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KS4 Homework answer sheet

It is only possible to get an **absolute age** in millions of years, for a geological event if it is possible to use radiometric dating techniques. The most usual form of dating for geological events is to establish a **relative age**: i.e. which order the events in a sequence occurred. Thus geologists use two concepts of time, an **absolute time scale**, and a **relative time scale**. Research is constantly attempting to improve accuracy of the absolute timescale, and the match between the two.

In establishing the **relative time scale** six laws and principles are used:

1 **Law of Original Horizontality:** all sedimentary rocks were originally laid down in a more or less horizontal attitude.
2 **Principle of Lateral Continuity**: in principle, a sedimentary rock is laid down in a layer (or bed) that extends sideways (originally horizontally) and a bed may therefore be found in other places.
3 **Law of Superposition**: in any sequence of strata that has not been overturned the topmost layer is always the youngest and the lowermost layer the oldest.
4 **Law of Faunal and Floral Succession**: Fossil organisms have succeeded one another in a definite recognisable order over geological time. It follows that the same combinations of fossils in rocks have a similar (relative, not absolute) age, as do the rocks that contain them. This means that the relative age of sedimentary rocks may be identified by the fossils they contain.
5 **Law of Cross-Cutting Relationships:** any structure (fold, fault, weathering surface, igneous rock intrusion, etc.) which cuts across or otherwise deforms strata must be younger than the rocks and structures it cuts across or deforms.
6 **Law of Included Fragments:** particles are older than rock masses in which they are included. So the pebbles in a conglomerate are from rocks older than the conglomerate itself.

At The Ercall the sequence is worked out in the following way:
Intrusive igneous rocks, by definition, must have been intruded into other rocks (called "country rocks") even if these country rocks are not visible at an exposure. Therefore the igneous rocks are younger than the country rocks (Law of Cross Cutting relationships). Also, since the conglomerates lie on top of the granophyre, and contain rare weathered pebbles of granophyre, the conglomerates must also be younger than the granophyre which supplied the pebbles. (Principles of Superposition and Principle of Included Fragments), with weathering and depositional events between the two. **So F, then A then D.**

After deposition the sands and pebbles must have been cemented**, so C is next.**
Later the rocks were uplifted, faulted, tilted and eroded, (Law of Cross-cutting Relationships) thereby exposing them for quarrying. Afterwards the quarries were protected. **So G then E then B**

The correct order with oldest first is:

YOUNGEST EVENT

B. The quarries are sold to Shropshire Wildlife Trust as a nature reserve.
E. Resistant rocks are dug out of the ground for use as road stone.
G. Uplift, tilting, faulting and erosion of the conglomerate and sandstones occurs.
C The pebbles and sand are cemented into hard sedimentary rocks.
D. Pebbles and sand, weathered from older rocks, are deposited in beds on top of the granophyre.
A. The overlying rocks are eroded until the pink granophyre is exposed at the earth's surface.
F. Magma is intruded into older rocks and crystallises into a pink igneous rock called granophyre.

OLDEST EVENT

This is an example of awful doggerel that could be used to motivate students.

Ercall Pome.

"Pardon my **intrusion**",
said the pink **granophyre**
as it rose up from the mantle
but could not get much higher
because the cooling of the magma
meant its crystals were quite small
and when they had solidified
it wouldn't move at all.

"Forgive my **erosion**"
said the shallow sea
as it flowed over the surface
and it plucked the pebbles free,
but the pebbles that were made
from the underlying rocks
got cemented together
in a seven metre block*

"Excuse my sedimentation"
said the grains of sand
as they sank to the sea bed
and became a quartzite band.
The rocks got deeply buried
in the time that these things take
so the forces of earth movements
made some large earthquakes.

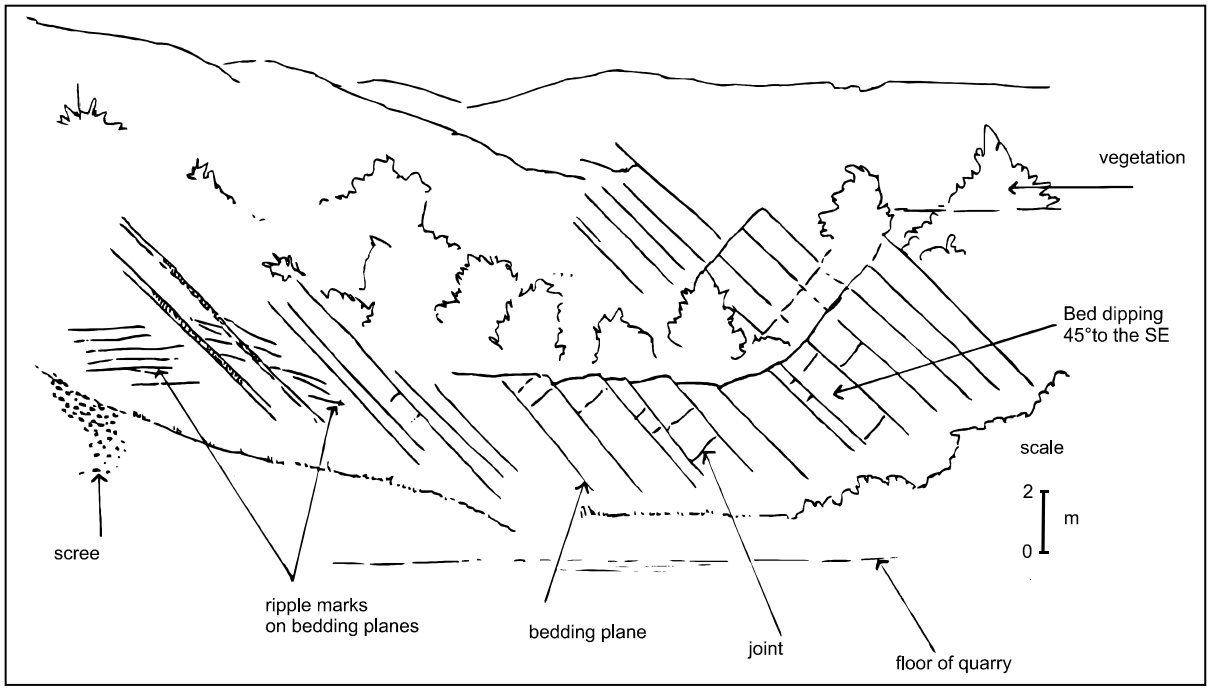
"I apologise for digging",
said the Shropshire quarryman
as he blasted out the road stone
for where the new roads ran
but the rock is most hardwearing
so it's very good to use
and the nice pink colour
makes our pathways pretty to use.**

"Welcome to our Reserve"
said the Shropshire Wildlife Trust
as they started to look after
all the landscape as we must.
And this is how we got to here
so now I'll have to run
because it's getting rather late
but at least my homework's done.

*I know it's not a block, it's a bed – but it doesn't rhyme!

** I am running out of rhymes

Answer for Pupil Worksheet for Locality "B"



Pupil Work sheet for Localities "C" & "E"

Reading the clues in the sedimentary rocks

1. Carry out all of the tasks at locality C and then complete the information for the sandstone by ticking the correct boxes in the table.

2. Carry out all of the tasks for Activity 1 at locality E and then complete the information for the conglomerate by ticking the correct boxes in the table.

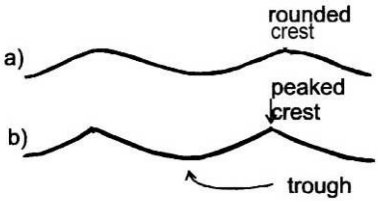
The completed table will give you a summary of some of the things you have found out about the sandstone and conglomerate and how they may have formed.

	Sandstone	**Conglomerate**
The rock shows layers so it was probably deposited in water	✓	✓
The rock is made up of medium sized grains (0.5 to 2mm across) so it was laid down in low to medium energy conditions	✓	
The rock is made up of coarse grains (more than 2mm in size) so it was laid down in higher energy conditions		✓
The particles are rounded so they were transported over a long period of time	✓	
Most of the particles are made of quartz and /or quartzite	✓	
The particles are made of a mixture of different rock types		✓

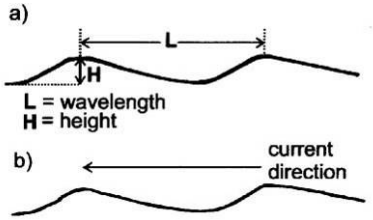
Pupil Worksheet for locality "D"

2. Use diagrams 1 and 2 to help you choose the words that describe the shape of the ripple marks. Record your descriptions in the table.
3. Measure the **wavelength** (**L**) and **height** (**H**) of the ripple marks. (Clue: If you are not sure what these terms mean look at drawing 2). Record your measurements in the table.
4. Use your measurements to calculate the **ripple index** (**R.I**.). Show your working in the table.
5. Measure the horizontal distance from crest to trough. Then measure the horizontal distance from trough to the next crest. Divide the short distance into the long distance to calculate the **Ripple Symmetry Index (RSI).** See diagram below.

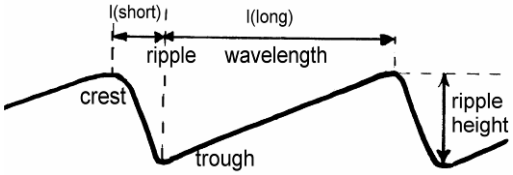
1. Symmetrical ripples



2. Asymmetrical ripples

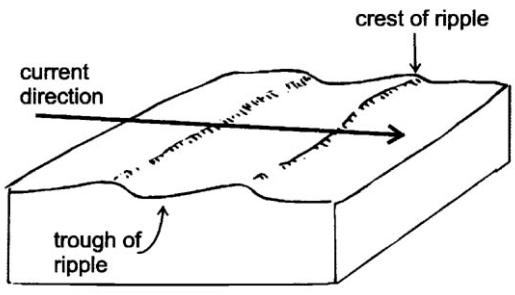


Descriptions	**Put a tick against the word(s) that describe the ripples**
Shape of ripples in cross section: symmetrical? asymmetrical?	✓
Shape of ripples over the crest: peaked? rounded?	 ✓
Shape along the crest: roughly straight/ parallel? roughly straight/ parallel but splitting? curved/ sinuous?	 ✓
Ripple measurements: **Wavelength (L):** **Height (H):**	Write your measurements here (in mm) 170mm 15mm
Calculation of the ripple index (R.I.) **R.I. = wavelength (L)** divided by **height (H)**	Write your working here $\frac{170}{15}$ = 11.33 or an approximate answer.
Calculation of the Ripple Symmetry Index (RSI) **RSI = l(long)** divided **by l(short)** (see the diagram below to get the right measurements)	Write your working here. (A low answer, close to 1 or 2). Ripples with RI below 15 AND an RSI below about 2.5 are those formed by wave action. (See **ERC4 E.S. briefing**)

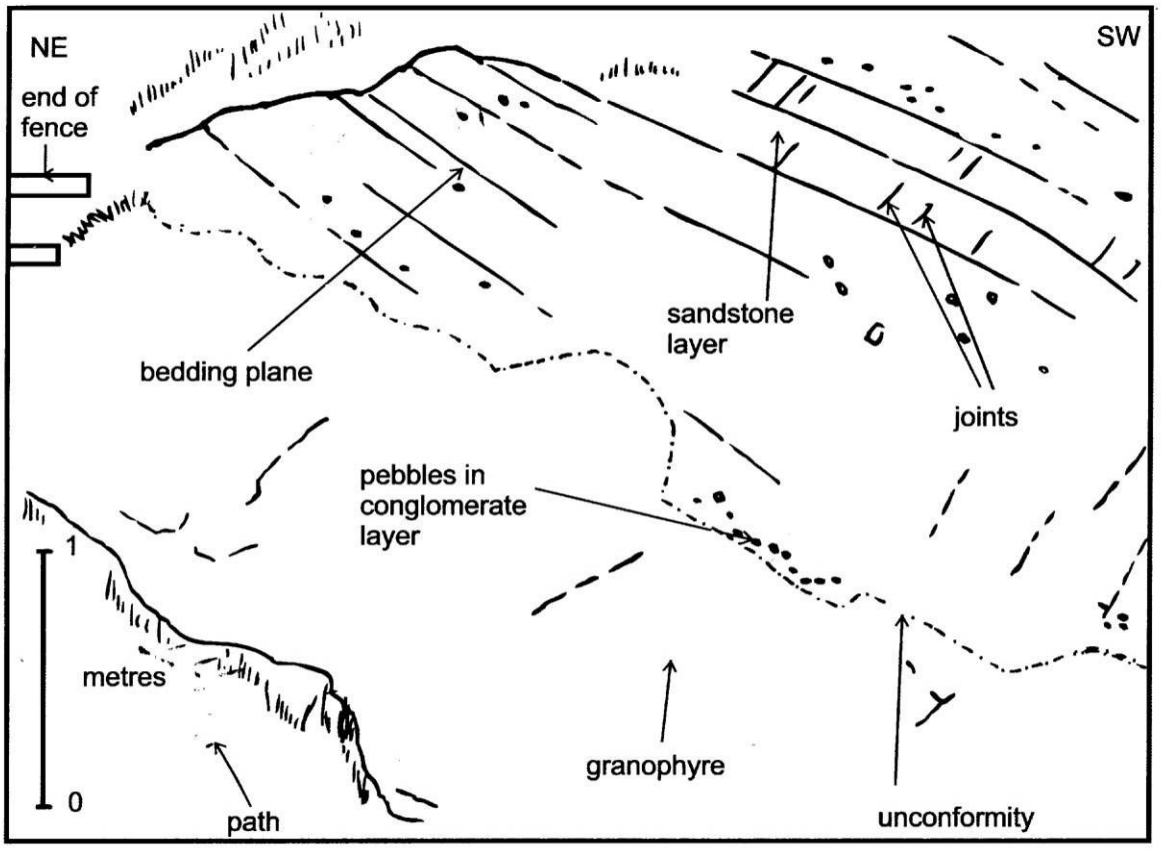


1. On diagram 3 draw in an arrow to show the current direction that may have produced these ripple marks.

3.

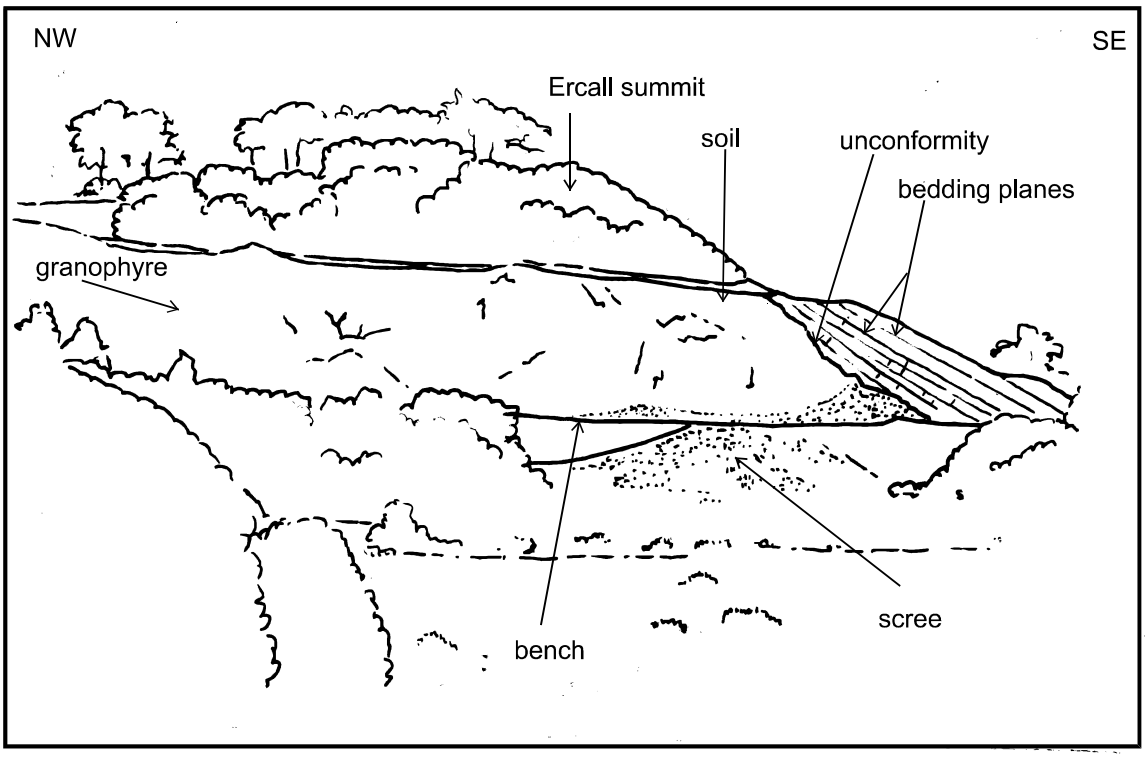


Answer for Pupil Worksheet for Locality "E", Activity 2



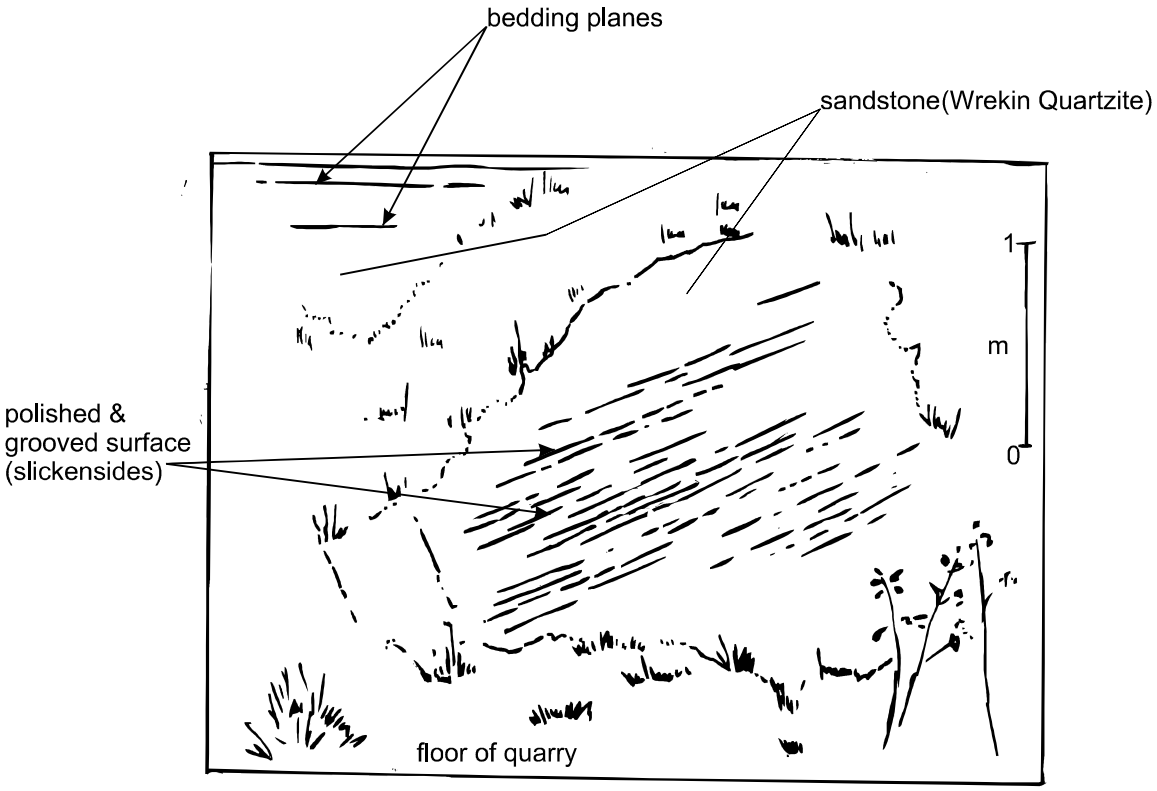
Note: This gives a clue to the answer. The pupils may produce a slightly different final drawing showing where the unconformity lies, but they may be right!
(The key point is that they identify an uneven / irregular boundary between the two rock types).

Answer for Pupil Worksheet for Locality "F"



Rock	When it was formed	How it was formed
Wrekin Quartzite	540 million years ago. In the Cambrian Period.	From sand & gravel deposited in the sea/ on a beach.
Granophyre	560 million years ago. In the Precambrian Era.	From magma. In an igneous intrusion.

Answer for Pupil Worksheet for Locality "G"



Describe the shape & size of slickensides.	Long (0.5 – 1.0m long), shallow (0.5 – 1.00cm deep) parallel grooves.
What is the orientation of the slickensides?	Approximately horizontal & running approx. west to east.
How were the slickensides formed?	When one rock surface moves over another under pressure / when the rocks were faulted.
When did the slickensides form?	After the sandstone formed, when later earth movements must have occurred and the rocks were faulted.
What else may have happened when these slickensides formed?	The rocks fractured & slipped causing an earthquake.
Describe one other pieces of evidence you've seen today for ancient earth movements in the Ercall quarries	1. Tilted layers of originally horizontal sandstone & conglomerate (at locations "C" & "D"). 2. Small fault (brittle fracture) cutting across the ripple marked surface (at location "D"). 3. Granophyre at location "E", which formed deep under the Earth's surface, but is now on the surface, is evidence of vertical earth movements (as well as the erosion which has removed the overlying rocks). 4. Ripple marked surfaces appear twice in the face of quarry 2 (at location "F").

Answer for Pupil Worksheet for Locality "H"

Describe the rhyolite:
It has crystals so small you can't see them, and they lie in thin bands of lighter (pinker) and darker colour.

Explain how the rhyolite was formed:
It was cooled very quickly because the crystals didn't have time to grow to a larger size. This means it is an igneous rock which probably formed at the Earth's surface, not underground.

Use the evidence from your observations around the quarries to work out the relative age of these rhyolites and fill in the table below.
(Relative age means "Is it older, or is it younger than the rhyolites?")

Is the rhyolite older or younger than these events?	**Answer: older or younger**	**The evidence to support this is.**
Quarrying?	**OLDER**	*The rhyolite itself has been quarried.* ***Law of Cross-cutting relationships****: the quarry face cuts the rhyolite, so the rhyolite is older than the quarrying.*
The deposition of the conglomerates?	**OLDER**	*Pebbles weathered from the rhyolite have been found in the conglomerates. (****The Law of Included fragmentss*** *states, the rock providing the pebbles must be older than the rock containing the pebbles).*
The deposition of the sandstones?	**OLDER**	*The conglomerates are older than the sandstones because they are underneath them (****Law of Superposition****). If the rhyolites are older than the conglomerates, (see above) then they must also be older than the sandstones.*
The tear faulting?	**OLDER**	*The tear faulting cuts across the sandstones. This means the sandstones are older than the tear faulting, and the rhyolites are older than the sandstones (See above). So they must be older than the faulting.*
The episode of tilting of the rocks?	**OLDER**	*The tilting affects the sandstones. This means the sandstones are older than the tilting, and the rhyolites are older than the sandstones (See above). So they must be older than the tilting.*
Present day weathering?	**OLDER**	*Present day weathering can be seen to affect these rocks. The Law of Cross-cutting relationships states that the rhyolite must therefore be older than the weathering.*
The formation of the granophyre?	**?**	*In fact radiometric dating shows that the rhyolites pre-date the granophyre (which must therefore cross-cut them). However,* ***NO*** *evidence to indicate these relative dates has been seen by your group.* *Point out that Earth Scientists often have to work with pieces of evidence which are missing because they have never been preserved, have been eroded away, or are still buried*