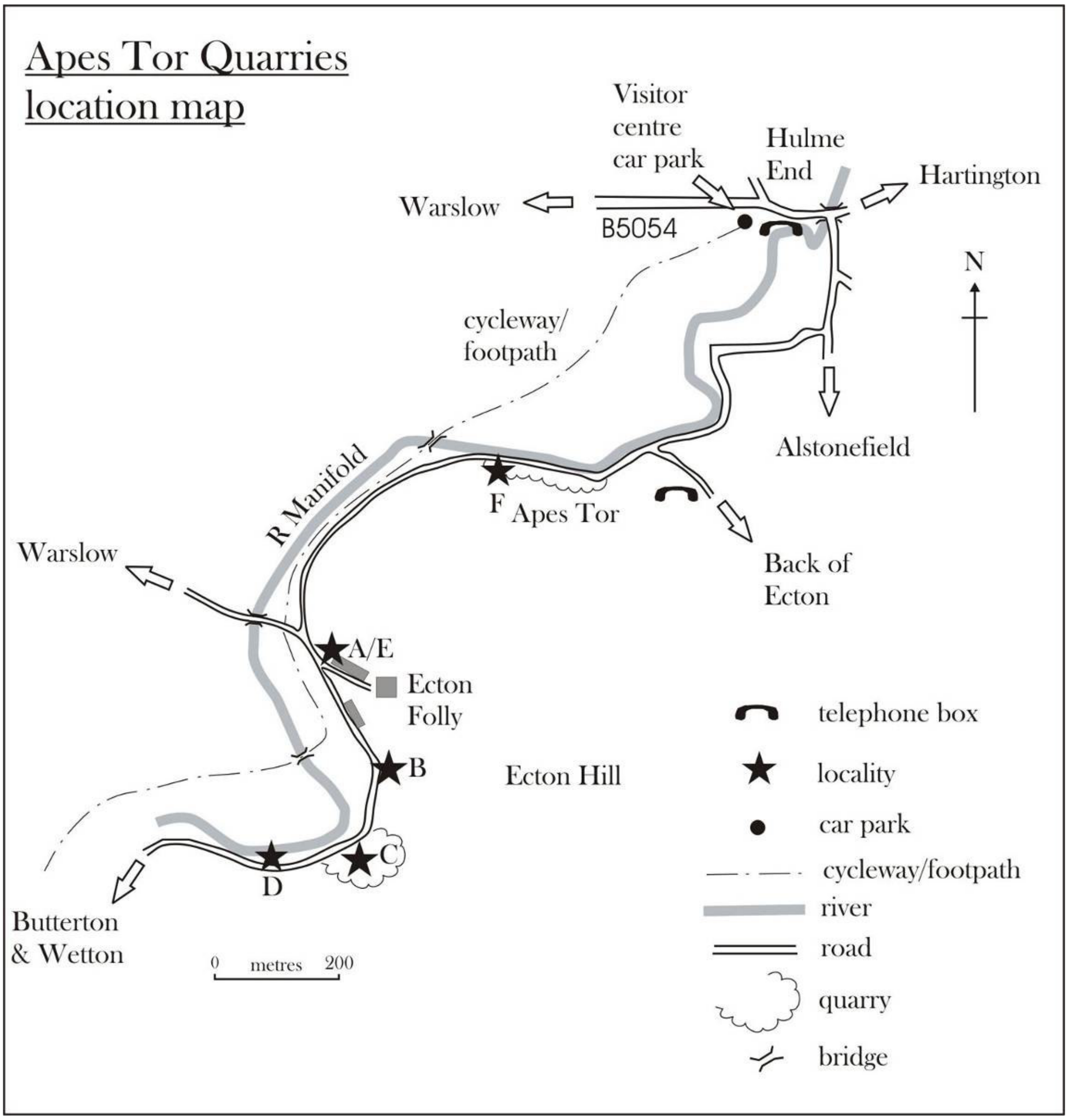
APES TOR: KS4 SITES A TO E

Introduction

Pupils will need: a) a clipboard with relevant worksheets and maps;
b) a measuring tape, compass & clinometer
Group leaders should have a plastic bottle of dilute HCl,, and a sheet of card to demonstrate the folding in 3D at site F

☛ Bring the group to site "A" along the cycle track from the Manifold Valley Visitors' Centre Car park. See **Figure 1**.
With large groups it may be advisable to split into two parties. The first party following the route ABCDE (A), and the second party following the route DABCE (A). Both parties should come together to move to site F further along the road. [Note: site E is a return to site A]. Use the site photographs to help you locate the sites on **Figure 1.**

Figure 1. Map of the Apes Tor – Ecton Hill Sites



Site A: Small, disused quarry at road junction for lane up to the folly. ***10 mins***

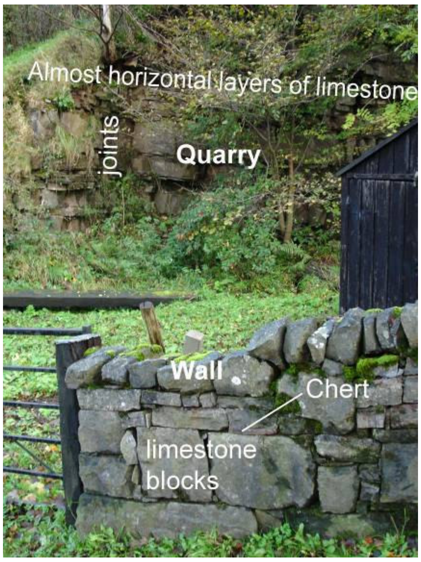


Figure 2. Site "A"

Stand by the gate and draw pupils' attention to the wall, built of limestone blocks and containing layers of chert. Afterwards, point out the quarry, a few metres away (See **Figure 2**).

Do not enter, as this is private land.

	Possible questions/tasks	*Possible answers* (words in brackets indicate need or opportunity for further teaching)
Q1	Observe and describe the rocks in the wall.	Colour: grey/brownish-grey Feel: fine to medium grain. Few fossils
Q2	Which is the main rock type making the wall here?	Limestone. (Other answers may be given – ask for reasons)
Q3	What test can we use to confirm the rock is limestone ?	Action of dilute acid – do test on sample.
Q4	Which of the three main groups of rocks does this fit into? (Sedimentary, igneous or metamorphic?)	Sedimentary
Q5	How can you tell? (Evidence – may need reminder)	Accumulation of grains, layered/bedded
Q6	Could the rocks in the wall have come from the old quarry behind? Explain.	Yes, same rock description/rock type
Q7	Is there another rock type present? Describe.	Yes, black in colour, no visible grains (Rock type is **chert**, in effect dried-up silica gel)
Q8	Look around. What else can you see these rocks being used for?	Houses, field walls, bridge
Q9	Describe the layering in the rocks in the quarry face	Horizontal, varied thicknesses/some thin, some thick beds (The layers are called beds; layers are separated by bedding planes)
Q10	Would these beds have been formed as horizontal/flat beds?	Yes (roughly) (**Principle of Original Horizontality)** (The sediment was deposited in the sea – evidence of shelly fossils)
Q11	Now relate what we saw in the class demonstration to the rocks in quarry face. Which beds were formed (or laid down) first and are therefore the oldest in this quarry?	Lower beds formed first (**Principle of Superposition**)
Q12	Can you see any cracks across the layers?	Yes (The cracks are called **joints** or **fractures**)
Q13	Can you suggest how the fractures might have formed?	Most fractures probably formed during earth movements (**uplift**). (Take other suggestions e.g. quarry blasting, shrinkage)

Site B: Roadside spoil tips between car park and house ***15 mins***

☛ Take the group about two hundred metres south to site "B" Stay on the road side of the fence, but reach over to fetch samples, which should be returned after use.
These tips are formed of the unwanted products (called spoil) of 18th and 19th century copper mining, which were tipped over the edge of the dressing floors on the hillside above after the valuable minerals had been separated.

Figure 3 Site "B"

	Possible questions/tasks	*Possible answers* (words in brackets indicate need or opportunity for further teaching)
Activity Q1	Collect a small range of samples of different rocks from the tips. Identify.	Limestones (various colours and grain sizes); chert. Rocks show a few fossils (e.g. **crinoid** stems)
Q2	Estimate the range of size of the pieces of spoil	From a few millimetres up to, say, half a metre
Q3	Why is the material angular and so varied in size?	It is angular because it has been dumped from the top of the slope, and not travelled far (natural transportation rounds off the edges) It is of many sizes because of the crushing of the mined rock and separating out the valuable minerals before throwing the waste away.
Q4	All the material on the tips has slid down the slope and come to rest. What force caused the spoil to slide down?	Gravity (Note: the fragments are still mostly angular because they have not moved far)
Q5	Why did the material stop / come to rest?	Balance of forces – gravity v. friction
Q6	Estimate the angle (gradient) of the slope. See **Figure 3**.)	Around 30º (First estimates are always too large!)
EXTENSION Q7	Look up at the slopes. What is now stopping the material from washing down under gravity when it does rain?	Growth of vegetation holding rocks and soil in place.
EXTENSION Q8	Why is there no vegetation on the steepest slopes?	Too steep to retain soil when it rains. On steep slopes water run off is greater.
EXTENSION Activity Q9	Look for minerals in the rocks seen as crystals, specks, patches or lines of colour. Describe: what colours are they? *(Note: there are dozens of different minerals to be found on these tips, but most are rare).*	Most likely minerals: clear or white crystals: (calcite - calcium carbonate); red (iron oxides); green (malachite - copper carbonate); brassy (pyrite – iron sulphide or chalcopyrite – copper iron sulphide); grey or bluish grey (galena – lead sulphide) Set a time limit on this search for minerals!

Site C: Old quarry in different rock beyond car park ***10-15 mins***

☛ Continue south along the road for about 150 metres to Site C. (See **Figure 4**)
At site C we recommend that parties stay on the road side of the fence. A stile has been provided for entry, and no 'keep out' signs erected, but the steep hillside above presents a serious hazard from falling material. In addition, taking a group over the stile (twice) takes time. Large blocks from the quarry can be inspected close to the other side of the fence.

After the closure of the mines this quarry was worked for aggregate for roads and tracks. It is now a significant part of the Manifold Valley SSSI. **As a result, no material should be collected from any of these sites.**
The rock type here is called a **breccia** (pronounced: brech-e-a*)*. Breccias are made of angular fragments cemented in a fine grain matrix. (See **Figure 5**.)The fragments cannot have moved far from where they were formed, as they would otherwise be rounded by the processes of transportation.
Commonly, breccias are formed by the cementing of scree material. However this is an unusual example, as the sequence below explains.

Figure 4. Fossil Scree at Site "C"

Figure 5. Sample of fossil scree

	Possible questions/tasks	*Possible answers* (words in brackets indicate need or opportunity for further teaching)
Q1	Compare the material in the quarry with (1) the limestone seen at locality A (2) the spoil heaps or tips at locality B Describe the rock. Does it break apart easily?	Broken angular fragments cemented together to form new rock. This rock is called a **breccia.** (Note: difference between breccia & **conglomerate** - made of rounded fragments) No
Q2	Suggest what the fragments may be made of.	Look like bits of broken limestone
Q3	Suggest what the fine material (the matrix) between the fragments may be made of.	Looks like mud, but it's very hard
Q4	Suggest how the rock can be tested to show it is limestone.	Acid test on fragments – positive. (Note: Acid test on matrix – also positive) Thus rock is made of limestone fragments embedded in a 'limey' mud cement.
Q5	Is this rock older or younger than the mining (which finished about 100 years ago)?	Has to be older – timescales for rock formation are longer than 100 years. (This is clearly not a spoil tip from the mine).
Q6	Can we suggest where the limestone fragments have come from?	Weathering; since they are **angular**. This points to **freeze/thaw weathering**, and formation of a localised **scree slope** with **steep angle of rest.** (Note the steep hillside at this point is north facing – in summer, it still rarely gets much direct sunlight)
Q7	When could the climate have been so cold that extensive freeze/thaw action like this could happen?	Ice Age. Ice would have scraped away such loose material, but after the melting of the last ice when it was still cold it would have been cold enough for this to happen. So up to about 10 000 years ago.
EXTENSION Q8	Tell the pupils that the cement in the breccia is lime cement (it fizzes in dilute HCl). Then ask "Where did the lime cement between the fragments of limestone come from?"	'Limey' mud from chemical weathering of surrounding limestone combined with rain-washed 'soil', which set hard, just like building cement!
Conclusion	Think of the site as a relic of a past cold climate equivalent to Arctic Tundra today. The rock fragments were broken by freeze-thaw weathering within the rock cycle and accumulated in scree slopes. The chemical cement that flowed between the angular rock fragments then kept them as they were formed in these steep scree slopes.	

Site D: Bank of River Manifold ***10 mins***

☛ Continue southwards along the road for about another 100 metres and cross the road to the river bank. There are several possible points at which a party can be safely grouped to observe the river from the bank, but perhaps the best is to continue along the road from locality C, round the corner in the road (NB This small road carries a surprising amount of traffic: TAKE CARE!) and stand in the open area on the right with a good view of the whole valley and hillsides. You may want to point out the gated adit in the hillside across the road from site D, as a relic of the area's mining history.
The purpose of this session is to relate the revision of the rock cycle to a real situation where weathering, erosion, transport and deposition can be observed.
Student field worksheet 1 is provided at the end of this section.

Note that the river itself is privately-owned fishing, and no-one should go down the bank, enter the water, disturb the river bed or throw things into the river.

Figure 6. The Manifold valley from Site "D"

	Possible questions/tasks	*Possible answers* (words in brackets indicate need or opportunity for further teaching)
Q1	What kinds of weathering might be operating on bare limestone rock in this valley, and on the limestone below the soil?	A combination of physical weathering (freeze/thaw giving angular fragments) and chemical weathering (by weak acids in rainwater and soils forming products in solution)
Q2	How is material moved down the valley sides to the river?	Gravity and rain-wash
Q3	What happens when the material reaches the river?	Material is moved along by the river (transported).
Q4	Can we see any evidence for erosion, transport and deposition on and around the river banks?	Erosion and undercutting of banks. Deposition of gravel banks in river can be seen when the water is clear. When muddy, it is evidence of the river's suspension load.
Q5	What other product of weathering is transported by the river? How could you test for the presence of this material?	Much material produced by chemical weathering is in solution and transported as the river flows. Collect a water sample from the river, filter it to remove the material carried in suspension and then evaporate the sample to dryness. The residue is the soluble load.
Q6	The valley floor is covered in river sediments. How could these sediments have been transported and deposited?	Transported when the river flooded over its banks and deposited sediment to form the flood plain.
Q7	Where is most of this sediment eventually transported and deposited?	To the sea where it is deposited. (Note: transported via the River Trent to the North Sea)
Q8	What happens to the sediment next?	Compaction of sediment, squeezing out most of the water, cementing (like at locality C but by solutions circulating near the sea floor).
EXERCISE	Complete the rock cycle diagram using what has been learnt from localities B, C, D.	

Site E: (Which is the same as Site A) ***5 mins***

☛ Take the party back, north, along the road and return to Site A.
Again stand by the gate, looking at the quarry wall. Refer to the rock cycle diagram

	Possible questions/tasks	*Possible answers* (words in brackets indicate need or opportunity for further teaching)
Q1	Which parts of the rock cycle can we see evidence for here?	Evidence for **compaction** and cementing to form a hard rock (process called **lithification**) Evidence of sediment deposited in layers Evidence for Earth movements and uplift – formed on sea floor, but now over 200 metres above sea level
Q2	We noted before that the bedding was nearly horizontal here. We are going to move round to the north side of the hill next, where there are some good exposures of rock layers. Predict whether these are likely to be horizontal or not.	On basis of horizontal rocks here, likely to be horizontal still round the corner

☛ Now move the whole party, in narrow file under close supervision, with appropriate front and back markers to warn of approaching traffic, along the road on the outside of the bend (left side of road) as far as Site F at Apes Tor – about 300 metres.