

## **AS and A LEVEL**

*Drawing Skills Handbook*

# ***GEOLOGY***

**H014, H414**

For first teaching in 2017

## **Geological drawing**

Version 1

# CONTENTS

Introduction to geological drawing	3
Guidance for geological drawing	4
Drawing in the field	7
Drawing using a hand lens or microscope	15
Student Resource 1 – Field sketches: avoiding common errors	18
Student Resource 2 – Field sketches: relative sizes and relationships	19
Student Resource 3 – Drawings, graphs and tables checklists	21

# INTRODUCTION TO GEOLOGICAL DRAWING

This geological drawing skills handbook has been developed to support GCE Geology H014/H414. It could also be used to support GCE Geography H081/H481.

## Why bother?

The ability to draw, label and annotate geological outcrops and specimens is an important and useful geological skill. These days students may well challenge the need for making geological drawings, particularly given the ease of using digital photography for record-keeping. So how can it be justified? The following points help to provide a rationale for developing geological drawing skills:

- **Accurate observation and attention to detail is encouraged.** Having to draw a geological specimen not only increases the amount of time spent examining the specimen, which in itself will aid learning, but requires a much greater level of accurate observation than a casual examination (see **Figure 1**).
- **Synthesizing understanding of the underlying geological structure.** Field sketching encourages the geologist to 'get their eye in' to see the geology by mentally stripping away the soil and vegetation. In a field sketch the geologist synthesizes their three dimensional understanding that they have developed through detailed field observations (see **Figure 2**).
- **Active recording aids memory.** The educational philosophy behind this is neatly summarised in the well-known Chinese proverb:

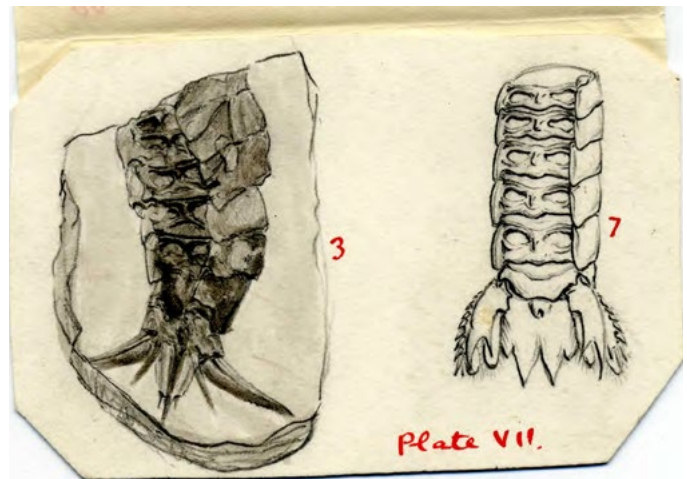
*I hear and I forget*

*I see and I remember*

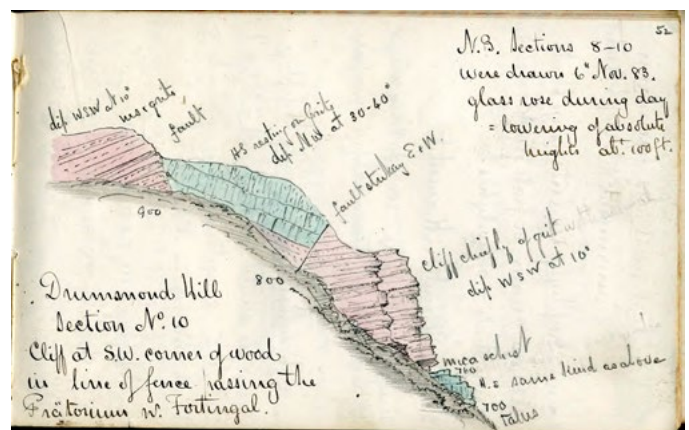
*I do and I understand*

*Confucius*

- **The drawing provides a permanent record of what has been observed.** There is a historic tradition within geology of providing accurate records of outcrops and specimens so that the images could be used for future reference purposes. Today's palaeontologists are often indebted to the illustrators of the 19th century, particularly where the 'type' (reference) fossil may only exist as an illustration. Even today, when digital photography can be used to store images, artists are still commissioned to record type specimens by drawing or painting. This is particularly the case for vertebrate fossils. This is partly because all the features of interest can be combined in one or several scientifically accurate but aesthetic images with great clarity (see **Figure 1**).



**Figure 1:** Sketch by Ben N. Peach. Memoirs of the Geological Survey of Great Britain. Palaeontology. 1908, Photographed by R.P. McIntosh. Reproduced by permission of the British Geological Survey. EA17/125'



**Figure 2:** H.M. Cadell sketch, photographed by R.P. McIntosh. Reproduced by permission of the British Geological Survey. EA17/125.

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# GUIDANCE FOR GEOLOGICAL DRAWING

## What equipment is needed?

- **Sharp pencil** – HB is generally preferred, but H, 2H or B (for emphasis) can all be used according to preference.
- **Pencil sharpener** – in the field geologists may carry a small penknife which can be used to test the hardness of minerals (Mohs 5.5).
- **Eraser**
- **Ruler** – for label lines.
- **Plain paper** – field notebook made from rag paper

## General Principles

When assessing geological drawing both **quality** of drawing and **labelling** are important. The latter may include **annotation**. The general principles described below apply to all types of geological drawing:

- **Use a sharp pencil only.** Don't use pens or coloured pencils.
- **Use clear, continuous lines.** A line which encloses a shape, such as a circle, should join up neatly without obvious overlap. Overlapping lines is a common error in hastily drawn sketches and is easily spotted and penalised by examiners.
- **Don't use any form of cross-hatching.** This includes cross-hatching and stippling which can be confused with real geological features such as cleavage or crossbedding. Students find this is a hard instruction to follow, and it is sometimes difficult to justify. In exceptional circumstances light shading may be used to identify real geological features such as pleochroism. A drawing is a scientific record and not an artistic impression. Shading must not be used to make the drawing look more realistic and/or to discriminate between different areas, it does not represent a permanent geological feature.
- **Accuracy is paramount.** It shows good observation. Remember that observation is assisted by understanding, so a good knowledge of theory goes alongside good drawing. Pay particular attention to the outlines of structures and to the relative proportions of different parts. Don't draw what you think you should see, for example textbook-style drawings. Draw what you observe.
- **Guidelines can help.** Faint sketching of the main areas of the specimen, which can later be erased, may help. Some students find a simple grid helps them.
- **Magnification and illumination.** To help in the drawing process it is often useful to use a hand lens or a magnifying glass for larger specimens and, for microscopy, both low and high power lenses when making preliminary observations. Field geologists usually carry a hand lens.

- **Make the drawing large enough.** If the specimen is a relatively large structure such as a fossil it should normally occupy more than half the available space on the page. In microscopy, individual mineral grains or crystals drawn at high power should be about one centimetre in diameter.
- **Correct mistakes.** If you make a mistake, use a good quality eraser to rub out the lines completely.
- **Include a title.** Include a title stating what the subject of your technical illustration or field sketch is.
- **Include a scale.** Include a scale, particularly on field sketches where the field of view could be a small outcrop or a complete mountain side (see **Annotating** below). If you are drawing from a microscope, it is useful to state the combined magnification of the eyepiece plus objective lenses used when making the drawing, e.g. x20 (low power) or x200 (high power). Note, though, that this is not the same as recording the scale.

## Annotating

Annotations are the written notes and labels that identify and/or explain features or processes on a scientific drawing. A label is word or short phrase that states what a feature is on a scientific drawing but not explanation. When annotating geological drawings, follow the guidance below:

- Use a sharp pencil.
- Label all relevant structures, including all minerals identified in the case of microscopy.
- Add a scale bar immediately below the drawing (see on the next page for special case of microscopy) and use a ruler to draw scale bars.
- Annotation lines should preferably be straight and start exactly at the structure being labelled; do not use arrowheads.
- Annotations should be written horizontally, as in a textbook, not written at the same angle as the label line.
- Arrange label lines neatly and make sure they don't cross over each other. It is visually attractive, though not essential, if the length of the label lines is adjusted so that the actual labels are right or left justified, i.e. line up vertically above each other on either side of the drawing.
- A title should be added at the top or bottom of the drawing, stating what the view shown or the drawn specimen is.
- Annotations are often used to draw attention to features of particular geological interest. See **Figures 2, 4, 8a, 8b and 15a to 15c** for examples of annotation in this booklet.

## Scale and magnification

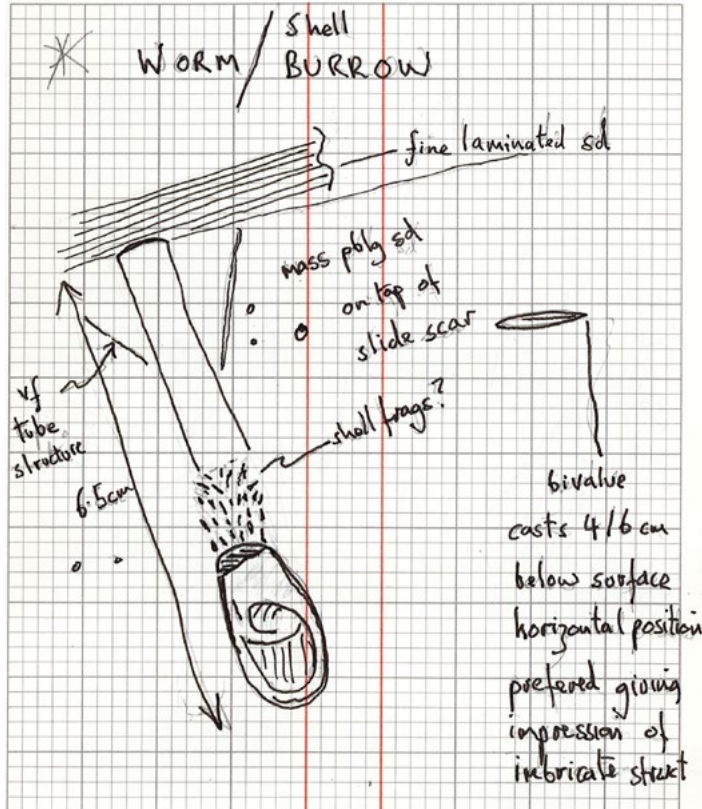
It is essential to give an indication of the scale/magnification of a drawing, particularly for hand specimens and field sketches. The actual size of an outcrop or fossil, for example, may be impossible to judge simply from a drawing. For drawings made using microscopes, if the actual scale or magnification is not given, it may be useful simply to indicate whether a low or high power lens was used. It is preferable to state the actual magnification achieved by the combined eyepiece and objective lens, usually just below the title.

### Calculating scale/magnification of a drawing

Scale, or magnification, is simply how much bigger or smaller the drawing is compared with the actual specimen. Calculate as follows:

1. Measure between two appropriate points of the drawing (e.g. total length or width).
2. Measure between the same two points of the specimen.
3.  $\text{Magnification} = \frac{\text{dimension measured on drawing}}{\text{dimension measured on specimen}}$

The following are examples of good drawings from a geologist's field notebook. **Figure 3** shows an in situ fossil, **Figure 4** shows a field sketch of a cliff section and **Figure 5** shows a sketch log with detailed inserts.



## Unfamiliar specimens

As stated above, the same basic principles of drawing technique apply to all field sketches and technical illustrations. Nevertheless, it can be daunting for a student if they are asked to draw something they have not seen before or in a new situation, for example a partial fossil at outcrop in the field, a sample of sand grains or an unfamiliar thin section. Assessment questions will always be phrased so that it is clear exactly what is required and any relevant information the student is not expected to know will be provided. The important thing to remember is to follow instructions carefully and to observe and draw the actual geological feature/specimen shown and not try to guess what should be visible. For example, you should not interpolate any parts of a fossil which may be missing or may still be encased within the rock.

Specimens should be studied carefully before any drawing is undertaken, noting particularly where the outlines of structures are going to be delimited in the final drawing. Depending on the subject, separate, more detailed drawings may be useful to highlight features of particular geological interest.

## Graphic Logs

Graphic logs are an exception to the no stipple rule. However stipple should only be used to identify the lithology of each bed and should not obscure any geological feature.

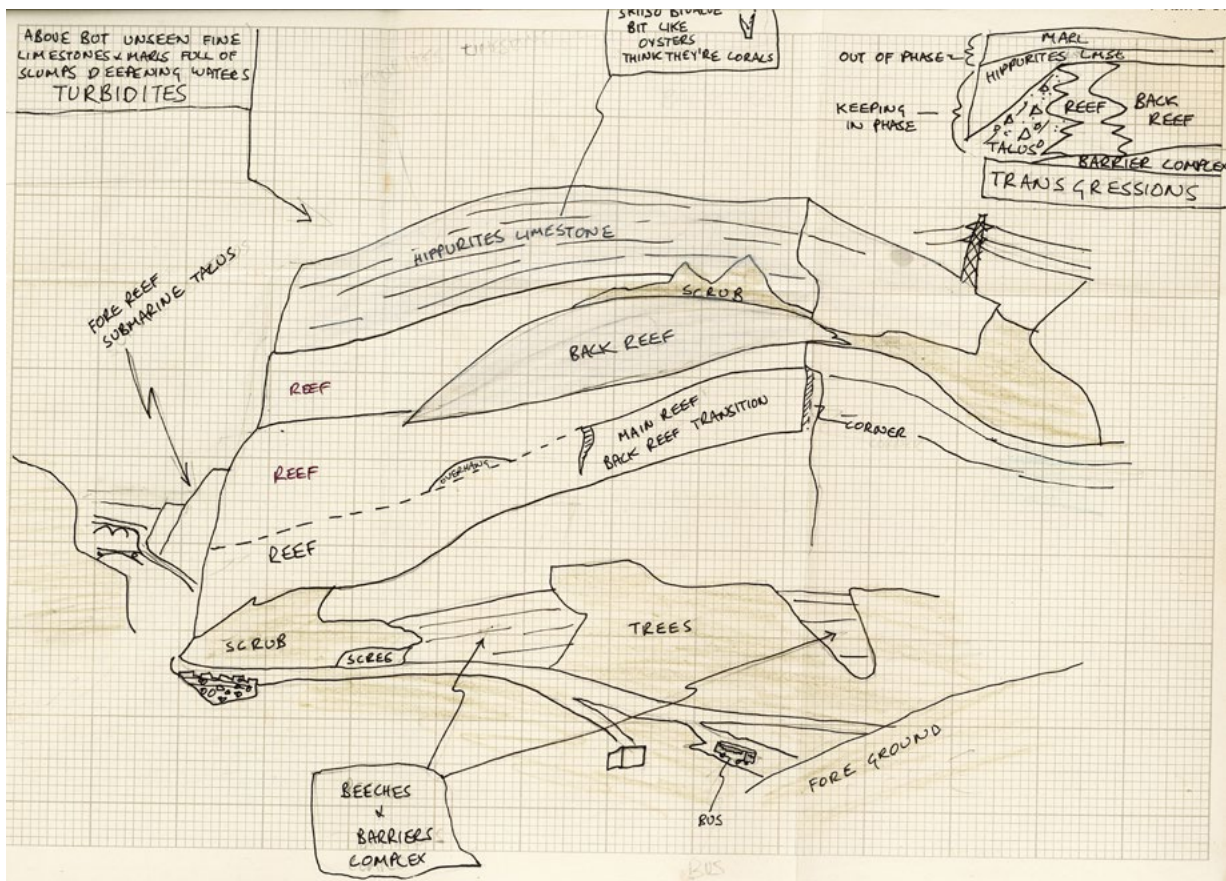
Detailed guidance on constructing graphic logs is provided in the Delivery Guide for Module 4 Interpreting the Past.

[www.ocr.org.uk/qualifications/as-a-level-gce-geology-h014-h414-from-2017/delivery-guide/module-ageol04-module-4-interpreting-the-past/delivery-guide-ageol04b-sedimentary-environments-in-time-surface-processes-and-products-412](http://www.ocr.org.uk/qualifications/as-a-level-gce-geology-h014-h414-from-2017/delivery-guide/module-ageol04-module-4-interpreting-the-past/delivery-guide-ageol04b-sedimentary-environments-in-time-surface-processes-and-products-412)

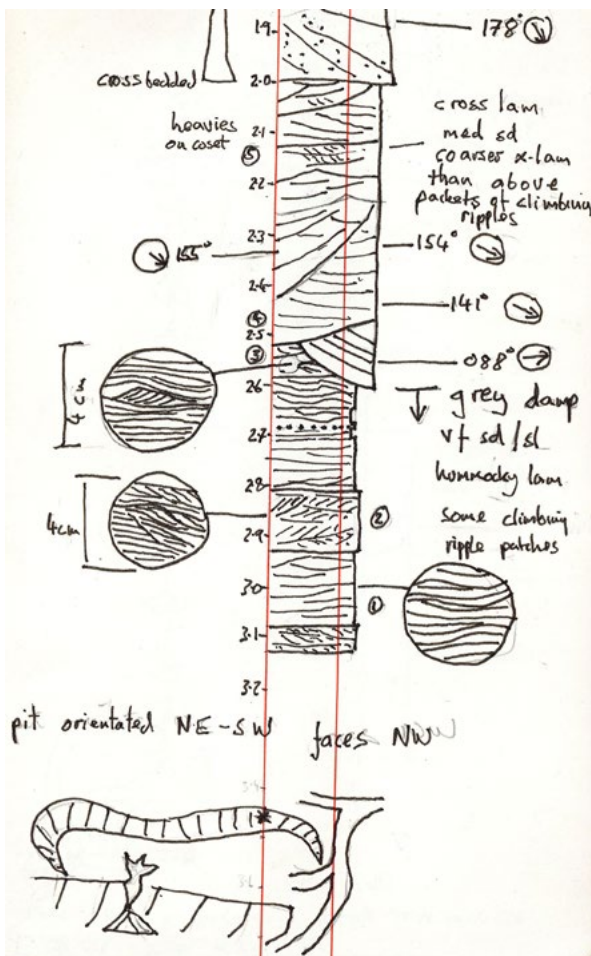
The Delivery Guide contains a tutorial, a number of student exercises; sample *Sedlog* data files that complement the *Illuminate* textbook and links to an external *ESTA* interactive resource.

**Figure 3 (left):** Drawing of feeding trace fossil and *Hiatella arctica* in life position, raised beach, Meskelv, arctic Norway. Note the information recorded on the *Hiatella arctica* feeding trace, possible imbricate structures and the small bivalve casts as a geopetal structure all relate to the sedimentary environment. The features of the fossil are not labelled although it is possible to identify the posterior gape and pallial sinus and show that the fossil is in life position. A scale has been drawn. However, the use of arrow heads is discouraged and care should be taken to ensure lines do not overlap or are left incomplete.





**Figure 4 (above):** Summary drawing of a Cretaceous Congost Reef, Tresp, Spain. This is a good geological drawing, fully labelled with more detailed annotations and explanatory diagrams on transgressive–regressive sequences and *Hippurites* (a rudist bivalve). The bus and powerlines provide scale. However, the drawing does not have an orientation, has used arrows to label features and the word *beaches* has been misspelt.



**Figure 5 (left):** Sketch log of Quaternary shallow marine sandstone, St Lawrence valley, Québec. This drawing makes good use of symbols and detailed enlargements with scales to show specific details. The numbers in circles refer to photograph and sample locations. Note the sketch map which gives sufficient detail to locate the fieldwork site.

# DRAWING IN THE FIELD

## The Field Notebook

The field notebook is the geologist's primary record of their scientific observations. It is important to include a record of when, where and the conditions under which your field data was collected. You should also include any relevant notes that could help anyone else find the fieldsite (e.g. contact details or access arrangements). Every geologist builds up a collection of field notebooks which they can refer back to. The records you are making now as a student will still be useful to you later in your professional career.

A typical geologist's field notebook will contain:

- field sketches summarising the geology – this would include sketch maps of the geology at a fieldwork site
- sketch logs of geological sequences – it can be quicker and more accurate to use this approach
- working diagrams/cartoons – used as a thinking tools to work out the three dimensional geometry of features
- detailed illustrations of hand samples or fossils

## Field sketching

The purpose of a geological field sketching is to record the relationships and shapes of geological features, summarise the geology, and to work out how the three dimensional shape of the geology interacts with the geometry of the landscape. It is not to produce a pleasing creative impression of an outcrop. Using a field sketch has three advantages as a scientific record:

- it is quicker and easier to draw a three dimensional relationship (for example an erosion surface),
- in preparing to draw a field sketch, and while drawing the outcrop, you will have to interrogate the geology. These thinking processes will help you to "get your eye in"
- a field sketch is a more accurate scientific record than a detailed description in most circumstances

Your field sketch will emphasise the geological features and relationships and minimise irrelevant features such as vegetation, weathering patterns and shadows. It will be a synthesis of your current understanding of the outcrop. It can help to use a pencilled grid in your notebook to construct your sketch. These guidelines may help:

- a field sketch is a scientific record and needs to include a scale, orientation and title.
- think about what you are trying to draw and turn your notebook so that your drawing will fit the view
- a field sketch should fill half the page area to allow space for notes – A5 is a good notebook size
- outline the basic shape of the view with a minimum number of pencil lines – try using just six lines

## Teaching field sketching

Field sketching is not an innate scientific skill for most people and being told to "draw what you see" can be confusing. Students associate drawing with a creative process in art rather than a scientific skill. Research shows that it is more important for students to be able to apply conceptual geological models when developing drawing skills, rather than prior artistic ability. Therefore teachers need to model the process to their students, using a large sketch pad or portable white board, and allow their students to see how conceptual understanding informs the construction of a field sketch.

Students cannot "draw what they see" until they can relate their conceptual understanding to the geology in front of them. It takes practice and field experience to "see the geology." Understanding how each student's ability in field sketching develops will help you to provide appropriate guidance and support. Individual Students' field sketches typically show a progression similar to Piaget's four stage developmental model for children's drawing skills:

- fortuitous realism – scribbled drawing may contain some geology by accident
- failed realism – drawings of blobs (rock outcrops) or artistic interpretations, but no understanding of the underlying geology
- intellectual realism – drawings show idealised textbook examples of features or fossils
- visual realism – drawings begin to reflect some understanding of the real geologic features

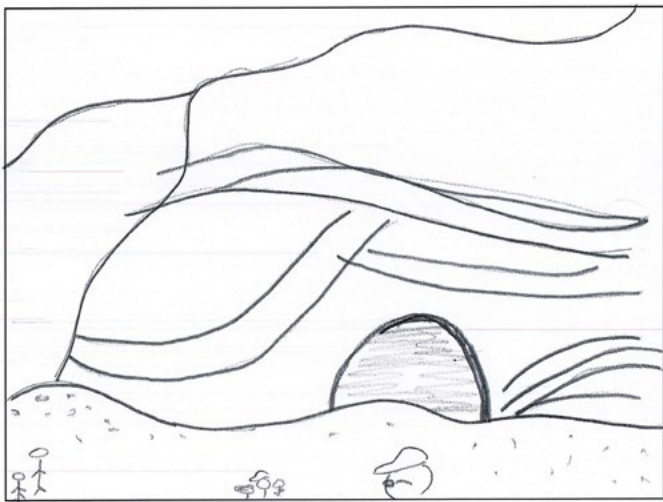
## Examples

**Figures 6a-e** shows folding and faulting at Broadhaven, Pembrokeshire. The four drawings were made from this photograph and demonstrate increasing competence from fortuitous realism (Fig 6b) to visual realism (Fig 6e).

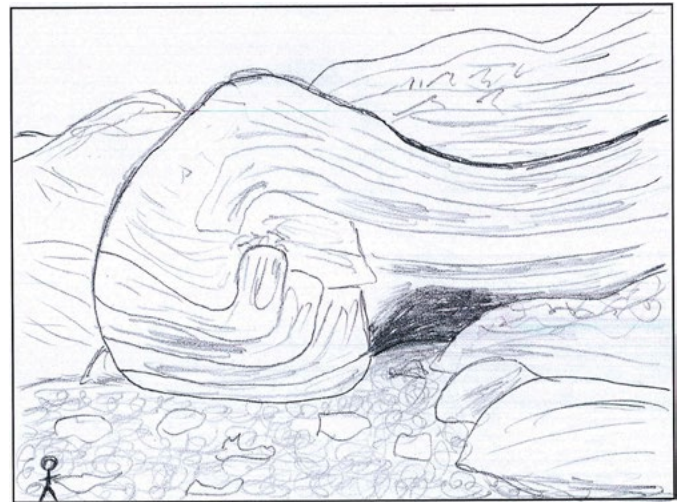


**Figures 6a:** Folds and faults, Broadhaven

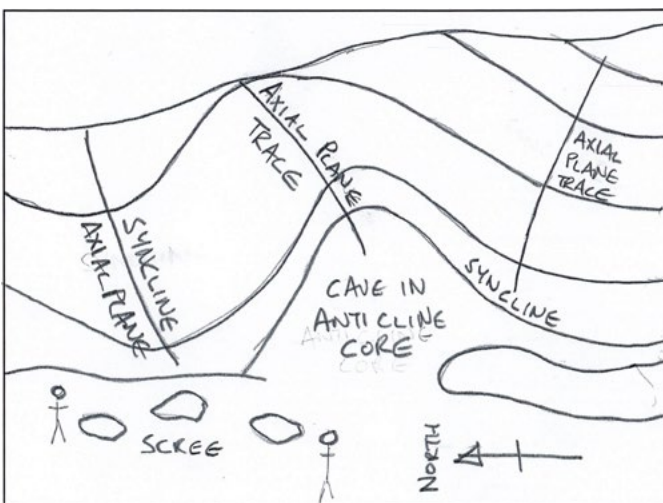




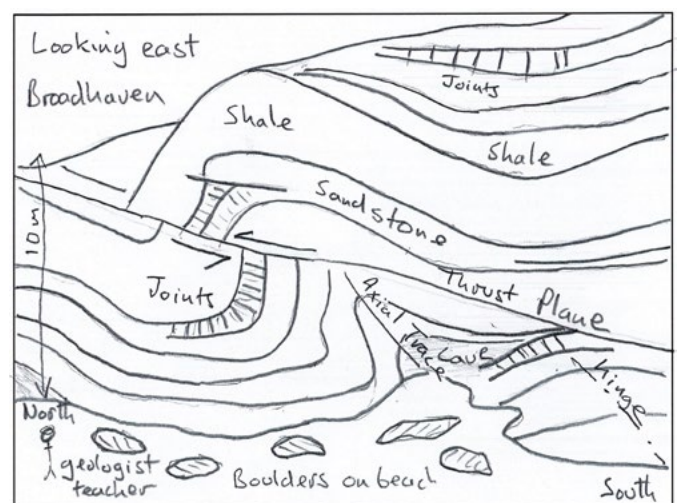
**Figures 6b Fortuitous realism:** The field sketch emphasises what the student is familiar with: the shape of the cliff, the cave and the people on the beach. Any geology is accidental and may have been included because of the interesting shapes. Talk through with the student what you can see in the cliff while you build up a field sketch based on your conversation. It may be enough at this stage for the student to copy up and annotate from your drawing.



**Figures 6c Failed realism:** The field sketch shows a more detailed representation of the view and an attempt to show some geology. The student has not linked their classroom understanding to what they can see in front of them. They may draw a single bed of rock as a series of unconnected blobs although they are aware that the bed continues under the vegetation. Modelling how to field sketch from photographs in the classroom will help students to understand the objective of field sketching before you take them outside the classroom.

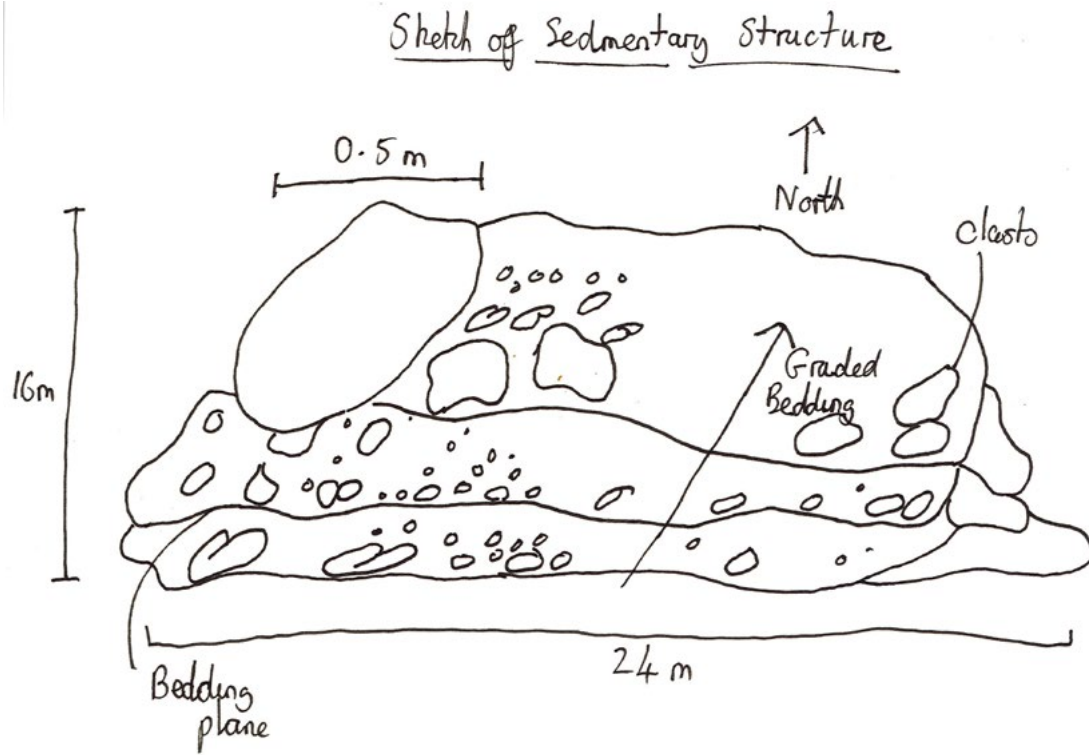


**Figures 6d: Intellectual realism.** This field sketch records the folded rocks in the cliff but not the faulting. Field sketching requires students to use higher level thinking skills and apply a synoptic approach. Students can be scared to move beyond simple models and ignore features that are not part of their textbook model. Reinforce the student's positive achievement and ask them what else they can see in the cliff in besides the folding.

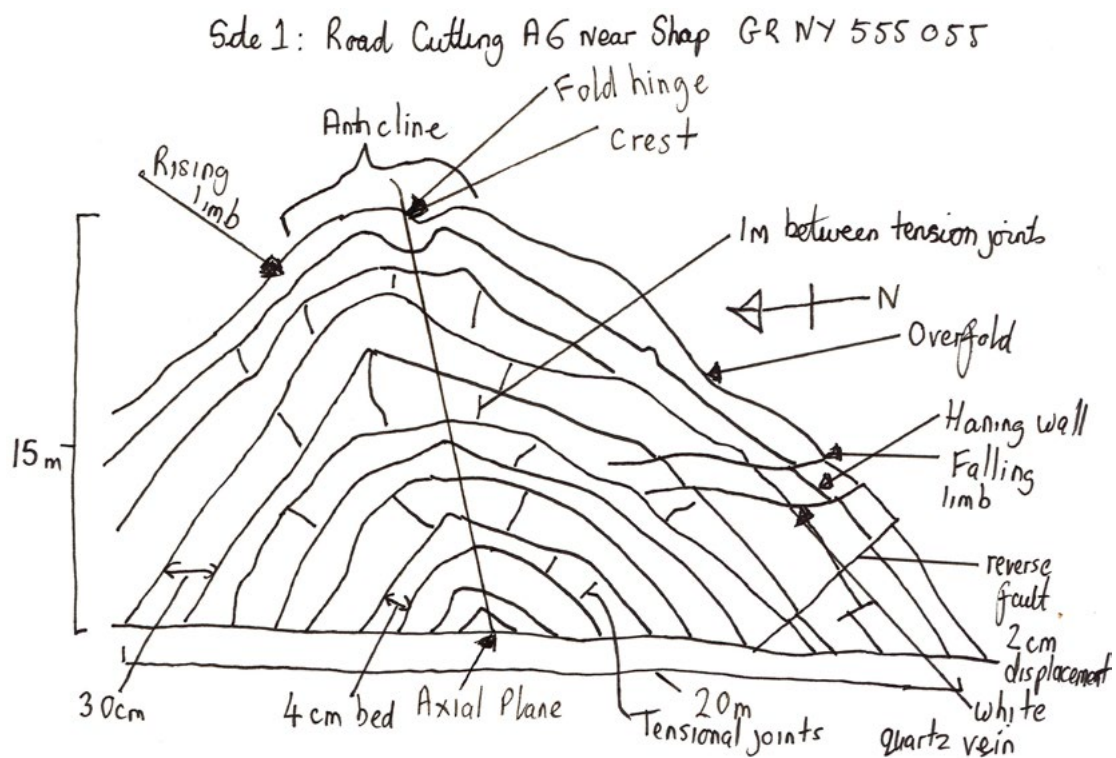


**Figures 6e: Visual realism.** This field sketch is recognisably of the view in Fig 6a and shows the relative relationship and sizes of the geological features. Although their sketch may lack the artistic impression of Fig. 6c the student has demonstrated their understanding of folding, faulting and the behaviour of sandstone when folded. The annotation of the hinge line on the whaleback fold shows an awareness structures are three dimensional.

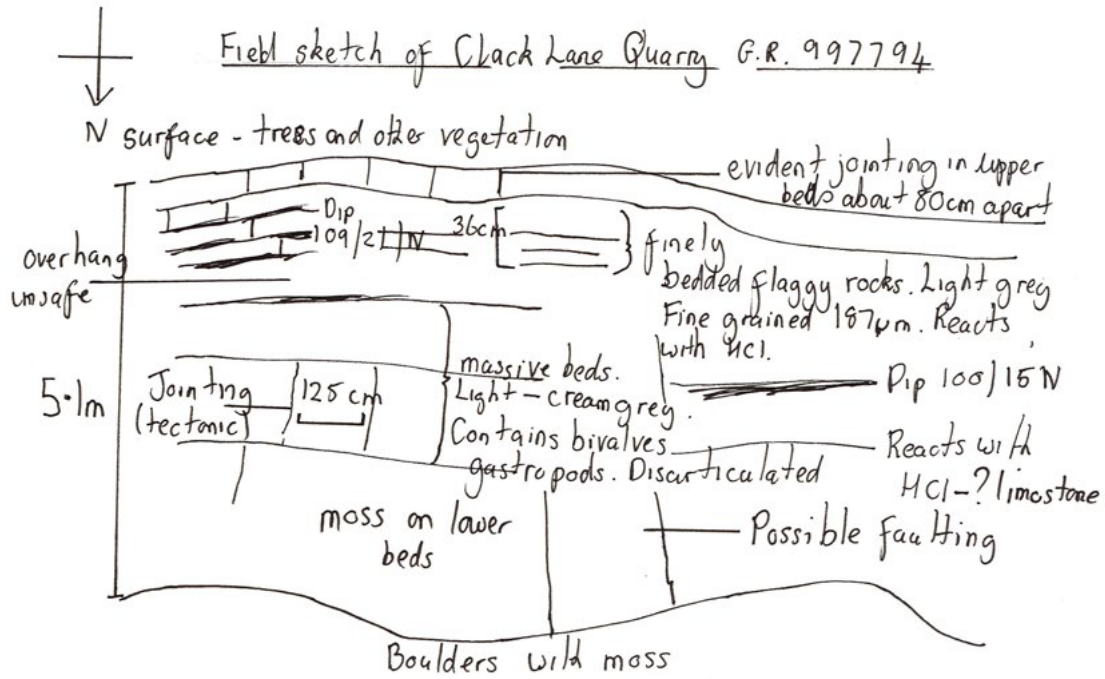




**Figure 7a Devonian wadi channel:** A clear, well-proportioned field sketch on which the orientation and the vertical and horizontal scales are noted. However, it is not clear if the outcrop is part of a larger unit and the scale information is contradictory. The large boulder has a diameter of 0.5 m but using the scale information the boulder appears to be 20 times bigger (9.7x6.4 m). Although there is a label for graded bedding there are no features on the sketch that support this interpretation.

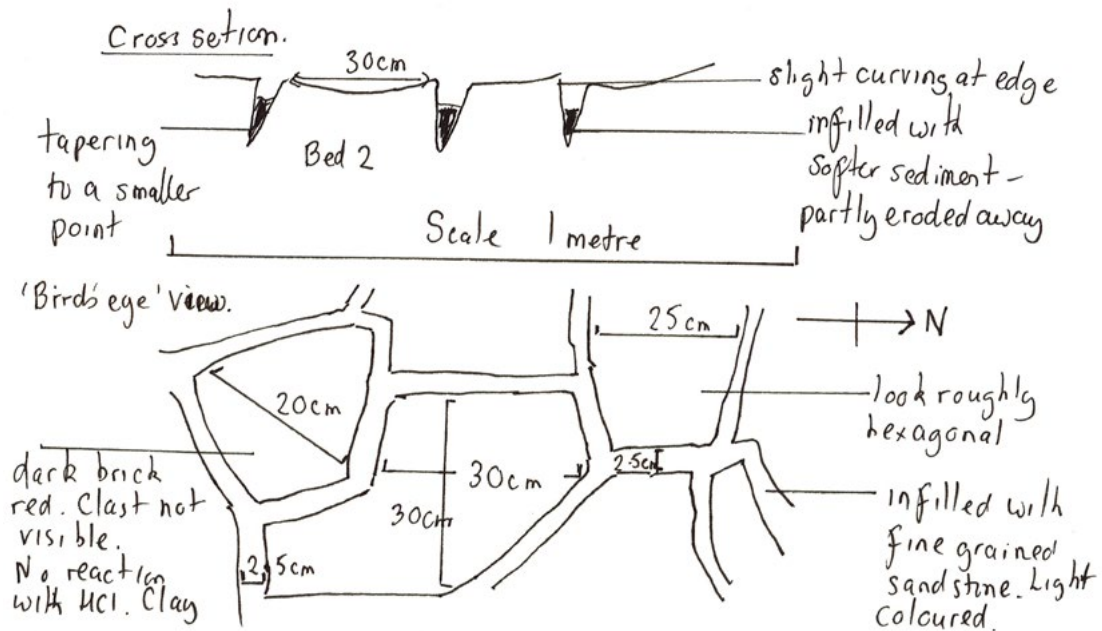


**Figure 7b Fold in Silurian Greywacke, Shap Fell:** A competent, well-labelled field sketch that shows all the basic elements: scale, notes, orientation and title. Most features have been recorded (bedding planes, joints and faults) but the flute marks (way-up structures) have been missed. The annotations could be more detailed and there are very few measured dimensions (no dips and strikes recorded). The labels are crowded together and the arrows (some of which cross over) make the sketch difficult to read. If the drawing had been extended to the full height of the outcrop and included parts of the adjacent folds it would have given the context of this fold as part of the large Bannisdale synform.



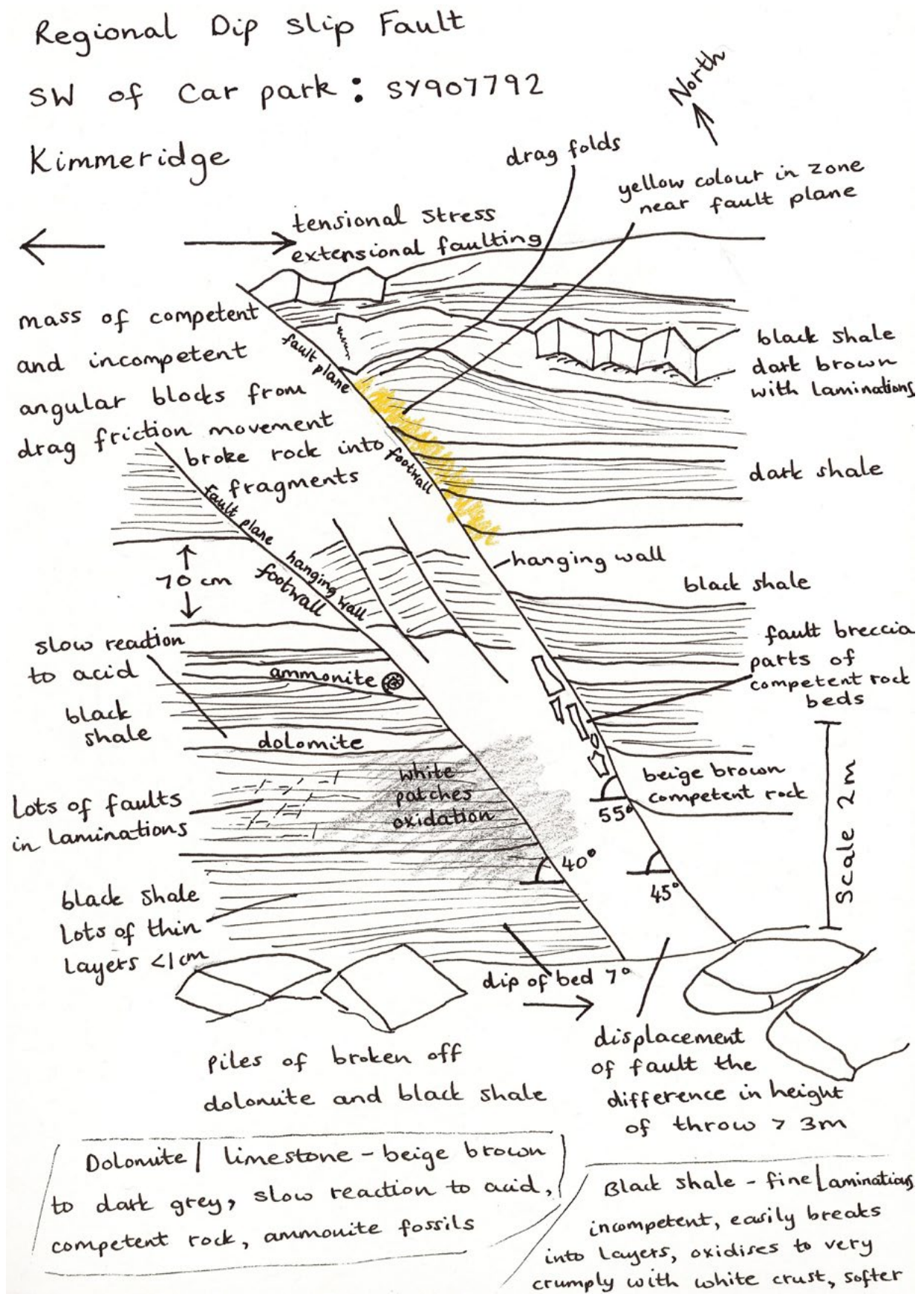
**Figure 8a Disused quarry, Langton Matravers, Dorset:** Crack Lane quarry was the source of the Purbeck Marble in many important Roman and Medieval buildings. On first viewing, limestone outcrops can appear monotonous and it is important to include detail from close up inspection. This sketch includes annotations of all the large features and more detailed quantitative data than Figs. 7a and 7b. The sketch could be improved by including close-up drawings of the fossils seen. Using an A5 sketchbook or a standard 130x205 mm field notebook would have allowed more space to lay out the drawing and annotations on the page.

Desiccation cracks. Beds 2 and 4. Tormore



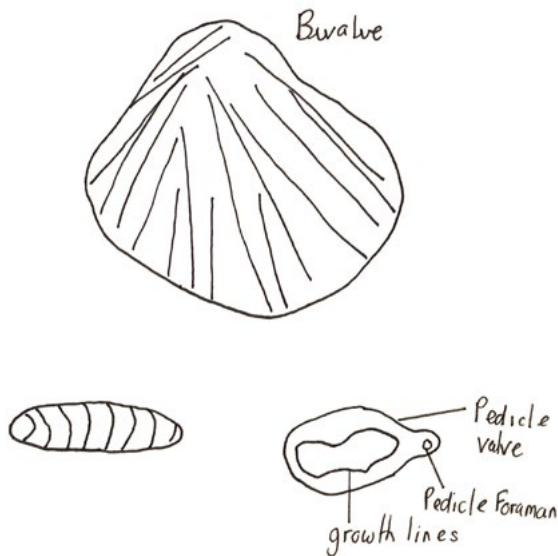
**Figure 8b Permian mudstones, Tormore, Isle of Arran:** A well-constructed cross-section and detailed sketch map that accurately records the shape, dimensions and relative positions of these geological features. The annotations are spaced out around the drawings and none of the labelling crosses over or obscures the recorded geology. The cross-section is an example of a cartoon thinking tool rather than a field sketch and could have incorporated some specific detail from the location (such as tepee structures). This drawing does not meet the standard for 1.2.1(d) as it does not record dimensions to a consistent number of decimal places.



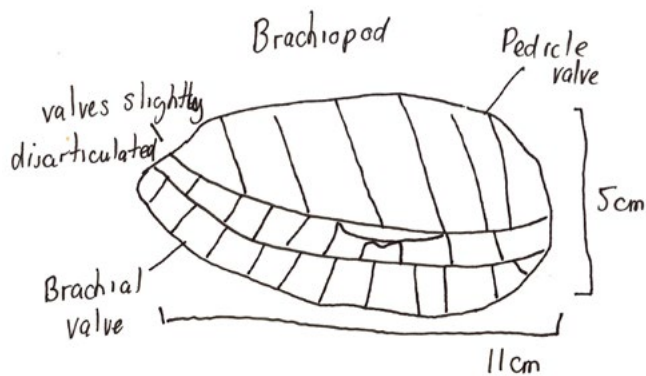


**Figure 9 Extensional fault, Gaulters Gap, Kimmeridge Bay:** This is an excellent example of a very high standard field sketch by an A level student from a legacy Fieldwork Task. By spacing the annotations around the sketch the student has been able record the effects of the faulting without obscuring any detail. More quantitative data (such as dips, strike and dimensions) could have been recorded. However, the unstable cliff face limited access for safety. Rather than double headed arrows it would be better to use the technique for recording dimensions used on Fig 8b.

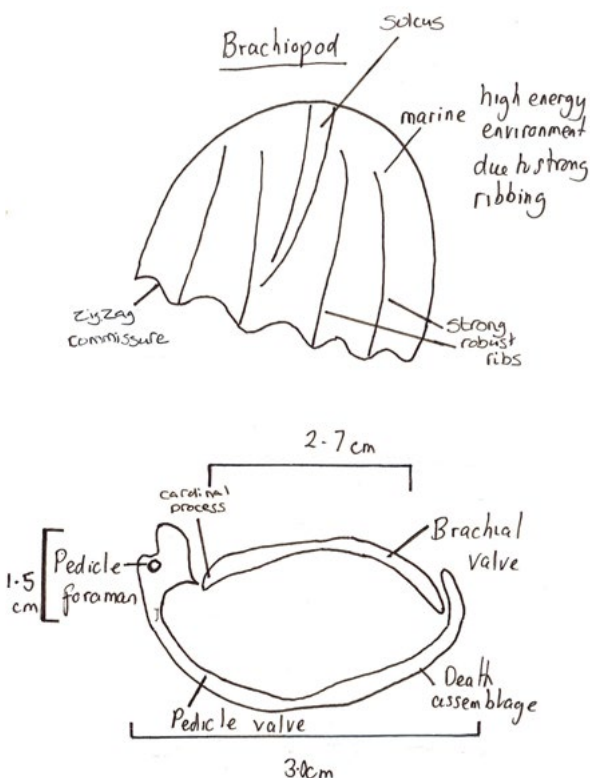




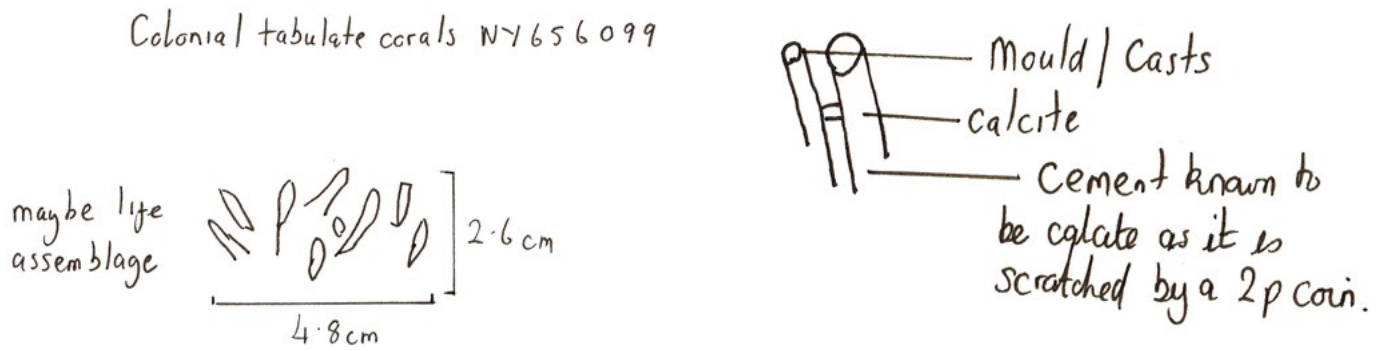
**Figure 10a Typical fossil drawing errors:** It is important for students to have experience of drawing and handling real fossils. If their only experience is technical illustrations in textbooks and museum specimens they will try to draw textbook examples, such as this sketch of a bivalve. Two views of a brachiopod fossil have also been sketched. All three drawings are of little value as a scientific record of the actual fossil samples as they lack a scale and any specific detail from the real fossils.



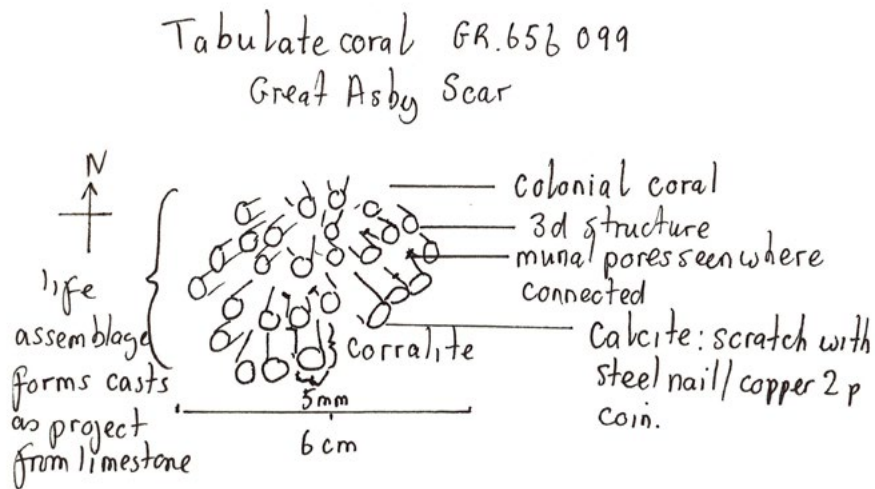
**Figure 10b Brachiopod fossil:** This field drawing is much clearer than Fig 10a, and includes a scale but it is still not a good scientific record. The shape is very generalised and it is lacking in detail which makes it difficult to distinguish between the valves. Several morphological features have not been labelled and the scale should have better resolution than  $\pm 1$  cm.



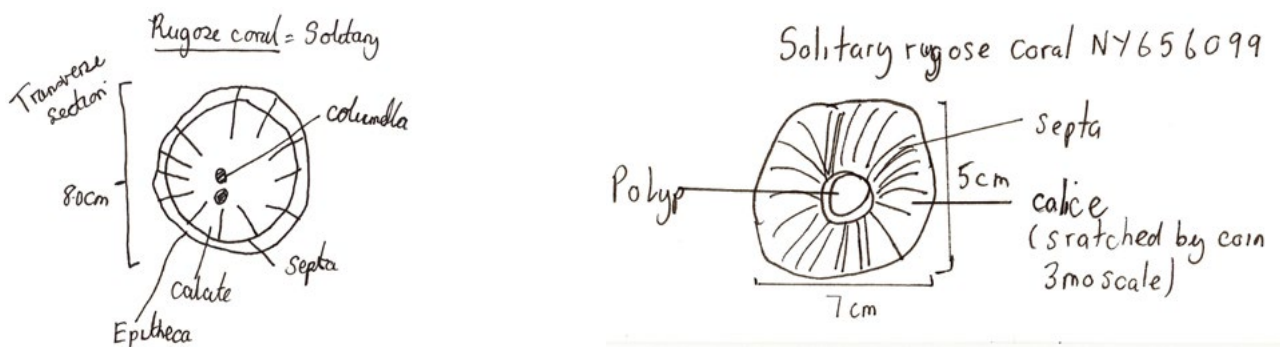
**Figure 10c Basic competence:** These are two views of an actual fossil made in the classroom. Many of the morphological features are labelled and a scale appropriate to the size of the fossil has been drawn using a ruler. On the upper sketch the sulcus is hard to identify (two curved lines) and the valve has been shown as complete, rather than partial. The lower sketch is true to life but could have been improved by including detail clearly visible under a hand lens (such as the infilling material and replacement minerals in the valve wall). These small details are more important than making the sketches of real fossils in your notebook look like diagrams from a textbook.



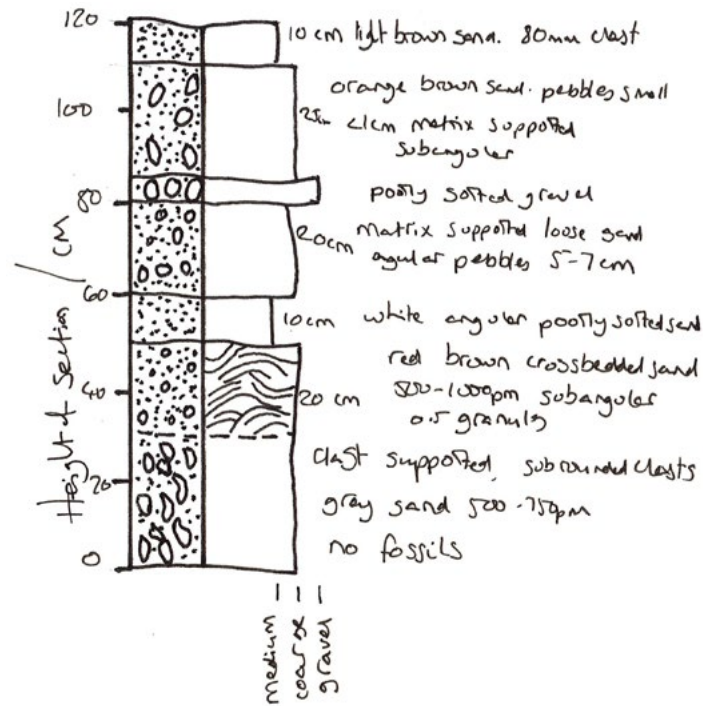
**Figure 11a Corals can be confusing:** The two sketches above (and Fig 11b below) show student drawings made at the same outcrop. Palaeozoic limestones can look uniform black at first and wetting the rock surface may help to bring out features. The drawing on the left contains an appropriate scale and location but lacks any meaningful annotation or distinguishing morphology. The other drawing is slightly better and includes some features observed in the field. However, the labels are confusing and fail to identify any relevant morphological features.



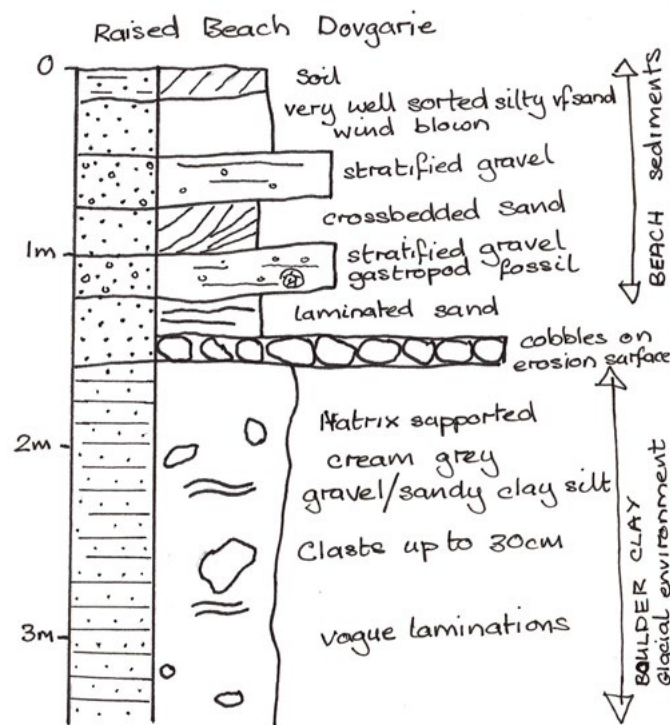
**Figure 11b Corals basic competence:** This is a basic competent student standard field drawing of a real colonial coral. The fossil has been much more carefully observed and an attempt has been made to record the three-dimensional structure of the colony. The mural pore detail has been drawn in based on hand lens observations in the field. The scale is unambiguous and to an appropriate resolution for the size of the fossil.



**Figure 12 Rugose corals:** The drawing on the left shows the septa as they were observed in the field specimen. This drawing shows basic competence, but the epitheca lacks detail that was observable in the field specimen. The drawing on the right has a title, location, scale and gives a better artistic impression of a fossil coral but it is not as good as a scientific record. The labelling of features is ambiguous and the drawing of the septa is generalised and lacks specific detail.



**Figure 13a Sketch log, Pleistocene gravels, Lincolnshire:** Being able to construct and interpret graphic logs is a skill that every geologist needs. A quick log sketched in a field notebook acts as a shorthand that will allow you to record the succession at a field site. This is a good example of a competent sketch log from a student notebook. The thickness of the individual beds is in proportion and the thickness of most beds has been recorded. Graphic logs are an exception to the no stipple rule and stipples has been used to show the lithology of each bed. The log could be improved by increasing the size of the drawing and using the additional space to write full rock descriptions.



**Figure 13b Sketch log, Dougarie, Isle of Arran:** Logging templates/sheets are a useful support tool for students when learning how to log and for logging longer sequences. However, when using a logging sheet there is a danger that students will draw very mechanical, rectilinear graphic logs (recording bed thickness accurately but not relationships within and between beds). This sketch log, drawn with a more fluid style, is an excellent qualitative record of grain size variation, lateral changes in beds thickness and the relationships between beds.



# DRAWING USING A HAND LENS OR MICROSCOPE

## Hand lens drawings

The purpose of hand lens drawings is to show features at outcrop or in hand specimens that may not be visible to the naked eye. The typical hand lens used by students will have a  $\times 10$  magnification and may have an achromatic lens (it does not separate out the transmitted light into constituent colours). Novice geologists may be tempted to try to make their drawing look like the specimen and fill the field of view with generalised mineral grains/crystals. It is only necessary to draw sufficient mineral grains/crystals to show the typical shapes and composition of the grains/crystals.

Follow these guidelines:

- Identify the different minerals present in the outcrop or hand sample.
- Don't draw every grain/crystal in the field of view
- Completely enclose each mineral grain by a continuous line and draw sufficient grains/crystals to show all the main minerals present in proportion.
- Fossils – identify the different morphological features present in the fossil. Examine mineral crystals that make up the fossil and identify the patterns they form: these can provide clues on how the original organism grew or how the fossil was formed.
- Accuracy is important – the specimen will not necessarily look like a textbook drawing. For example, most fossils are incomplete and not positioned in the outcrop in a way that best displays all the morphological feature you would expect to see in a textbook. They may also vary in size and shape from what you are expecting.
- If there is more than one specimen of a fossil at outcrop, or you have a loose fossil, then draw the fossil from different viewpoints (for example a plan and a side view).

## Microscope drawings

The purpose of a microscope drawing is to show as much accurate detail as microscopy will allow. As with hand lens drawings, it is easy to fall into the trap of wanting your drawing to look like what you can see down the microscope. It is better to draw a few mineral grains/crystals well than draw lot grains inaccurately.

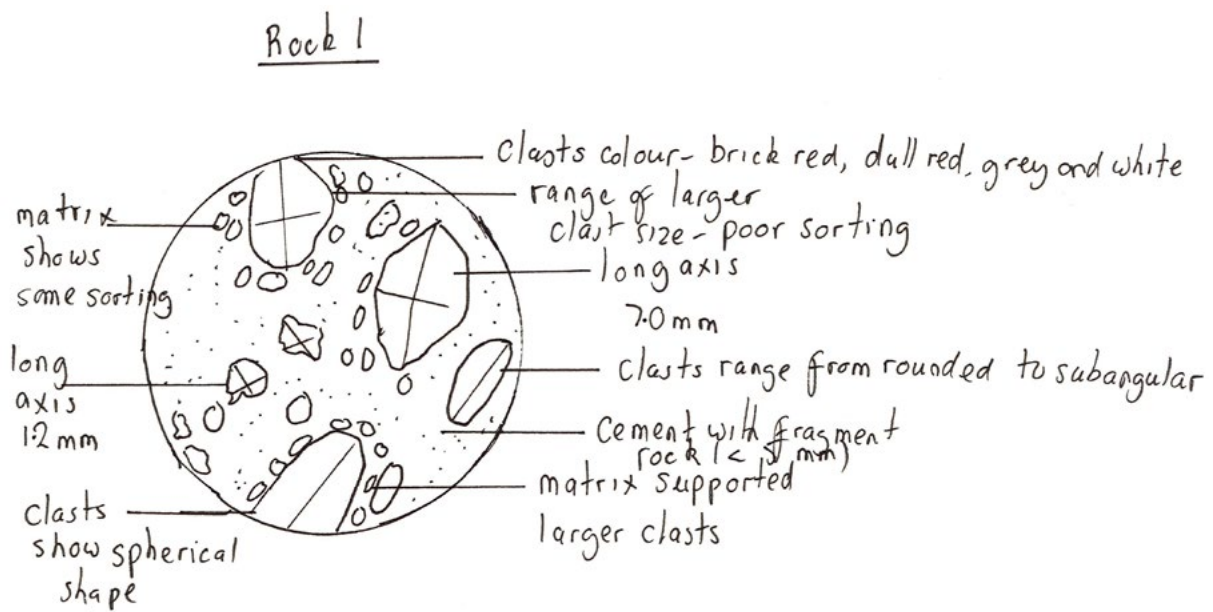
- Draw only a few representative adjacent mineral grains/crystals. If all the grains/crystals are similar, then three grains/crystals is often sufficient to show both mineral composition, grain/crystal shape, and the way in which grains/crystals are arranged in relation to each other.
- For monomineralic rocks such as quartzite, anorthosite or marble you should show the detail of only one grain, with outlines of adjacent grains just to show their relative positions.

- Photomicrographs/thin sections should be drawn under either plane polarised light or cross polarised light, not a combination of both.
- Show relief in your drawing using line thickness. Use a thin light line for low relief and a thicker darker line for high relief minerals.
- If the colour of a mineral in thin section or photomicrograph is an important distinguishing characteristic it should be shown on a drawing. However you must be unambiguous when drawing opaque or coloured minerals so that the shading is not confused for cleavage/striations.

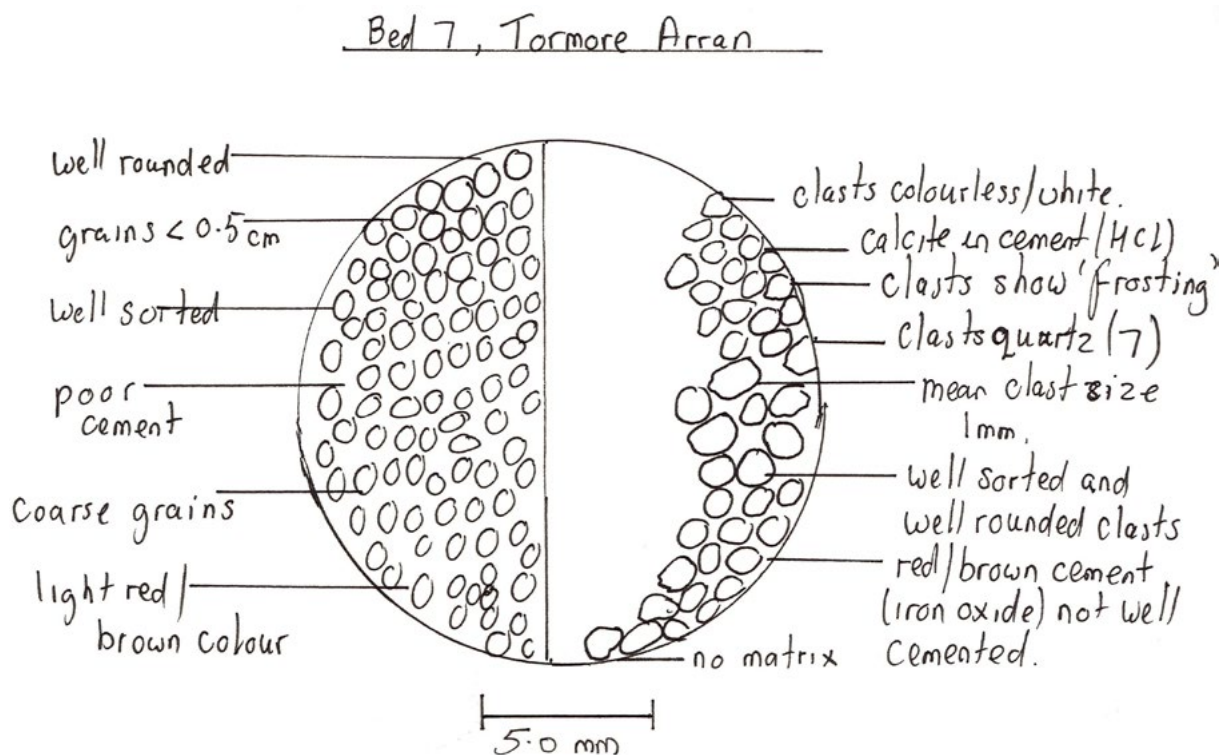
## Examples

**Figures 14a-b** show three examples of student drawings made in the field using a hand lens. Fig 14a is an example of good drawing technique. Fig 14b contrasts two different student drawings of the same millet grain sandstone to illustrate common errors.

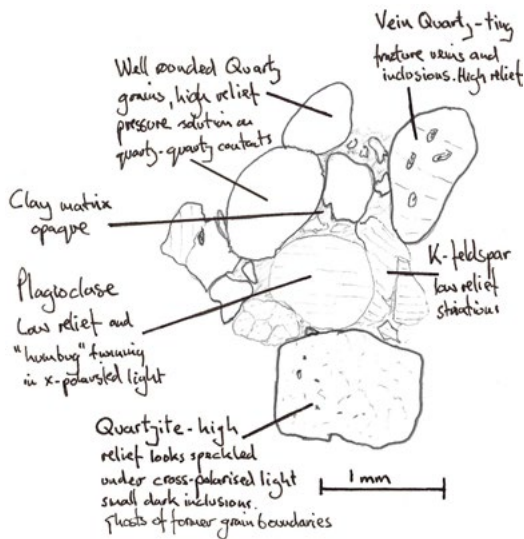
**Figures 15a-b** show drawings made in the classroom from photomicrographs of a sandstone, a granite and a garnet schist. These drawings were made using resources from an online thin section library.



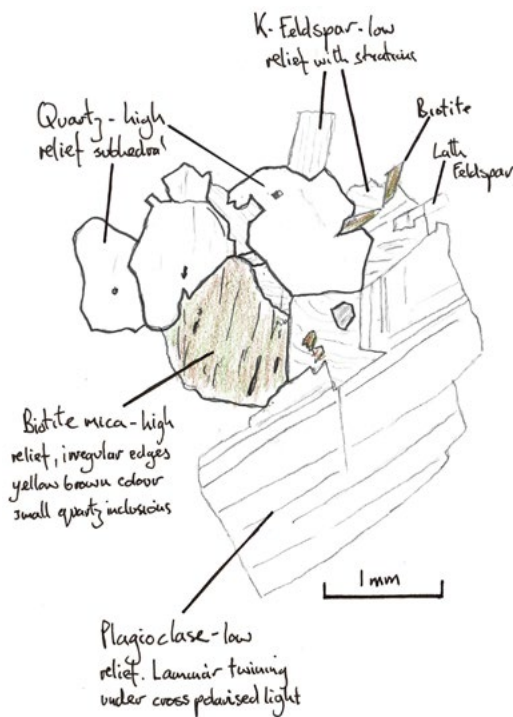
**Figure 14a:** poorly sorted immature sandstone (greywacke) viewed through a hand lens. This is an example of a good field drawing although it should have included a scale or note on the field of view to be competent. The student has accurately recorded the size, shape and relationships between individual sediment grains. The annotations could be improved by including information on the composition of the sediment grains and any mineral testing.



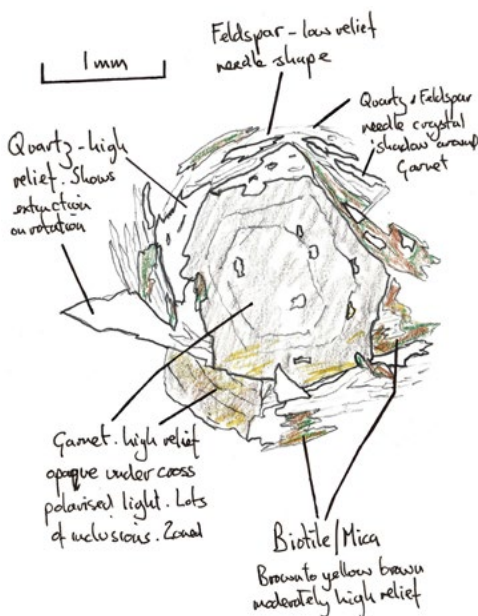
**Figure 14b:** Composite drawing based on student sketches of an aeolian sandstone. On the left the student has tried to fill the field of view with symbolic sand grains, a common error. The right hand side is an example of good competent drawing technique where more care has been taken to show the relative size, shape and relationships between the sand grains. Neither student noted that the field of view of the hand lens was 12 mm. Always include a scale or state the field of view of the hand lens in your field notebook.



**Figure 15a:** Torridonian sandstone. The student has used line density to represent the relief under plane polarised light to distinguish between the quartz and feldspar grains. Although this is a drawing showing the sample under plane polarised light, the appearance of the grains under cross polarised light has been used to identify the minerals present.



**Figure 15b:** Shap granite under plane polarised light. Note how a light colour shading has been used to distinguish between quartz and biotite mica. The appearance of feldspar minerals under cross polarised light have been used to distinguish between the plagioclase and K feldspar. A ruler has been used to draw the scale bar and the lines that label the annotated features.



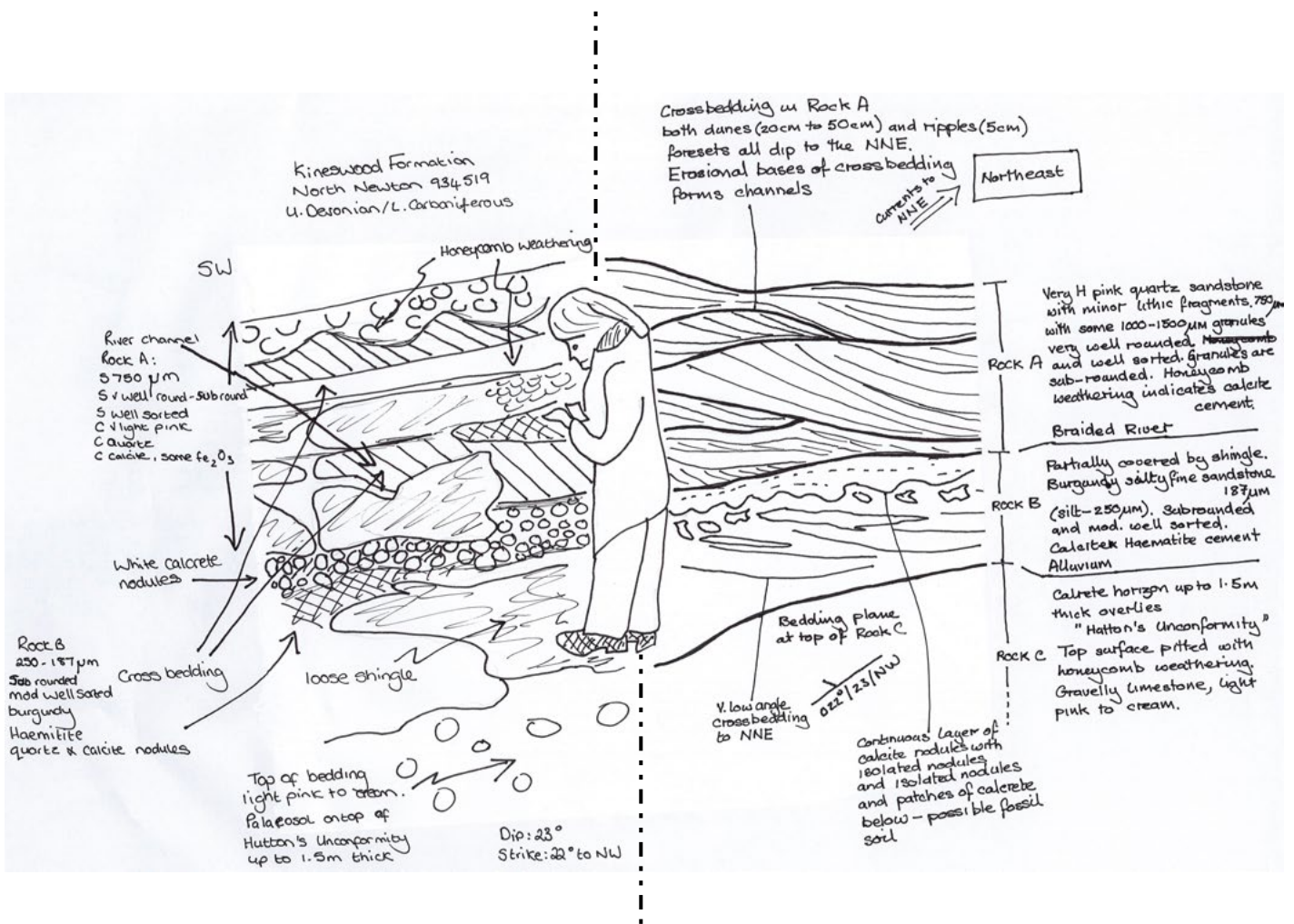
**Figure 15c:** Caledonian garnet schist under plane polarised light. Metamorphic rocks often display complex fabrics under the microscope and it is important not to expect undergraduate standard drawings. This student has concentrated on the shadow zone around one garnet porphyroblast and identified all main minerals. The interruption of the schistosity by the garnet could have been included if the view had been expanded. However, this would have required the student to expand an already very competent sketch.



# STUDENT RESOURCE 1 – FIELD SKETCHES: AVOIDING COMMON ERRORS

The field sketch below shows the Lower Carboniferous sedimentary sequence above Hutton's Unconformity at Newton Point, Lochranza, Isle of Arran. The left hand half of the drawing shows some common errors that are avoided in the right hand half. The right hand half of the drawing shows examples of good drawing technique by a student.

Annotate the field sketch using different colours to highlight the common errors and the examples of good field sketching technique.

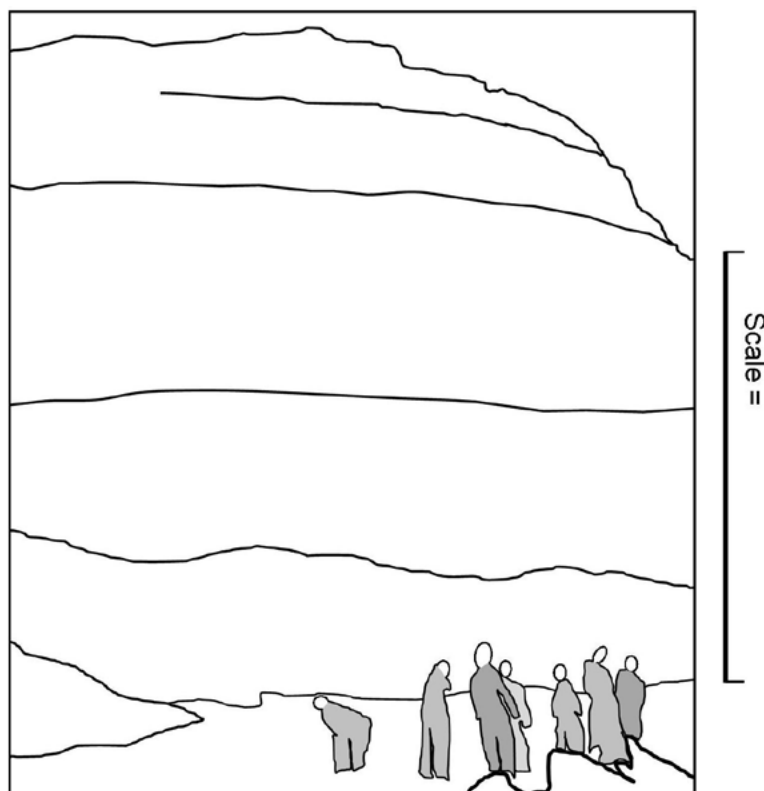


# STUDENT RESOURCE 2 – FIELD SKETCHES: RELATIVE SIZES AND RELATIONSHIPS

The photograph below shows a sequence of Tertiary sediments and a lavaflow that have been intruded by dykes and a sill. Examine the photograph and complete the field sketch showing the relationships between the main features.



- Add a suitable title
- Use the students to estimate the height of the cliff face
- The photograph was taken at 9 am in March. Using the shadows add an orientation to your sketch
- Basalt lavas are rich in iron which oxidises out as the rock weathers to soil. Use this information to identify the fossil soil and lava flow
- One of the sedimentary units contains large river channel
- Can you identify the order in which the igneous features were formed?

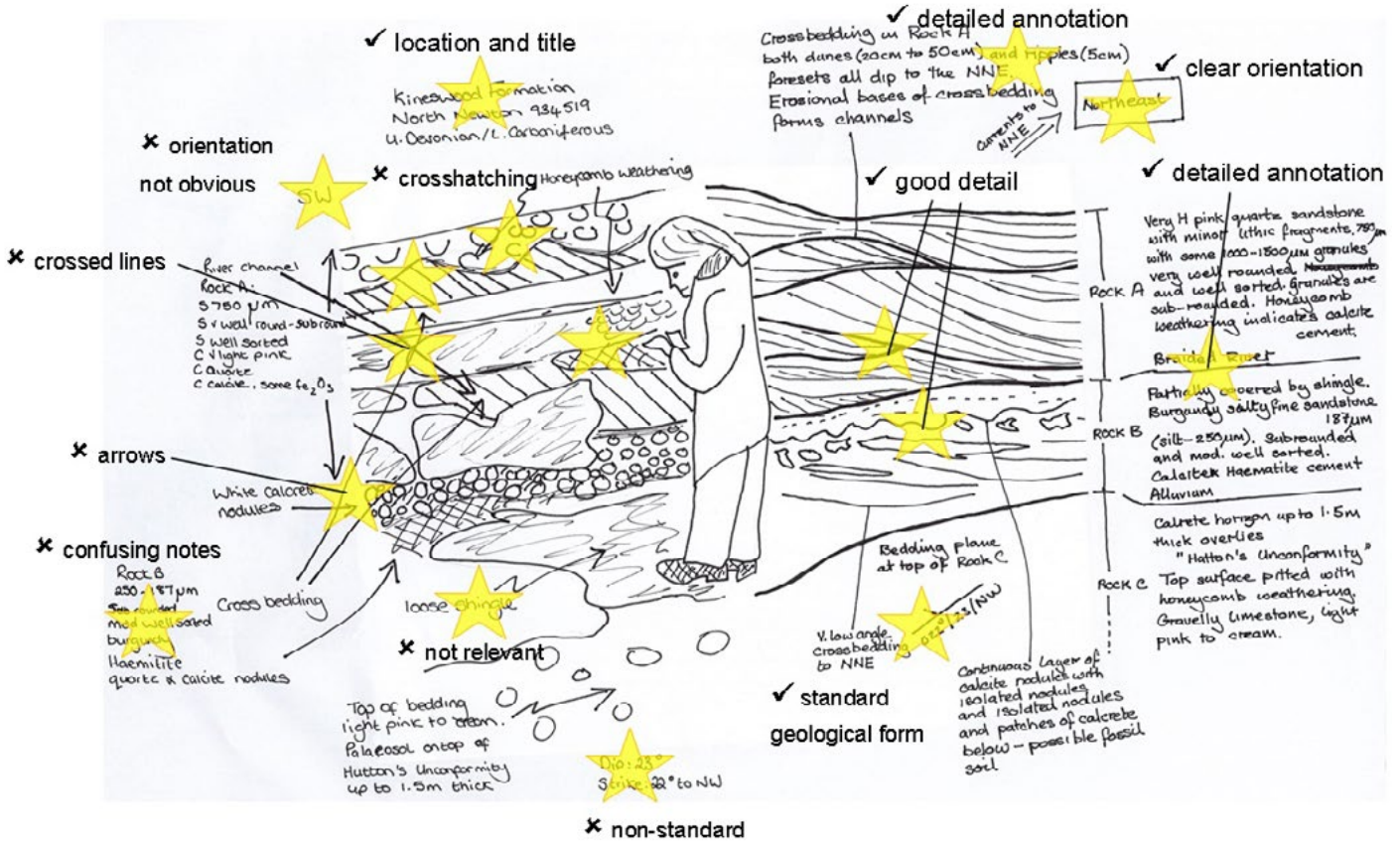




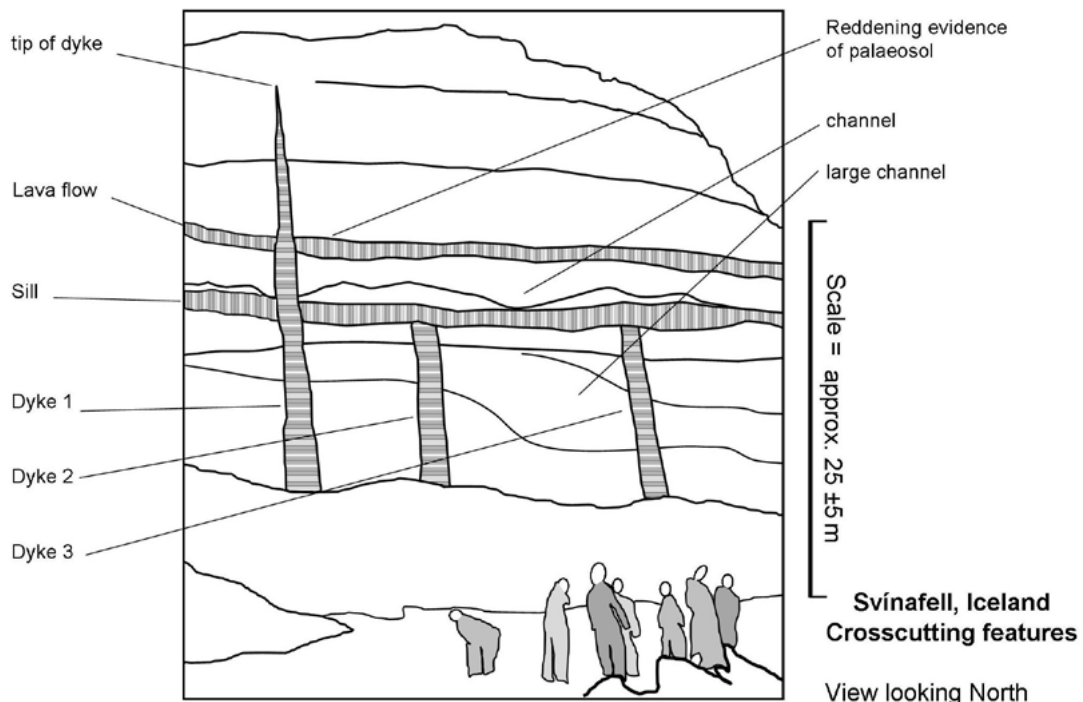
# STUDENT RESOURCE 1 AND 2

## GUIDANCE ON EXPECTED RESPONSES

### Student Resource 1 – Field sketches: avoiding common errors



### Student Resource 2 – Field sketches: relative sizes and relationships





# STUDENT RESOURCE 3 – DRAWINGS, GRAPHS AND TABLES CHECKLISTS

## Introduction

In line with the new DfE subject criteria for GCE Geology qualifications (available here: [www.gov.uk/government/publications/gce-as-and-a-level-geology](http://www.gov.uk/government/publications/gce-as-and-a-level-geology)), a number of practical skills will be assessed as part of the Practical Endorsement (directly-assessable practical skills) and within the examinations (indirectly-assessable practical skills). This includes presenting data and observations in drawings, graphs and tables.

All the practical skills that must be covered as part of the teaching and learning within the new Geology qualifications can be found in Module 1 of the new OCR Geology specifications:

Geology – H014, H414,

<http://www.ocr.org.uk/qualifications/as-a-level-gce/as-a-level-gce-geology-h014-h414-from-2017/>

The following pages contain three optional checklists that can be given to students to help self-evaluate their drawings, graphs and tables.

**When distributing the checklist section to the students either as a printed copy or as a Word file you can remove the teacher instructions section.**

## Drawings

The following practical Learning Outcomes relate to geological drawing:

Module 1: Development of practical skills in geology

1.1.2(c) *presenting observations and data in an appropriate format*

1.2.1(f) *present information and data in a scientific way (Practical Endorsement)*

1.2.2(b) *identification of geological structures in the field, recording observations as field sketches*

1.2.2(g) *production of annotated scientific drawings of fossils, or small scale features, from hand samples using a light microscope, or hand lens observation*

Drawing skills are also part of many of the Learning Outcomes throughout the geological content e.g.: 2.1.1(c)(ii), 2.1.2(b)(iii), 2.1.2(d)(iii), 3.3.1(a)(ii), 3.1.2(b), 5.4.1(b)(ii), 7.2.3(c).

Here is a checklist you can use for your drawings,

1	Your drawing and its label lines must be done with a <u>really sharp pencil</u> (not a pen).	
2	Your drawing should take up at least <u>half the page</u> / space available.	
3	Lines need to be <u>clear and continuous</u> – not ragged or broken – and no cross-hatching is allowed.	
4	Ensure the <u>proportions</u> are correct, i.e. different areas are the right size relative to each other, and that your drawing is a true likeness of the specimen that you are drawing.	
5	<u>Label</u> all the different areas of outcrop/fossil/thin section that you have shown, writing the words in pencil or pen.	
6	Draw label lines <u>cleanly</u> and <u>clearly</u> . Don't let the label lines cross each other and do not write on the label lines.	
7	Make sure the label lines <u>touch</u> the thing you are labelling.	
8	<u>Annotations</u> - add concise notes about the geological structures/features labelled on your drawing.	
9	Include a <u>scale</u> - add a scale bar immediately below the drawing if necessary.	
10	Include a <u>title</u> stating what the drawing is.	

Finally remember to do a quick **TONS/SNOT** Check – **T**itle, **O**rientation, **N**otes and **S**cale.

Remember: A drawing of a hand lens/microscope image should show characteristic grains/crystals in context but does NOT show every individual grain/crystal.

## Graphs

The following practical Learning Outcomes relate to graph drawing:

Module 1: Development of practical skills in geology,

1.1.2(c) *presenting observations and data in an appropriate format*

1.1.3(d) *plotting and interpreting suitable graphs from experimental results, including:*

(i) *selection and labelling of axes with appropriate scales, quantities and units*

(ii) *measurement of gradients and intercepts.*

1.2.1(f) *present information and data in a scientific way (Practical Endorsement).*

*Graphs must also be covered under the geology mathematical skills requirements,*

*See maths skills M2.2, **M2.7**, M2.9, M2.10, **M2.11**, M3.7, M3.8, M3.9, M3.10, M3.11.*

Here is a checklist you can use for your graphs,

<b>S</b>	<b>Size of the graph:</b> does the bit with actual plotted points in take up at least half the paper?	
<b>P</b>	<b>Plotting:</b> is every data point within half a little square of where it should be?	
<b>L</b>	<b>Line of best fit:</b> if there's a trend in your data, is it indicated with a smooth curve or straight line?	
<b>A</b>	<b>Axes right way round:</b> the thing you changed (independent variable) along the bottom; the thing you measured (dependent variable) up the side.	
<b>T</b>	<b>Title:</b> have you included a title that tells you what this graph shows?	
<b>A</b>	<b>Axis labels:</b> name of each variable with the right unit symbol.	



## Tables

The following practical Learning Outcomes relate to tables:

Module 1: Development of practical skills in geology,

*1.1.2(c) presenting observations and data in an appropriate format*

*1.2.1(d) make and record observations/ measurements (Practical Endorsement)*

*1.2.1(f) present information and data in a scientific way (Practical Endorsement).*

*Tables must also be covered under the geology mathematical skills requirements,*

*See maths skills M1.1, M1.2, M1.3, M2.2, M3.7.*

Here is a checklist you can use for your tables,

<b>1</b>	All raw data in a single table with ruled lines and border.	
<b>2</b>	Independent variable (IV) in the first column; dependent variable (DV) in columns to the right (for quantitative observations) OR descriptive comments in columns to the right (for qualitative observations).	
<b>3</b>	Processed data (e.g. means, rates, standard deviations) in columns to the far right.	
<b>4</b>	No calculations in the table, only calculated values.	
<b>5</b>	Each column headed with informative description (for qualitative data) or physical quantity <b>and</b> correct units (for quantitative data); units separated from physical quantity using either brackets or a solidus (slash).	
<b>6</b>	No units in the body of the table, only in the column headings.	
<b>7</b>	Raw data recorded to a number of decimal places appropriate to the resolution of the measuring equipment.	
<b>8</b>	All raw data of the same type recorded to the same number of decimal places.	
<b>9</b>	Processed data recorded to up to one significant figure more than the raw data.	



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