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

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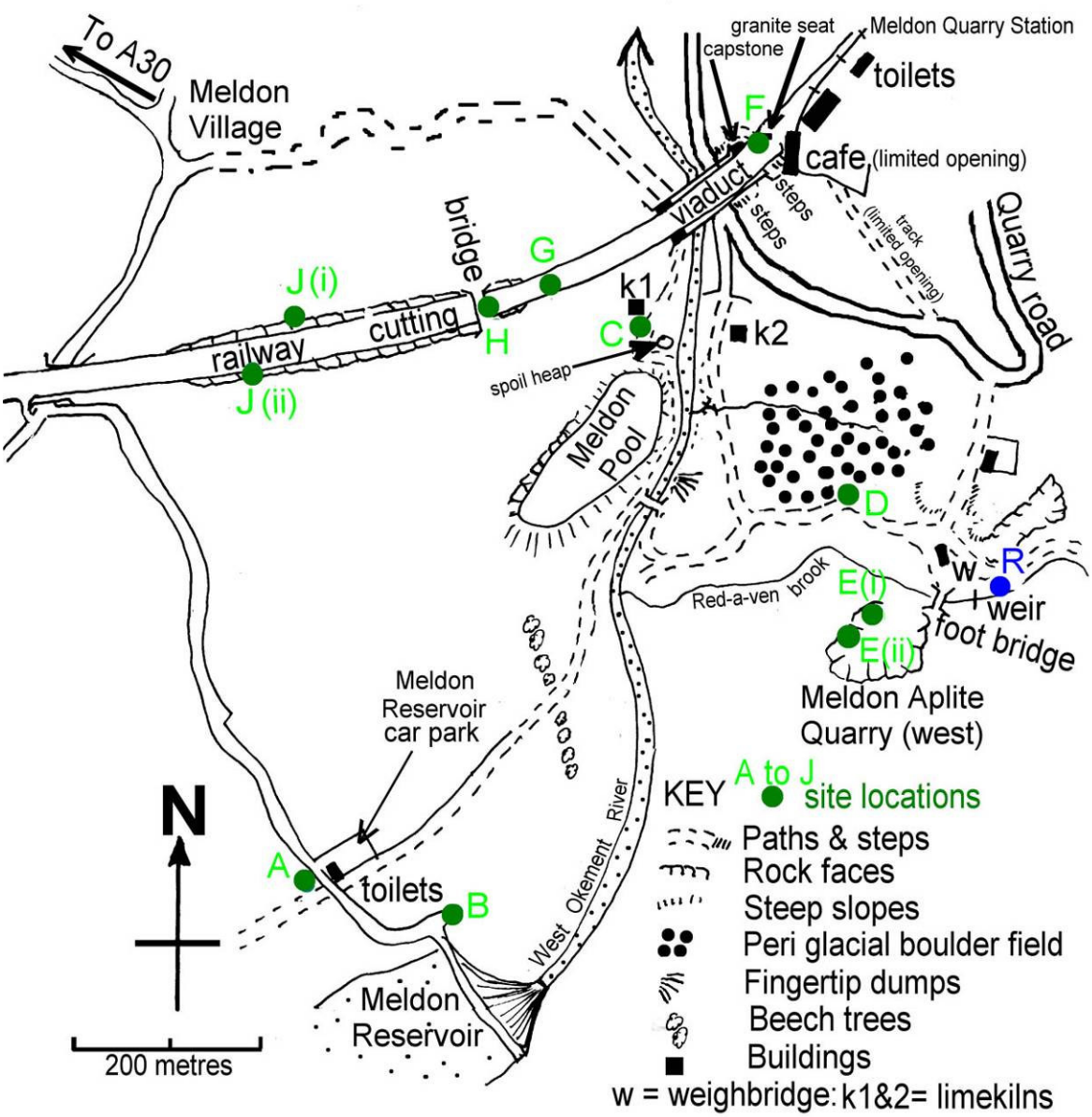
PUPIL ACTIVITY SHEET 1 Pupil Name .....

REFERENCE SHEET: This is a map of your visit to the Meldon Valley.



This is your Rock Reference Sheet 1

Rock description	Type	Group
Large white crystals; medium black crystals and glassy ones	Granite	Igneous
Medium white crystals & shiny flakes	Microgranite[Aplite]	Igneous
Fine, grey, thin layers, splits along layers	Mudstone	Sedimentary
Fine, grey, thin layers, very hard	Hornfels	Metamorphic
Fine, grey, layered, hard, reacts with acid	"Black limestone" [Marble]	Metamorphic
Medium crystals, mostly dark green/black	Dolerite	Igneous

PUPIL ACTIVITY SHEET 2 Pupil Name .....

Alternative Rock Reference Sheet 2

Rock description & formation	Type & other details
I am made of large crystals of minerals, over 2mm in size. My cream or white ones are feldspar. My glassy or grey ones are quartz. My shiny black ones are mica. My minerals interlock because they crystallised together from molten magma. Larger crystals indicate slower cooling at great depth in the Earth's crust. I am very hard and feel rough.	Rock type: **granite** Rock group: **igneous** I am not porous I do not fizz with acid
I am made of medium-sized crystals, 1-2mm in size. My cream or white ones are feldspar. My glassy or grey ones are quartz. My shiny black ones are mica. My minerals interlock because they crystallised together from molten magma. Medium sized crystals indicate cooling at depth in the Earth's crust. I am very hard and feel rough.	Rock type: **microgranite [aplite]** Rock group: **igneous** I am not porous I do not fizz with acid
I am made of fine clay mud. I may be grey or cream coloured. I was formed in thin layers on the sea floor. The water has been squeezed out and I am fairly hard, but can be split along my layers	Rock type: **mudstone** Rock group: **sedimentary** I may be slightly porous I do not fizz with acid
I am made of fine clay mud. I may be grey or cream coloured. I was formed on the sea floor. The water has been squeezed out and I was mudstone, but have been baked very hard by hot molten magma near me.	Rock type; **hornfels** Rock Group: **metamorphic** I am not porous I do not fizz with acid
I am made of fine lime mud. I may be very dark grey in colour. I was formed in layers on the sea floor. I was a dark limestone, but have been turned into marble by being baked very hard by molten magma near me.	Rock type: **marble** Rock group: **metamorphic** I am not porous I fizz when acid is put on me
I am mostly made of 1-2mm black or dark green crystals of minerals, including augite, and a sparking white mineral called feldspar. My minerals interlock because they crystallised together from molten magma. Medium sized crystals indicate cooling at depth in the Earth's crust. I am very hard and feel rough.	Rock type: **dolerite** Rock group: **igneous** I am not porous I do not fizz with acid

PUPIL ACTIVITY SHEET 3 Pupil Name .....

Site A(i) - Identifying stone blocks in walls.

Look at your section of wall to see how it was built, starting from the base!
Your teacher will discuss this with you, before you answer these questions.

What does "dry-stone" mean? Is your section dry-stone?	There is no cement between the blocks. Yes, this is dry stone.
Look at the shape of the rocks in the wall. Are they flat [easy to lay], blocky [need fitting] or round [difficult to lay]?	They are blocky (smaller pieces are put between them to make them fit.
Why are the walls usually wider at the base than at the top?	To make them more stable (harder to push over).
Sometimes walls are very wide. Try to identify any plants you see growing on top.	Grass, beech, moss, lichen
Some blocks have been broken and reveal fresh rock. How is the fresh face different from the rest of the rock?	No lichen or moss. Can see the grains and crystals (no weathered surface)
Using your rock reference sheet, magnifier, water dropper and acid dropper, try to identify 3 or 4 types of stone used in the walls and label them on the photograph. Look for freshly broken surfaces of rock.	See Rock reference sheets
Which is the most common rock type used to build your section of wall?	Hornfels

PUPIL ACTIVITY SHEET 4 Pupil Name .....

Site A(ii) - Identifying stone blocks in walls.

Look at your section of wall to see how it was built, starting from the base!
Your teacher will discuss this with you, before you answer these questions.

What does "dry-stone" mean? Is your section dry-stone?	There is no cement between the blocks. Yes, this is dry stone.
Look at the shape of the rocks in the wall. Are they flat [easy to lay], blocky [need fitting] or round [difficult to lay]?	They are blocky (smaller pieces are put between them to make them fit.
Why are the walls usually wider at the base than at the top?	To make them more stable (harder to push over).
Sometimes walls are very wide. Try to identify any plants you see growing on top.	Grass, beech, moss, lichen
Some blocks have been broken and reveal fresh rock. How is the fresh face different from the rest of the rock?	No lichen or moss. Can see the grains and crystals (no weathered surface).
Using your rock reference sheet, magnifier, water dropper and acid dropper, try to identify 3 or 4 types of stone used in the walls and label them on the photograph. Look for freshly broken surfaces of rock.	See Rock reference sheets.
Which is the most common rock type used to build your section of wall?	Hornfels.

PUPIL ACTIVITY SHEET 5 Pupil Name .....

Site A(iii) - Identifying stone blocks in walls.

Look at your section of wall to see how it was built, starting from the base!
Your teacher will discuss this with you, before you answer these questions.

What does "dry-stone" mean? Is your section dry-stone?	There is no cement between the blocks. Yes, this is dry stone.
Look at the shape of the rocks in the wall. Are they flat [easy to lay], blocky [need fitting] or round [difficult to lay]?	They are blocky (smaller pieces are put between them to make them fit.
Why are the walls usually wider at the base than at the top?	To make them more stable (harder to push over).
Sometimes walls are very wide. Try to identify any plants you see growing on top.	Grass, beech, moss, lichen.
Some blocks have been broken and reveal fresh rock. How is the fresh face different from the rest of the rock?	No lichen or moss. Can see the grains and crystals (no weathered surface).
Using your rock reference sheet, magnifier, water dropper and acid dropper, try to identify 3 or 4 types of stone used in the walls and label them on the photograph. Look for freshly broken surfaces of rock.	See Rock reference sheets.
Which is the most common rock type used to build your section of wall?	Hornfels.

PUPIL ACTIVITY SHEET 6 Pupil Name .....

Site A(iv) - Identifying stone blocks in walls.

Look at your section of wall to see how it was built, starting from the base!
Your teacher will discuss this with you, before you answer these questions.

What does "dry-stone" mean? Is your section dry-stone?	There is no cement between the blocks. No, this is NOT dry stone.
Look at the shape of the rocks in the wall. Are they flat [easy to lay], blocky [need fitting] or round [difficult to lay]?	They are blocky (here, cement has been put between them to make them fit.)
Why are the walls usually wider at the base than at the top?	To make them more stable (harder to push over).
Sometimes walls are very wide. Try to identify any plants you see growing on top.	Grass, beech, moss, lichen
Some blocks have been broken and reveal fresh rock. How is the fresh face different from the rest of the rock?	No lichen or moss. Can see the grains and crystals (no weathered surface).
Using your rock reference sheet, magnifier, water dropper and acid dropper, try to identify 3 or 4 types of stone used in the walls and label them on the photograph. Look for freshly broken surfaces of rock.	See Rock reference sheets.
Which is the most common rock type used to build your section of wall?	Hornfels.

PUPIL ACTIVITY SHEET 7 Pupil Name .....

Site B – At Meldon Dam Viewpoint

Look at the rock face and fallen blocks of rocks first, then the dam and reservoir afterwards.

Are the rocks similar to any you saw in the wall by the car park? Which ones?	Yes - Dolerite - the hard, black, fine, crystalline igneous rock. Aplite [microgranite] the hard, cream/white, fine, crystalline igneous rock. The wall is mainly made of hornfels, but there is little of this rock in the exposure above.
Are the rocks fresh or do they show signs of weathering?	Weathered – brownish colouring.
What else is happening to the rocks in the face?	They are breaking off, forming a scree slope under gravity and freeze-thaw. See: Working with Rocks.
What is forming at the foot of the rock face?	Rocks form a scree slope which breaks down by weathering to form soil.
Walk over the road towards the dam. What are the kerbstones made of?	Granite.
Meldon Reservoir was completed in 1972, to supply North Devon with water. What is the dam made of?	Concrete, made from cement [baked limestone & mudstone/shale], sand and coarse aggregate – local granite.

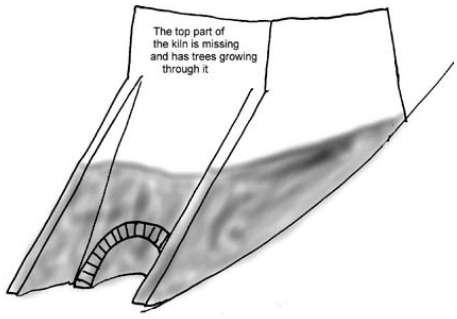
On the photograph below label the following features with the numbers 1, 2, 3 and 4:

1) **the concrete dam (about 30 years old)**
2) **the fence made of metal (about 30 years old)**
3) **the deep valley (since the Ice Age, about 10,000 years old.)**
4) **open farmland. (about 1,000 years old)**

PUPIL ACTIVITY SHEET 8 Pupil Name .....

Site C– Meldon Pool, Spoil Tips and Lime Kiln 1.

Look at the pieces of rock in the spoil heap. Where have all these pieces of loose rock come from?	Out of the Meldon Pool quarry.
Why are they dumped here in tips?	They are waste, not needed.
Inspect the dumped rocks. Most of them are layered. What does the layering tell us?	Layering in rocks tells us that they were originally formed from sediments laid down in water, usually on the sea floor. [These were laid down in Lower Carboniferous times 360 – 320 Ma. They have since been compressed and baked by metamorphism.]
Use your rock reference sheet to identify some of the rock samples. Test for porosity and with acid.	Mostly baked mudstone [hornfels], some glassy, silica rich layers of chert [similar to flint, but in layers]. Reaction with acid should reveal the presence of carbonates [limestone], but most will have been used in the lime kilns! Most limestones tend to be lighter in colour than these dark grey ones.
Suggest what the limestone could be used for.	As a building stone. Burnt in a lime kiln to make plaster, mortar, whitewash, antiseptic and spread on fields to neutralise acid soils.
What have the other rocks been used for?	As a building stone (for walls, farm buildings etc.)



This is a sketch of the whole limekiln, when it was working.

Shade in the part of the sketch that is left for us to see today.

Walk further along the path and you will see a building. What is it?	A Lime kiln.
What rock has been used to build this? Is it dry-stone? Suggest a reason for your answer.	Mostly blocks of hornfels. Not dry-stone, but cemented together because a kiln needs to have sealed sides, with air drawn in at base.
How does a limekiln work? What fuel was used?	Layers of limestone and charcoal from local woods [coal by rail after 1874] tipped in from top. Lit from grate at base, burnt for several days. Quicklime removed from base.

PUPIL ACTIVITY SHEET 9 Pupil Name .....

Site D - Boulder Field. Look at the field with boulders in it.

Notice the viaduct in the background. What is it crossing?	The West Okement River valley.
How deep do you think the valley is where it crosses the river?	Approximately 50 metres. (Its actually 46 metres.)
What do you think caused the valley?	Erosion by the river. All of the volume of rock excavated to form the valley was carried away by the river.
How old do you think that valley is, in years?	Accept guesses, but then point out that many river valleys in England have been cut since the Ice Age (about 10,000 years ago).
Draw the group's attention to the foreground. Describe the field and the boulders in it.	Fairly large field, overgrown/covered in thick grass, hawthorn bushes, bracken. Large, up to 1 metre, rounded boulders, partly buried. Covered in lichen.
The boulders are difficult to identify. Some will likely be granite or hornfels. How do we know that they have been here a long time?	Covered in lichen, which grows slowly. Partly buried under soil & grass. [If they have been here since the end f the Ice Age the answer is about 10,000 years.
We sometimes talk about climate change. How was the climate different 10 to 20 thousand years ago?	Cold with glaciers nearby. Like the present tundra of Northern Canada.
What do you think happens to frozen ground during the summer?	Surface begins to melt, but only to a metre deep and stays frozen underneath. This is known as permafrost ["permanently frozen"].
How do you think boulders could move in those times?	A combination of sliding, slumping and rolling over icy ground would move the material down even gentle slopes.
What has happened to the boulders which were originally found all over the area?	Cleared and used in walls, buildings etc. This was done by early farmers, especially when land was ploughed for growing crops. Sheep can graze in boulder fields!

PUPIL ACTIVITY SHEET 10 Pupil Name .....

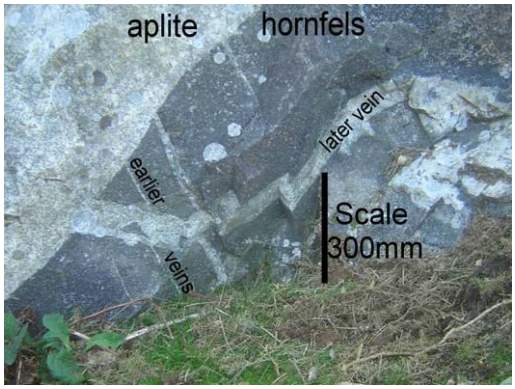
Site E (i)– Meldon Aplite Quarry.

Match the first photo with the rocks in the quarry face at the NE corner of the quarry.

Use your rock reference sheet to identify the two rocks seen here. Label the photo with their names or numbers.	One rock is Aplite, label it number **1** on the photo. The other is hornfels, label it number **2** on the photo.
Which rock shows layering [bedding], giving us a clue that it formed in the sea?	The hornfels is bedded. It was once mudstone.
What do you think has happened to it since it formed?	Earth movements have lifted it up above sea level and tilted it.
Use a compass to find out which direction do the layers [beds] now slope [dip]?	NNW, [at an angle of 35 degrees from horizontal]
Where is the oldest layer [bed] you can see here? Mark "oldest bed" on the photo.	The oldest bed is underneath; at the bottom.
Is the boundary between the two rock types here: Fairly straight, along the layering? or Irregular? Label your photo: The boundary is	Is fairly straight, along the layering [but in places small veins have squeezed into the hornfels]. The intrusion likely followed a bedding plane here.

PUPIL ACTIVITY SHEET 11 Pupil Name .....

Site E(ii) Meldon Aplite Quarry



Walk along the path to the left, along the face of the quarry for about 20 metres.

Match the second photo with the rocks in the quarry face.

Label the photo with the names (or numbers) of the rock types.	Aplite **1** and hornfels **2.**
Look for the layering in the hornfels. Is it similar to the last place, sloping [dipping] to the NNW [approx]?	Yes.
Describe the boundary between the two rock types here. Is it? Along the layering? or Cutting across the layering? Label your photo:	The boundary is ..cutting across the layering, And breaking through as small veins.
Remind yourself what aplite was before it became hard rock.	Molten magma in the Earth's crust – cooled to form igneous rocks.
Which rock was here first – aplite or hornfels? Explain your answer.	Hornfels first, then hot, molten aplite magma squeezed up & pushed into existing rock and baked it to hornfels.

The molten magma forced its way into the surrounding rocks along a line of weakness, probably a fracture [crack], and cooled to form a long dyke, over 10 metres wide.

Have a look around

What clues tell you that this was once a quarry?	Steep, sides of nearly vertical rock faces cut into landscape, freshly broken rock. A flat floor.
What rock was quarried from the quarry?	The igneous rock, Aplite.
Why is the quarry floor so wet?	These rocks are not porous. Few cracks to let water soak away [not permeable].
Try to identify some plants on the quarry floor.	Mosses, marsh grasses.
Try to identify some plants growing around the edge of the quarry.	Gorse, grasses.
Look for signs that the rocks have being weathered since the quarrying stopped over 50 years ago.	Rocks not fresh, except where recently broken. Soil forming at base of faces and in cracks.

PUPIL ACTIVITY SHEET 12 Pupil Name .....

Site F - Meldon Station and Viaduct.

The seat

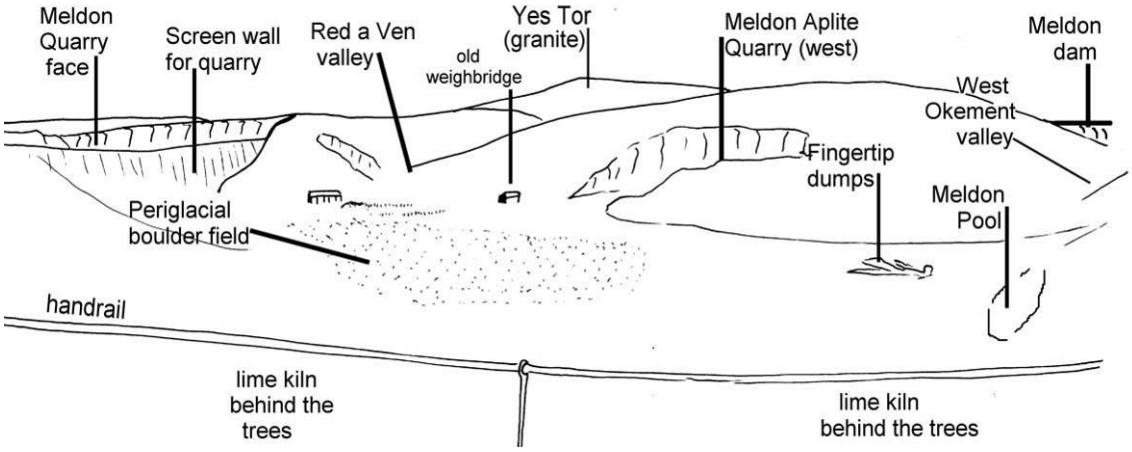
Look closely at the polished seat. Is it made of separate grains or interlocking crystals?	Interlocking crystals of minerals.
Describe the colours of the different minerals. How big are they [less than 1mm, 1-2mm, or over 2 mm]?	White [feldspar]. Black [mica]. Glassy [quartz] Mostly over 2mm.
Use your rock reference sheet to name the rock type and group.	Granite – igneous.
What tests could you do on this rock?	Porosity, Acid.
Why is this rock type suitable for making such a seat?	Strong, doesn't split, resistant to weathering [chemical & physical], can be polished.
Describe and identify the rock used to support the seat.	Made of crystals [1-2mm], mostly white or glassy. Aplite – igneous.

The Capstone

Look at the capstone at the end of the viaduct. What is the rock made of?	Crystals: white [feldspar], black [mica], glassy [quartz].	
How is it similar to the seat?	Similar rock type – granite.	
How is it different from the seat?	Not polished, but "dressed" to shape. Feldspar crystals are larger.	
Why is this rock type suitable for making capstones?	Strong, doesn't split, resistant to weathering [chemical and physical].	
What does the capstone prevent from getting into the bricks beneath?	Water, which causes them to flake [as at the next bridge].	

PUPIL ACTIVITY SHEET 13 Pupil Name .....

Site G – Meldon Viaduct Viewpoint.



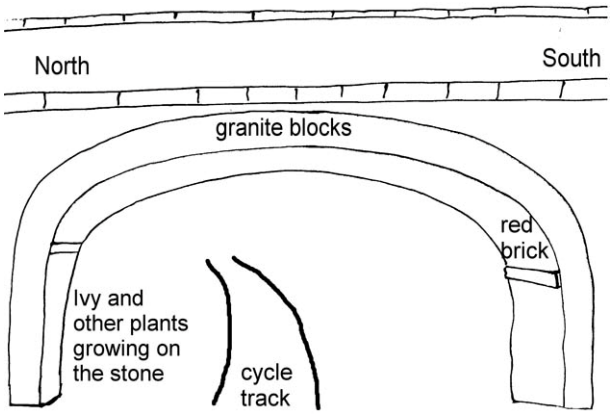
Look south and east from the viaduct and match up the sketch above with the Meldon Valley.

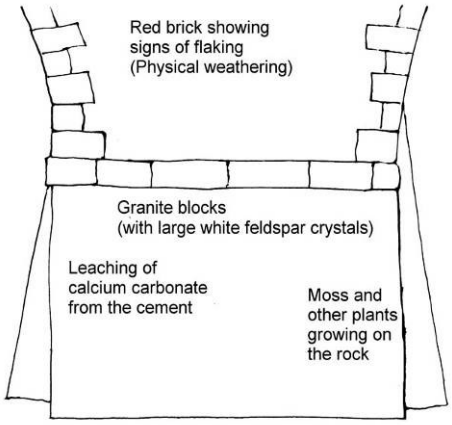
Label on the sketch the numbers 1 to 8 for the following features:

1) Yes Tor [granite]
2) Boulder field
3) Meldon Pool
4) Finger tip dumps
5) Meldon Aplite Quarry West
6) Meldon Quarry
7) Meldon Dam
8) Red-a-ven valley

PUPIL ACTIVITY SHEET 14 Pupil Name .....

Site H – The Railway Bridge: Weathering





Check with your compass and mark the left-hand sketch of the arch with north and south in the correct places.

The railway was opened in 1871. How many years has this bridge been here	About 130 years.
What rock are the large blocks made from? (use your reference sheet). Label the sketch where the blocks can be found.	Granite
What are the small red blocks used under the arch? What are they made from? Label the sketch where they can be found.	Bricks. Clay/mudstone - baked in a kiln.
The bridge is not dry-stone. What has been used to hold it together? What is this material made from?	Mortar. Sand and cement. Cement is made from limestone & mudstone.
Look out for signs of water soaking through the bridge from on top. What is happening to the bricks?	Pieces breaking off [partly through freeze-thaw action].
What is water doing to the mortar?	Lime in mortar is dissolved by acids in rainwater and precipitated lower down on the blocks & bricks. Like stalactites or flowstone in limestone caves.
What is water doing to the granite?	Not much! Tiny flakes of the minerals might be loosened by water and winter freeze-thaw, lichen & moss cling on to rough surface!
On the sketches mark where ivy is growing up the bridge. What other plants can you find growing on the bridge? Label two of them.	Other examples: Lichen Moss Algae [black & red].

PUPIL ACTIVITY SHEET 15 Pupil Name .....

Site J(i) & (ii) – The Railway Cutting

Match the photograph with the exposure of rock that you can see, then answer the questions.
Your teacher might be able to show you a piece of rock from here.
Mark on the photo, using the numbers 1 to 4, the following features:
1) The youngest bed.
2) The oldest bed.
3) Thin beds of mudstone.
4) Scree slope of weathered rock with soil and plants growing on it.

The rock looks similar to the hornfels you have already seen. How is it similar and how is it different??	**Similar:** Made of thin layers, fine grained. **Different:** Not as hard. Not been baked so much by the hot granite because it was further away.
Use your rock reference sheet to find out what rock it is.	Mudstone. Plus some thin bands of silty and sandy material.
Is the rock layered? What does layering tell us about how these rocks were formed?	Yes. Layering indicates that the original sediments [mud, silt, sand] settled out in water.
Fossil sea shells have been found in these rocks. What does this tell us about how the rocks were formed, over 320 million years ago?	The mud forming the rock settled out in the sea.
Why are they now hundreds of metres above sea level and tilted northwards?	Earth movements – uplift caused by plate collision.
Since the railway cutting was dug, what has built up at the base of the rock face?	Weathering of rock face has caused bits to fall off and form a slope of broken rock material, called scree. Soil is being formed and plants are growing.
Identify three plants growing here.	Silver birch, brambles, bracken [fern], etc.
Move 10 metres further west (Jii) and look on the left [south] side of the trackbed. Describe the rock here.	It is the same sort of rock! Thin beds of mudstone, sloping [dipping] north.
Does this bed of rock slope UNDER or OVER those on the other side of the cutting?	Under.
Are these beds OLDER or YOUNGER?	Older.

PUPIL ACTIVITY SHEET 16 Pupil Name .....

SUMMARY WORKSHEET (1)

On our visit to the Meldon Valley we have found out a lot about the rocks beneath our feet.

Identifying stone blocks 1. The walls by the car park are made of stone. Describe the most common one.	Layered/banded, hard, fine grained, grey/brownish.
2. Use your rock reference sheet to find out what it is.	Hornfels.
3. You should also find one or two rocks made of crystals, describe one, and name it.	Large white crystals with darker ones in a block[granite], … or small-medium dark crystals in an irregular lump[dolerite].
At Meldon Dam 1. How has the weather affected the rock face near the dam?	weathered to brownish colour.
2. What has collected at the foot of the rock face?	Weathered/broken rock material that formed scree.
3. What is it turning into as the weather breaks it down?	Soil.
4. Name one plant you can see growing in it.	Grass, gorse etc.
5. What man-made rock is the dam made of?	Concrete made of granite lumps in cement [made from mixture of burnt limestone and mudstone].
Meldon Pool and tips 1. Which is the commonest waste rock in the dump by Meldon Pool?	Hornfels.
2. What was Meldon Pool before it filled with water?	A quarry.
3. What was removed from there?	Dark grey limestone.
4. Where was this material taken and what was it turned into?	Taken to the lime kiln to be turned into lime by burning with charcoal/coal.
Boulder Field What are two clues which tell you that the boulders in the boulder field have been there a long time?	1 … half-buried by soil & vegetation, 2 ….covered in [slow-growing] lichen.

PUPIL ACTIVITY SHEET 17 Pupil Name .....

SUMMARY WORKSHEET (2)

Meldon Aplite Quarry 1. In the Aplite Quarry you can see lots of hornfels in the face. Check to see if it is layered or not layered	Layered.
2. Is the hornfels flat or tilted?	Tilted.
3. In which direction is the hornfels tilted? (Use a compass)	North to NNW.
4. Describe a different rock type you can see here.	Hard, white, medium-fine crystals.
5. Use your rock reference sheet to identify it.	Microgranite [Aplite].
6. How could this light coloured rock squeeze in along the cracks into the layers of hornfels?	It was originally hot liquid magma.
7. What was the Microgranite [aplite] used for?	Roadstone [aggregate], abrasive, glass bottles.
Meldon Station and Viaduct At the station and viaduct give examples where the following have been used: 1. Granite 2. Microgranite [aplite] 3. Bricks 4. Iron & steel	 1 the seat & cap of parapet. 2 the seat support. 3 the walls of parapet. 4 the rails & viaduct.
Railway Bridge 1. What stone was used to build the bridge over the railway track?	Granite.
2. What else was used to build the bridge?	Bricks and mortar.
3. How has the weather affected the bridge since it was built, over 130 years ago?	Water has washed out the lime in the mortar and streaked the blocks and bricks. Freeze-thaw of water has damaged the bricks under the arch.
Railway Cutting From the path look at the rocks in the railway cutting. 1. Are they layered or not layered? 2. Are they flat or tilted. (Look very carefully). 3. Use your compass to check in which direction. 4. Is this the same as or different from the hornfels in the quarry? 5. Use your rock reference sheet to identify the rock. (It is fine grained, but not as hard as the hornfels).	 1. Layered. 2. Tilted. 3. North to NNW. 4.The same. 5. Mudstone.

PUPIL ACTIVITY SHEET 18 Pupil Name .....

SUMMARY WORKSHEET (3)

To Make You Think: 1. Shells of ancient sea creatures have been found in these mudstones, limestones and sandstones. What are ancient remains of animals and plants called?	Fossils.
2. What does layering in rocks made of sand, mud, lime mud and fossils tell us about how these rocks were formed? Was it on land, or in the sea?	In the sea.
3. Sand, mud and lime mud are types of sediment. This word gives a clue to the name given to a large group of rocks formed in layers in water. What is this name?	Sedimentary.
4. What has happened to these rocks after they were formed on the sea bed, 350 Million yeas ago?...	They were tilted by great Earth movements and eroded/worn away.
5. You have seen two or three rocks made entirely of crystals grown together. They formed in a different way, cooling from something which was originally very hot. What is the name given to hot molten rock?	Magma.
6. This large group of rocks is named after the Latin word ”ignis” meaning “fire”. What is this name?	Igneous.
7. What did this hot rock do to the layers of mudstone and other rocks which were already here?	It baked the mudstone into the very hard hornfels.
8. What name is given to the group of rocks, like hornfels and slate, that have been changed by great heat or pressure?	Metamorphic.

You have learned a lot about the rocks of the Meldon Valley.
Well done!