

3. The Reef Quarry: from the west. (About 30 minutes)

☛ Bring the group to a point west of Reef Quarry and point out the salient features. This site is an almost unique example of a small circular (patch) reef, with the surrounding beds complete with the fossil animals that lived there. These animals include corals, crinoids, and brachiopods. This is a very important site, do not cross the fences, or stand on, or damage the outcrop, nor attempt to collect any material. Good examples of the fossils can be seen in the loose blocks by the path. Here the reef itself has been quarried away, and the beds at the edge were deposited on a slope, around the central reef. They have not been tilted, they were deposited more or less at this angle. See **Figure 1**.

Figure 1. Reef Quarry From the West (location 3: (See Figure 1 NSC11KS4Ex1))



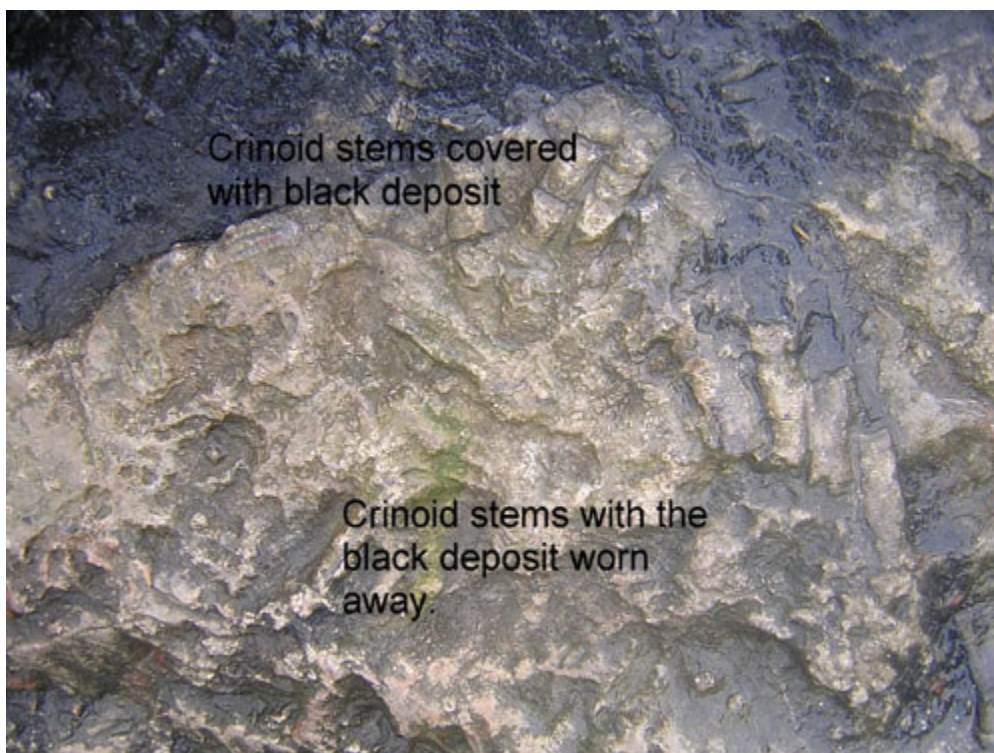
“What shape and size (height & width) do you think this reef was?”	[Almost circular, called a “patch reef”, about 10 metres height exposed, and about 70 metres across]
“In which direction do you think the fore-reef might be found?”	[The back-reef is to the north (left) so the fore-reef would be expected to the right (south)]
“What animals might you expect to be found here as fossils?”	[Corals, although these have been largely quarried away, and also brachiopods and crinoids, from the worksheets.]

☛ Investigation of the blocks by the footpath will reveal brachiopods in life position (although the blocks have been moved and may be on their “side”) The crinoids are best seen on the far side. The far side (north and North Eastern side) of Reef Quarry is approachable by footpath. The slope of the rock here represents the seafloor at the edge of the reef and the animals that lived on it at one point during the Carboniferous period. Inspection of the surface of the limestone reveals many crinoid stems, some apparently still rooted and fossilised where they died and fell. This indicates that they were living here in some profusion on the edge of the reef, in shallow water.

4. The Reef Quarry: from the north east. See Figure 1 NSC11 KS4 Ex1 (About 20 minutes)

<p>“Using the worksheet to help you, can you identify these fossil animals?”</p>	<p>[They are crinoids, related to starfish and echinoids. They are not plants.]</p>
<p>“What kind of conditions would allow such a high density of crinoids (and the corals, now quarried away) to exist?”</p>	<p>[See document NSC8 Info reef]: Plenty of food, appropriate depth, oxygen, sunlight, salinity, temperature, and current strengths not strong enough to uproot them or sediment to bury them. Lack of predators, steady rise in sea level allowing the reef to build up.]</p>
<p>“What possible reasons could there be for all of these animals dying at more or less the same time?”</p>	<p>[Reverse the answers to the previous question, and then ask them to look at the fossils and suggest which one they think is likely – and why. The evidence is not clear, although there is a black coating over the rock which might have smothered the filter feeders (see Figure 2 below)</p>

Figure 2. Crinoid Fossils at Reef Quarry. (location 4.)



5. The South East Quarry viewpoint. (About 15 minutes)

☛ Bring the group to the last viewpoint above South East Quarry and examine the wall ahead on the left for signs of the steeply dipping fore-reef beds. These can be difficult to see in poor light. See **Figure 3** Take this opportunity to summarise the evidence for these reefs. Remember that these beds were deposited at an angle, and the dip here is not due to tilting (which is to the NE at locality 1)

Figure 3. The Fore-Reef Beds from the viewpoint above South East Quarry. (location 5)



<p>“How high is the quarry face here?”</p>	<p>[About 30 metres. i.e. a good section through the beds]</p>
<p>“Why is it difficult to see the steeply dipping fore-reef beds?”</p>	<p>[Much of the beds have been quarried away, thereby making access and interpretation more difficult. Other factors interfering with the evidence are: earth movements; erosion, and other possible nearby examples of reefs still being buried. The lighting conditions are also important, a sunny afternoon is best]</p>

NATIONAL STONE CENTRE: KS4 EXERCISES AT LOCATIONS 3, 4 & 5

<p>“How closely do the limestones in this area match the ideal picture of a reef that we were using?”</p>	<p>[The fossils suggest warm, shallow marine environments; The area to the north shows rolled fossils and bedding, suggesting some current action & could be back-reef; The Reef Quarry evidence is partly missing, but the surrounding beds suggest deposition against a slope (the reef), and they suggest conditions that allow many animals to survive; the currents here were not strong, as the fossils have not been transported far from their life positions (i.e. sheltered by the reef); There is some evidence of steeply dipping fore-reef beds, suggesting deep water lay to the south]</p>
<p>“Which way would you walk to get onto younger rocks?”</p>	<p>[Uphill – to the east. The younger rocks outcropping on the hills to the east are shales, sandstones and coal seams deposited in a delta environment]</p>
<p>“So what does that tell us about what finally happened to this limestone sea area?”</p>	<p>[Silted up with delta deposits, eventually forming swampy land where vegetation grew and eventually formed coal seams.]</p>
<p>“Modern coral reefs are found only between 30 degrees north and south of the equator. The National Stone Centre is 53 degrees north. What are reefs doing here in Wirksworth?”</p>	<p>[Links to Plate tectonics and plate movements. During the Carboniferous this part of Britain was just south of the equator (where limestone seas existed) and has been moving northwards ever since (across rainy equatorial areas with big rivers and deltas, and rapid vegetation growth, allowing coal seams to form.)</p>