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

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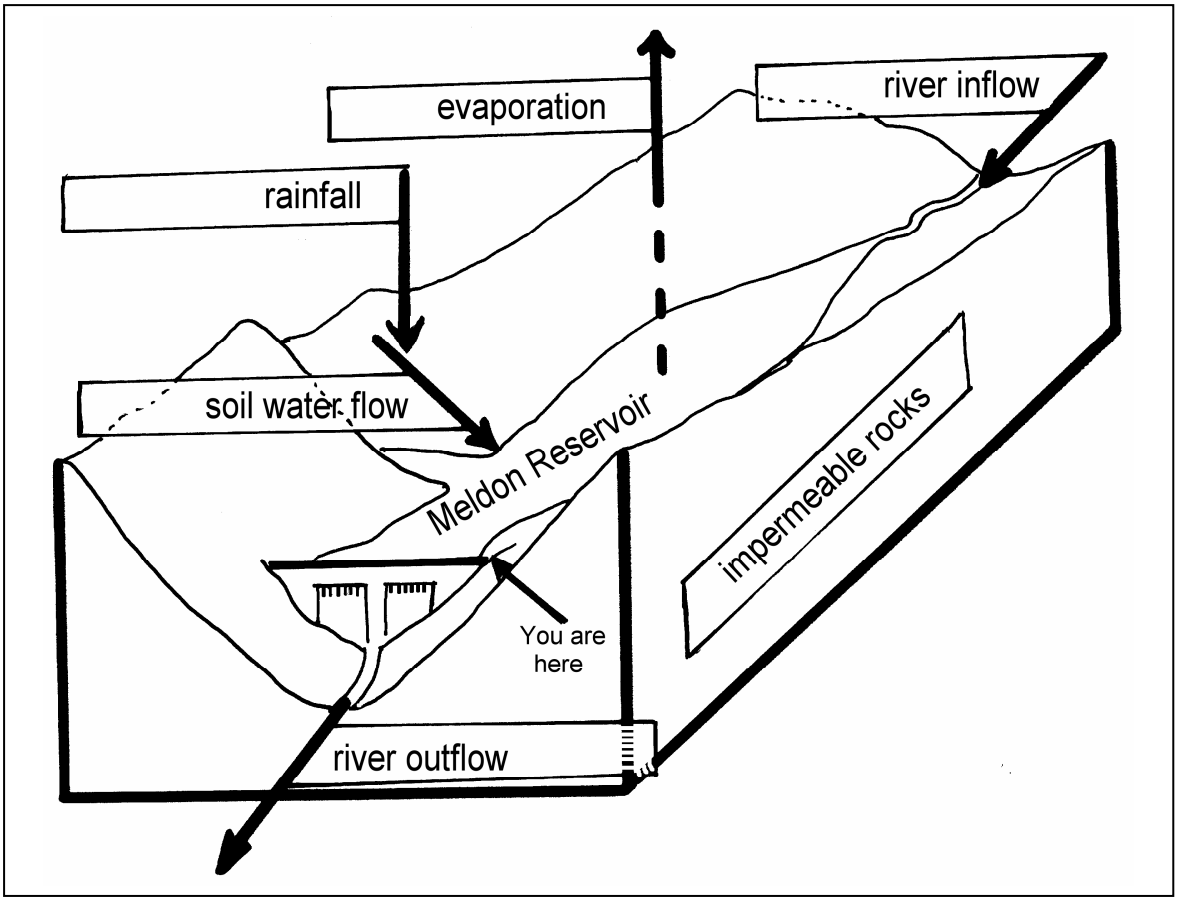
WORKSHEET 1 **Pupil Name .....**

Site 1: The Water and Rock Cycles at Meldon Reservoir.

Write the following labels in the correct boxes on the diagram showing water flow through the Meldon reservoir.

Evaporation; River inflow; River outflow; Rainfall; Soil water flow; Impermeable rocks.



What happens to the sediment carried by the river <u>downstream</u> from the dam?

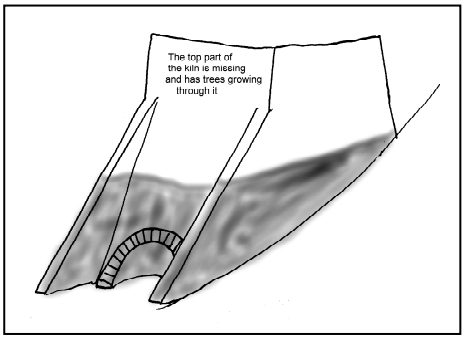
It is moved along the West Okement river to the River Torridge and then deposited in the sea off the North Devon coast.

What happens to the sediments carried by the river <u>upstream</u> of the dam?

It is deposited in the reservoir when the current slows down. It will slowly fill up the reservoir.

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

Site 2: Meldon Lime Kiln.



When limestone is roasted, it breaks down into a gas and a solid. Complete the equation.

$CaCo_3$ + energy = _**CaO**_(solid) +_**CO_2**_(gas)

When fully working, the limekiln might have looked something like the sketch. Shade in on the sketch those parts of the kiln that you can still see today.

What evidence can you see for weathering attacking the kiln?

Physical: (not obvious) Many blocks may have been removed by humans to be re-used in another buildings.

Chemical: The lime in the cement has been attacked by acid rain and needed re-pointing.

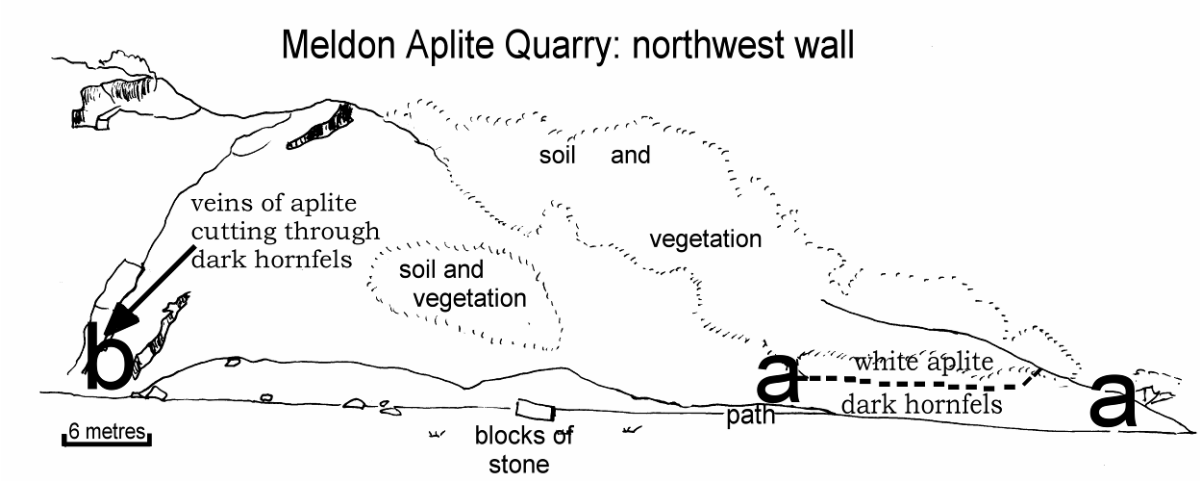
Biological: Trees are growing their roots into the stonework. As they grow they will prise the blocks apart.

Investigating The Spoil Heap.

How many different rock types can you find in the spoil heap?	**Two: Very dark angular blocks around 150 mm across, or larger. Also paler blocks of carbonate rock.**
Can you see any sedimentary features in these blocks?	**Yes, bedding planes are clear on many pieces.**
Are these rocks porous (do they let water through)?	**No**
Do they react with dilute HCl?	**The hornfels don't, the limestones do react.**
To which rock type did these blocks belong before they were metamorphosed?	**Sedimentary.**
Are there many lumps of limestone in these spoil heaps? If not, why not?	**Nearly all of the limestone was used in the kilns as it was a very scarce resource.**

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

Site 4: A Study Of The Rocks At Meldon Aplite Quarry.



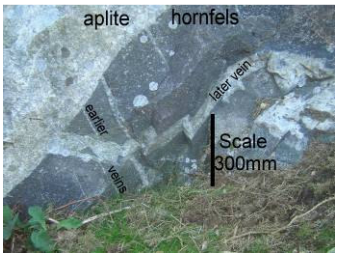
Between **a – a**: draw in the line of contact between the two rocks, aplite (the white rock) and the hornfels (the dark rock).
Label the two rocks on the sketch.
Then describe the two rock types using the table below.

	Hornfels	**Aplite**
Does the rock show bedding?	**Yes.**	**No**
Is bedding horizontal or not? Can you give the dip amount and direction?	**No it is dipping.** **About 35^0 to the north north west.**	**It is not bedded.**
Is it a coarse, medium or fine grained rock?	**Fine grained.**	**Fine grained.**
Is it made of grains or interlocking crystals?	**Grains.**	**Crystals.**
Is it porous? (Does it let water through?)	**No.**	**No.**
Does it contain fossils?	**None found.**	**None found.**
Does the rock react with dilute HCl?	**No.**	**No.**
Is the rock type Igneous, Metamorphic or Sedimentary?	**Metamorphic.**	**Igneous.**
Explain how this rock was formed.	**Deposited in deeper water and undisturbed by wave action.**	**Crystallised from a sheet of magma deep underground.**

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

Site 5: A Study Of The Aplite At Meldon Quarry.

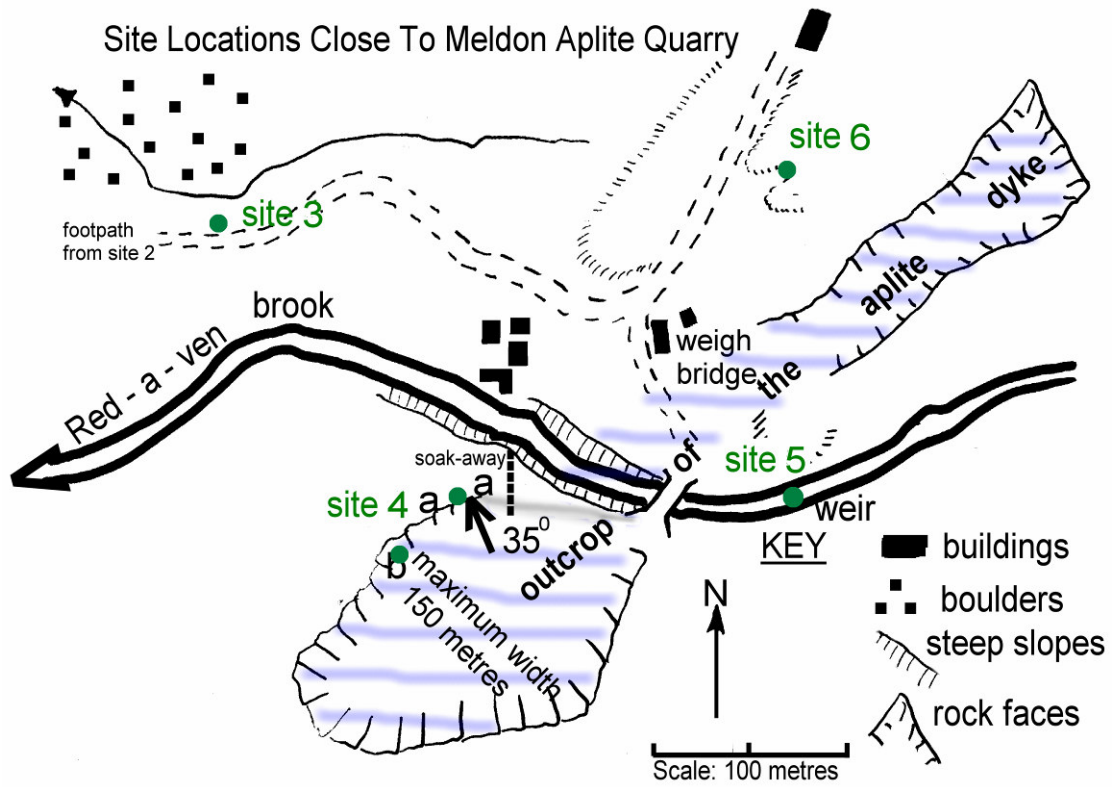
Sketch part of the contact between the two rocks at point "**b"** on the map which shows that one rock must have been liquid. Label the following features on your sketch**: hornfels; aplite; earlier veins** and **later vein**. Give a scale.



On the map below:

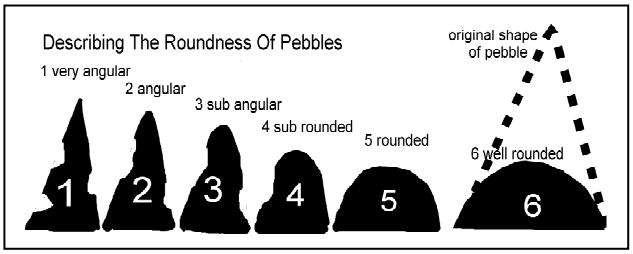
1. Mark on the north arrow in the key.
2. If you measured the dip at site **a**-**a** then draw in the dip arrow in the correct direction, and write the amount of dip in degrees next to it.
3. On the map draw in the soak-away that drains the water from the quarry.
4. Use the scale to estimate the maximum thickness of the aplite in metres. Write your answer on the map.

The aplite has now been quarried away. Shade in the area on the map you think it originally covered.



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

Site 6. Four Steps To Describing Red-a-ven Sediments.



INFORMATION: The diagram to the left helps you to describe rounding or angularity.

Step 1. Describing The Sediment. (Circle the answers)

Is it cemented together? **No**

Is it bedded? **No**

Is it sorted? **Yes**
(gravel & sand banks)

Is it in a channel? **Yes**

Do the fragments include any of the following? **IGNEOUS METAMORPHIC**

Are the fragments mainly rounded or angular? _ **sub angular/rounded**__

SEE YOUR COLLECTED DATA IN STEP 2

Step 2. Data Collection On Angularity / Rounding:

Rounding Scale (1 to 6)	Place a cross in this column for each of the 20 fragments you describe.	Count the number of fragments in each of the 6 categories.
Very Angular 1		
2		
3		
4		
5		
6 Well rounded		

Add up the number of angular fragments (1, 2 & 3) and the number of rounded pebbles (4, 5 & 6).
Calculate the percentage of ANGULAR fragments.
(multiply the number of angular pebbles out of 20, by 5)

% angular = expect answers over 60%.

The longest axis of the fragments I measured is

Over 64 mm.

The minimum stream velocity needed to deposit this fragment is (see step 3):

300 cm per second.

Step 3. Use the longest axis you measured to estimate speed of flow using the table below.

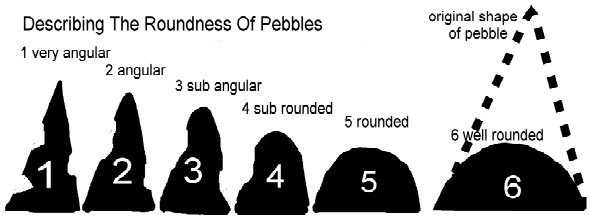
Diameter of Fragment in mm.	Minimum Stream Velocity to Deposit this Fragment
Over 64mm (Cobble)	300 cm per second. (extremely high flow)
4mm to 64 mm (Pebble)	100 cm per second (very strong flow)
2mm to 4 mm (Gravel)	60cm per second (very fast flowing stream)
2mm to 0.5 mm (Coarse sand)	12 to 15 cm per second (more normal stream flow)

Step 4. Now explain how you think this deposit was formed?
Remember to include weathering, erosion, and transport (flow velocity), followed by deposition. How did these things happen? What is your evidence for these conclusions? (SEE STEPS 1 TO 3)

The pebbles were weathered from exposures upstream and transported down the channel at times of higher velocity. The size of the fragments suggests that at times speeds of up to 300 cm per second are reached. The angularity of most of the fragments suggests they haven't been moved very far.
When the flow slows down below 100 cm per second the pebbles are deposited in sorted patches of pebbles and at flows less than 12 cm per second, sand is deposited in the channel. These sediments will only be moved downstream again when velocity increases.
The pebble rock types suggest that upstream igneous and metamorphic rocks are exposed to weathering.

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

Site 7. Four Steps To Describing The Mystery Sediment.



INFORMATION: The diagram to the left helps you to describe rounding or angularity.

Step 1. Describing The Sediment. (Circle the answers)

Is it cemented together? **Yes, (loosely)**
Is it bedded? **Yes (roughly)**

Is it sorted? **Yes**
Is it in a channel? **No, it is in a layer.**

Do the fragments include any of the following? **IGNEOUS METAMORPHIC**

Are the fragments mainly rounded or angular? ___ **angular** ___

SEE YOUR COLLECTED DATA IN STEP 2

Step 2. Data Collection On Angularity / Rounding:

Rounding Scale (1 to 6)	Place a cross in this column for each of the 20 fragments you describe.	Count the number of fragments in each of the 6 categories.
Very Angular 1		
2		
3		
4		
5		
6 Well rounded		

Add up the number of angular fragments (1, 2 & 3) and the number of rounded pebbles (4, 5 & 6).
Calculate the percentage of ANGULAR fragments.
(multiply the number of angular pebbles out of 20, by 5)

% angular = _expect answers well over 80%__.

The longest axis of the fragments I measured is

__ over 5 __mm.

The minimum stream velocity needed to deposit this fragment is (see step 3):

__ over 100 __ cm per second.

Step 3. Use the longest axis you measured to estimate speed of flow using the table below.

Diameter of Fragment in mm.	Minimum Stream Velocity to Deposit this Fragment
Over 64mm (Cobble)	300 cm per second. (extremely high flow)
4mm to 64 mm (Pebble)	100 cm per second (very strong flow)
2mm to 4 mm (Gravel)	60cm per second (very fast flowing stream)
2mm to 0.5 mm (Coarse sand)	12 to 15 cm per second (more normal stream flow)

Step 4. Now explain how you think this deposit was formed?
Remember to include weathering, erosion, and transport (flow velocity), followed by deposition. How did these things happen? What is your evidence for these conclusions? (SEE STEPS 1 TO 3)

The sediment is sorted and roughly bedded and has a flat top, suggesting it has been deposited in water.
The angular shape of the fragments suggests they haven't been transported far.
The fragments are mainly metamorphic and igneous, so they came from an area where these rocks are exposed to weathering (i.e. locally?).
They have been here long enough for a clear soil profile to begin forming.
Accept any logically derived hypothesis that refers to observations and evidence.
[Note: No record exists of how this deposit was actually formed. It is too high above the Aplite quarry floor, and too far away from the modern Meldon Quarry to have been a tailings pond for either site. It is possible that it was related to the Glass Factory, (precise location unknown) that briefly operated here from 1920.]

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

Site 8: A Study Of The Stone In The Seat.
Use the table below to help you describe the stone used in the seat and in the cap rock to the viaduct.

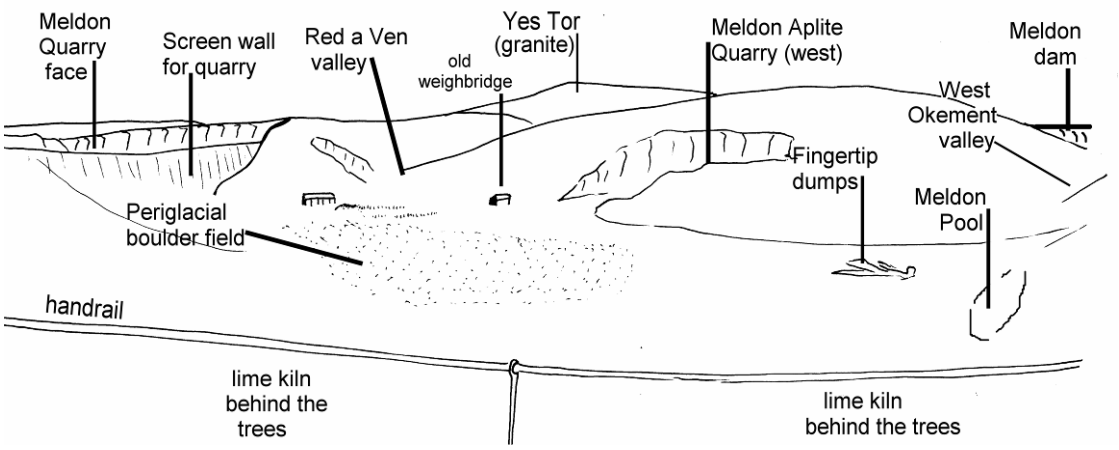
	The polished stone in the seat.
Does the stone used in the seat show any bedding?	**No.**
Is it a coarse, medium or fine grained rock?	**Coarse.**
Is it made of separate grains or interlocking crystals?	**Interlocking crystals.**
How many different minerals can you see? What colour are they?	**Three.** **Black, white and glassy.**
Is the rock porous? (Does it let water through?)	**It is not porous.**
Does the rock contain fossils?	**No.**
Does the rock react with dilute HCl? (Wash with water afterwards)	**No.**
Is the rock type Igneous, Metamorphic or Sedimentary?	**Igneous.**
What name do we give to this rock?	**Granite.**
What properties does this rock have which makes it suitable to be made into a seat?	**No splits (joints or bedding).** **It is strong enough, and resistant to chemical and physical weathering.** **It can be polished to look attractive.**
What properties does this rock have which makes it suitable to be made into the nearby cap rock for the viaduct.	**No splits (joints or bedding).** **It is strong enough, and resistant to chemical and physical weathering.** **It is also available from close by and cheap to obtain and transport to the site.**

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

Site 9: The View From The Viaduct.

On the sketch label the following features:

1. **Meldon Dam;**
2. **West Okement valley;**
3. **Meldon Pool,**
4. **Fingertip dumps;**
5. **Meldon Aplite Quarry;**
6. **Yes Tor (granite);**
7. **Red-a-ven valley;**
8. **Peri-glacial boulder field;**
9. **Screen wall for working quarry;**
10. **Meldon Aggregate quarry.**



Looking out from the viaduct, what evidence can you see for the processes listed below that are active in this landscape?

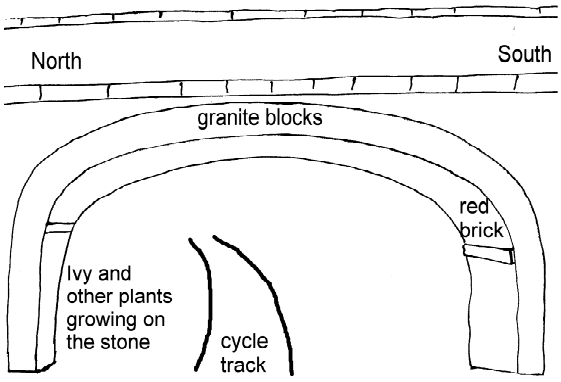
Process	Evidence seen from the Viaduct.
Human activity	**Many buildings, the viaduct, walls etc. The now disused Meldon Aplite quarries – both east and west, and the Meldon aggregate quarry off to the left (east).**
Freeze-Thaw activity	**The large boulders broken by powerful frost activity at the end of the last glacial period.**
River erosion	**The valleys of the Red-a-ven and West Okement have been excavated by rivers.**
Uplift of the Earth's crust	**The coarse-crystal granite of Yes Tor, on the skyline, was formed 3 to 4 kilometres below the surface but now is 300 metres above sea level.**
Chemical weathering	**The grey coating on the metal parts of the viaduct is there to protect against chemical weathering.**
Photosynthesis	**Any green leaves.**
Biological growth	**Leaves, twigs, grass, flowers etc.**
Biological decay	**Dead leaves, branches etc. (depending on the season).**

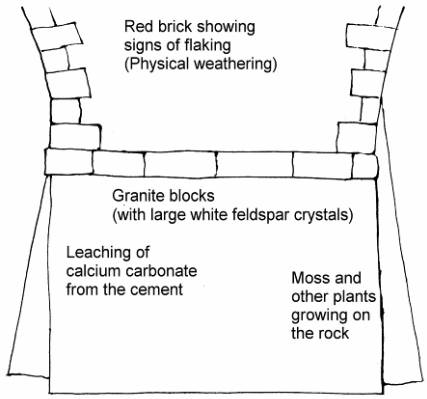
WORKSHEET 9 **Pupil Name .....**

Site 10: Study Of The Railway Bridge.

On the sketches of the bridge below mark on the following features:

north; south; stone blocks; red bricks; cycle path; signs of chemical, biological and physical weathering.





Describe the evidence for chemical and biological weathering of this bridge.

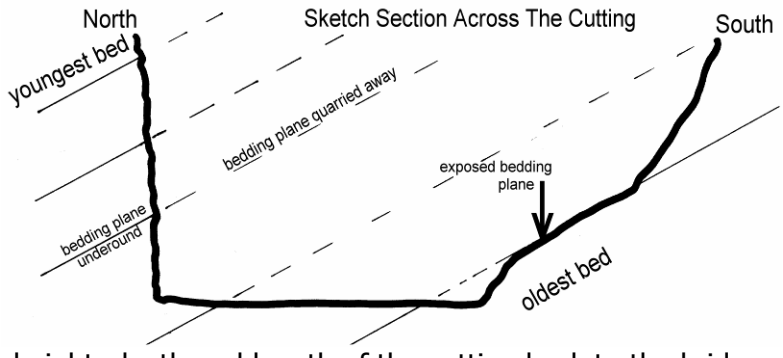
Chemical weathering: **Leaching of calcium salts from the cement.**

Physical weathering: **Flaking of the red bricks from the underside of the bridge.**

Biological weathering: **Growth of plants and lichens on the stone work of the bridge.**

Study Of The Railway Cutting.

After measuring the dip sketch in the line of several (imaginary) bedding planes across the section of the cutting below (dashed lines above ground). Mark on the oldest and youngest beds.



Estimate the height, depth and length of the cutting back to the bridge and calculate the volume of rock removed during its construction. (volume = length **x** width **x** depth)

To get the weight in tonnes multiply the volume by rock density: 2.9 gm ^{3} cm.

Estimate: 200m long x 10m deep x 10 m wide = 20,000 cubic metres.

[Assuming a density of around 2.8 gm ^{3} cm about 56,000 tonnes in weight.]

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

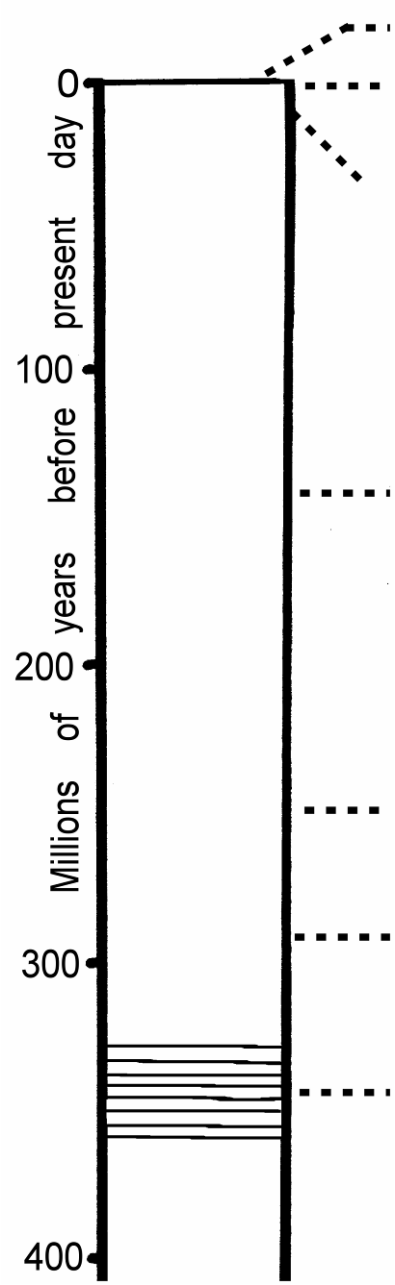
Site 11: Spot Those Blocks.
Between here and the car park see how many of the following blocks you can find and describe in the walls and gateways:

granite; bedded hornfels; mineral veins; man made rock.

Your sketch of the wall block	Brief description of block
	**Granite:** Size of block (mm) Size of largest crystal Signs of weathering
	**Hornfels showing bedding** Size of block (mm) Thickness of beds Signs of weathering
	**Mineral veins.** Size of block (mm) Number of veins (do any later veins cross-cut earlier ones?) Signs of weathering
	**Man-Made "rock"** What colour is it? What is it made of?

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

Summary Worksheet.



Human use of rocks (quarrying and cuttings).
Present day rivers began eroding the landscape (e.g. Red-a-Ven brook)
Freeze – thaw weathering at end of last glacial period.
Ancient period of erosion and no deposition in the Meldon area.
Mountain building period (of tilting, folding and metamorphism).
Intrusion of aplite and granite with metamorphism of sedimentary rocks.
Deposition of fine sedimentary muds in a deep sea.

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

1) **Intrusion of aplite and granite with metamorphism of rocks to hornfels.**
2) **Deposition of fine sedimentary muds in a deep sea.**
3) **Freeze – thaw weathering at end of last glacial period.**
4) **Human use of rocks (quarrying and cuttings).**
5) **Mountain building period (of tilting, folding and metamorphism).**
6) **Present day rivers began eroding the landscape (e.g. red-a-Ven brook).**
7) **Ancient period of erosion and no deposition in the Meldon area.**