BLACK ROCK: KS4

At Black Rock

Pupils will require a clipboard, copies of the relevant exercise sheets below, and access to a tape measure and hand lens. Members of staff should carry a small plastic bottle of dilute HCl.

☛ First, bring the group to the Black Rock outcrop (see Figure 1), avoiding close inspection of the information boards! Behind you is the highpoint of the mine spoil heap and the site of the headgear for the Cromford Moor mine shaft, of which no trace exists today.

TASK 1. BLACK ROCK INVESTIGATION: (The work at this site should take about an hour or so, depending on how much time is spent finding minerals on the spoil heap in Task 3)

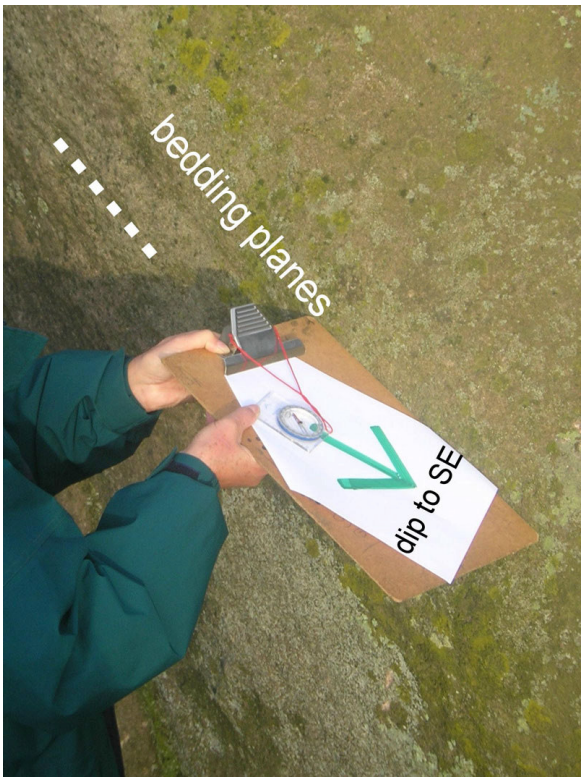
"This is Black Rock. What kind of rock forms this outcrop?"	[It shows grains of quartz cemented together. It shows parallel bedding planes. It is a sedimentary rock called a sandstone.]
"Can you find any evidence of how it is being weathered?"	[The soil at the sloping base of the outcrop is very sandy, being made up of grains released form the rock by the chemical weathering of the cement holding them together. **See Figure 1**.]

Figure 1. Sandstone and Soil at Black Rock

"Are the rocks here still horizontal? What has happened to them since they were deposited"	The beds have been uplifted and tilted about 10 degrees to the SE. The kinds of forces required to do this are tectonic ones related to plate movements. The tilting is most easily seen at the base of Black Rock crag. There is no need to climb the crag, as bedding is visible as linear features in the side of the outcrop. The space here is suitable for only three of four to make the measurement at a time, the rest may observe from the top of the spoil heap. Measurement of direction of dip with a compass, should give a south easterly direction. Measurement of angle of dip of the south west corner of the crag, with a clinometer, should give an answer around 10 to 15 degrees. .When measuring the dip use a clipboard to get a good surface. Take care to get the maximum slope of the beds (the true dip) the linear traces of bedding on the crag are deceptive (false). See **Figures 2 & 3.**

Ask pupils to sketch the outcrop and label the bedding and dip of the gritstone, and mark the shale below.

Figures 2 and 3 Measuring the Dip at Black Rock



"These rocks are dipping almost directly to the south east, which way would you need to walk in order to get onto younger rocks?" and **"Which way to get onto older rocks?"**	"These rocks are dipping almost directly to the south east, which way would you need to walk in order to get onto younger rocks?" and "Which way to get onto older rocks?"
"Can you now work out the order of deposition (ie oldest to youngest) of these three rocks: shale, limestone and gritstone? Record your answers on worksheet 7"	[The shale is clearly below the gritstone at Black Rock, (and so is older) and the limestone is under the shale, and also visible to the west, outcropping extensively in Dene Quarry. It is clearly dipping towards, and under, the shale (and so is oldest)].

Group Leaders might now want pupils to link these rock types to the larger picture of changing environments of deposition, and Plate Tectonics, before proceeding to the economic geology story.

"What kind of conditions of deposition allowed the limestones in the National Stone Centre to form?"	A clear, shallow, warm sea, with reefs and lagoons]
"The rock above the limestone, (and below this sandstone) is a shale (it isn't well exposed here, but can be glimpsed at the top of the spoil heap as black mud). What does that tell you was happening to this clear warm sea?"	[influx of muddy material eroded from land, and killing the reefs]
"Above the shale is this sandstone at Black Rock. What does the change in grain size from muddy (shale) to sand tell you about the current strength.?"	[Current strength increasing]
"The rocks higher up the hill, above this sandstone, include coal seams. What does that tell you about conditions of deposition at that time?"	[a swampy land area with vegetation growth sufficiently rapid to form coal seams when buried in the stagnant swamp water. The sequence of rock types in this area indicate a transition from deposition in a marine area to a low lying deltaic swamp environment, which had been built out into the sea by very large rivers, over a timescale of a few million years.]
"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?"	[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, and continuing to its present position today.]

Using pupil Worksheet 6, summarise how you worked out the order of the three rocks (oldest to youngest). How might this be interpreted as evidence for Plate movements?

TASK 2 BARRELEDGE (GRITSTONE) QUARRY INVESTIGATION

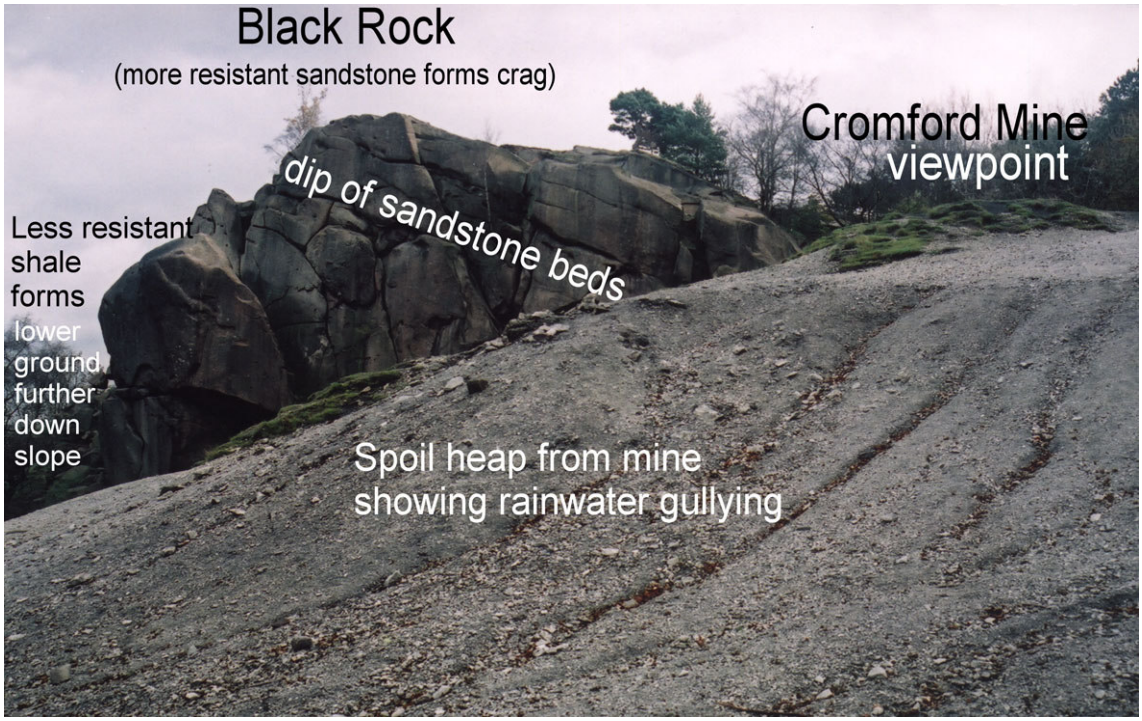
"What evidence can you find that Gritsone (sandstone) has been quarried close by ?"	The obvious outcrop of Black Rock shows no sign of quarrying (there's no need to climb it). To the east is a wall and two gateposts made of gritstone. The track alongside the field to the south is also dark gritstone, not pale limestone. This track also has rough "cobblestones" of grit.
"Stone wasn't moved too far due to the expense, so the quarry isn't far away. How would you set about finding the quarry itself?"	The map puts the main gritstone outcrop eastwards. The quarry is now a slope overgrown with bracken and birch, about 200 metres up the hill.
"How would you describe the impact of this quarry on the landscape today?"	Impact very minor, it is almost like a natural wooded slope. See **Figure 4**. (very different from the Dene Quarry site to the west). Not only was it a small operation, it has been left to naturalise. Comparisons with Dene Quarry and the National Stone Centre can be drawn.

Figure 4 Barreledge Quarry

☛Bring group to The high point of the Cromford Moor mine spoil heap (see **Figure 5**) This is close by a slight depression where the headstock stood. Often it has water in it.

TASK 3. MINING FOR METALS INVESTIGATION.

Figure 5 The Cromford Mine viewpoint.



"The records tell us that this is the site of Cromford Mine, where up to 100 men and women mined for metal ore up to 1850. It is in the area of the shale outcrop. Why is this a surprise?"	Shale is a more plastic rock and rarely has open fissures to allow minerals to be emplaced. Usually shales act as a cap to stop minerals moving upwards through them. This mine shaft went down 128 metres to get to the vein in the limestone below. It lies along a fault running west-east through the site. (Pupils who insist that the limestone outcrop is a more likely site are correct. To the west are the hummocks of extensive old mine workings clearly visible from this point.)
"What evidence is there that miners were working veins in the limestone below the shale?"	There are many lumps of pale grey limestone laying about on the surface.
"What evidence would you look for to confirm the idea that this site is a spoil heap of a mine?" and **"How would you find out what metal was being mined?"**	Check through the lumps of spoil to see if there are traces of ore minerals, then identify them (See the mineral identification sheet: **BR12 minident**).
"Using the identification chart see if you can find out which ore mineral was being mined here. Keep an eye open for the other minerals (gangue minerals) also in the veins".	Give the pupils fifteen minutes to scour the spoil heap looking for lumps of limestone with traces of minerals. (See document **BR12 minident** for additional information) [For this exercise it is sufficient to tell pupils that there are four possible metal sulphide minerals likely to have been formed in these veins: Pyrite (FeS_2); chalcopyrite ($CuFeS_2$); galena (PbS) and blende (ZnS). In fact the main ore mineral here was galena, and there are enough traces to confirm this. This was a lead mine, although there are some traces of blende. The gangue (unwanted, non-metaliferous) minerals present here are calcite ($CaCO_3$); fluorspar(CaF_2); and barite ($BaSO_4$).]
"Why do you think this mine might have closed down?"	Possible answers include: the ore became mined out; fall in the price of lead; more expensive mining conditions (e.g. cost of drainage, or longer shafts and adits); competition from other, more profitable, lead mining areas.

In fact the mine was re-opened in the 1920s as a source of white calcite, and it is from this period much of the limestone spoil dates. It was used in the manufacture of bleaching powder, calcium carbide, glass, soap, paper and paints, the production of which was expanding at this time.

Using Worksheet 7 summarise your findings. What is the evidence that this was a lead mine? Explain why it was sited on the shale area, and why it might have closed. Why was it reopened in the 1920s?

☛ Return to the transport, either back to the National Stone Centre along the High Peak Trail (about 15 minutes) or arrange for minibus transport to meet the party at the picnic, or a coach, in the area close by the Steeple Arch cemetery. (about 5 minutes)