Funded by Defra's Aggregates Levy Sustainability Fund, administered by English Nature.

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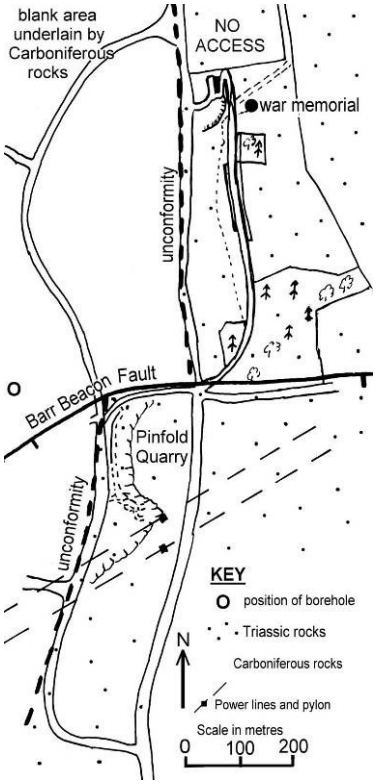
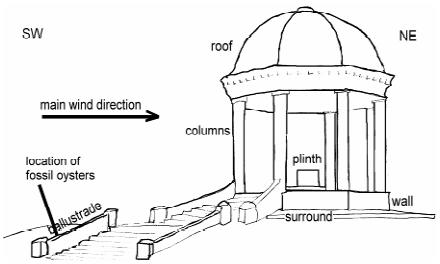
WORKSHEET 1 **Pupil Name .....**

Site 1: Investigating The Barr Beacon War Memorial.



1. Mark your location as "**site 1**" on the map to the left.
2. Mark each of the other sites on the map as you come to them.
3. Investigate the materials used to make the different parts of the memorial, and how they are being weathered. Record your observations in the tables below.
4. On the diagram mark on the SW and NE sides of the sketch. Draw an arrow to show the direction of main wind (and rain)



	Description of the material used	Reason it was used.
Roof	**Sheets of copper**	**Easily worked into sheets. Impermeable.**
Columns	**Limestone (Portland Limestone with fossils)**	**Strong, easily shaped and attractive colour.**
Plinth	**Blocks of red, bedded sandstone.**	**Small blocks easily cemented to together to form the plinth. Contrasting colour.**
Wall	**Limestone (Portland Limestone with fossils)**	**Easily shaped into blocks. Matching colour with columns.**
Surround	**Flat blocks of grey sandstone. (Need to look closely at broken edges)**	**Hard wearing and easily shaped into flat pieces.**
Balustrade	**Limestone (Portland Limestone)**	**Easily shaped. matching colour.**

	Evidence of weathering	Weathering type
Roof	**Copper weathering to green malachite $CuCO_3$.**	**(Chemical)**
Columns	**Fossils weathered proud of limestone surface.**	**(Chemical)**
Surround	**Cracks and uneven surfaces**	**(Physical)**
Balustrade & steps	**Fossils weathered proud of matrix. vegetation growing in cracks**	**(Chemical) (Biological)**

WORKSHEET 2 **Pupil Name .....**

Site 2: Curbs and Steps

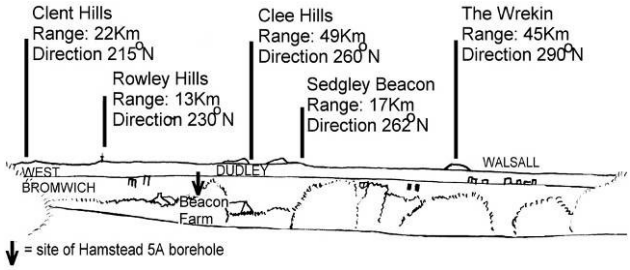
On each side of the road are curb stones and steps. Look closely at them and try to identify the materials they are made from.

THESE MATERIALS ...	... ARE BEING USED FOR THESE MAN MADE STRUCTURES
Red brick	**Riser on step.**
Concrete slabs	**Flat tread for step.**
Rounded quartz pebbles	**Aggregate addition to concrete.**
Cement / mortar	**Bonding stone together.**
Angular dolerite pebbles	**Aggregate addition to cement.**
Tarmacadam	**Waterproof and resistant road surface.**

THESE MATERIALS ...	... HAVE THESE PROPERTIES THAT MAKE THEM USEFUL HERE
Red brick	**Easily shaped from clay. Once fired are strong and weatherproof.**
Concrete slabs	**Easily cast into shape. Once set they are strong and weatherproof.**
Rounded quartz pebbles	**Physically and chemically resistant. Bond well with bitumen and cement. Cheap and easily available.**
Cement / mortar	**Is easily applied and sticks well to stone. Dries to a strong weatherproof bond.**
Angular dolerite pebbles	**Physically and chemically resistant. Bond well with bitumen and cement. Cheap and easily available.**
Tarmacadam	**Bitumen bonds together resistant rock fragments is a flexible and waterproof surface.**

WORKSHEET 3 **Pupil Name .....**

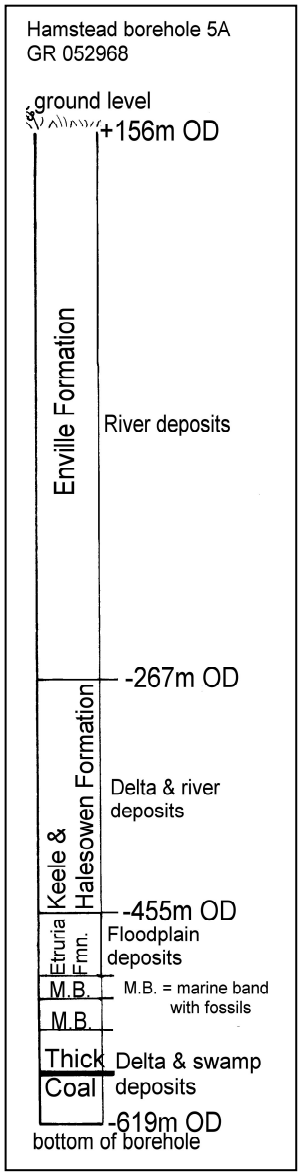
Site 3: The viewpoint to the SW.



1. Estimate how far you can see today. _____Km

2. Why are the hills higher than their surroundings?

They are made of rocks more resistant to weathering than the rocks under the lower ground.



3. Notice the buildings in Walsall in the distance. What natural materials might have been used to make:

Walls	**Bricks from clay**
Roof	**Tiles from clay or slate**
Windows	**Glass from sand**
Heating oil	**Petroleum**
Roads	**Bitumen from petroleum**
Electric wires	**Copper from metal, plastic from petroleum**

4. Why do you think the Hamstead borehole (left) was drilled?

They were looking for coal (Thick Coal seam)

5. How was the coal seam formed?

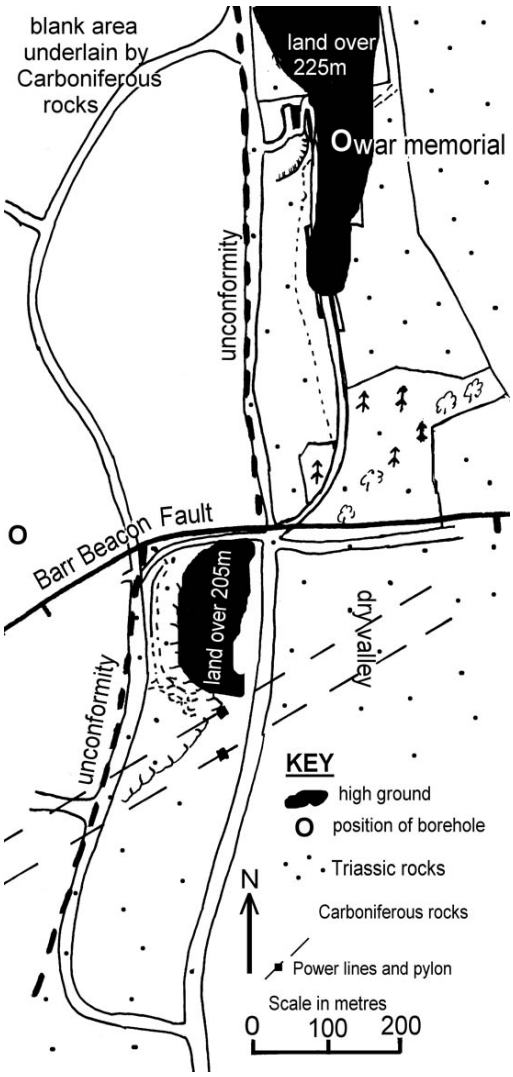
Vegetation buried in marsh or shallow lake deposits away from oxygen. Then buried and compressed,with water and CO_2 slowly being lost

6. During the time these beds were deposited, how many times was the area flooded by the sea?

Twice: there are 2 marine bands

WORKSHEET 4 **Pupil Name .....**

Site 4: The viewpoint to the South.



1. Mark your position, site 4 on the map.

2. What feature is marked on the map running from east to west near your position?

   The Barr Beacon Fault

3. You have been walking along the Barr Beacon Ridge, but in front of you is a valley. What has happened to the ridge? (Hint: Look at the dark areas on the map.)

   The higher ground south of the fault is away to the right (west). This is caused by movement on the fault.

4. Describe the river valley in front of you.

   Gentle slopes, straight valley. No river.

5. Why is there no river in the bottom of this valley?
   Rainwater percolates through the soil and into the rock below.

6. Look at the soil you are standing on. Describe it.
   It is very sandy with rounded pebbles in it. When water is poured onto it, it soaks in very quickly.

7. Can you suggest what differences there must have been, either to the climate or the permeability of the soil, when the river cut this valley in the past?
   Either the climate was wetter, so there was enough water to fill the river, or the permeability must have been less in the past. (Due to being frozen solid after the Ice Age, whilst melt water flowed over the surface?)

WORKSHEET 5 **Pupil Name .....**

Site 5: A Study of the boundary wall

Inspect the dark blocks in the wall along the pavement near the Barr Beacon Nature Reserve entrance. Describe the rock that forms these blocks using the table below to help you.

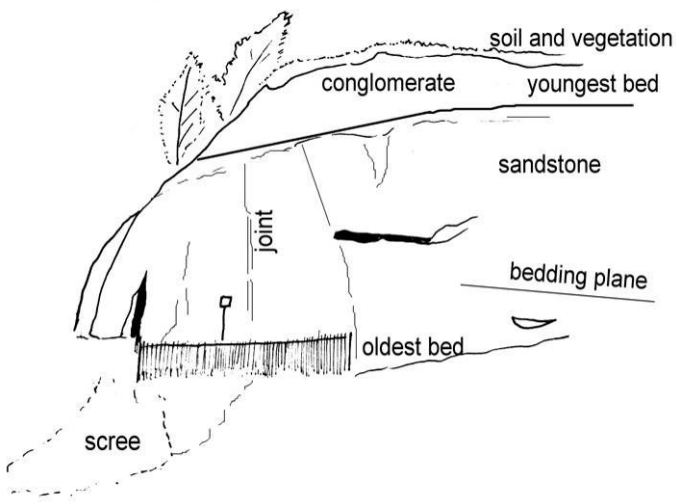
What colour are these blocks?	**They are black**
Do they show bedding planes?	**No**
Are they made up of interlocking crystals?	**Yes**
Is the rock coarse medium or fine grained?	**Medium**
What kind of rock is it?	**Igneous (dolerite)**

Site 6: Field Sketch of Pinfold Quarry

On the sketch label the following features.

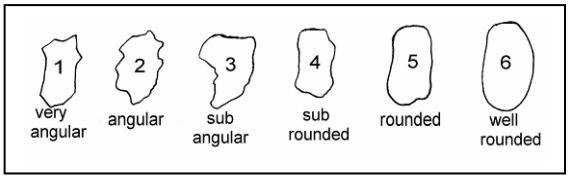
1. Joint plane
2. Bedding plane
3. Scree
4. oldest bed
5. youngest bed
6. soil & vegetation
7. conglomerate
8. sandstone

Draw in one or two bedding planes on the lower right side of the face.



WORKSHEET 6 **Pupil Name .....**

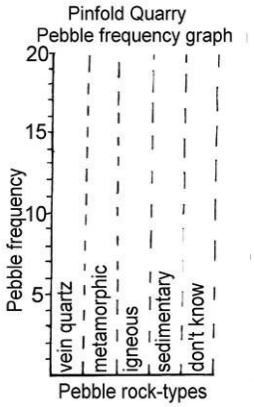
Site 6a. Pinfold Quarry pebble study.



1. PEBBLE SHAPE INVESTIGATION.
Use the diagram on the right to help you describe the rounding of theses pebbles.
The shape of most of these pebbles is: **Well Rounded**

2. PEBBLE-TYPE INVESTIGATION.
Drop a marker, such as a pen, on the scree and pick the 20 pebbles closest to it. Use the pebble sheet to help you identify them and record the frequency of pebble types below. Then graph your results on the right.

VEIN QUARTZ	IGNEOUS	META-MORPHIC	SEDIMENTARY	DON'T KNOW
Your results Total =	Total =	Total =	Total =	Total =
All results. Total =	Total =	Total =	Total =	Total =



3. TRIASSIC CURRENT VELOCITY INVESTIGATION
Find the **largest** unbroken pebble in your part of the scree and measure the long axis. Use the table below to work out the minimum speed of flowing water needed to transport that pebble. Summarise your conclusions on the right.

Diameter of Fragment in mm.	Approximate Minimum Flow Velocity to Deposit this Sized Fragment
Over 100 mm	400 cm per second (extremely high shooting flow)
Over 64mm	300 cm per second. (extremely high flow)
4mm to 64 mm	100 cm per second (very strong flow)
2mm to 4 mm	60cm per second (fast flowing stream)

The longest axis of the largest pebble is (**200)** mm.
This means that a minimum flow speed of at least **400** cm. per. second would have been needed to deposit this fragment during Triassic times.

4. SUMMARY.
Most of these pebbles are **well rounded** in shape. The two most common pebble types are **white quartz** and **grey quartz**. The largest pebble is _____mm across, and suggests a flow of **400** cm per second when it was deposited in the Triassic period.

WORKSHEET 7 **Pupil Name .....**

Site 5a: The story of pebbles inside a pebble.

A pebble is formed when a rock is physically weathered into small lumps. This means that the formation of a pebble marks the beginning of a new Rock Cycle. How many Rock Cycles can you see evidence for in the conglomerate pebble?

Stage of Rock Cycle		Evidence seen or deduced in Pinfold Quarry
0 million years ago Deposition	THIRD CYCLE	Modern day pebbles deposited on the scree slope in the bottom of the quarry.
Erosion & Transportation		They have been transported downwards under the force of gravity and rain water.
Weathering		They have been weathered from the beds above by physical weathering (plant roots & frost) or chemical weathering destroying the cement.
Uplift		The beds containing the pebbles have been uplifted to 200 m above sea level exposing them to weathering.
245 million years ago Deposition	SECOND CYCLE	Sand, containing many rounded pebbles (including our conglomerate pebble) was deposited by powerful rivers flowing into a desert.
Erosion & Transportation		The sand and pebbles must have been eroded and transported by the powerful rivers into a desert.
Weathering		The pebbles must have been weathered from exposures of older beds of quartzite (metamorphic) rocks and mineral veins of white quartz – and igneous and sedimentary rocks.
Uplift		Older beds must have been uplifted to be exposed to weathering.
400 million years ago Deposition	FIRST CYCLE	These older beds must have been deposited to form the older conglomerate, that is now "inside" our conglomerate pebble.
Erosion & Transportation		The pebbles inside the pebbles must have been transported by water because we can see they are rounded off (rounded / sub rounded).
Weathering		These very old beds must have been weathered to form the "pebbles inside the pebbles" we see today.
Uplift		Very old rocks must have been uplifted to be exposed to weathering.

WORKSHEET 8 **Pupil Name .....**

Site 6b: Measuring a rock sequence.

Measure a 1 metre thickness of rock, starting from the bottom of the face. Then look carefully at the beds from bottom to top and decide where the main changes happen: e.g. from sandy to pebbly; from flat bedded to cross bedded. There should be about 3 or 4 divisions depending on where you take the section.

1. Then measure the **thickness** of each and fill in the description in the table below.

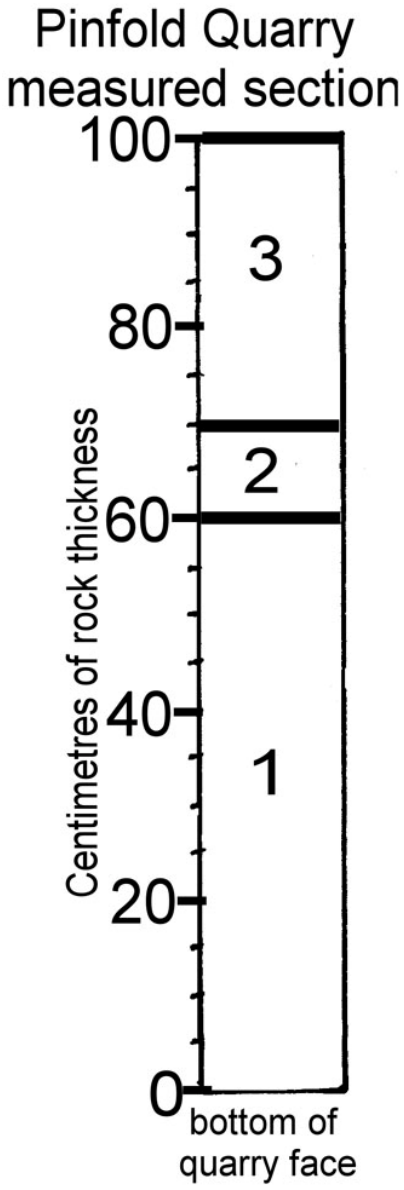
	Thickness in cm.	Description THIS IS ONE EXAMPLE FROM THE FACE. **PUPIL'S SECTIONS WILL VARY**
3	**30cm**	**At the top is a flat bedded fine grained sandstone**
2	**10cm**	**Coarser sandstone with cross bedding from the SW**
1	**60cm**	**At the bottom is a sandstone with a few sub angular pebbles.**

2. Plot the thicknesses in order on the Graph on the right, from **bottom** to top.

3. Measure the direction of flow for any cross beds you can see

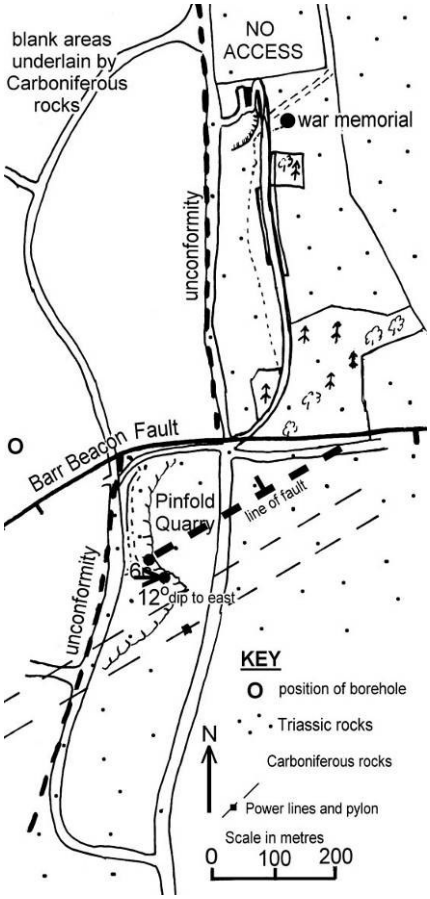
DIRECTION: SW

4. Sketch your section of rocks here.

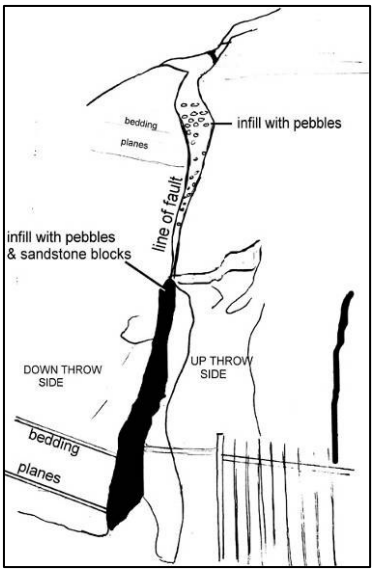


WORKSHEET 9 **Pupil Name .....**

Site 6c: Investigating a break in the rocks.



1. Sketch the fault in the space below.
2. On your sketch mark on the following
   - **a:** bedding planes
   - **b:** fault plane
   - **c:** fault plane in filled with pebbles
   - **d:** down throw side and up throw side



3. Measure the **dip of the beds** and record the direction and amount of dip.

The direction: **090° from North** and the Dip Amount: **12°**

4. Draw an arrow showing this direction on the map at site **6c**.

5. Use a compass to measure the direction of the fault. **030° from north (NE-SW)**

6. Draw a line in this direction on the map to show the fault running into the hillside.

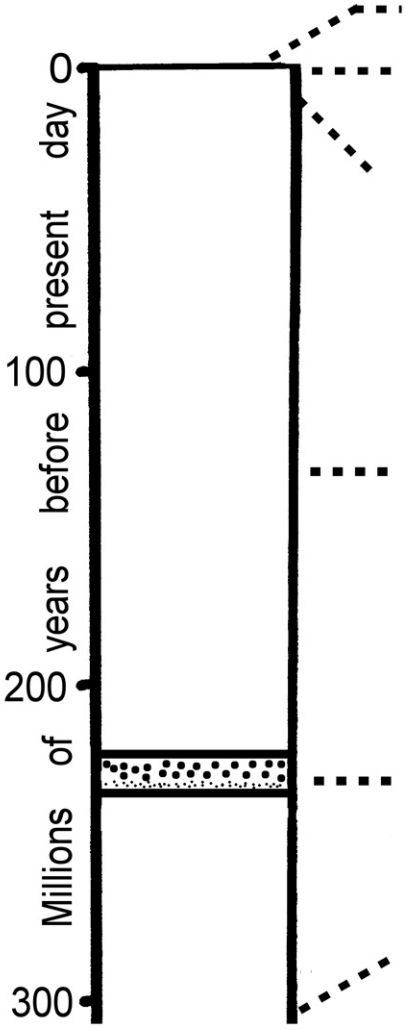
7. Did this fault occur **before** or **after** the deposition of the conglomerate beds which are on top of the sandstones?

ANSWER: **AFTER**

8. How do you know? **Principle of Cross Cutting relationships. The infill contains pebbles form the upper bed, so they must have been present when the opening occurred.**

WORKSHEET 10 **Pupil Name .....**

Summary of events at Barr Beacon Nature Reserve.



Erosion of pebbles to form scree in the quarry.

Quarrying of the rocks for aggregates (sand & gravel).

Erosion of dry valleys by rivers now dried up.

A very long period when faulting, weathering and erosion occurred.

Transport & deposition of rounded pebbles to form conglomerates.

Deposition of the sandstone in a desert environment.

Deposition of coal and other rocks before the Triassic period began.

Write each of the sentences below in the correct box in the summary column above:

1) A very long period when faulting, weathering and erosion occurred;
2) Deposition of the sandstone in a desert environment;
3) Transport & deposition of rounded pebbles to form conglomerates;
4) Quarrying of the rocks for aggregates (sand & gravel);
5) Erosion of pebbles to form scree in the quarry;
6) Erosion of dry valleys by rivers now dried up;
7) Deposition of coal and other rocks before the Triassic period began.

WORKSHEET 11 **Pupil Name .....**

PUPIL HOMEWORK SHEET: The two rock cycles at Barr Beacon.

FIRST CYCLE: deposition. What can you say about the deposition of the older beds you have seen [The Hopwas Breccia and Kidderminster Conglomerate]?

The sandstone was deposited first by currents flowing from the SW. The sand contains pebbles up to 2cm across which are sub angular, suggesting they were not transported too far.

The conglomerate lying on top has very large rounded pebbles suggesting the currents became much more powerful. Both beds are coloured red suggesting deposition was in an arid climate causing the iron to be oxidised.
The pressure marks on the pebbles suggest they were then deeply buried under later rocks.

FIRST CYCLE: uplift and tilting. What can you say about the changes to the beds cause by plate tectonics? HINTS: tilting and faulting..

The beds are now over 200 metres above sea level and so must have been uplifted. The beds have been tilted to the east (by about 10^0). They have also been faulted by the Barr Beacon Fault and a smaller fault in Pinfold Quarry.

SECOND CYCLE: weathering and erosion. What evidence of present day weathering and erosion have you seen? HINTS: screes, vegetation, memorial etc.

The memorial has been weathered so that the copper has turned into green carbonate (malachite). The fine material in the limestone pillars have also been weathered to let the fossils stick out from the rock. This has been caused by rain and wind from the SW.
The soil in Barr Beacon is full of pebbles, and the scree in Pinfold Quarry has many pebbles, also weathered from the conglomerate.
The roots of trees growing into the Quarry will also break up the rock.

SECOND CYCLE: sediment transport. How have you seen weathered sediments being transported?

In Pinfold Quarry the pebbles have fallen onto the scree. There are also signs of rain wash gullying the faces and washing material onto the quarry floor.

Human Use Of Stone and Aggregate (sand and pebbles)