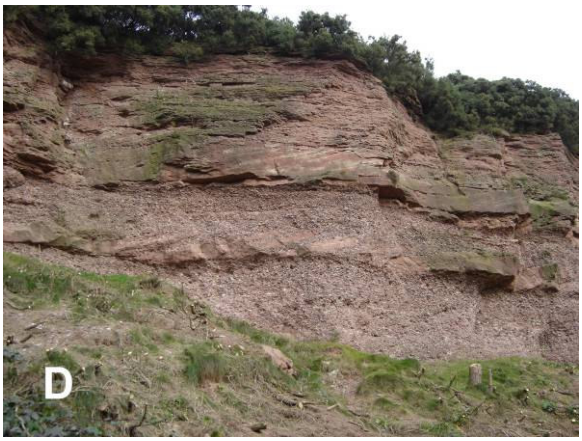
LOCALITY C: QUARRY FACE AT THE EAST MARGIN OF THE QUARRY **15 minutes**

☛ Move the group about 50 metres north to site C. View the site from the track below. **There should be no collecting from the face at this locality**

Possible questions/tasks	Possible answers (words in brackets indicate need or opportunity for further teaching)
T1 Collect a small loose sample of sandstone from the scree slope below the quarry face. Describe the colour of the rock.	Red brown colour. (The red colour is due to the presence of **haematite**, an iron oxide in the clays that stick to the grains in the sandstone. This shows the rock was formed in an oxidising environment on land).
Q1 Relate to what we saw at locality B and the evidence that the layers were deposited by water. Can you suggest how the sandstone was deposited?	In a river flowing over the land.
T2 Does a small drop of water sink in or run off the surface of the sandstone? What does this test tell you about the rock?	Water sinks into the rock/fills up the holes in the rock. Sandstone is a porous rock. (It also allows water to pass through it so it is a porous & permeable rock).
T3 Rub the surface of the sandstone and describe what happens. What does this tell you about the rock?	Grains rub off. Red stain left on fingers. The grains are not strongly held together/are not well-cemented. (The red stain is produced by the mineral haematite in the clays that stick to grains in the sandstone).
Q2 Can you see any fossils in the rock? What does this tell you about the rock?	No fossils seen. Not much. (It may be that organisms (a) couldn't live in the environment at the time the rocks formed or (b) were not preserved).
T4 Sprinkle some grains rubbed off the surface of the sandstone on a piece of ruled (1, 5,10 mm) graph paper. Are the grains about the same size? Estimate the average size of the grains.	Yes. Estimated size = 0.5 mm (The grains are described as medium sized grains and they are about the same size so the rock is described as **well sorted**)
Q3 Now relate to what we saw in the class demonstration to the size of the sandstone grains. Was the deposit laid down in low, medium or high energy conditions.	Medium to low energy conditions
T5 Use a hand lens to look at the shape of the grains. Are the grains rounded, angular or between rounded & angular?	Responses will vary depending on the sample chosen. Most of the grains between rounded and angular, but are nearer rounded rather than angular in shape so are sub-rounded.
Q4 Relate to what we saw in the class demonstration to the grain shape. What does the grain shape tell you about how far the grains were transported?	The grains were carried over a long distance. (Grains **abrade** one another as they are transported and the further they travel the more rounded they become).
Q5 Are most of the grains made of the same mineral? (Evidence?)	Yes - on the basis of similar colour (pale or clear) and similar hardness (scratch steel). (Most of the grains are made of the mineral quartz.)
T9 Students asked to complete part of the table summarising the evidence for the sedimentary processes that probably formed the sandstone.	A completed worksheet for sites C & D is shown at the end of this document.

LOCALITY D: QUARRY FACE, EAST MARGIN OF THE QUARRY **50 minutes**

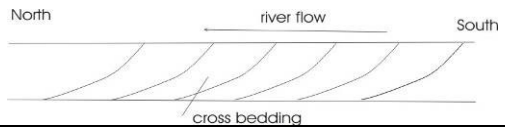


☛ Move the party along the face another 20 metres to site D

(See **Figure 1**, left) Stand on the track below the face looking east. This view shows the SSSI. **There should be no collecting from the face at this locality.**

Figure 1. Site D.

Possible questions/tasks	**Possible answers (words in brackets indicate need or opportunity for further teaching)**
Q1 Why are there so many loose pebbles in the scree slope?	The pebbles were not strongly cemented together/the conglomerate was friable/easily broke into bits. (This was an advantage when the pebble beds were worked in the quarry to provide aggregates for roadmaking).
T1 Work in small groups. From the scree slope below the quarry face collect 10 loose pebbles from the conglomerate. Place the pebbles on a piece of graph paper. Estimate the average size of the pebbles. Are the pebbles about the same size?	Results will vary depending on the group sample taken, but the pebbles will all be more than 4mm in diameter. (By definition **pebbles** are 4-64mm diam., **cobbles** are 64-256mm diam., **boulders** are >256mm diam.) The pebbles are not about the same size. (The rock is described as **poorly sorted**).
Q2 Now relate to what we saw in the class demonstration to the size of the pebbles. Was the conglomerate laid down in low, medium or high energy conditions.	High (Higher energy conditions are needed to transport large particles such as pebbles).
Q3 Look at the shape of the pebbles. Are the pebbles rounded or angular?	Rounded (and with smooth surfaces).
Q4 Relate to what we saw in the class demonstration to the pebble shape. What does the pebble shape tell you about how far the pebbles were transported?	The pebbles were carried over a long distance. (Grains **abrade** one another as they are transported).
T2 Work in small groups. Look at the 10 pebbles collected by your group. Are most of the pebbles made of the same material? (Evidence?)	No - on the basis of different colours, different hardness, layering vs no layering, crystals vs grains. (Other answers may be given – ask for reasons) (There are many rock types represented in the pebbles, although most of the pebbles are made of quartz or quartzite. Many of the pebbles match rocks found far south of Park Hall. Some are found as far away as S.W. England & Brittany).

T3 Extension work. In your group work out a way of collecting a random sample of 20 pebbles. Use the pebble identification sheet to identify the rock types, which have been weathered & eroded to form the pebbles. you collected. Can you suggest where the pebbles came from? (Clue – it may be useful to wet the surfaces of the pebbles to show details that will help your identification).	Most likely types identified are quartzite, quartz, conglomerate, breccia, sandstone, decalcified limestone, chert, granite, rhyolite. The source of some of the pebbles can be traced. (The provenance of the pebbles or where the pebbles came from identified in this activity may provide a suitable homework activity)
T4 Students asked to complete the table summarising the evidence they have seen that indicates the sedimentary processes that probably formed the conglomerate.	A completed worksheet is shown at the end of this document.
Q5 The rocks in this quarry face show at least 4 beds. Which two sedimentary rocks form the different beds here? (Evidence – may need reminder)	Sandstone (finer grained, darker red colour) Conglomerate (coarser/pebbly layer, lighter/varied colour)
Q6 Observe the layering in the rocks in the quarry. The beds at the top appear to show horizontal layers. Now look at the two beds at the base of the quarry face and describe the layering in these two beds?	Bottom bed is conglomerate. Looks like a thick horizontal layer. The second bed contains sandstone and conglomerate layers. Layers of varied thicknesses/some thin, some thick beds. Layers are not horizontal/are sloping by about 25 degrees to the left/to the north. (This second bed shows **cross bedding**)
Q7 Refer back to what we saw in the class demonstrations of river erosion, transport & deposition. Can you suggest how the cross bedding may have formed?	Sediment transported and deposited by currents/flowing water. (The cross bedding was produced by water currents in a river when moving sediment avalanched down a slope)
Q8 If you were standing here when the sediment was being deposited, now what do you think it would have been like?	Wet/underwater and in strong currents.
Q9 Now relate what we saw in the class demonstration to the rocks in this face of the quarry. Can you suggest the direction in which the river was flowing?	Flowing from the south to the north 
Q10 Refer back to the evidence from the pebbles. Does this flow direction match where the rocks making up the pebbles came from?	Yes – most of the pebbles moved from areas to the south of Park Hall.
Q11 Observe the top of the cross bedded layer where a thick conglomerate bed cuts across the top of the sand and pebbly layers. Can you suggest how this conglomerate bed formed?	Pebbles were picked up when the river was flowing very fast. Pebbles were then deposited after a sudden decrease in river velocity. (Thick pebbly layers were moved and deposited by **flash floods** by the river)
Q12 Can you see cross bedding in other layers in this face of the quarry?	Yes. (Cross bedding is most clearly shown in the sandstone layer above the thick conglomerate bed, but be prepared to take other sightings)
T5 Students asked to complete and label the field sketch	A completed worksheet is shown at the end of this document. nb. Sketch of quarry to show bed, bedding plane, sandstone, conglomerate, oldest bed, cross bedding, current direction, flash flood deposit