'Quarries - A Fieldwork Approach.'

Pilot GCSE - Option 7
Investigating Geography through Fieldwork
Assessment Objectives: AO1, AO2, AO3

Through this module pupils will be encouraged to:

- Use existing scientific and geographical knowledge
- Use secondary sources
- Develop their observational skills
- Share information in order to answer questions
- Work together to bring skills learnt in the classroom to bear on new problems
- Work safely in the field
- Present the results of a field investigation in a different format

Teacher introduction and overview.

The themes explored in this unit help students to answer the following questions:

- How does the underlying geology determine landscape
- What can we learn about depositional environments from studying rock outcrops
- How are geological products used by society today – obtained through a Homework Activity.

Students will be asked to use the knowledge gained through a series of classroom exercises and a visit to a quarry or the Virtual Quarry Resource to design a leaflet for Key Stage 3 students using the information gained from secondary and primary resources. In order to complete this task they will use:

- Computer network for Internet access
- Virtual Quarry Resource
- Samples of rocks and minerals
- Ordnance Survey Maps
- Geological Maps
- Rock and mineral specimens
- Compasses
- Digital camera

A second task, which could be used as an alternative or an extension activity, asks students to consider the various options available for the site once quarrying has finished.
Students will gain experience in working safely in the field, making and recording reliable observations and measurements, using prior scientific and geographical knowledge to aid understanding and data presentation techniques.

The systematic approach outlined in the lesson scheme provides a working template for use in any type of quarry. Quarries provide an area of exposed rock face, which enables students to work in small groups recording and interpreting their finds. Quarries in areas of carbonate rock are often full of fossils and provide that extra element of excitement; this may just be the day some fantastic hitherto unknown fossil is discovered! Sand and gravel sites where clastic sediments have been laid down in beds enable learners to investigate relative ages and changing environmental conditions. In areas where these sediments were deposited by meltwater as glaciers retreated students can gain some understanding of the impact changing climate may have today if global temperatures continue to rise and ice on land begins to melt. Quarries where folding or faulting of rock is exhibited, or sections where igneous rocks intrude into sedimentary beds can all link to geological activities taking place on the Earth's surface today as well as providing the tools for a classic approach to creating geological logs which allow analysis of the timing of events and the effects those events have had on landscape development over time. The lessons do not

attempt to answer these questions but rather provide a systematic approach to preparation, fieldwork and follow up sessions that can be applied to fieldwork in any type of quarry real or virtual.

The basic structure is:

The lessons and practical sessions

The lesson plan comprises of 5 lessons but could be extended to 6, or if the Virtual Quarry Resource is used reduced to 4. Students will use their observations and knowledge to produce a leaflet aimed at Key Stage 3 pupils to help support work on Rocks and Weathering and the Rock Cycle. An alternative, or extension task asks students to consider the ways in which we use quarries once active removal of the rock ceases.

Lesson One

What do we know about the site and the type of rock exposed there?

- Setting the scene, emphasis on the purpose of the fieldwork and the relevance of the classroom activities to that fieldwork.
- Ordnance Survey and Geological maps are used to produce cross sections of the area to be visited and to aid interpretation of the site from secondary sources.

Homework

- Written piece describing the formation of the rock types found in the area to be studied

Lesson Two

What is so special about the rocks in the fieldwork area? What do we want to find out? What will we need to do before the fieldtrip or use of the Virtual Quarry Resource?

- Homework used to begin discussion of rock types
- Hands on session using rocks and minerals appropriate to the field site
- Sketches produced from projected images or the Virtual Quarry Resource

If session 3 is to be the field trip

- Information on appropriate clothing, personal equipment needed
- Introduction to the tasks to be completed after the field trip

Homework

- How does society use the rock quarried from the particular area to be visited. How could we ensure the rock quarried is used in a sustainable manner?

Lesson Three, if used (classroom based)

The tasks in Lesson Two can be repeated if necessary before the field trip using a more difficult image for the field sketch and asking questions regarding sorting of grains and cementation of the sedimentary rocks, crystal relationships in the igneous rocks and degrees of alteration in metamorphic rocks if these have been used. For homework students could be given a list of the health and safety issues associated with carrying out fieldwork in quarries and asked to suggest the 2 things they consider most important to ensuring they work safely.

Field Trip

What information can be collected in the field or from secondary sources?

- Use structured questions to guide individual observation and recording exercises.
- Students will be brought together at regular intervals to discuss findings, interpret those findings and ensure all students are gaining from the experience.
- Students are reminded of the tasks they will complete in the following week(s).

Lesson Four (Five)

What can we do with our findings?

- Summing up
- Students identify material to be used in the leaflet and where appropriate the alternative task.

Lesson Five (Six) (if used)

- Completion of tasks.

Key Stage 4: Pilot GCSE - Option 7: Investigating Geography Through Fieldwork: The unit involves aspects of all three of the Assessment Objectives, *i.e.* AO1, AO2 and AO3.

This quarry linked unit provides the opportunities to address the following main concepts outlined in Option 7:

- **About the environment: by extending knowledge and understanding of geological processes**
- **Through the environment: by extending students skill base and through encouragement of collaborative learning**
- **For the environment: y considering the use we make of areas such as quarries once their working life is complete**

Context

Sometimes fieldwork is about taking controlled measurements or testing hypotheses, it can include collecting data to support (or reject) a new business proposal or be related to establishing the environmental quality of a local water course. Out-of-classroom activities offer a tangible bridge between local concerns and national or international issues.

Fieldwork investigation has a long history in the development of geographical thought. Many early geographers were in fact explorers undertaking observations and recordings of their travel experiences. Candidates are required to investigate fieldwork traditions, and the RGS-IBG Unlocking the Archives website offers a rich resource for this part of the fieldwork unit.

Through this unit candidates should engage with a critical review of fieldwork, rather than accepting it as an unquestioning force for good. They should be questioning 'What is fieldwork?' and 'How is it justified?' The role of fieldwork can vary. It can be 'about' the environment (developing knowledge and understanding), 'through' the environment (developing practical skills and providing activity based learning) and 'for' the environment (with a social change agenda).

Candidates should also explore the power relationships and influences that lie behind explorations and commercial investigations. They should be encouraged to think critically about why certain research activities are commissioned, how the data is used and with what effect. Where geographers from different economic or environmental persuasion, or from a different social or cultural background have carried out an investigation, would the results be presented in the same way?

One of the strengths of fieldwork is that it requires candidates to project a range of practical, organisational and intellectual skills onto a real world issue. This involves them in exploring the complexity of geography. The real world often demands critical reflection to support meaningful description, explanation

and judgements. Candidates should have a go at the interpretation of the world first-hand, or, arguably, their geographical education will be lacking.

Job provides a summary of the extensive range of fieldwork strategies (see GTIP web pages http://www.geography.org.uk/gtip/gtip_4c.asp#design), and a significant element of this unit is that candidates are required to critique and reflect upon these so as to improve their ability to plan and organise their own investigations.

Since Job's summary was produced, there has been significant debate surrounding virtual fieldwork. It may be helpful to share some of these discussions with your candidates. They will be well placed at the end of this unit to develop their own dialogue on virtual fieldwork.

Content

This unit is divided into four sections:

- *Finding out about fieldwork*, candidates consider the relevance, purpose and significance of fieldwork. **This section is not addressed by the quarry linked unit.**

- *Undertaking fieldwork,* through designing a project candidates explain the main features of different data collection methods and outline logistical and health and safety considerations.
- *Reporting back, data-handling,* candidates carry out a basic analysis of data using a range of techniques and report back on their findings appropriately.
- *Fieldwork in action,* candidates should be personally involved in planning, implementing and reporting back on at least two fieldwork projects.

Concepts

This unit draws on all five of the Pilot GCSE concepts:

- *Uneven development*. Fieldwork involves candidates in describing, explaining and making judgements about observed spatial variations. The consideration of the simultaneity of difference is one of geography's major contributions to developing a meaningful understanding of real-world issues.
- *Interdependence.* Any fieldwork investigation should enable candidates to explore how the place they are studying is linked with others through geographical flows, patterns and processes. Scale should be used as a 'zoom lens' to focus a study. No study should be based entirely and exclusively at any one scale or one place. **The quarry linked unit provides a "first step" to obtaining these goals.**
- *Futures.* The future of the place being investigated should be explored in a meaningful and informed way. Candidates should be supported in considering alternative geographical imaginations. These should be informed, reasoned and rational, and may involve candidates in imagining different social, environmental,

political and economic priorities and philosophies. **The quarry linked unit provides a "first step" to obtaining these goals.**

- *Sustainability*. A critical understanding of perceived environmental, cultural and economic sustainability is important in thinking critically about any locality at any scale.
- *Globalisation*. The impact of global patterns, processes, systems and flows all have an influence on the development of any place. How these are perceived informs the decisions made in and about any locality, and candidates should come to understand that their decisions must be based on high quality geographical imagination. Meaningful fieldwork creates such information. **The quarry linked unit provides a "first step" to obtaining these goals.**

Assessment objectives

The unit involves aspects of all three of the Assessment Objectives, *i.e.* AO1, AO2 and AO3. Inevitably a particular emphasis (50%) is placed on AO3. A knowledge and understanding of *'the purpose and character of fieldwork, gaining awareness of the different types of fieldwork, the role of market research and surveys in informing decision makers and the relevance of fieldwork to society and the wider world'* is part of AO1. Developing an awareness *'of the knowledge skills and understanding implicit in designing a simple fieldwork project, including understanding how health and safety considerations are integral to the planning process'* is part of AO2 but also has some overlap with A03. Candidates' ability to select and use skills by demonstrating *'an awareness of a range of approaches and techniques of data collection, including qualitative and quantitative approaches, primary and secondary data and the role of ICT in research'* are part of AO3 but also has some overlap with AO2. The ability *'to use and apply appropriate skills and techniques in the planning, implementation and reporting back of the candidate's own fieldwork projects'* forms part of AO3.

Opportunities for linking themes

All the core themes and optional units allow opportunities for fieldwork. In particular there are strong links with the core theme 'My place' and optional units on 'Coastal management', 'Planning where we live' and 'Urban transport'.

Ensuring that the unit is 'predominately academic'

This unit is *difficult to classify on the academic-vocational continuum*. It is predominantly academic in that it is focused on a body of knowledge, skills and experience pertaining to fieldwork. However, it will inevitably be applied by candidates since fieldwork must be used in a context. There is also a vocational relevance to jobs and careers in survey work, research, public relations and marketing

Planning content

The planning grid for the Investigating Fieldwork is available as a download from the Pilot GCSE web pages.

Conclusion

This unit has the potential to motivate young people and to challenge them to explore the relevance of geography in general and fieldwork in particular. It should broaden the previous experiences of the candidates and develop their transferable skills and understanding that can be applied to other areas of the Pilot GCSE course and to their experiences beyond formal geography lessons.

Diane Swift (GA) and Judith Mansell (RGS-IBG)

www.geography .org (2005)

Lesson One

- What do we know about the type of rock exposed at the site?

Introduction to the site to be used or visit to the Virtual Quarry Resource

Students should use Ordnance Survey and Geological Maps of the area to gain an understanding of the landscape and/or any special features.

Students will need to know that:

- On the geological map different rock types are shown as different colours
- The stratigraphic column shows the age relationship of the rocks on the map
- On a stratigraphic column the oldest rocks are at the bottom of the column the youngest at the top
- Some geological maps show the solid rock and the Drift deposits. Drift refers to geological material deposited since the end of the last Ice Age. Till (boulder clay), peat, glacial sands and gravels, river alluviums are some examples of Drift, not rock but important deposits particularly for the aggregate industry.
- Students should already be familiar with the Ordnance Survey maps nomenclature

Task

- Using contour lines an image of the form of the land in the area of the quarry should be made, teachers should ensure students are comfortable with the concept of a 2D image showing a 3D structure, that they understand the relationship between width of spaces between contour lines and the steepness of the land
- Students draw cross sections using the contours
- Students draw another cross section from the geology map showing the rocks outcropping at the surface
- This is superimposed onto the Ordnance Survey cross section

Homework

Students write a paragraph about each of the rock types identified on their cross section. They then answer the following question: Why is this rock (sediment in the case of sand and gravel quarries) quarried?

Teachers information

Use this homework to start the second lesson. Answers should identify igneous rocks as crystalline, carbonate rocks as susceptible to chemical weathering or as full of fossils, clastic sedimentary rocks such as sandstones, gritstones or mudstones should have some mention of weathering, transportation and deposition. If the written work is in response to removal of sands and gravels then the depositional environment is important, river or glacial meltwater?

Lesson Two

What is so special about the rocks in the fieldwork area? What do we want to find out? What will we need to do before the fieldtrip or use of the Virtual Quarry Resource?

Using student's homework to prompt a question and answer session recap on the types of rocks/minerals likely to be found on trip

Task
Working in fours students are given a small selection of the rock types and minerals likely to be found in the quarry. Can they identify the rock types? Can they identify the minerals? What can they say about the rocks i.e. hard, friable, grain size, and fossils?

- Recap where necessary on Mohs scale of hardness, remind students this tests the hardness of minerals **not** the hardness of a rock. Ensure safe use of dilute hydrochloric acid to test for calcium carbonate. Recap on porosity and permeability if necessary, what effect does this have on the rate of weathering processes.

Ensure students understand the purpose of the fieldwork to be undertaken. Students will use their knowledge of rock types to interpret depositional environments. In follow up activities they will consider why these materials are quarried.

Students will gain skills in:
- Observation
- Working in unfamiliar situations
- Working to deadlines
- Applying prior knowledge to a problem
- Interpretation of a geological sequence

One of the tasks that will be completed on the trip will be a field sketch of part of the quarry.

Students will need to know that:
- A sketch of the area is not a piece of art but a means of conveying information to others
- Sketch should include a scale and orientation
- Sketch should be labelled

www.bbc.co.uk/scotland/education/int/geog/limestone/field/index.shtml provides a useful series of images and information on how to carry out a field sketch which may prove helpful to less confident students but there is too much extraneous detail

included to make them really useful when sketching a rock face in a quarry –lots of trees are included for example.

Task

Using the Virtual Quarry Resource, a photograph, slide or image from the Internet project an image of a quarry face for the whole class to study. What can the students see? Differences in colour, evidence of bedding, fractures or joints, screes can all be easily identified from an image.

- Working on their own students make a simple labelled sketch
- They then list their observations
- An initial interpretation is made – does the student think the rock is the same throughout the area they have sketched, are they able to identify the rock type i.e. sedimentary, igneous
- This interpretation is shared with their peer
- By sharing their thoughts each pair should be able to generate questions that they would like answered i.e. why is that section darker than the rest, where have all the boulders come from?

The teacher should circulate throughout this exercise, as by listening to the student's conversations in the think/pair/share exercise you will be able to assess levels of knowledge and understanding and address any areas that are weak during the feedback.

- Students ask their questions. Use the image, any quarried materials available and the maps to ensure students feel confident about their excursion.

- Information should be given to students on appropriate clothing and equipment needed for fieldtrip i.e. stout footwear, wet weather gear, sun screen if appropriate, hard hats, clipboard and paper (or hard backed notebook) pencil (not pens as they do not write well in the rain!), camera if available, packed lunch

- A large clear plastic bag can be used to protect the clipboard and paper if the weather is really wet; the bag needs to be large enough to enable students to continue to write on the paper.

- Students will be using the information obtained at the quarry to produce an information leaflet for Key stage 3 students.

Homework

You will be undertaking fieldwork in a (insert the type of quarry to be visited) in order to determine the depositional history of the rocks. This information will be used to help you produce an information leaflet for use by Key Stage 3 students studying the Rock Cycle.

Decide on three tasks that you think it will be important to carry out on your field trip to collect appropriate data. Briefly outline the tasks, describe how you will carry them out and how you will use the information in your pamphlet.

Lesson Three

The tasks in Lesson Two can be repeated if necessary before the field trip using a more difficult image for the field sketch and asking questions regarding sorting of grains and cementation of the sedimentary rocks, crystal relationships in the igneous rocks and degrees of alteration in metamorphic rocks if these have been used.

Lesson Four

Fieldtrip or Visit to Virtual Quarry

What information can be collected in the field or from secondary sources?

Visit to the quarry

Following a clear explanation of the Health and Safety procedures in place at the quarry students are given a brief walking tour of the area picking out examples of features identified and discussed in class.

Approaching a rock face in a systematic manner

Students will find it much easier to compare data from one site to another if they work in a systematic manner. It will also help to ensure they have actually looked at the rock face and recorded what they saw rather than what they thought should be there.

A teacher's information sheet is provided which could be readily adapted to provide a student worksheet.

TEACHERS INFORMATION SHEET

QUARRY FIELD TRIP

This sheet provides a range of questions that students will have the opportunity to answer on a visit to a quarry.

The first stage of the visit should consist of a linking session to the work carried out in class. What does the area look like, are you in a valley or a river basin, on a hill or a flat floodplain? Why was this quarry sited here? Are the geological materials extracted needed for building houses, libraries or courthouses, sandstone for example or Portland Stone? Does the site provide aggregates, for example sands or gravels or crushed rock? Is the material quarried used as decorative facings on prestigious buildings, Shap granite for example or maybe fossil rich limestones?

On the initial walk around the site draw the students attention to specific areas of interest particularly relating to the tasks they will complete on the visit.

It is important students understand the purpose of their field investigation before they start any task so they can plan their time well to ensure they complete all tasks. The approach taken here for sedimentary rocks is to try and answer the questions:

What was the depositional environment?
How do we use the quarried materials?

- Questions about shape and size of grains link to transportation and erosion
- Questions about sorting link to transportation
- Variations in the type, shape and size of grains found in adjacent beds lead to questions about changes in climatic conditions, availability of sediments
- Questions about cement can lead to consideration of varied transport and depositional environments
- For carbonate rocks investigation of fossil assemblages can lead to a range of questions about food sources, changes in salinity or influxes of clastic material from the land.

Students should take a systematic approach to investigating geological outcrops.

Information Sheet

Information for students and teachers. This information could be produced as a handout omitting the notes for teachers, which are shown in italics, or used as a prompt for teacher led investigations.

On approaching the rock face stand a little distance from it and take a good look at the whole face. This is a good point from which to make a sketch. Remember to include a scale and a compass direction and to label prominent features.

- *Ensure students use 3 figures to record their compass reading i.e. 280 degrees or 036 degrees, not East or West*

Now step up to the face. Remember to wear a hard hat at all times. Do not climb on the face. Geologists like to work in pairs when examining a quarry face so they can discuss what they see, you should do the same!

- *Depending on the size of group and number of helpers you may need to divide your group into fours rather than pairs. It is important that students' work together, one may be very good at spotting fossils, another at measuring grain sizes. By sharing information as they work all students' gain something from the experience.*

Answer the following questions:

1. What is the overall colour of the rock?
2. What is the mineralogy of the rock – can you see quartz or mica, how can you tell if you have quartz or calcite?
3. Is this a sedimentary, metamorphic or an igneous rock?

- *Some students may require help with identifying minerals.*

Once you have decided which rock type you have you will need to ask different questions of each type of rock.

If you have SEDIMENTARY ROCK

Is it a clastic sedimentary rock or a carbonate sedimentary rock?

- *Students can test with dilute hydrochloric acid if they are unsure*

If it is a CLASTIC SEDIMENTARY ROCK

1. What is the grain shape?
2. What is the grain size?
3. How well are the minerals sorted?
4. What is the cement?
5. Can you see bedding?
6. Are any sedimentary structures visible?
7. Each of steps 1 – 6 benefit from a small sketch to support your written answers, remember to include a scale and to say whereabouts in the quarry face the sketch was taken from
8. What can you say about the depositional environment?

- *Grain shape is an important indicator of the degree of transportation the mineral has undergone. As the mineral is eroded so any sharp angular points will be worn away, the grain becomes progressively rounded. This is not the same as becoming a sphere. Sphericity refers to how ball like the grain is, will it roll in the palm of your hand like a marble for example. A long thin grain can still be well rounded even though it is not a sphere.*
- *Sorting is another important indicator of transportation. As rock fragments and minerals are transported some, such as feldspar, will react chemically with water and eventually go into solution. Others, such as mica may be trapped in the slow moving waters and silts at the edge of a river. If the sediment being examined is mainly quartz it is said to be very well sorted, a mixture of quartz, mica, feldspar would be classed as poorly sorted and if there were rock fragments amongst that mixture it would be very poorly sorted.*
- *If the cement is quartz the rock will be hardwearing, usually light in colour. If the cement is iron the rock will have a reddy brown appearance and may be quite friable. This is an important feature to consider when deciding what will make a good building stone.*
- *All sediments are laid down horizontally; the mass of sediment laid down during any one event is described as a bed. Bed thickness cannot tell you anything about the length of time deposition continued for, a thin bed may have taken many thousands of years to be deposited if there was little sediment available whilst a thick bed may have been deposited rapidly if the sediments were being transported from a weathering mountain range. The gaps between the beds are every bit as important as the beds themselves. Can students see ripples on the top of the beds, are there weathered particles from the top of one bed incorporated into the base of the next, has a soil formed at some time on the top of a bed? These clues all tell us that deposition stopped for a time, a soil tells us that the rock was exposed at the surface of the Earth.*

- *Sedimentary structures may include graded bedding, a structure showing that heavier particles were deposited first and then progressively lighter particles deposited as velocity dropped. There may be ripples, or evidence of dunes, there may be load casts. Load casts form when new sediment is washed on to existing sediment, which has not yet lithified (become rock). If the new sediment is denser than the pre-existing material it may sink into it in places and students will be able to see the resultant ball like structure which forms.*
- *Depositional environments vary from river to estuary to glacial meltwaters. If these sediments were laid down in an estuarine environment there are likely to be more muds than sands, if glacial then a range of sediment sizes from at least cobbles to sands will be evident.*

If it is a CARBONATE ROCK

1. Can you see fossils?
1. Are they abundant?
2. Is there a diversity of organisms?
3. Are the shells whole, broken or crushed?
4. What type of organisms can you see?
5. Do you know if the organisms were swimmers, filter feeders or burrowers?
6. What can you say about the depositional environment?

- *Once students have recognised fossils in the rock then they need to gather information that will help them identify the conditions prevailing when the organisms were alive.*
- *If fossils are abundant this shows there was a ready food source, it is likely the waters were relatively shallow and warm as this encourages productivity.*
- *If there is a wide diversity of organisms this suggests that conditions were stable, few organisms can live in waters with low pH or excessive mineral salts for example. If those conditions prevailed there might be an abundance of one type of organism exploiting the environment but there would not be a range of different organisms.*
- *If the shells are whole then burial was rapid following death or indeed the sediments covering the organisms may have been the cause of death.*
- *Broken or crushed shells indicate high-energy environments, storms or transport towards a beach where strong currents and tides broke up the shells.*

- *Identification sheets can be obtained from the British Geological Survey (www.bgs.org.uk) or may be provided as part of a teachers pack by the education section of a fossil rich quarry.*
- *The type of organism found can give clues to the environment, burrowers may be escaping predators but could also be escaping the variable conditions found near to shore. Swimmers may show adaptations to protect them from predation, ornamentation on their shells for example to make them more difficult to grip or the ability to swim rapidly backwards!*
- *All of these points should help answer the question regarding depositional environments.*

If you are in a SAND AND/OR GRAVEL QUARRY

- *Working sand and gravel quarries are usually only open to school parties as part of a guided tour however if requested most quarries will attempt to support some primary exploration in an area they consider safe. The United Kingdom has identified a number of Regionally Important Geological Sites (www.rigs.uk) in disused sand and gravel quarries and there is a variety of literature available which could support a classroom-based investigation.*

You should take the same systematic approach.

On approaching the quarry face stand a little distance from it and take a good look at the whole face. This is a good point from which to make a sketch. Remember to include a scale and a compass direction and to label prominent features.

Can you see any large-scale features; is the deposit a dune for example?

- *Students should be able to see the inclined bedding of a large dune; often there are changes in the colour or size of grains, which help to pick out the shape of the dune.*

Now step up to the face. Remember to wear a hard hat at all times. Do not climb on the face.

1. What shape are the grains?
2. Can you identify any minerals?
3. If there are gravels what shape are they?
4. Are the sands and gravels sorted? Remember sands and gravels are moved by a fluid, usually water, and deposited as the velocity of the fluid drops, heaviest first then progressively lighter material. Use a hand lens and a tape measure to identify the shape and the size of the grains in your area.
5. Draw a sketch to show how shape/size alters as you move from the bottom of the section upwards.

6. Look closely at the grains; can you see clay particles in the sand and gravels? Clay particles often make the sands and gravels look dirty or dusty.
7. What can you say about the depositional environment?

- *Grain shape, size and mineralogy are all important tools for helping to determine if the sediments have been transported by river or melt water.*
- *Sorting is also a useful clue to depositional environments. Ask the students to imagine the sediment load of a river and then to imagine that river in flood. What would happen to the sediments? They would be deposited on the floodplain but would not be sorted, there would be a jumble of sizes and shapes dropped as soon as the water's velocity fell as the river over banked. What other situation could the students suggest where this lack of sorting might be apparent, rock falls, scree slopes for example.*
- *Trying to produce a useful sketch of the grain relationships in loose sands and gravels requires a different approach. It is best to draw a measured section, recording changes in grain size and identifying any specific features found i.e. sands with shell fragments.*
- *Why would anyone need to know if there were clays in amongst the sands and gravels? Sands and gravels will be used as aggregates by the construction industry, clay will need to be washed away before the aggregate can be used and so the cost of extracting the aggregate is significantly increased if there is a high percentage of clay mineral amongst the grains.*

It is useful to bring students together at intervals during the quarry face exercise to ensure there are no real problems, to answer general questions, to share any exciting finds, to ask students to share information. Remind students of the reason for being there – to find out about depositional environments and to consider the uses of the material quarried.

If you have IGNEOUS ROCK

You should take the same systematic approach.

On approaching the quarry face stand a little distance from it and take a good look at the whole face. This is a good point from which to make a sketch. Remember to include a scale and a compass direction and to label prominent features.

At the rock face ask the following questions:

1. What size are the crystals?
2. What shape are they?
3. Choose a small area (about the size of a 50 pence piece) that gives a good representation of the minerals in the rock and their shape and size relationships and make a sketch of it. Using a handlens will help. Remember to include a scale.
4. Is the rock intrusive or extrusive?
5. Can you say something about the environment it was deposited in e.g. is this a small intrusion of igneous rock which has forced its way into sediments or is the whole quarry comprised of igneous rock?
6. How is the rock weathering? Can you see iron staining, broken fragments at the base of the rock face?

- *Students measure a selection of minerals in order to give a true representation of the rock as a whole. They should recall that crystal size reflects cooling rates and helps determine if the rock is intrusive or extrusive, crystals visible to the naked eye mean the magma cooled in the Earth at a slow rate. The sketch should include each mineral showing the way it fits with neighbouring crystals. If the rock being examined is similar throughout then students need only draw a small section. It is important they do not draw a "currant bun" a circle with 2 or 3 crystals in it, igneous rocks are crystalline, there are no gaps between the crystals!*

- *It may be difficult for students to determine how the rock was emplaced; you may need to make reference to the geological map of the area if this is a large intrusion. If the igneous rock has formed as a smaller emplacement, say a sill or dyke, which has forced its way through the country rock then students may be able to see the contact point. If so they may also be able to identify a change in the size of the crystals in the igneous intrusion. Magma next to the country rock will have lost heat more quickly than that in the centre of the intrusion; although the crystals will still be easily identified they will be smaller than those further away from the country rock.*
- *If the igneous rock formed as a lava flow then evidence of escaping gas bubbles or difference in crystal size between the top of the flow and the base should provide helpful clues for students.*
- *Look for evidence of chemical and physical weathering; think about the climatic conditions in the area. On the highest parts of Dartmoor for example the temperature rarely rises above 6℃ during the winter months and regularly falls below zero at night. Along the coast of Devon and Cornwall the temperatures may not be so harsh but igneous exposures will be attacked by salt spray.*

Before leaving the quarry call the students together and discuss their findings, linking to the original question about depositional environments. Then ask them to consider the evidence they have seen of the Rock cycle in action, of weathering processes so they are able to link their work in the quarry to the main task associated with the field trip.

Lesson Four and Lesson Five

What can we do with our findings?

Using students notes and sketches produce an overview of the quarry on the board.

Task

Students will use the information gathered at the quarry to produce an information leaflet that could be used by other classes who cannot actually visit the quarry or by Key Stage 3 students to support work on rocks and weathering and the rock cycle.

An **alternative task** is provided. This addresses issues of sustainable development and citizenship by asking students to consider the ways in which quarries are used once active removal of rock material has ceased.

Task One

Students will need:

- Copies of maps, Ordnance Survey and Geological.
  Ensure the correct copyright agreements are in place before photocopying the maps.
- Their drawings and data collection from the visit
- Access to the Internet
- Access to computing facilities

Student Information

You will produce an informative and attractive leaflet, which will be used by younger students to learn about quarries and the Rock Cycle or produce an informative leaflet which could be used by Key Stage 4 students who were unable to attend the field trip.

Your leaflet should include:

- A map of the area
- A geological map of the area
- An explanation of the rock type found at the quarry
- Some sketches or a piece of written information to show what <u>you</u> found when carrying out your investigation at the quarry
- Your own photographs if available
- Links to the Rock cycle and weathering processes
- Information about the end use of the quarried material

Students work in groups to produce the information leaflet, they may decide to concentrate on one aspect of the Rock Cycle and they way in which there fieldwork provided evidence to support this information. So for example if fieldwork has taken place in an area of igneous intrusions students may describe the structure of the Earth and the formation of intrusive or extrusive igneous rock before concentrating on the rock type they examined. If students carried out their investigations in a limestone quarry they may decide to concentrate on weathering processes to illustrate another aspect of the Rock Cycle.

- Students need to constantly review the purpose of the leaflet, it should contain enough detail to be of use to the students it is aimed at.
- Students can use photocopies of maps or draw their own sketch maps
- The cross sections produced in an earlier lesson could be scanned into the word document, as can any photographs taken.
- Data collected at the quarry should be presented in a systematic manner – use the questions posed on the quarry task sheet to guide students on this point.
- There should be evidence of analysis of the data collected when suggesting depositional environments – it is not enough the sediments were laid down in a sea, how did the student come to that conclusion, what evidence have they seen, did the secondary sources (maps/Internet research) help them to draw that conclusion.
- Some information on the everyday uses for the materials being quarried should be included.

Task Two

Students consider the various options available for the site once quarrying has finished. Students use the Internet to find examples of restored quarries or link to UK RIGS (www.ukrigs.org) for examples of quarries that have been granted special status because of their interest to geologists. Students should use the Internet to look at the National Stone Centre site (www.nsc.org) to see the way in which a disused quarry can be used as an educational resource. Quarry companies such as Tarmac (www.tarmac.co.uk) and Bardon Aggregates (www.) have useful information on their web sites regarding after use of quarries.

Students could produce this information in the form of a Powerpoint presentation or as additional information for inclusion with the leaflet produced for Task One. Many quarries provide information boards along public footpaths following the boundaries of a working quarry. Using the information gained from their own field investigations students, working in groups, could create a series of information boards including one showing the important role quarry workings can play in providing habitat for a range of plants and animals.