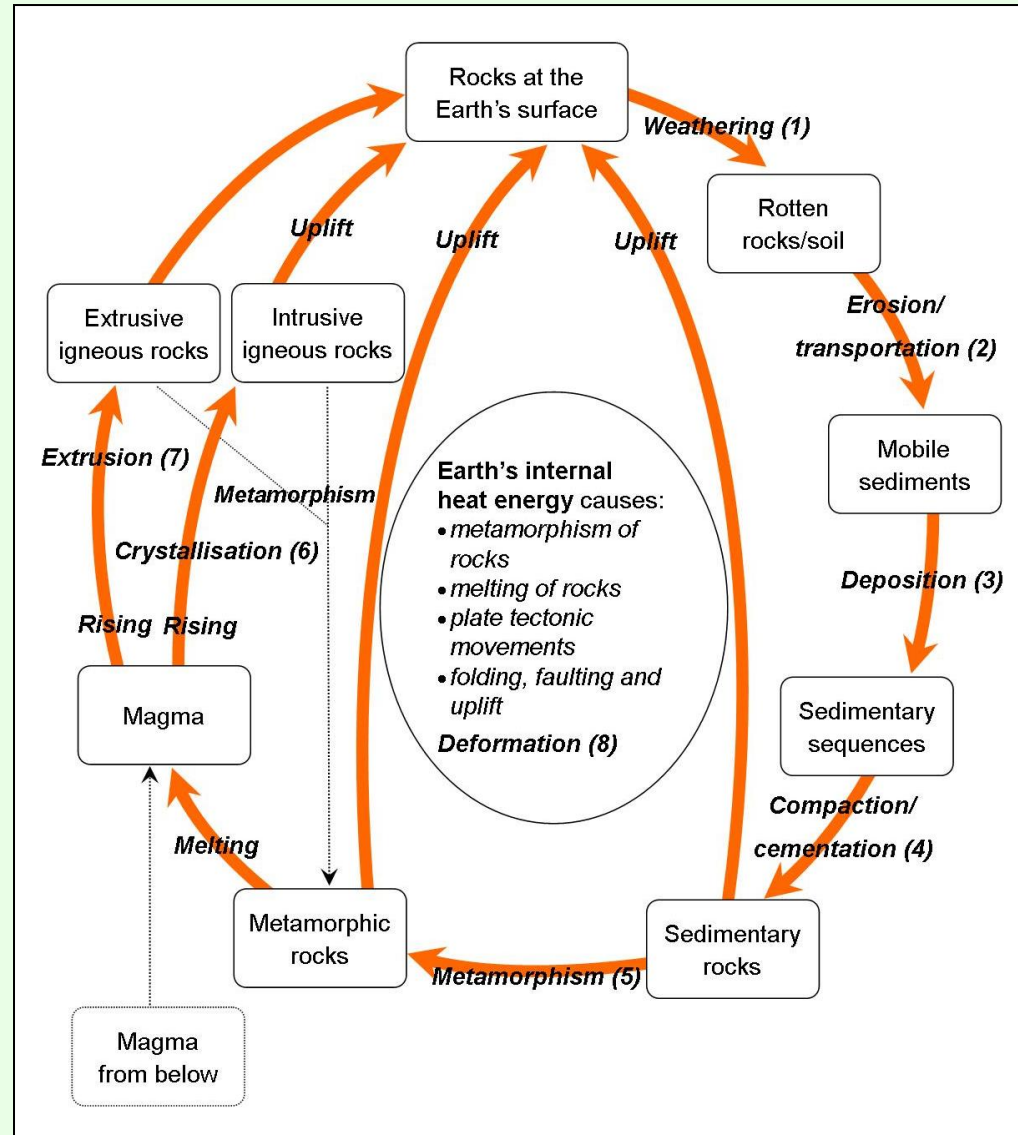
From rock...
to closeup...
to exposure
to a thin slice under the microscope
to a thin slice in crossed polarised light
to rock in use

Enter the world of rocks

Rock reference sheet		Hand specimen	Thin slice
		Conglomerate - pebbles of grains cemented/compressed together - a coarse-grained sedimentary rock.	
		Sandstone - pebbles of grains cemented/compressed together, often with layers (bedding) - a medium-grained sedimentary rock.	
		Mudstone - mud-sized grains compressed together, often with fine layers (lamination) - a fine-grained sedimentary rock.	
		Limestone - fine grains cemented/compressed together; fine (often dark) carbonates, usually with little siliceous.	
		Gneiss - light material compressed together - a block sedimentary rock.	
		Basalt - dark-coloured, fine-grained (too small to be seen) interlocking crystals (dark-coloured crystals are usually rich in iron/magnesium) - a fine-grained, dark-coloured, iron/magnesium-rich igneous rock, often with gas holes.	
		Granite - pale-coloured, coarse-grained (clearly visible) interlocking crystals (dark-coloured crystals are usually rich in iron) - a coarse-grained, pale-coloured, iron-rich igneous rock.	
		Porphyrite - very dark-coloured, coarse-grained (clearly visible) interlocking crystals (dark-coloured crystals are usually rich in iron/magnesium) - a coarse-grained, very dark-coloured, very iron/magnesium-rich igneous rock.	
		Slate - multi-layered (too small to be seen) interlocking crystals parallel with each other, not broken into sheets (cleavage) - a fine-grained, low-grade metamorphic rock.	
		Schist - clearly visible interlocking crystal particles with each other - a medium-grade metamorphic rock.	
		Gneiss - clearly visible interlocking crystals in bands - a high-grade metamorphic rock.	
		Marble - clearly visible interlocking crystals - formed when limestone is metamorphosed. The calcium carbonate crystals react with silicate.	

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The dynamic rock cycle



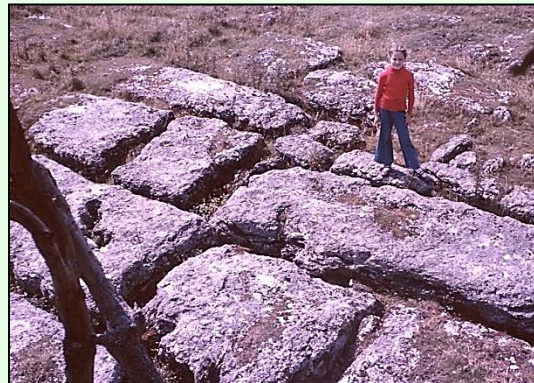
'The Rock Cycle'

The dynamic rock cycle

Activity 1: Weathering **- breaking up or breaking down material** **at the Earth's surface** (tens to hundreds of years)

Investigate three different types of weathering through:

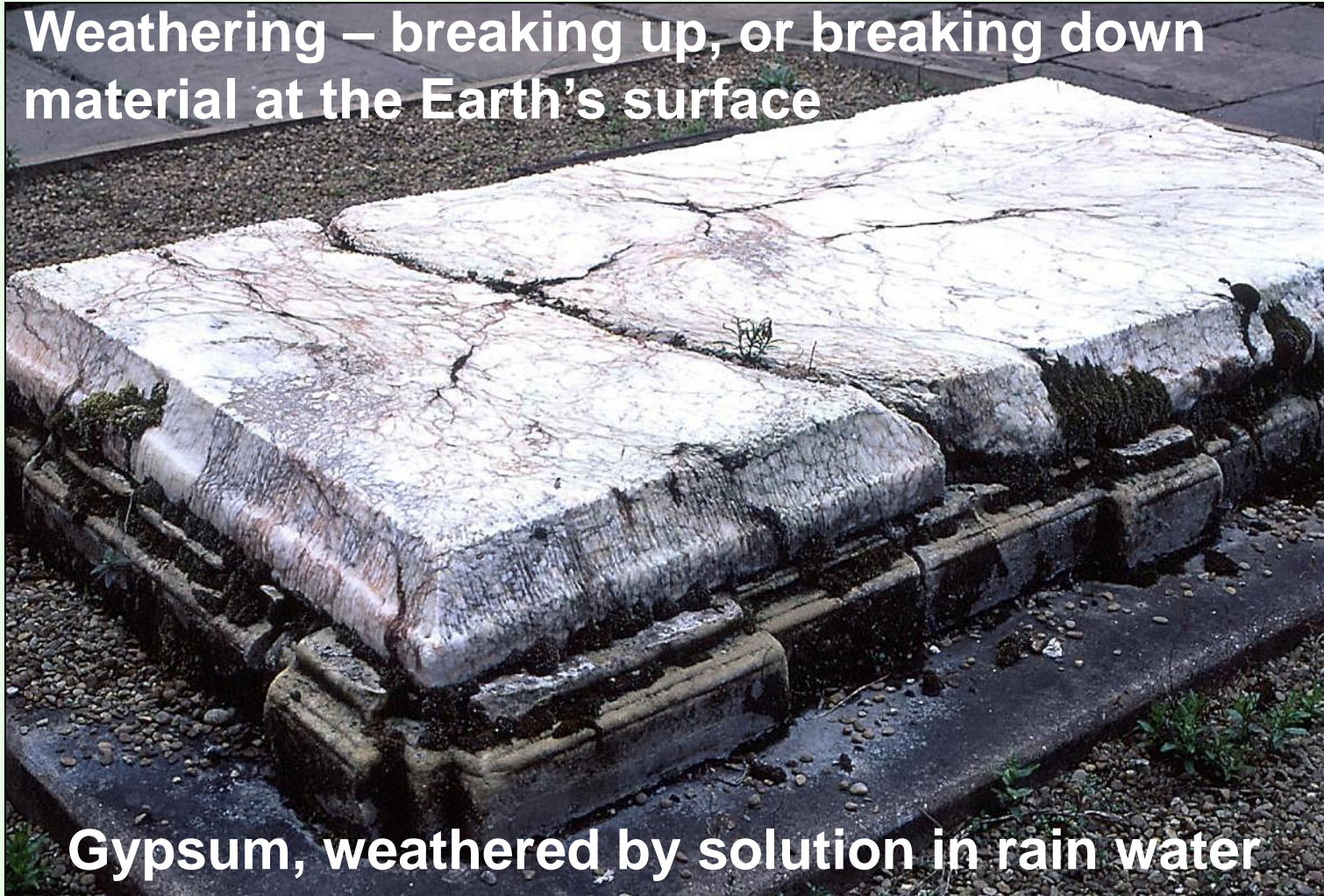
<https://www.earthlearningidea.com/Video/Weathering1.html>



The weathering of a limestone platform, Yorkshire, UK

The dynamic rock cycle

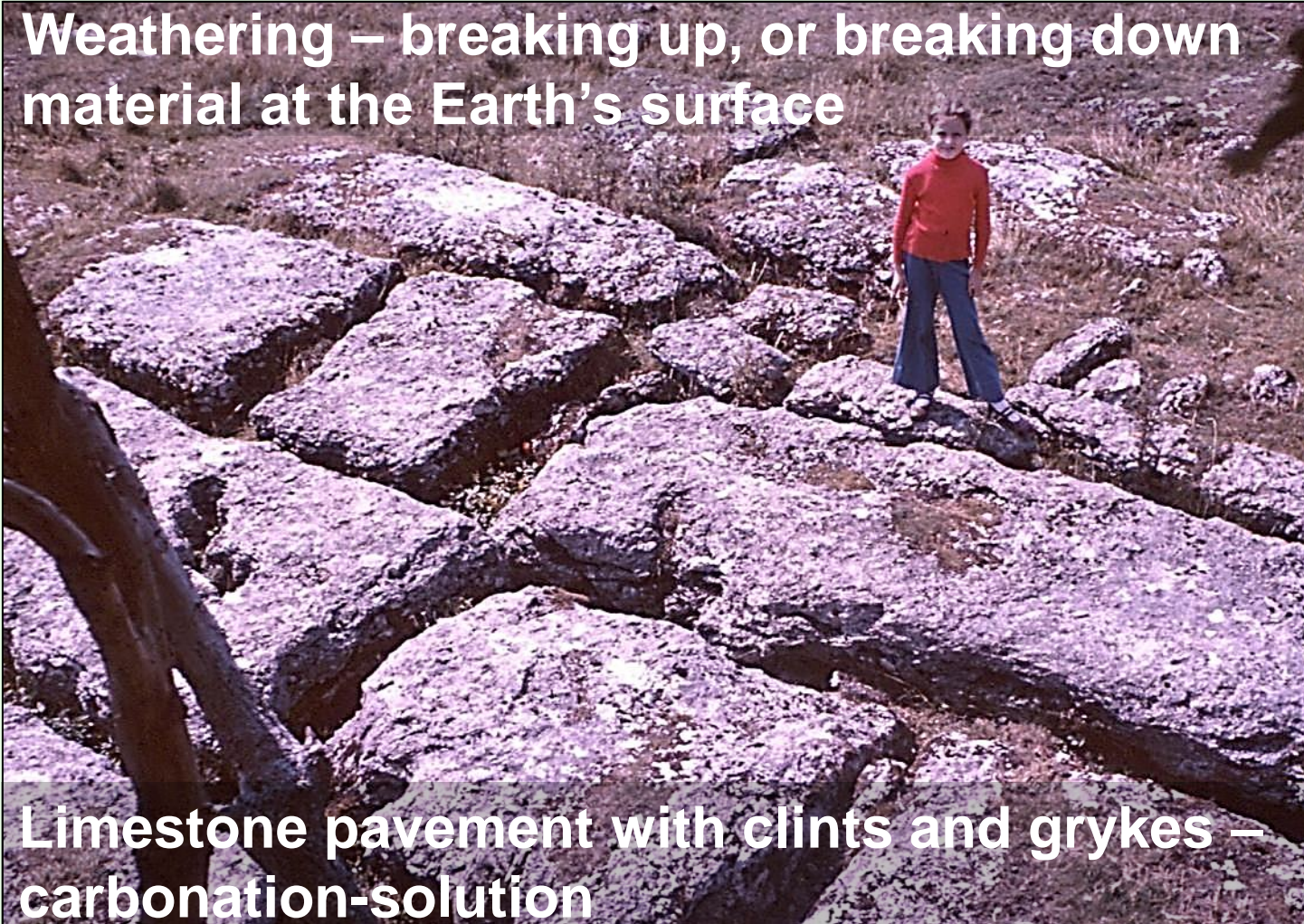
Weathering – breaking up, or breaking down material at the Earth's surface



Gypsum, weathered by solution in rain water

The dynamic rock cycle

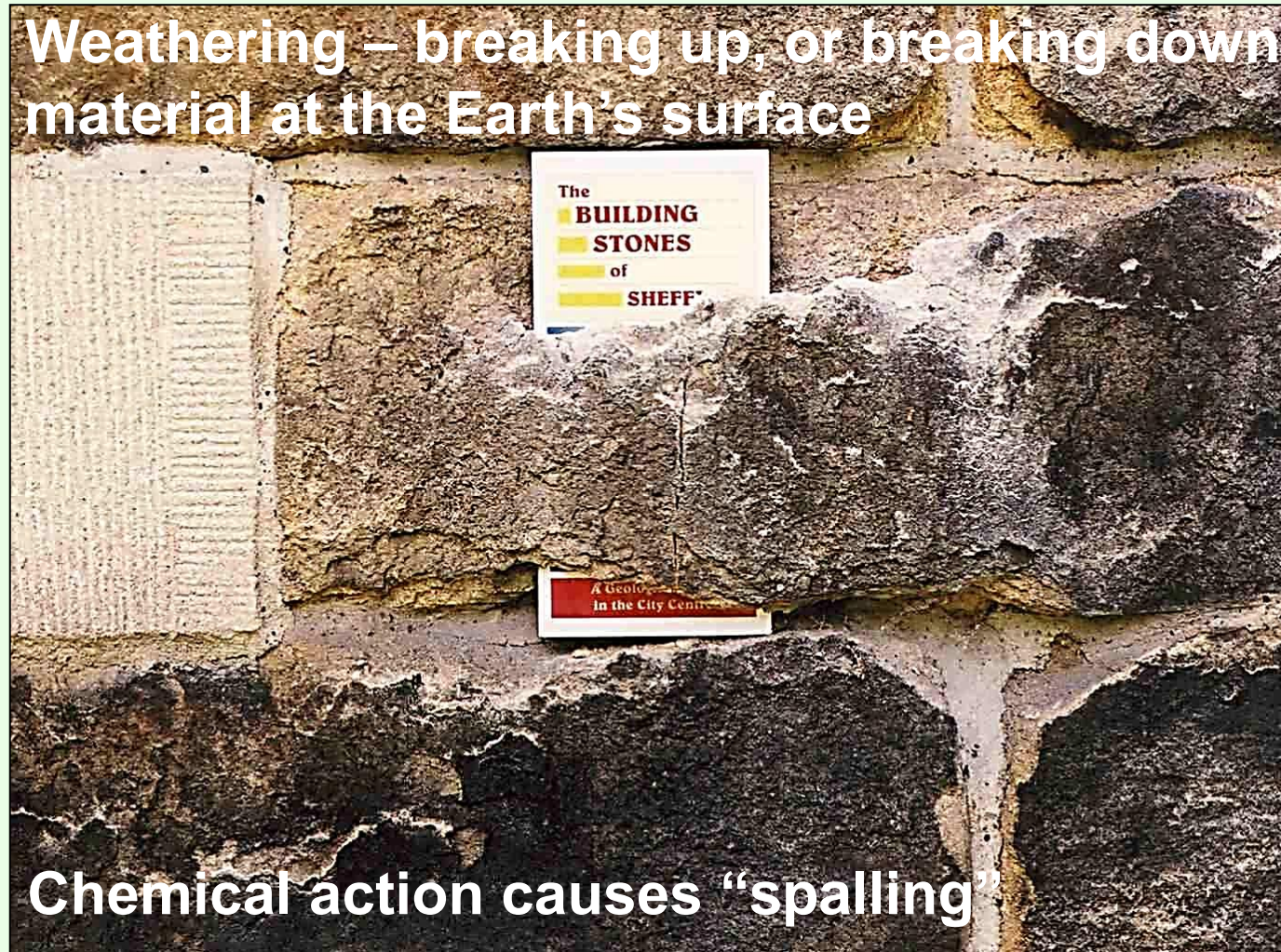
Weathering – breaking up, or breaking down material at the Earth's surface



Limestone pavement with clints and grykes – carbonation-solution

The dynamic rock cycle

Weathering – breaking up, or breaking down material at the Earth's surface



Chemical action causes "spalling"

The dynamic rock cycle

Weathering and erosion

Weathering definition: Weathering is the natural break up (physical break up) and break down (chemical breakdown) of rock and other materials *in situ* (in place) at the Earth's surface, without the removal of solid material

Erosion definition: Erosion is the removal of solid material, which has usually been loosened by weathering - by gravity, flowing water, wind or ice; erosion is usually the beginning of transportation

So, in summary:

Weathering loosens solid material and removes dissolved material.
If solid material is removed – this is erosion

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Activity 2: Erosion and transportation - rock resistance (seconds to tens of years)

Investigate rock resistance to find out how rocks erode at different rates and use this to explain the formation of uplands and coastal headlands by the more resistant rock types. You can find the video at:

<https://www.earthlearningidea.com/Video/Erosion.html>



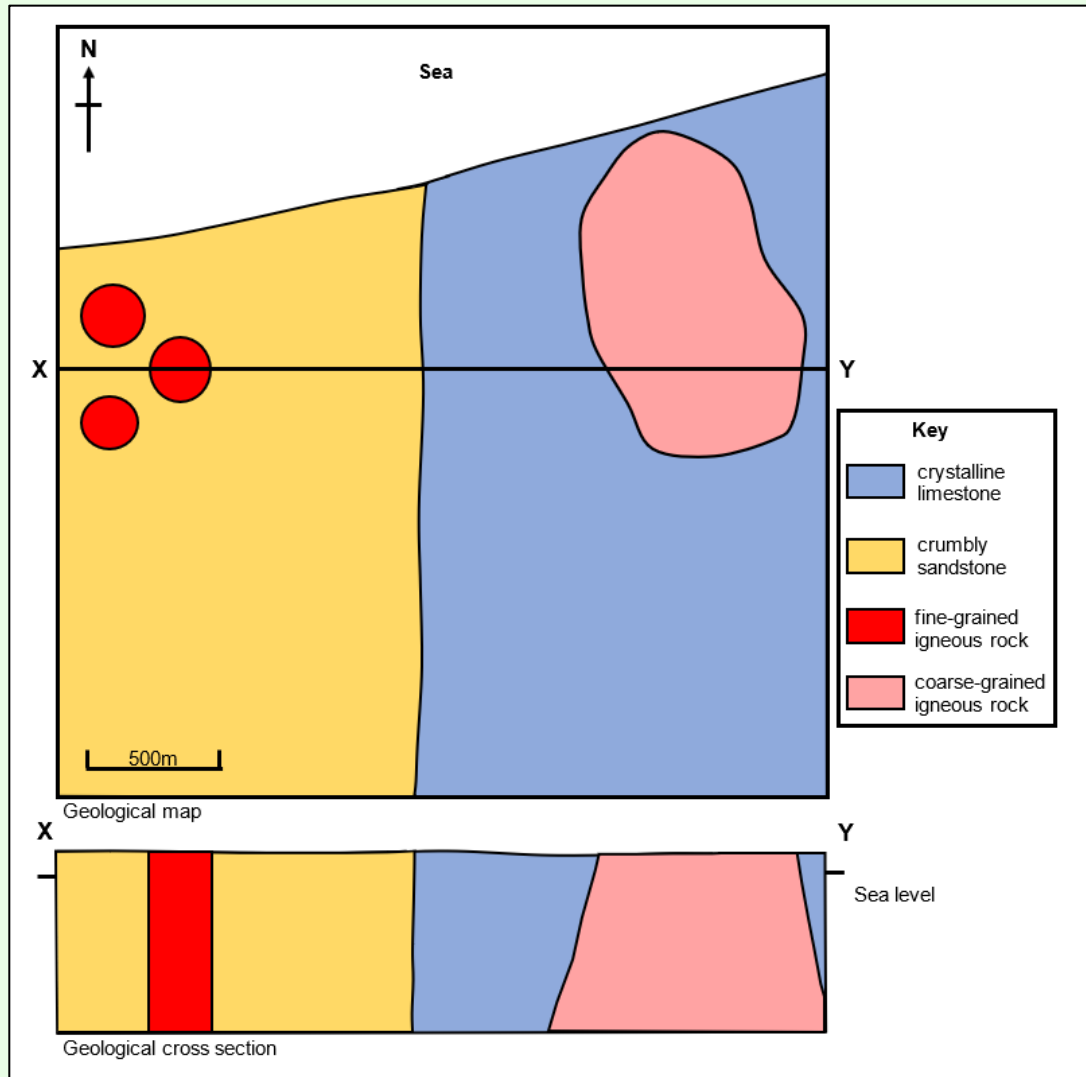
Investigating erosion

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Erosion – investigating the resistance of rock samples

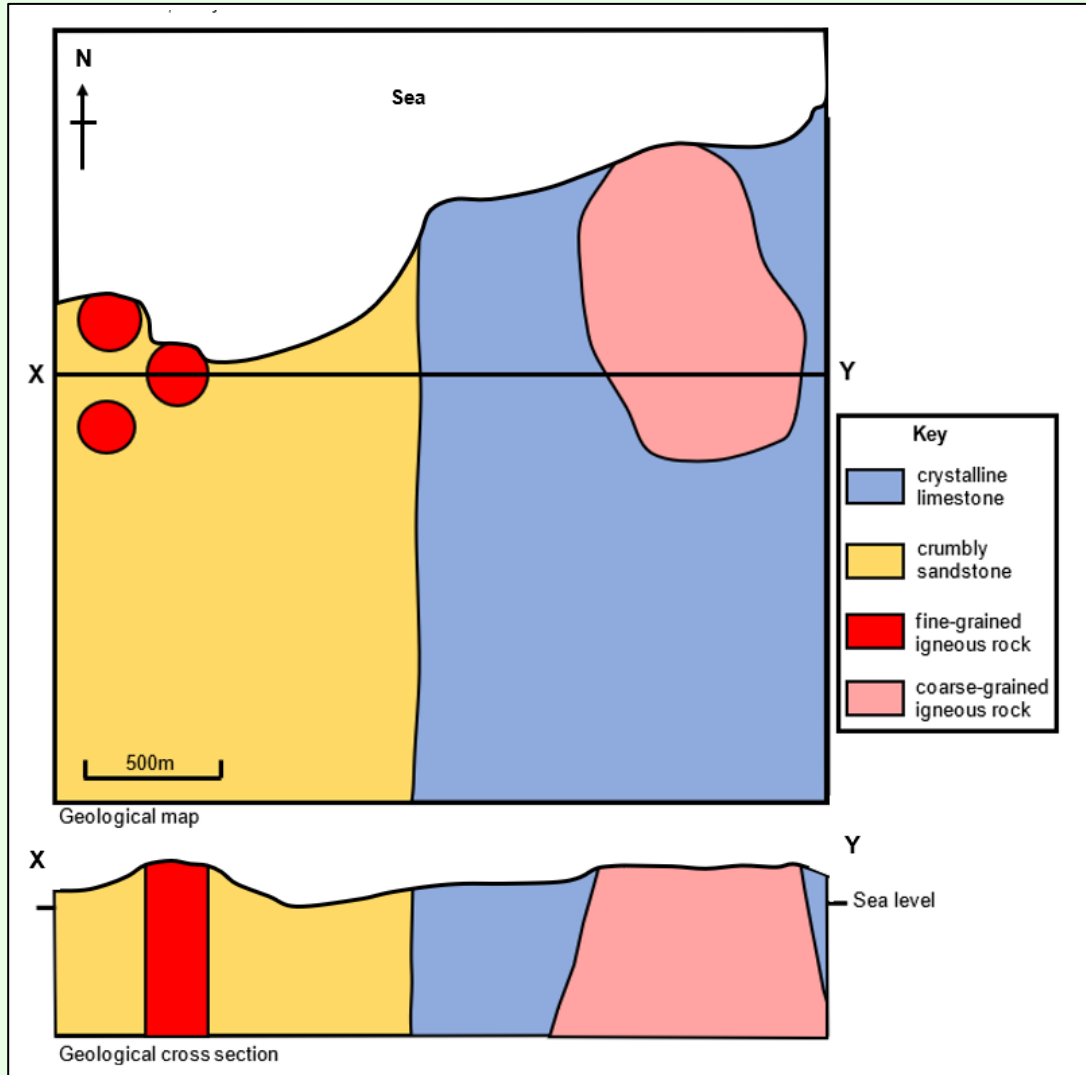
This area formed of
four different rock
types has a straight
coastline and a flat
surface.

What will it look like
in 10,000 years ?



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Erosion – investigating the resistance of rock samples



- Which rocks form headlands, hills? Which form bays, valleys?
- What does it mean when you walk uphill?

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Erosion – investigating
the resistance of rock
samples



A sandstone bump creates a blind summit

The dynamic rock cycle

Activity 3: Transportation and deposition **- the movement of sand in flowing water** (seconds to thousands of years)

Investigate the processes by which sediment grains are eroded, transported and deposited by flowing water, in the lab – through the videos at:

https://www.earthlearningidea.com/Video/Small_scale_processes1.html



'Rainstorm erosion' (runoff from a heavy rain carries topsoil from unprotected, highly erodible soils in northwest Iowa)

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Deposition
– investigating
the movement
of sand in water

**The bed of a shallow stream.
Which way is the current flowing?**

The dynamic rock cycle



Deposition
– investigating
the movement
of sand in water

**Sand flats at Conway, North Wales, UK.
Which picture matches the gutter – this one,
or...?**

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Deposition
– investigating
the movement
of sand in water

... this one?

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Deposition
– investigating the movement
of sand in water



Cross-bedded sandstones in the Orkneys, Scotland

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Activity 4: Compaction and cementation - sediments into rocks (hundreds to millions of years)

All sediment was once loose. To become rock, the grains need to be squeezed together (compacted) and/or glued together (cemented). Investigate this through:

https://www.earthlearningidea.com/Video/Compact_cement1.html



‘Syringe on the palm of your hand and press the plunger to squeeze water out’

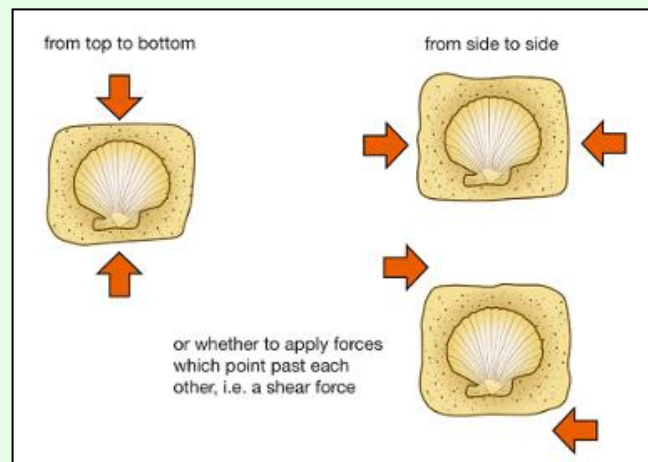
The dynamic rock cycle

Activity 5: Metamorphism - detecting the distortion

(millions of years – during mountain building)

These activities simulate the effects of pressure in forming metamorphic rocks. Video at:

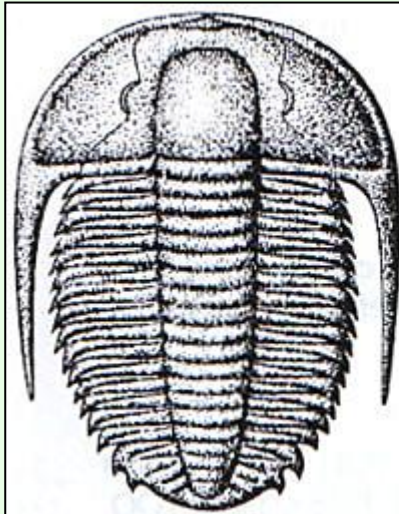
<https://www.earthlearningidea.com/Video/Metamorphism1.html>



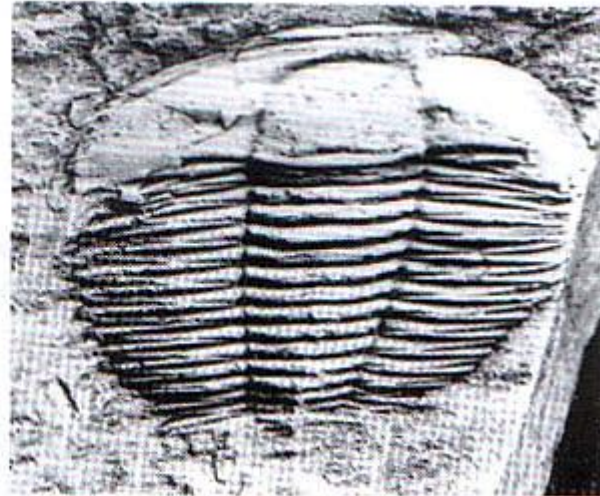
'Distortion'

The dynamic rock cycle

Metamorphism - detecting the distortion



A trilobite - as it lived
(and died)



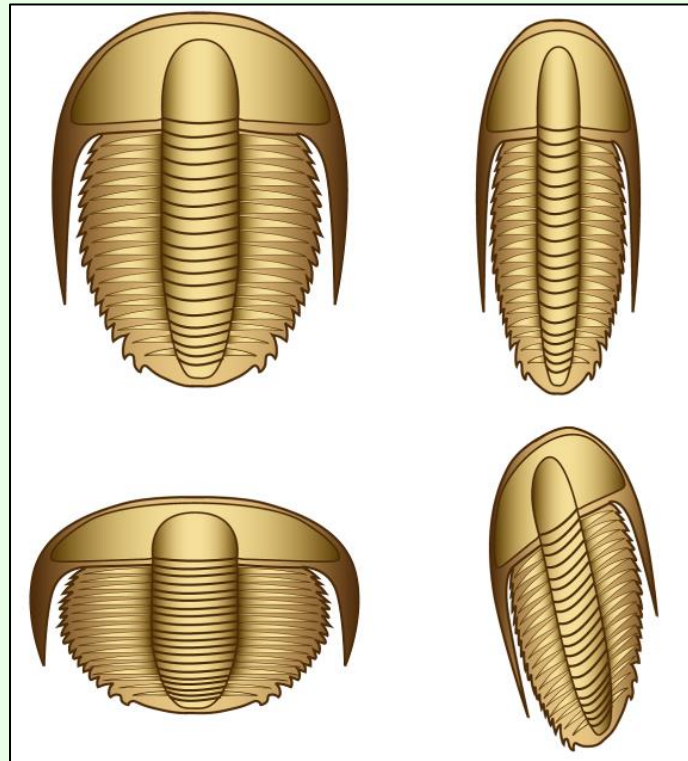
A trilobite as found in the
metamorphic slates of North
Wales

- By how much has the trilobite been distorted? - $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$?
- By how much have the surrounding rocks been distorted?
- By how much has North Wales been distorted?
- What might be big enough to cause this scale of distortion?

The dynamic rock cycle

Metamorphism - detecting the distortion

Study each of the drawings below. They show several trilobites found in slates. The top left is an undistorted trilobite; the trilobites in the other pictures have been distorted by forces in the Earth.



The dynamic rock cycle

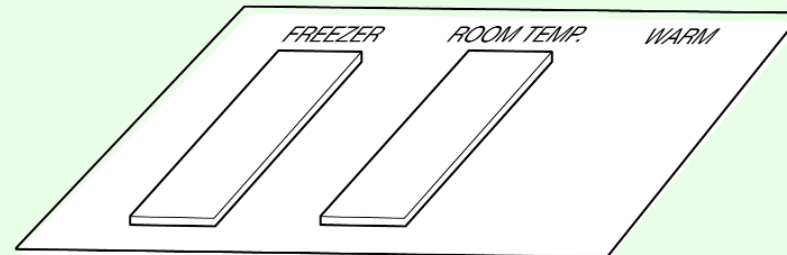
Activity 6: Crystallisation

- **fast or slow cooling, large or small crystals**

(Extrusive – seconds to weeks; Intrusive - thousands to millions of years)

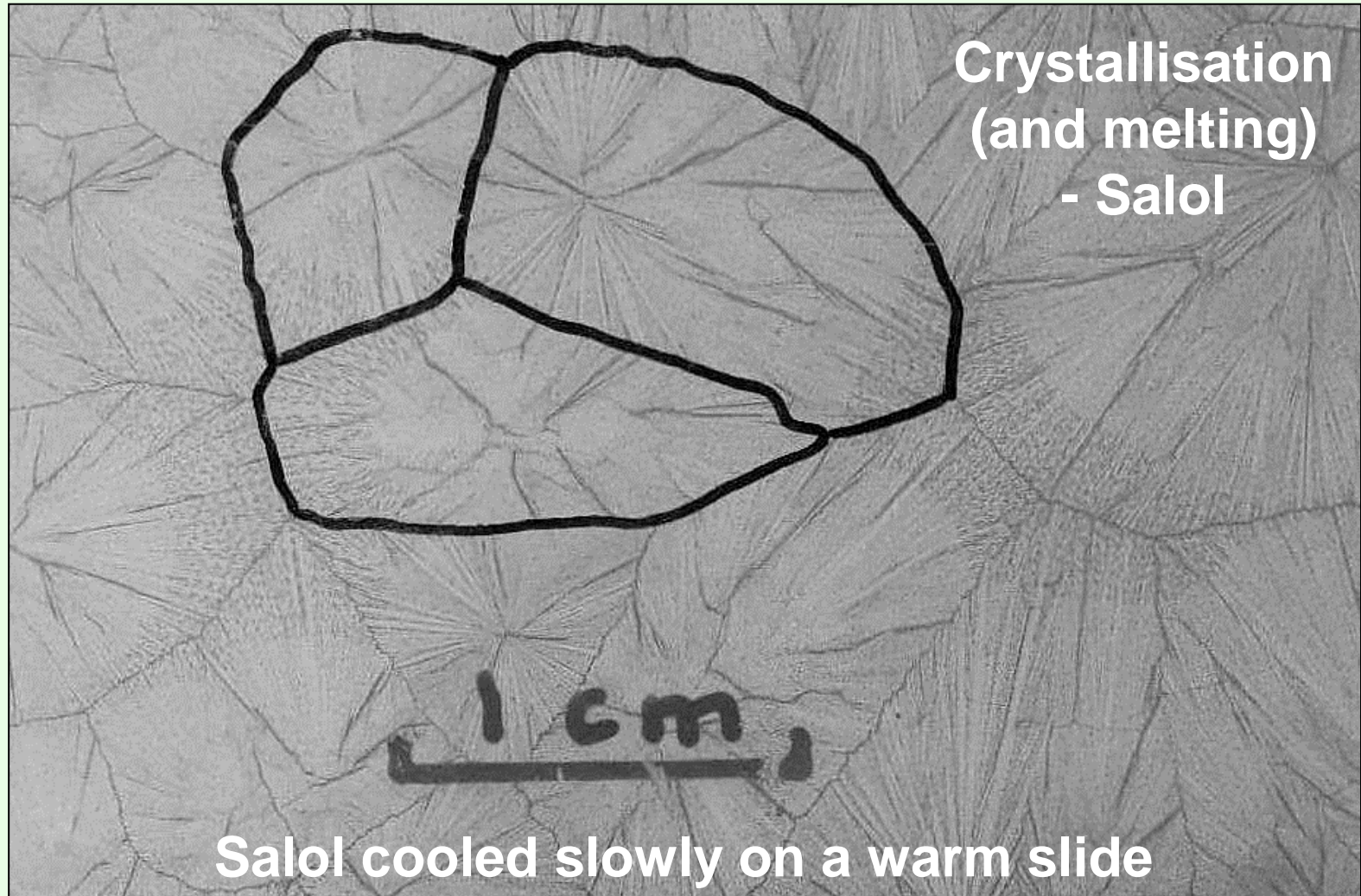
We can find out why the crystals in igneous rocks have different sizes through simulating the growth of crystals from magma by growing crystals from a melt in the laboratory. See:

<https://www.earthlearningidea.com/Video/Crystallisation.html>



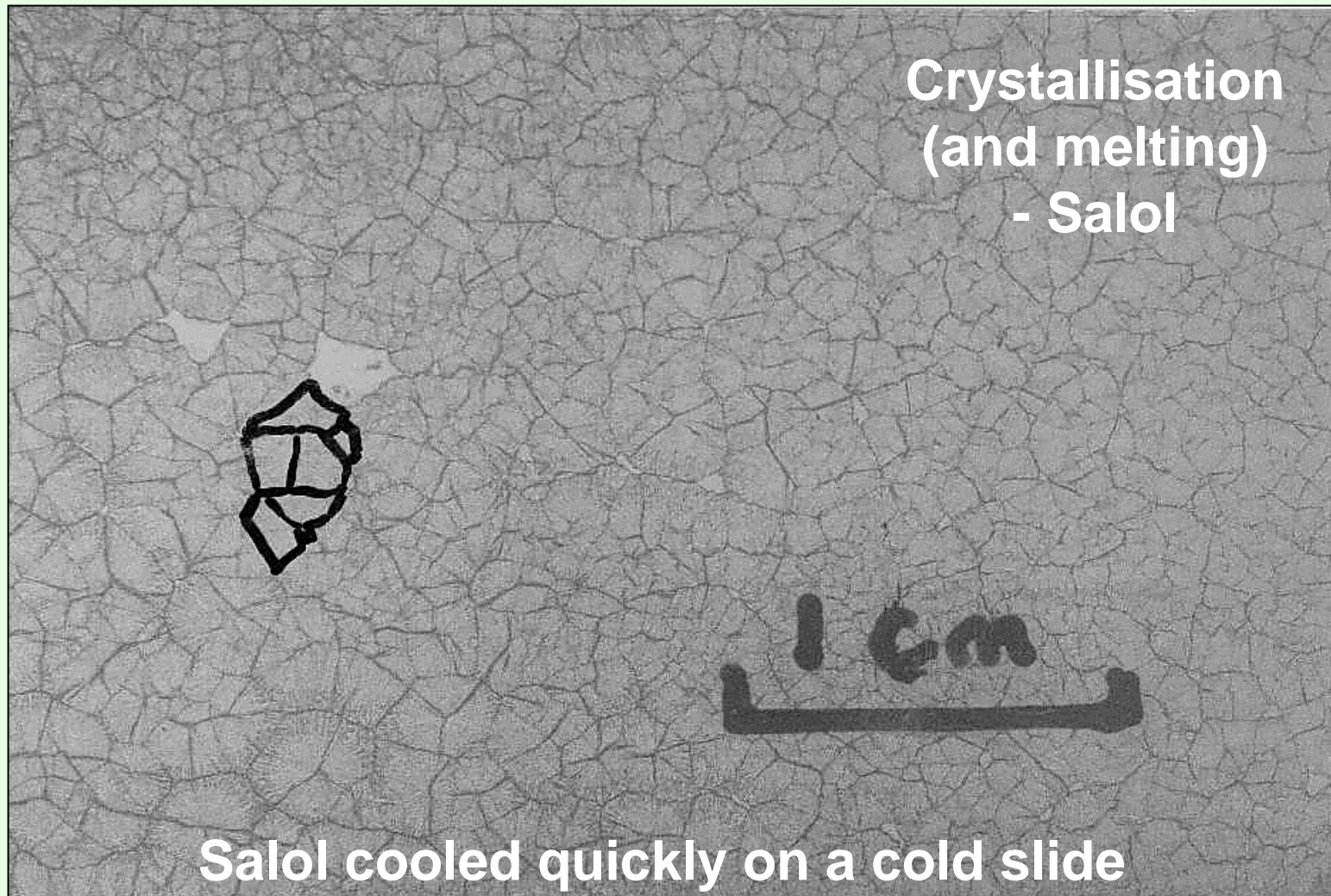
microscope slides on the 'freezer' and 'room temperature' parts of the paper

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See videos at: <https://www.earthlearningidea.com/Video/Salol.html>

The dynamic rock cycle



See videos at: <https://www.earthlearningidea.com/Video/Salol.html>

The dynamic rock cycle

Activity 7: Extrusion - Igneous rocks 'in the laboratory' (seconds to weeks)

This activity helps to investigate what controls the viscosity of lava and how this influences the shape of volcanic landforms – at:

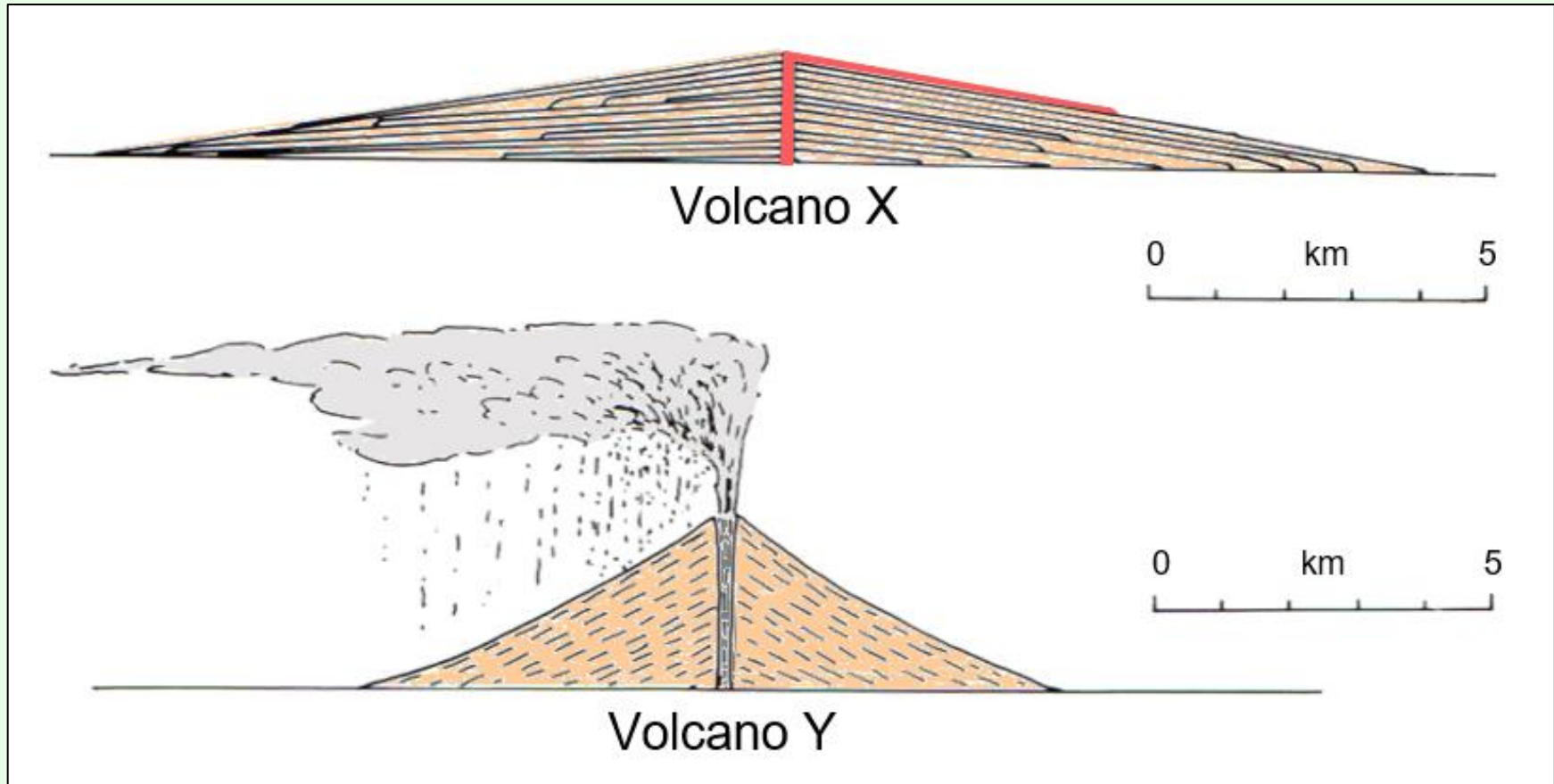
<https://www.earthlearningidea.com/Video/Extrusion.html>



Mount Etna eruption

The dynamic rock cycle

'Lava' in the laboratory: the treacle investigation



- Which volcano was formed by runny lava?
- Which volcano was formed by slow-flowing lava?
- Which sort of eruption would you like to watch?

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'Lava' in the laboratory: the treacle investigation

Scientific accuracy

- Whilst the treacle model of magma correctly shows that the temperature of the magma, the amount of crystals it contains and its water/gas content (as well as its composition), all play key roles in how explosive eruptions are ...
- ... water content has the opposite effect of that shown by the treacle model
- For complex reasons, the more water a volcanic magma contains, the more explosive it usually becomes.

The dynamic rock cycle

Activity 8: Deformation and uplift - make your own folds and faults

(seconds [faulting] to millions of years [folding, faulting, metamorphism during mountain building])

This activity shows how folded and faulted rocks can provide evidence of the size and direction of the forces which produced the deformation. See the video at:

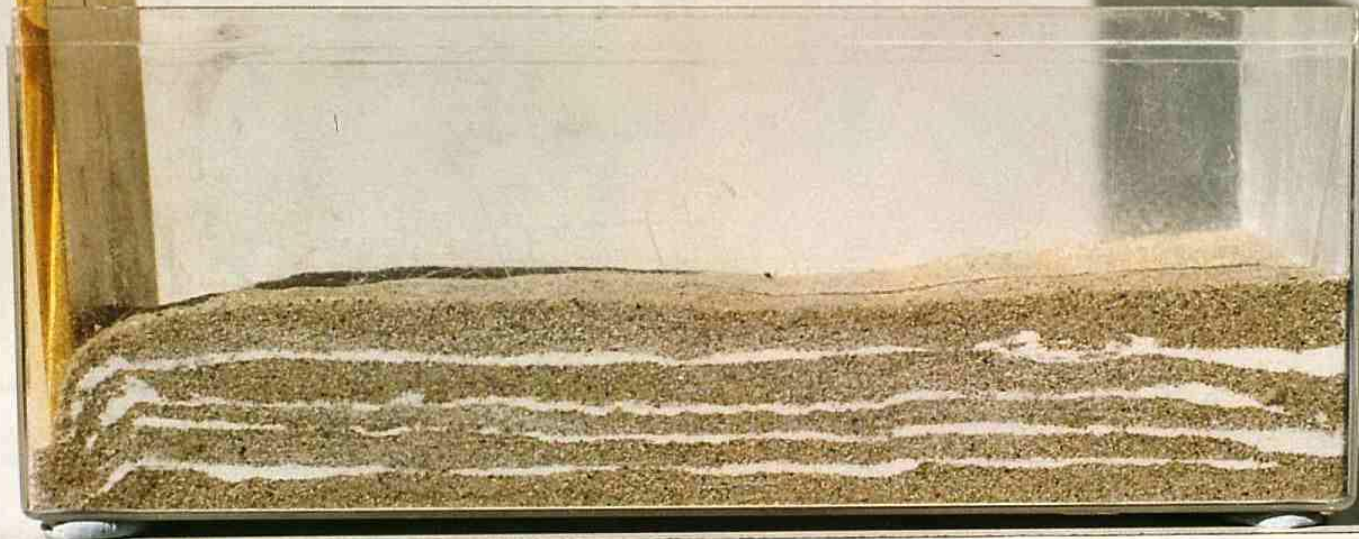
<https://www.earthlearningidea.com/Video/Deformation.html>



'Folded strata'

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Deformation – make your own folds and faults



The Himalayas in 30s...

The dynamic rock cycle

Deformation – make your own folds and faults



The Himalayas in 30s

The dynamic rock cycle

Deformation – make your own folds and faults



The Himalayas in 30s

The dynamic rock cycle

Deformation – make your own folds and faults



The dynamic rock cycle

Deformation – make your own folds and faults



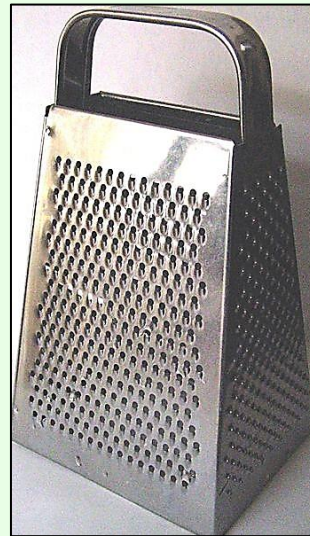
Normal fault,
Orgreave opencast site, Rotherham, UK

The dynamic rock cycle

Rock cycle review: The rock cycle in wax

When you have taught the rock cycle, revisit and revise it with your pupils. Videos at:

https://www.earthlearningidea.com/Video/RC_review1.html



The dynamic rock cycle

Rock cycle review: A wax volcano in the lab

Volcanoes are exciting – hence all the volcano footage on TV. They can be used to fire pupils' imaginations, and safe analogues of the behaviour of molten rocks can be demonstrated in the school laboratory. This Activity consists of a teacher-led demonstration for the whole class. It also demonstrates how “rocks” may form below “ground”, as well as on the surface. See:

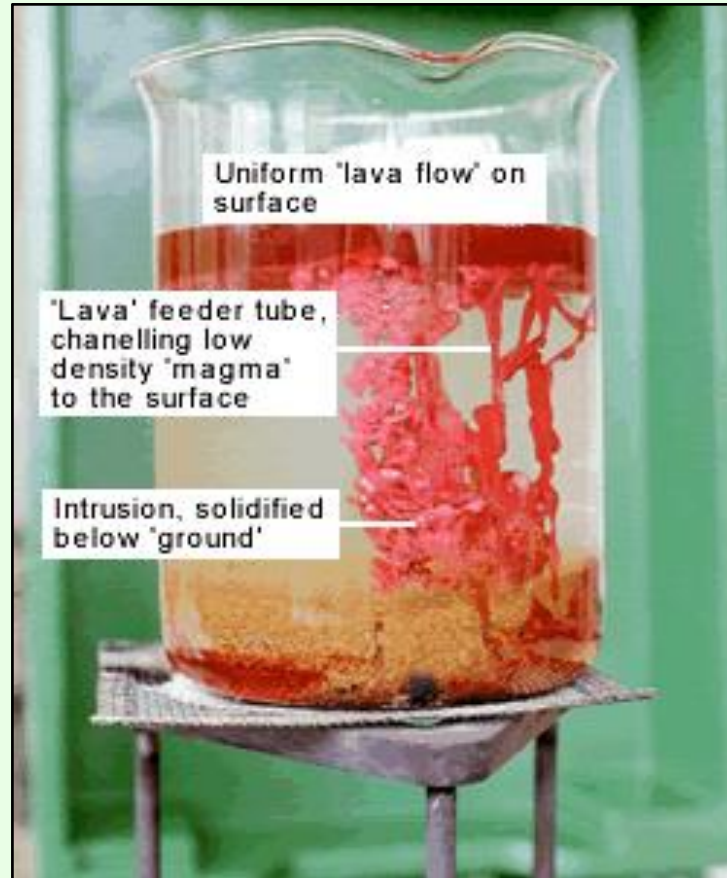
https://www.earthlearningidea.com/Video/RC_review2.html



'wax volcano'

The dynamic rock cycle

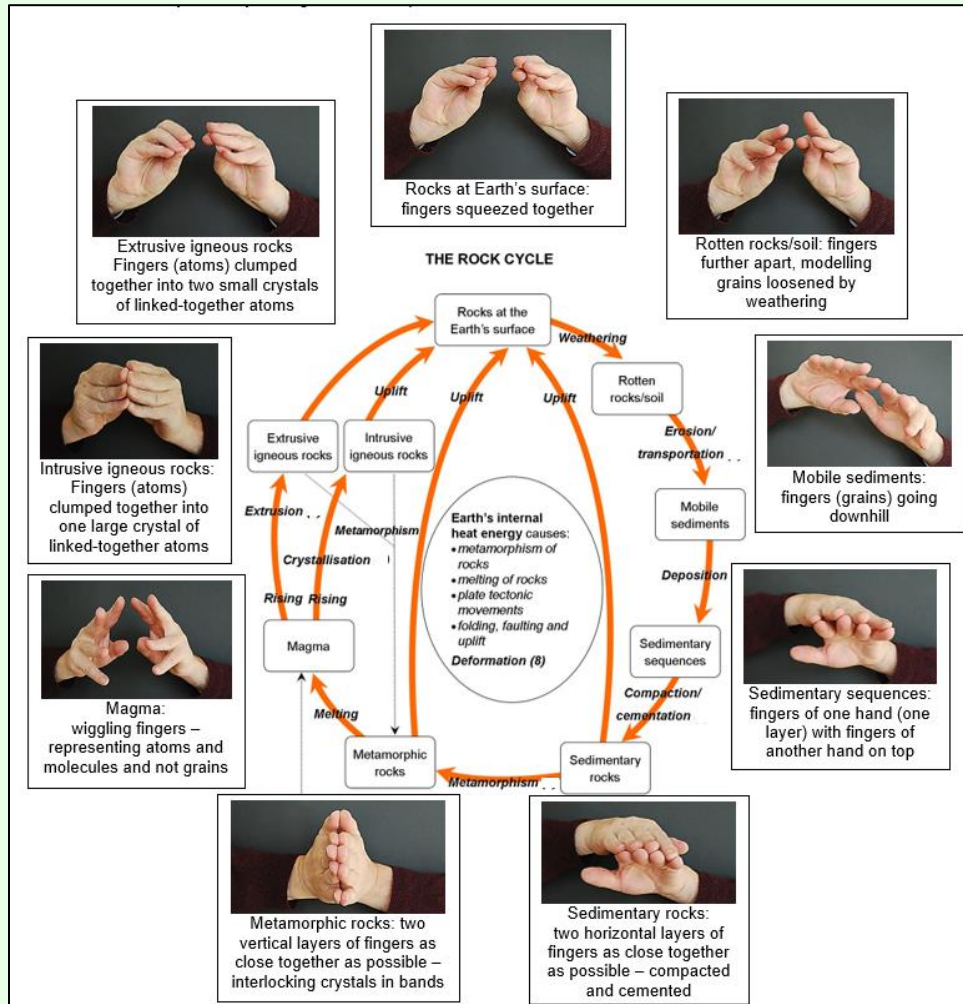
Rock cycle review: A volcano in the lab



(Click to set the volcano off)

The dynamic rock cycle

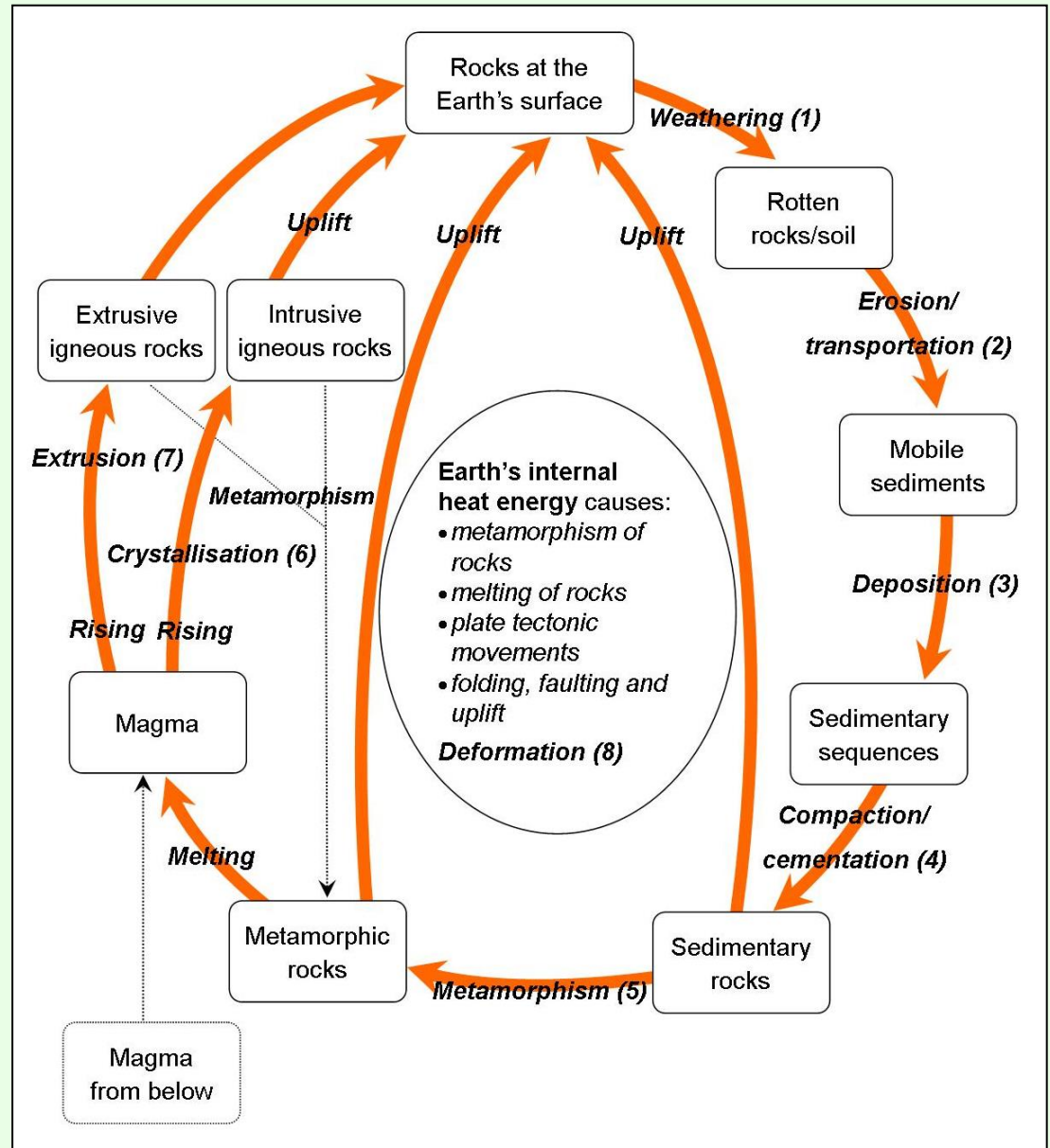
Rock cycle review: The rock cycle at your fingertips



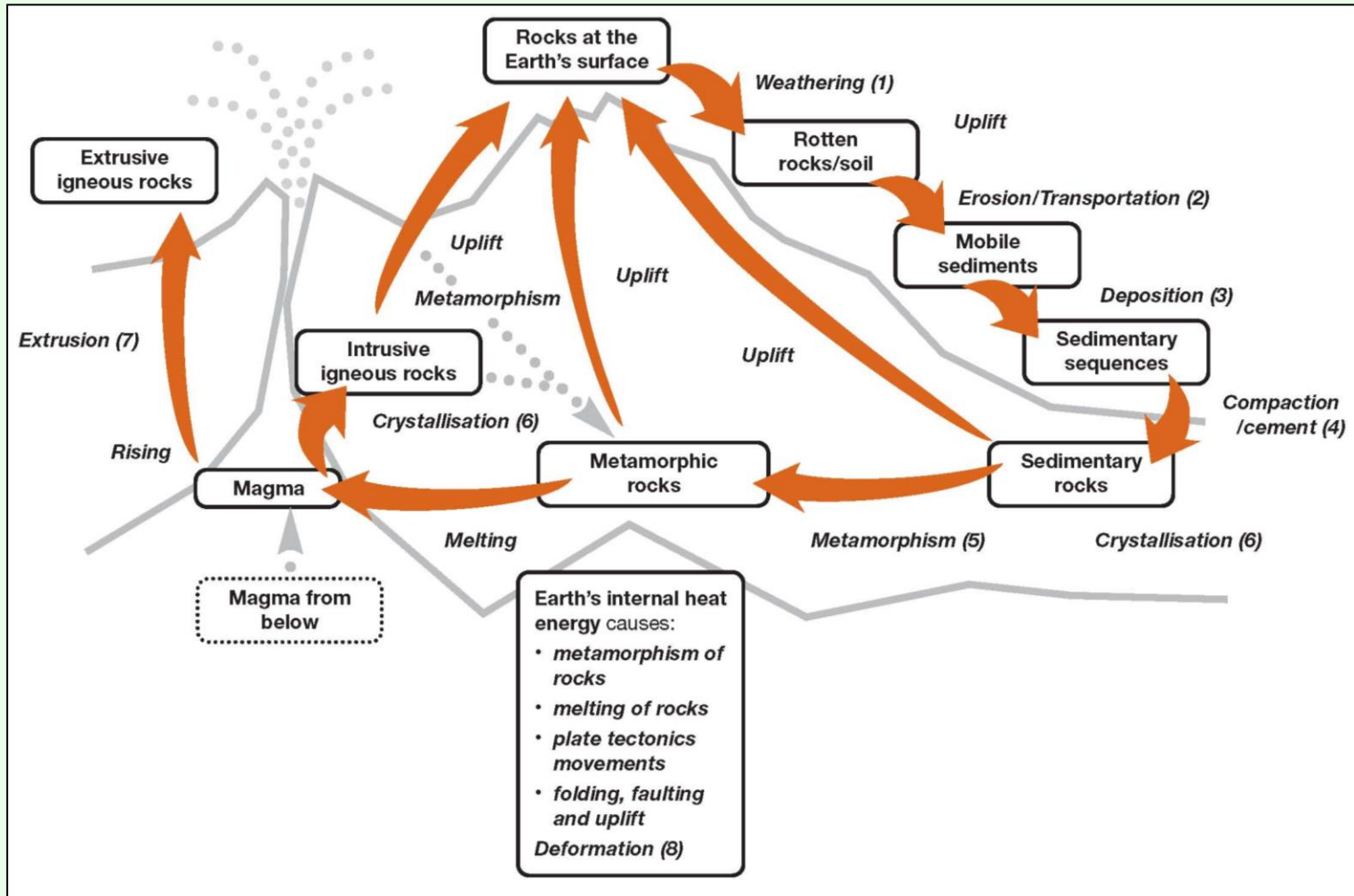
See:

https://www.earthlearningidea.com/Video/RC_review3.html

The dynamic rock cycle



The dynamic rock cycle



'Diagrammatic version of the rock cycle'

The dynamic rock cycle

Copyright

'Diagrammatic version of the rock cycle' © redrawn from an original by BP International Limited, with permission

'The Rock Cycle' © ESEU

Background image: 'Key Stage 3, Sc3.4 The environment, Earth and universe' ©Peter Kennett

Background image: 'Attainment target 1: How science works' © Peter Kennett

Background image: 'Attainment target 3: Materials, their properties and the Earth' © Peter Kennett

Background image: 'Level 5' © Peter Kennett

Background image: 'Level 6' © Peter Kennett

Background image: 'Level 8' © ESEU

Background image: 'Exceptional performance' © Peter Kennett

Rock reference sheet © Michèle Bourne and Peter Kennett, ESEU

'Gypsum, weathered by solution in rain water' © Peter Kennett

'Clints and grykes – carbonation-solution' © Peter Kennett

'Chemical action causes "spalling"' © Peter Kennett

Investigating the resistance of rock samples to "erosion" © Earth Science Teachers' Association (ESTA)

'A sandstone bump creates a blind summit' © Peter Kennett

'Rainstorm erosion' (runoff from a heavy rain carries topsoil from unprotected, highly erodible soils in northwest Iowa) © Photo by Lynn Betts, USDA Natural Resources Conservation Service

'The bed of a shallow stream' © Peter Kennett

Sand flats at Conway (2 images) © Peter Kennett

The dynamic rock cycle

Copyright continued...

'Cross-bedded sandstones in the Orkneys' © Peter Kennett
'Syringe on the palm of your hand and press the plunger to squeeze water out' © ESEU
'Distortion' © ESTA, redrawn by ESEU
'Trilobites' (drawing and image) © ESTA
'Trilobites' (drawings) © Chris King, redrawn by ESEU
'Microscope slide on the 'room temperature' part of the paper' © ESTA, redrawn by ESEU
'Salol cooled slowly on a warm slide' © Peter Kennett
'Salol cooled slowly on a cold slide' © Peter Kennett
Mount Etna eruption © Fabricius
Volcano X and Y © ESTA
'Folded strata' © Peter Kennett
'The Himalayas in 10s...' © Peter Kennett
'Squeezebox' © Peter Kennett
'Break thrust, Lizard' © Peter Kennett
'Orgreave opencast site, South Yorkshire' © Peter Kennett, ESEU
'Red candles' © loyna
'Cheese grater' © Emj
'Matches – Swan Vestas' © Oxfordian Kissuth
'Wax volcano' © Peter Kennett

The dynamic rock cycle

Workshop outcomes

The workshop and its activities provide the following outcomes:

- identification and terminology of rock cycle products, including soils, sediments and rocks;
- knowledge and understanding about rock cycle processes and timescales, including weathering, erosion/transportation, deposition, compaction/cementation, metamorphism, melting, crystallisation, extrusion and deformation;
- methods of teaching the abstract concept of the rock cycle, using a range of teaching approaches;

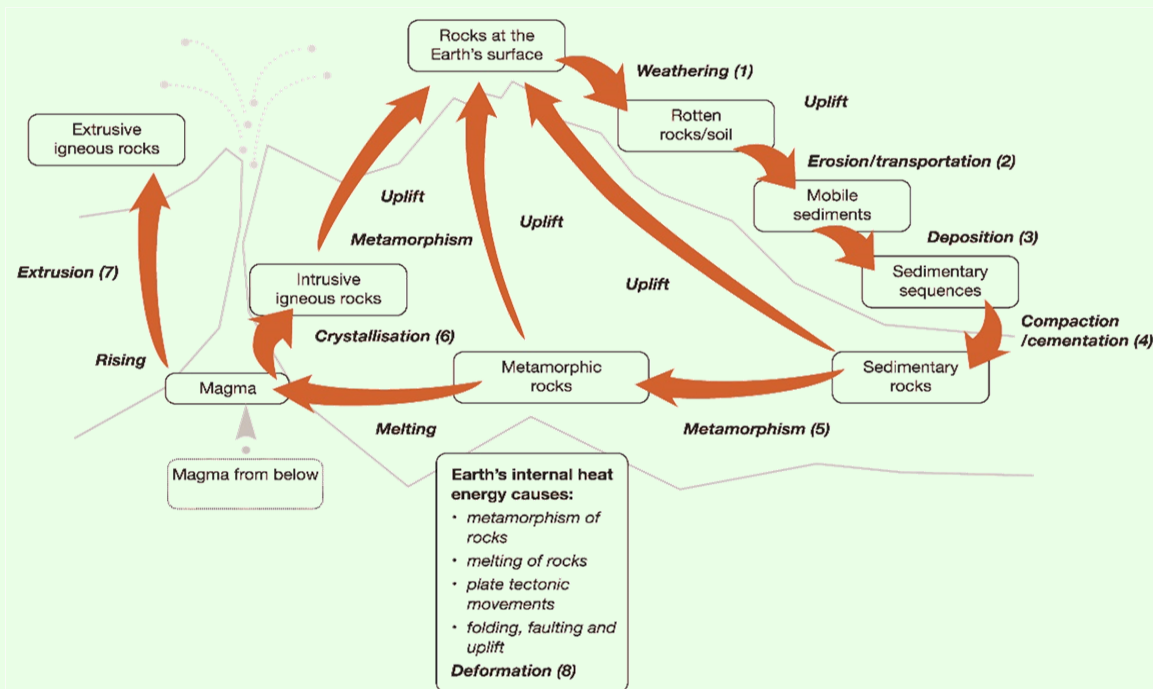
The dynamic rock cycle

Workshop outcomes

- introduction to a range of Earth science laboratory activities, from simple modelling to more complex investigations;
- approaches to activities designed to develop the thinking and investigational skills of pupils;
- links between laboratory models and planetary processes, some of which are locally active and therefore relevant to pupils;
- an integrated overview of the geological Earth science commonly taught to 11 – 14 year olds.

The dynamic rock cycle – online

Earth Science for science and geography – video workshop



Developed from
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