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

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☛On the journey
On the journey to Meldon pupils should be encouraged to look out for ways in which stone is being used in the environment. This can be seen in walls, buildings, roads and concrete. If this topic has not been part of the preparation for the visit, it should be covered in the follow-up.

☛Items to bring on the Visit
Appropriate waterproof clothing and stout footwear. Wellies are easy to clean, but difficult to climb steep slopes. First Aid kit.

Enough copies of the selected worksheets/notes etc:
***Map of sites in the Meldon Valley.**
***Rock Reference Sheets. 2 versions - use as appropriate.**
***Site A (i to iv) worksheets [4 versions] - Identifying stone blocks in walls.**
***Site B worksheet - At Meldon Dam Viewpoint.**
***Site C worksheet - Meldon Pool, Spoil tip & Lime kiln.**
***Site D worksheet - Boulder field.**
***Site E (i & ii) worksheet - Meldon Aplite Quarry.**
***Site F worksheet - Meldon Station and Viaduct.**
***Site G worksheet - Meldon Viaduct Viewpoint.**
***Site H worksheet - Railway Bridge - Weathering.**
***Site J (i & ii) worksheet - Railway cutting.**

The Summary Worksheet may be used instead of the previous worksheets if this is thought appropriate.

Plus: Notebook, sketchbook, camera, magnifiers, water dropper bottles, tape measure, small ruler, piece of millimeter graph paper [laminated], compass and materials for any other fieldwork activities. Teachers and adult helpers should each have dropper bottle containing dilute acid for testing limestone. Domestic lime de-scaler may be used, and should be diluted to adequately react with limestone [try x 10 dilution]. Tissues should be kept handy in case of spillage.
Equipment for collecting soil samples. Useful background information can be found in: **Exploring a Dartmoor Valley – The Meldon beneath our feet.**

☛On Arrival
From the B3260 (see the map in **MAQ3 locaccess**) follow the signs through Meldon village, turning sharp left under the old railway bridge. Park minibuses at Meldon Reservoir car park [SX 562 917], where there are public toilets and picnic space. At the dam there are picnic tables. Remind the children of Health and Safety issues. Avoid animal poo.

☛Using the pupil worksheets
The Earth Science teaching trail and pupil worksheets (See document **MAQ8**) are very detailed, as there is a lot of information to be found in the rocks and the uses made of them. In the notes for each locality there are teaching points related to key observations and interpretations on the formation of rocks, and soils, with additional reference to wildlife. The pupil worksheets are linked to these observations/teaching points. **Teachers will need to decide which materials are appropriate for their pupils to use and select and adapt the sheets accordingly.**

There are plenty of opportunities to record information by taking photographs, sketching, mapping and note-taking to aid follow-up work. When soil samples are taken, the location of each sample should be marked on the map and on the collecting container.

For some children it may be useful if an adult helper acts as a "scribe", recording the agreed answers on a copy of the worksheet. All should complete their own sheets as part of follow-up work, as an individual record of the work they did on their visit.

☛Key points to investigate
We are looking at four aspects of these exposures of rock:
1 - to find out how the different rocks were formed;
2 - to find out what happened to the rocks after they were formed;
3 - to find out what is naturally happening to them today or in the recent past.
4 - to find out what they have been used for by Man.

☛ The underlying theme for this visit is that the landscape we see today has been produced by natural and human activity, and that some parts are millions of years old, whilst other parts, close by, are only a few days or years old. The Trail is written to start from the Meldon Reservoir car park, assuming that minibuses are being used, and where there are **toilets.** In the Summer months the Meldon Railway Station could be used as the starting point after a train trip from Okehampton. (See **MAQ4 Locaccess** for contact details).

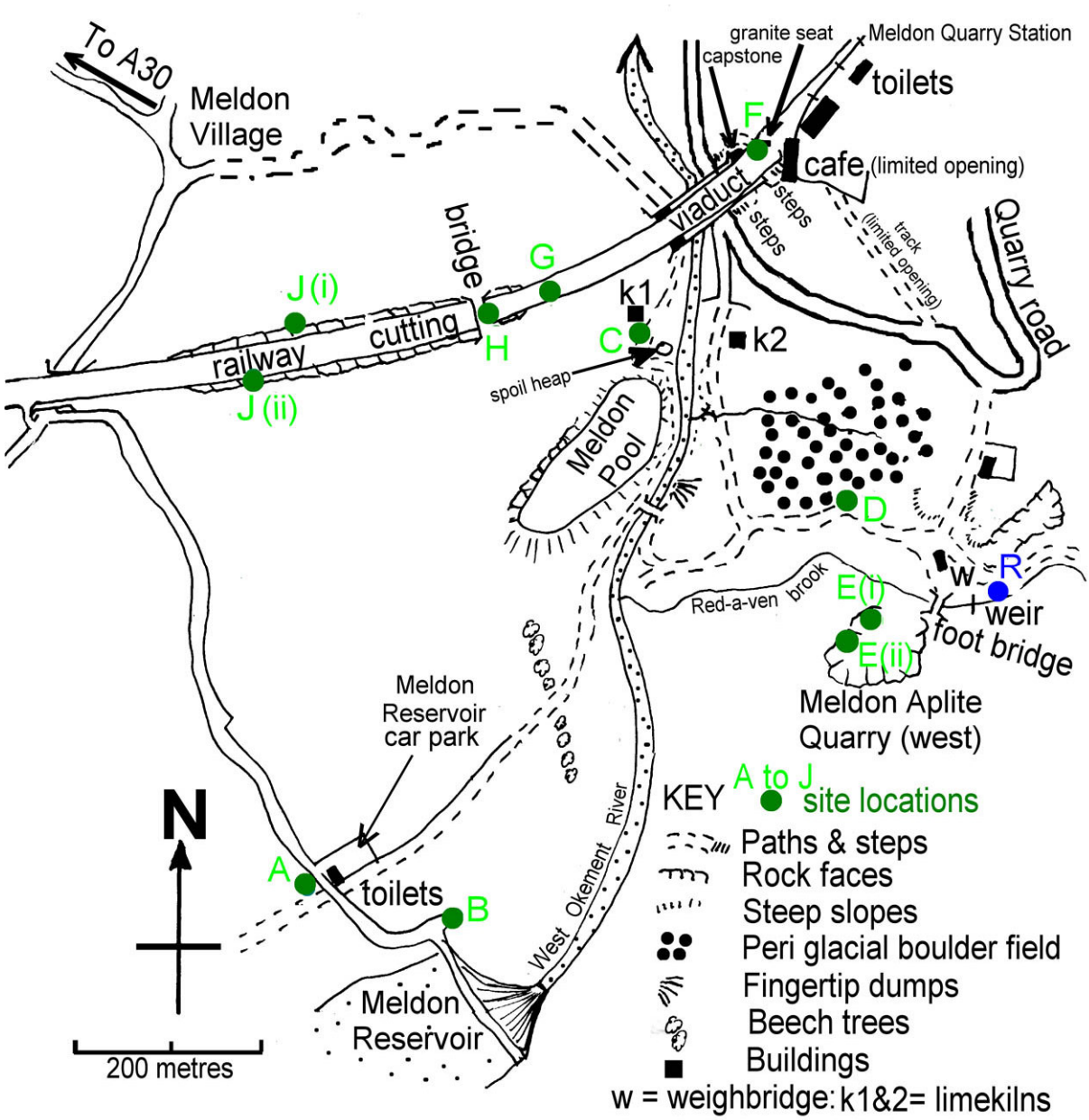


Figure 1. Map of sites in the Meldon Valley.

The first reference sheet has a map and rock recognition sheet and should be used by pupils throughout the visit to locate the sites (all labelled) and identify rocks.

Site A – Investigating stone walls - Assemble the group near to the re-built walls near entrance to Meldon Reservoir car park. (The group could be split in several smaller groups to ease overcrowding at the cattle grid at the car park entrance).

GENERAL DISCUSSION:

Ask the group where they think all the stones for the walls have come from?
Along with soil, stones are part of the weathered rock material found at the Earth's surface. Mountains and the entire landscape around us are being attacked by rain [including acid rain], rivers, ice, snow, plant roots and animals.
These local lumps of stone clearly show signs of weathering, being different in colour on the outside, from freshly broken inside. This can be seen in several rocks in these walls, where they have been hammered to shape when the wall was re-built to make the car park entrance.

Look at the wall to see how it was built, starting from the base!
Teacher-led discussion – main points:
Stones are first laid out beside where the wall is to be built [or rebuilt].
Ground levelled and turf removed, to provide firm footing.
Large flat shapes best for stability in base layer.
No mortar used – hence "dry-stone" wall.
Smaller flats follow, sloping inwards to stop later stones slipping off.
Through-stones bind the wall together, stopping it from bulging.
Larger blocks used at ends, next to where gatepost stone would normally be.
Smaller stones fitted between larger stones.
As work progresses, the wall is built narrower towards the top, to help stability.
Finally top or coping or cap stones are placed on top, wedged together to prevent them being dislodged. May be same rock type and shape as the rest of the wall or may be different – you may have plenty of rounded boulders left!
Very wide walls may have turf tops and bushes or trees planted on top.
Hammer is usually only used occasionally.
Originally the stones were collected from local fields and rivers, and quarry waste was used later.

What purposes do walls have?:
As boundary between landowners.
As divide within a farmholding for rotation of crops and stock.
To keep animals penned in, off roads, and sheltered from bad weather.
Expensive to build – skilled job, takes time.
Alternatives: hedgerows take time to grow, need more looking-after, laying, cutting.
Fences and wire – no protection for animals.

Pupils record the information on the relevant **Site A (i to iv) worksheet – Stone walls.**
It will be a great help if the children have already done some rock identification [see **Working With Rocks].**

The group could then be split into four parties, each using one of the two available rock reference sheets to identify 3 or 4 blocks in "their" piece of wall. Write the name of each rock on the photo on the worksheet. The teacher should decide on the appropriate labelling of the photo when the rocks have been identified; e.g. use sticky labels, arrows, etc.
Test rocks with a water dropper to see if the rock is porous.
Teacher should test rocks with dilute acid to see if the rock fizzes – confirming a limestone or marble. Each section of wall will almost certainly NOT contain all six rocks described.

☛ **Keep a look-out for traffic.**

After the wall exercise, assemble the group together to discuss findings: the most common rock type used is hornfels. Ask what sort of rock they would predict/expect to see if you dug into the ground near here? (Answer: the wall builders would have used the local rock rather than carry it very far i.e. hornfels).

How old do you think these walls are?
Some parts are only a year or so, as they are newly repaired. Other parts may be nearly 200 years old.

Moving to Site B – Meldon Dam Viewpoint.

☛From the car park entrance turn left, walk down the road, through the gate, round the corner to view Meldon Reservoir, the dam and exposure of rock on the left (See **Figure 1**). There is no need to scramble up to the rock face as there are fallen blocks to hand. Notice the thin soil with gorse on the top and on the scree below the face.
The teacher may also wish to use this location to introduce the Water Cycle and the work of rivers**.** Note the work of rivers cutting their valleys into the underlying rocks of the natural landscape.

The pupils should use **Site B worksheet – At Meldon Dam Viewpoint** to record observations.

Questions/teaching points	**Answers/interpretation/comments**
Are the rocks similar to any you saw in the wall by the car park? Which ones?	Yes. [Use rock reference sheets]. Mostly dolerite - hard, black, finely crystalline igneous rock. Hot molten magma was forced along a fracture in the original mudstones and cooled to form of a near-vertical sheet of rock called a dyke. Much of the exposure is made of this. Age: Late Carboniferous c. 285 million years ago. Some aplite [microgranite]. One block on top of the wall is a creamy/white igneous rock, also formed as a dyke, at a slightly later date. Hornfels may be present! - dark, hard, layered rock, originally mudstone, later baked by heat of metamorphism from hot magma which cooled to form the granite of Dartmoor.
Are there signs of layering and fractures [cracks]?	Yes - plenty of evidence of nearly vertical fractures and also some roughly horizontal ones. Typical of igneous rocks like dolerite and aplite [microgranite] in a dyke. There is little sign of bedding layers of hornfels.
Test the fallen blocks. Are they porous or not? Do they react with acid or not? [test conducted by teacher].	Not porous, though water may go down cracks. No reaction with acid – so no limestones.
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.**]
Try to identify two plants growing here [and at the top of the face]. How old do you think the plants and blossoms are?	Grass and gorse. Others? Plants: up to a few years old. Blossom & flowers: a week or so.
How is this wall different from the walls you have already investigated? Suggest why it is different.	Not “dry”-stone, but mortar used to hold the blocks of rock in place. It is a ‘retaining” wall, strong enough to hold back the scree of broken rock and soil, keeping the road clear.
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. So how old is it? What is the dam made of?	35 years (in 2007). Concrete, made from cement [baked limestone & mudstone/shale], sand and coarse aggregate – local granite.
Suggest reasons why this valley of the West Okement River was chosen for the dam and reservoir.	Hard, non-porous rocks. Steep-sided valley (deep reservoirs evaporate less). High rainfall. Away from towns/settlements.
Why did many people object to building the dam and reservoir here?	Loss of farmland. “Spoiled” the landscape.
Ask the group how long they think the valley has been here?	They probably won’t know, but many river valleys have been cut since the end of the Ice Age 10, 000 years ago.

GENERAL DISCUSSION:
Assemble the group together. Briefly discuss the observations and references to the Water Cycle being used by Humans i.e. holding up water here so that people and industry can use it, before it goes back to the sea. Also point out that different bits of the landscape are of different ages.

Moving to Site C – Meldon Pool, Spoil Tip and Lime Kiln 1.
Teachers may wish to use the walk to Meldon Pool to investigate various aspects of wildlife. See **Exploring a Dartmoor Valley – The Meldon beneath our feet.**

☛ Return to the gate just before the car park and turn right along the bridle path, sign posted "To Meldon Viaduct". Follow the path down, through the row of beech trees. The path levels off, with Meldon Pool on the left and the footbridge over West Okement River on the right, with a spoil tip beyond the pool where the path bends. Lime Kiln 1 is a short distance further on, towards the viaduct (see **Figures 1 & 2**).

Figure 2. Lime Kiln 1.

Meldon Pool is the flooded remains of a limestone quarry. It is very deep and should only be viewed from the path. This is difficult to see clearly, as the area is well wooded. It should be possible to see on the distant face that the original sedimentary hornfels rocks are tilted.
[NOTE: They are part of the east-west folding of SW England, resulting from the Armorican Orogeny, with compression from North and South about 300 million years ago.]

Inspect the spoil tip at the bend in the path and look at main rock types. Use **Site C worksheet – Meldon Pool, Spoil Tips and Lime Kiln 1** to record the information.

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

Questions/teaching points	Answers/interpretation/comments
Why is it difficult to see Meldon Pool from the path?	Overgrown with trees etc.
Stay on the path. Describe any rocks you can see at the sides of the Pool.	Layered, tilted on end, steep sides.
How can you tell that this is not a natural pool? What was it once?	Steep sides, fairly straight. Was once a quarry.
Where have all these pieces of loose rock come from?	Out of the quarry.
Why are they dumped here in tips?	They were waste: not needed.
Inspect the dumped rocks. Most of them are layered, as you can see in the old quarry. You may have done an experiment about layering in rocks. 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 Million years ago. They have since been compressed and baked by metamorphism.]
Use your rock reference sheets 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. [limekilns].
Walk further along the path and you will see a buildings built to use limestone. What is it?	Lime kiln.
Does it look as thought it is a complete kiln? What has happened to it? (see the sketch on **Site C worksheet**)	Only the lower third is left. The rest has been removed by humans and weathering.
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.
What transport was used to move the limestone, the waste and quicklime?	Small railway tubs, pushed by men and boys, horses and carts take the quicklime to local customers. Note the iron plate close to the remains of a weighbridge.

Assemble the group together. Briefly discuss the findings and how this valley has been used by Man to obtain and move raw materials.

NOTE: Layers of charcoal from the local woods were used in the early days, with coal brought in by railway after 1874. Earlier limekilns are thought to have been destroyed by quarrying and tipping. Notice the iron platform near the weighbridge, used to weigh the carts of lime before they set off for local deliveries. Quicklime was used for plaster, mortar, whitewash, antiseptic and spread on fields to neutralise acid soils. Alternating layers of limestone and fuel [charcoal or coal] were tipped in at the top and burnt over several days to 1000 ^{0}C, before being extracted from the “eye” or “grate” at the base. This was the only limestone source for miles around, so it wasn’t wasted.

Ask how old these Lime Kilns are? At least 130 years, probably much older.

Moving to Site D – Boulder Field.

☛Retrace your steps back to the footbridge over West Okement River (see **Figure 1**).
NOTE: When the group crosses over the footbridge, look down to see what the river bedload consists of [pebbles, sand, mud]. If this is disturbed the mud becomes suspended load! There is also lime dissolved (invisibly) in the water.

Notice that the river is cutting through the quarrying spoil tips here – erosion in action.
Immediately after crossing the river, on your left, are more spoil tips, fed by spoil from the quarry transported by small rail tipper trucks. As the trucks reached the end of the line and tipped their load the tips grew out as "fingers" [hence "finger tip dumps]. Trucks on rails were also used to transport the limestone to lime kiln 2, beyond, being hauled up an incline to tip in their load at the top (see **Figure 1**).

☛Follow the path to the right [south] and round to the left [east] up the slope. On your left is the boulder field. This is what remains of the pre-historic landscape before Man intervened with farming, mining and quarrying. We need to think about where these boulders came from, how they arrived here and what happened to other boulders which likely existed in surrounding fields.

Figure 3. Site D – Boulder Field.

Site D worksheet – Boulder Field.
Look across to the Meldon Viaduct to give an idea of the depth of the valley which has been eroded – 46 metres deep. Look at the field with boulders in it. Perhaps you think it is rather unusual!

Questions/Teaching points	Answers/Interpretation/Comments
Describe the field and the boulders in it. They are difficult to identify. Some will likely be granite or hornfels.	Fairly large field, overgrown/covered in thick grass, hawthorn bushes, bracken. Large, up to 1 metre, slightly rounded boulders, partly buried. Covered in lichen.
Where have they come from? How might they have arrived here? Have they been here long? How do we know?	No rock seen exposed nearby. Broken from the underlying rock. Carried here somehow – too large for rivers and not rounded enough. The lichen tells us they have been here a long time.
We sometimes talk about climate change. How was the climate different 10 to 20 thousand years ago?	Cold with glaciers nearby. SW England was beyond the main Ice sheets, but was very cold – 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? Give the group time to think about this and prompt when necessary.	The whole surface layer of weathered rock material, including boulders, would be waterlogged. A combination of sliding, slumping and rolling would move the material down even gentle slopes over the permafrost below.
What has happened to other boulders which were originally found all over the area?	Cleared and used in walls, buildings etc. This was done by early farmers, when land was ploughed for growing crops. Sheep can graze between boulders in the fields!

GENERAL DISCUSSION: Assemble the group together. Ask "How long have these boulders been here"? (Answer: The end of the Ice Age, possibly as long as 10,000 years or so.) Point out how the landscape has very old, as well as quite young, pieces in it. Often these pieces are next to each other. e.g the boulders, the walls, the buildings.

Moving to Site E(i) – Meldon Aplite Quarry.

☛ Continue east uphill, along the footpath towards the weighbridge and other old buildings. [The teacher might ask the children to think about what might have been weighed here. Answer: it was rock!]. Turn right and head south, across the footbridge over the Red-a-ven Brook. **Take care as there are no side rails**. [NOTE: Upstream, to the right, above the weir, is a suitable place to investigate the sediment load of the stream, unless the river is in spate. In the KS3 materials (**MAQ8 KS3worksheets**) there is a pebble exercise which could be adapted for younger children. A range of materials are being moved by the river, from large boulders, rounded by the work of freeze-thaw and rivers, to sand and fine mud, with chemicals in solution. (See site "**R**" on **Figures 1 & 4**).]

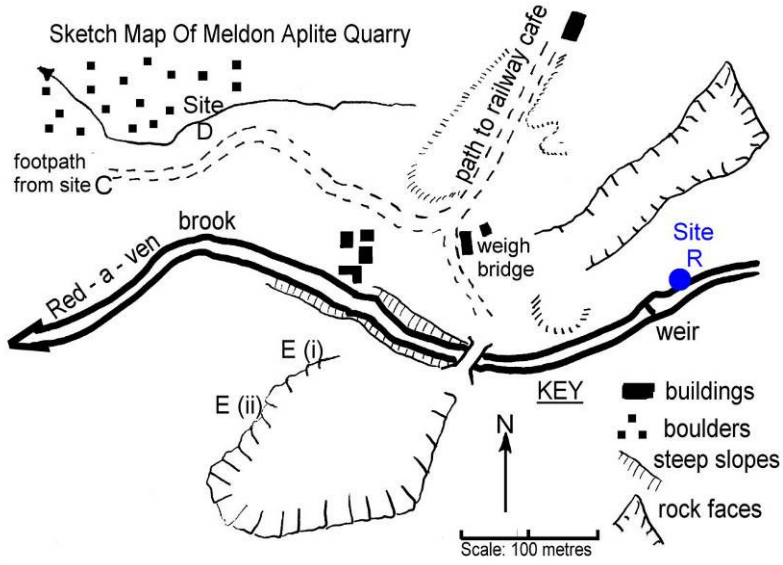


Figure 4. Map of sites D and E.

☛ To the SW is Meldon Aplite Quarry. The floor is very wet because the rocks are impermeable. Keep to the right and skirt round the wettest parts and stop at the first exposure of rock. The igneous rock, aplite [a medium to fine grained igneous rock called microgranite] has been intruded into the sedimentary mudstones which had already been baked [metamorphosed] into hornfels. The worksheet helps to find the evidence for what has happened, mainly by looking at the boundary between the two rock types in two places.

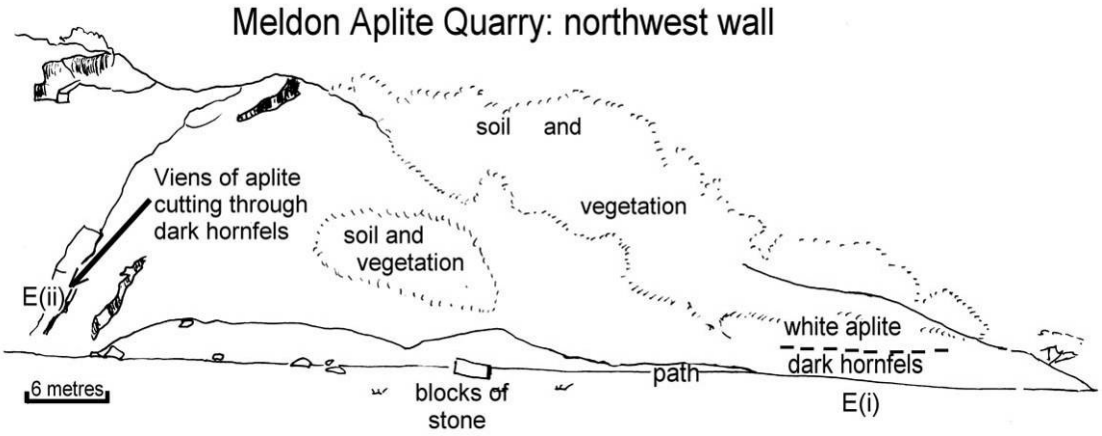


Figure 5. Sites E(i) and E(ii).

☛ From Site E(i) there is a path all the way along the foot of the steep face, but the worksheets refer only to the first 25 metres. Parties should stay away from the steeper slopes further along from Site E(ii). See **Figure 5.**

Site E(i) worksheet - Meldon Aplite Quarry

Match the photo on the pupil worksheet with the rocks in the quarry face at the NE corner of the quarry.

Questions/teaching points	Answers/interpretation/comments
Use your rock reference sheet to identify the two rocks seen here. Label the photo with their names (or numbers).	Aplite (**1**) above hornfels (**2**) below.
Which rock shows layering [bedding], giving us a clue that it formed in water?	Hornfels was mudstone when it formed, before it was metamorphosed.
Check the layering in this rock. Is it flat as originally laid down under the sea? [You may have done an experiment on layering in rocks].	No it has been tilted. The sedimentation experiment in the preparation work shows horizontal layering when settled under water. The original horizontal is here tilted.
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.	Oldest at the bottom.
Describe the boundary between the two rock types here: Is it: Fairly straight, along the layering? or Irregular?	Fairly straight, [but there are places where small veins have squeezed into the hornfels]. The intrusion likely followed a bedding plane here.

Moving to Site E(ii).

Continue along the face of the quarry to the left for about 20 metres.
Match the second photo (**Figure 6**) with the rocks in the quarry face. This is Site E(ii).

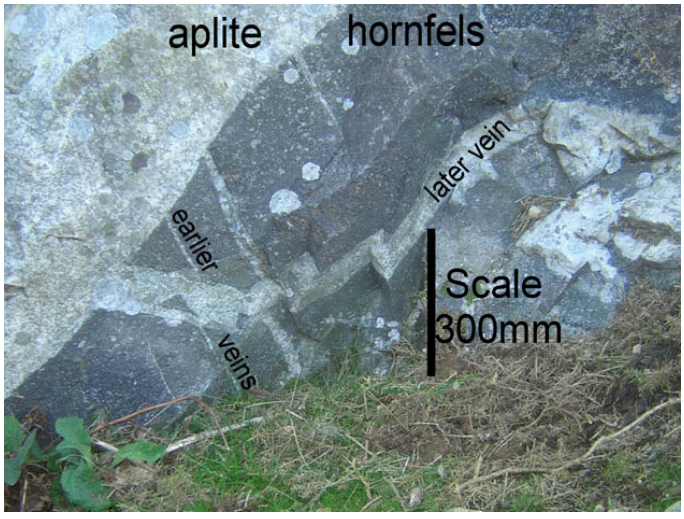


Figure 6. Site E(ii).

Site E (ii) worksheet – Meldon Aplite Quarry.

Questions/teaching points	Answers/interpretation/comments
Label the photo on the worksheet with the names (or numbers) of the rock types.	Aplite **1** and hornfels **2.**
Look out for the layering in the hornfels. Is it similar to the last place, sloping [dipping] to the NNW [approx]?	Yes.
How would you describe the boundary between the two rock types here? Along the layering? or Cutting across the layering? Label your photo: 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 – forms igneous rocks.
Which rock was here first – aplite or hornfels? Explain your answer. Charles Darwin was one of the first scientists to think about this.	Hornfels first, then hot, molten aplite magma squeezed up and pushed into existing rock and baked it to hornfels.

The molten magma forced its way into the surrounding rocks along a line of weakness, possibly a fracture [crack], and cooled to form a dyke, over 10 metres wide. [The large space behind you in the quarry is where this rock used to be before it was quarried away.]

Have a look at your surroundings.

Questions/teaching points	Answers/interpretation/comments
What clues tell you that this was once a quarry?	Steep, three sides of nearly vertical rock faces cut into landscape, freshly broken rock. A flat floor.
What rock was quarried from the quarry?	Aplite (a fine grained rock similar to granite).
Why is the quarry floor so wet?	These rocks are not porous. There are a few cracks to let water soak away, but the rock is 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.
Try to find any signs that the rocks have been 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.
Tell the group that the rock (Aplite) has been dated as being 250 million years old. Ask the group how old they think the quarry is?	Older than 50 years, when quarrying stopped.

Moving to Site F (see **Figures 1 & 4).**

☛ **If the railway café is open** then the route to Site F on the viaduct is as follows:
Retrace your steps and cross the Red-a-ven Brook by the bridge. (Taking care as there are no rails). Continue northwards past the weighbridge. As you pass the old quarry buildings have a look at the display board. Cross the cattle grid and turn left, **taking great care across** the Meldon Quarry access road. Keep to the right for 70 metres, turning right along a footpath heading NW. This is a gentle climb for 200 metres to Meldon Station, where there are toilets and refreshments. [THIS PATH IS ONLY OPEN WHEN THE STATION IS OPEN].

[**The alternative route**, when the café is not open, is from the Meldon Aplite Quarry is via limekiln 2 and through the gate to cross the Quarry Road underneath the viaduct (see **Figure 1**). Taking care when crossing the road, ascend by the stepped path, coming out at the NE end of the viaduct, close by the café.]

☛**Groups travelling to the Meldon Valley by train will start the Teaching Trail here. [The site map and relevant reference sheets will need to be handed out here.]**

☛There are several teaching points around the station and viaduct.

1. Eastwards from the station (away from the viaduct) the path leads to a display board about Meldon Quarry. This is a poor viewpoint as railway carriages and quarry buildings are in the way. The railway was saved in 1965 to serve the quarry, which it still does. It was owned by British Rail and the hornfels was used for railway ballast. Some aggregate also goes by road.
2. Look out to see what the path is made from – aggregate chips coated in bitumen [tar].
3. Soil development can be seen at the side of the path, with grass roots extending down into soil and sub-soil [with various small chunks of rocks]. The soil has developed on the Man-made railway embankment! Collect a sample for later investigation.
4. Railway ballast. Look out for hornfels, dolerite and even one with reddish and green crystals [related to granite, likely from a quarry in Leicestershire!].

Site F - Worksheet - Meldon Viaduct

There are several blocks of granite rock being used at the station end of Meldon Viaduct. Focus on the polished piece forming the seat, and the rough hewn piece forming the capstone at the end of the viaduct (see **Figures 7 & 8).**

Figure 7. The Granite Seat.

Questions/teaching points	**Answers/interpretation/comments**
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.	White [feldspar]; Black [mica]; Glassy [quartz].
Use your rock reference sheet to name the rock type and group.	Granite – igneous.
What tests could you (or your teacher) 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, mostly white or glassy. Aplite – igneous.

Figure 8. The Granite Capstone.

Look at the capstone at the end of the viaduct. What is it 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.
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].
The railway was opened in 1871, so how long has this capstone been in place?	About 130 (odd) years.

Moving to Site G - Meldon Viaduct Viewpoint.

☛Move the group onto the viaduct, about two thirds of the way to the SW end (see **Figure 9**).
The opportunity should be taken for this overview of the Meldon Valley to orientate the position of features already seen [or about to be seen].

Pupils use **Site G – worksheet - Meldon Viaduct Viewpoint** to record observations. Features may be labelled using the number system on the worksheet. The teacher may wish to devise an exercise on the use of a compass from a suitable point on the viaduct and add the position to the features pointed out here.

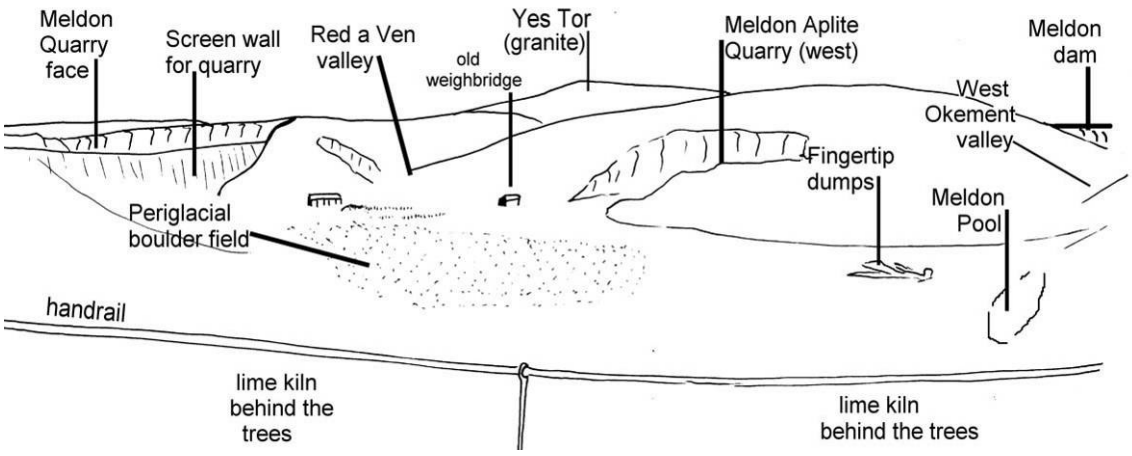


Figure 9. The view from the Viaduct.

The teacher may wish to split the group into smaller parties and include in the itinerary a look from the viewpoint **under** the viaduct using the short path at the SW end.

"The lattice girders are supported by interwoven piers. The first set are made of wrought iron and riveted together. The second set are made of mild welded steel, fitted in 1878 to support double track when the line was extended to Plymouth."

Note the strength and stability of lattices and triangles. As there was no large span required use could be made of closely spaced slender piers. Compare the design and construction of the viaduct with the granite and brick overbridge at the next locality.

Note also the special grey paint used to protect the iron and steel from the ravages of weathering. See **MAQ6 Prep & follow-up** notes for more details.

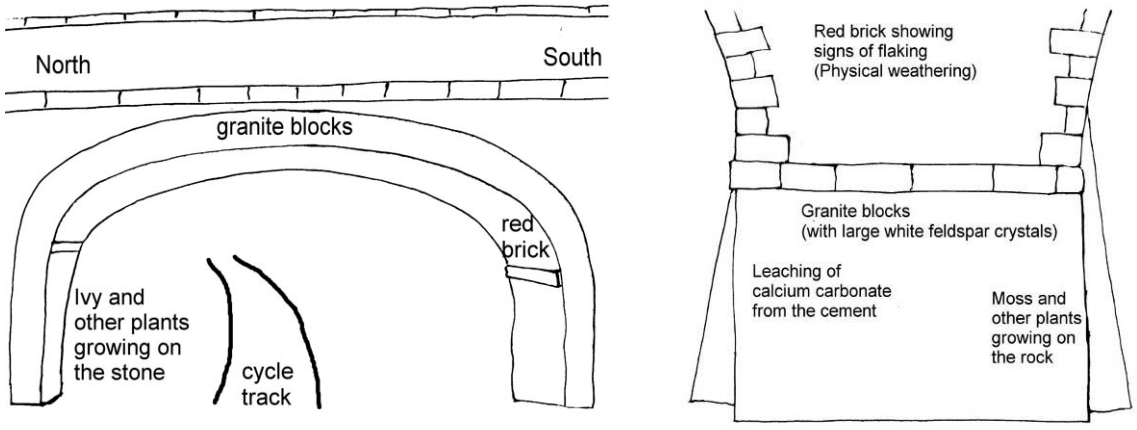
GENERAL DISCUSSION: After completing the exercise the teacher may want to remind groups that some of the labelled features are only a few tens of years old (e.g. screen wall for the quarry), some are more than a hundred years old (e.g. the railway) whilst some of the others are many millions of years old (e.g. the rocks).

Moving to Site H - The Railway Bridge – Weathering

☛Continue south westwards for 150 metres along the old track-bed, now part of the "Granite Way" cycle track and footpath, to the over-bridge. Apart from looking at the materials used to construct this bridge, we have the opportunity to see the effects of 130 years' weathering on natural and man-made materials.

Remind the children about the effects of rain, wind, snow, ice, acid rain, the atmosphere etc ["weather"] on everything on the Earth's surface. Rocks are eventually broken down to sand and clay, forming soils which enable plants and animals to live. Examples of the three types of weathering [physical, chemical and biological] can be seen here. Note the importance of water and "air" in these processes.

Site H - Worksheet – The Railway Bridge – Weathering
Split into two groups, one for each side & each abutment, to use the pair of sketches on the worksheet.



Figures 10 & 11. Sketch of Site H, the Railway Bridge.

Questions/teaching points	Answers/interpretation/comments
Check with your compass and mark the sketch of the arch with north and south.	**See Figure 10.**
Label the sketch of the abutment (bridge end) your group is investigating [north OR south].	**See Figure 11.**
Look for the large white crystals in the stone blocks. What rock is it? (Use the rock reference sheet)	Granite.
What are the small red blocks used under the arch? What are they made from?	Bricks Clay/mudstone - baked in a kiln.
On both diagrams label one place where each of these can be seen.	**See Figure 10 & 11.**
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 and mudstone.
Look out for signs of water soaking through the bridge from the path 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 and 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].

You might like the group to think about the way this bridge differs from the viaduct in design and materials used to build it.

Moving to Site J(i) – The Railway Cutting.
Continue westwards from Site H (there is no Site I!) along the trackbed for 120 metres. On the right [north] is site **J(i),** a 10-metre high exposure of thinly-bedded mudstones, dipping northwards [into the face]. The scree material at the base is overgrown, so it is suggested that an adult collect a sample or two to show the children to help with the tasks on the worksheet (see **Figure 12**).

Figure 12. The rocks at Site J(i)

☛The engineering of railways has many aspects, barely touched on in these Trail notes. By far the most important for geologists is the digging of cuttings, tunnels etc and exposing long sections of rock to investigate. Over the years the rocks weather, soils form and plants colonise the cutting. Luckily there are two places along here where the rocks are still exposed to view.
They are mudstones. Because they are further away from the granite they are less altered than those further south. The heat of the intrusions of granitic magma baked them to form hornfels, seen at the aplite [microgranite] quarry and in walls at the Meldon Reservoir car park (see **Figure 13**).

[NOTE: Groups starting the Trail from Meldon Station will see these later].

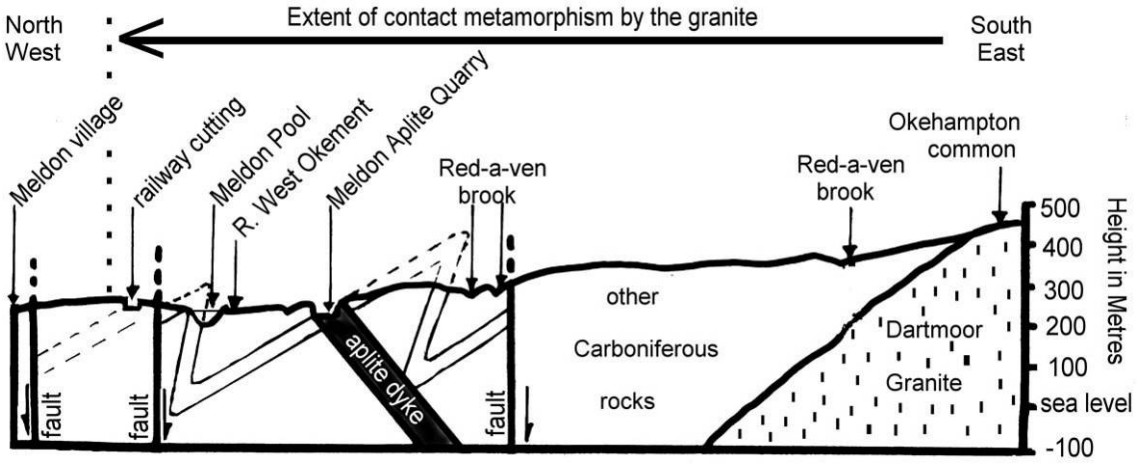


Figure 13. A sketch section across the area.

Site J(i) – Worksheet - The Railway Cutting.

Questions/teaching points	Answers/interpretation/comments
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.
A few 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.
On the photo mark on: The youngest bed. The oldest bed. Scree slope of weathered rock which is becoming soil and plants are growing in it. Thin beds of mudstone. The numbering system on the worksheet could be used instead of labels.	

Moving to Site J(ii)

☛Ten metres further along on the left [south] is site **J(ii).** Here more easily seen, is the gentle slope of another exposure, also dipping northwards. This dips UNDER the lowest of the beds on the other side of the track-bed and so must be OLDER.

Figure 14. Site J(ii)

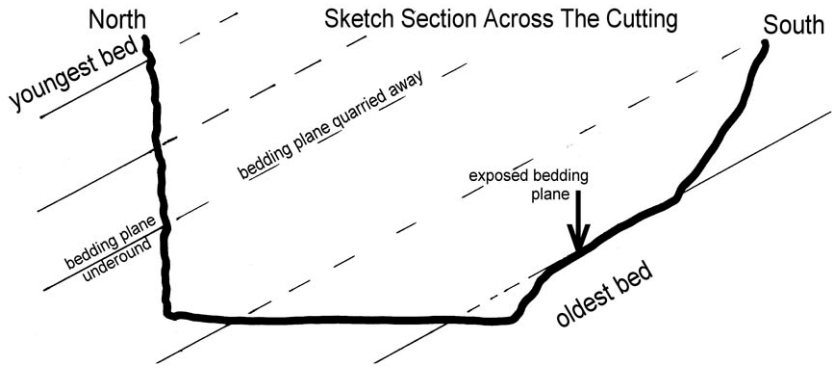


Figure 15. Cross section of railway cutting at Site J(ii).

Site J(i & ii) – Worksheet - The Railway Cutting.

At site **J(ii),** older children may make a measurement of the steepest angle [dip] of the slope, using a clinometer [a type of protractor]. They dip at about 30 degrees from horizontal (see **Figure 13**).

Questions/teaching points	Answers/interpretation/comments
Move 10 metres further west and look on the left [south] side of the track-bed. Describe the rock here.	It's the same rock as at J(i)! Thin beds of mudstone, sloping [dipping] north.
Does this rock slope UNDER or OVER those on the other side of the cutting?	Under. They go underground!!
Are these beds OLDER or YOUNGER than those on the other side of the cutting?	Older.

☛Assemble the group together ready to return to the car park where the trail began. Those starting at Meldon station should also follow this route. Continue west for 250 metres to leave the path at the next bridge, going down the steps and follow the left fork, signed "Meldon Reservoir and Dartmoor". This last 600 metres provides the opportunity to look at more dry-stone walls, both old and re-built. Mortar is used occasionally. Finally, the Meldon Reservoir car park is on the left, with toilet facilities. Those who started at Meldon Station will find this a suitable lunch stop.

☛Groups which started at the Viaduct should continue the visit at Site 1 and follow the itinerary back to Meldon Station.

Summary Of The Main Points About The Landscape.
The landscape of the Meldon Valley is made of some parts that are millions of years old, and also parts that are very young, even younger than the pupils in the group (e.g. insects & flowers).

Flowers and blossom on trees (and individual insects): a few days or weeks.
The quarrying at Meldon: about 100 years, but still going on today.
The quarrying at Meldon Aplite Quarry: stopped 50 years ago.
The railway: built about 130 years ago.
The limekilns: active more than 150 years ago.
Farming was probably started a couple of thousands of years ago.
The boulder field was formed about 10,000 years ago.
The rocks were formed about 300 million years ago.

☛The final worksheet **(in MAQ8worksheeets**) is the Summary Activity sheet (pages 16, 17 & 18), which could be completed **as an alternative** to the other worksheets by younger children or those who find the others too difficult. It could be used in combination with a selection of the more detailed worksheets, especially ones involving labelling, or as revision or in follow-up work.