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Examiners' report

GEOLOGY

H414

For first teaching in 2017

H414/03 Summer 2022 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Advance Information for Summer 2022 assessments

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our website.

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Paper 3 series overview

The focus of this paper is on applied practical skills in relation to provided stimulus materials. Candidates are expected to understand a range of field techniques which includes;

- interpretation of rock/mineral/fossil descriptions,
- photo interpretation including sketching to mimic
    - field sketching and labelling
    - manipulation of data such as measuring and converting scales
- construction of graphic logs
- plotting and interpreting a range of different types of graph
- drawing and interpretating rose diagrams
- results of laboratory experiments
- field observations
- map work to include;
    - drawing of cross sections
    - calculation of true thickness
    - interpretation of features shown on maps
    - labelling features onto maps
    - drawing conclusions from maps both coloured geological and outline problem maps
- Constructing geological histories from cross sections, photographs and maps

As such there is an emphasis on candidates being able to identify named minerals, rocks and fossils and to be aware of their diagnostic features. Theoretical knowledge is tested as well but usually with the context of a specimen, diagram or photograph.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
• carefully read the stem and any other information provided as part of the question • were accurate with their labelling, plotting and drawing • used terminology effectively, giving examples where appropriate • in the extended prose questions clear explanation of similarities and differences created a coherent response. As did the use of terminology and example of rocks/minerals/fossils • showed workings in the maths questions which can gain marks even if the final answer is incorrect • used rock and mineral names appropriately.	• misinterpreted the topic of the question • did not show workings for the maths questions • wrote about mitigation techniques/issues without development • did not write about the required number of issues • did not structure the extended questions as the stem outlined. Responses for example did not illustrate similarities of differences • did not use a range of terminology or names of rocks/minerals • did not use appropriate axis scales for graphs • were not precise in locating features on diagrams.

Question 1 (a) (i)

1 **(a)** The table shows information about four different siliciclastic rocks.

Sample	Grain size	Roundness	Sorting	Composition	Rock type
A	>2 mm	Angular	Poor	Large rock clasts, smaller sand-sized grains and a fine sandy matrix	Breccia
B	>2 mm	Rounded	Poor	Large rock clasts, smaller sand-sized grains and a fine sandy matrix	
C	0.0625–2 mm	Angular to sub-angular	Poor	Rock clasts, grey and white sand-sized grains, clay matrix	
D	<0.0625 mm	Cannot be seen with hand lens	Cannot be seen with hand lens	Cannot be seen with hand lens	

(i) Complete the table by identifying samples **B**, **C** and **D**. Sample **A** has been completed for you. **[2]**

Most candidates were able to identify all/some of the correct rocks. A number recognised that Specimen D was fine grained but opted for Siltstone rather than the clay grade rocks, having mis-interpreted the grain size information.

Question 1 (a) (ii)

(ii) Rock **C** contains grains of **two** unidentified minerals.

- The first is a grey mineral that shows no cleavage and cannot be scratched by a steel nail.
- The second is a white mineral and shows two good planes of cleavage.

Identify these **two** minerals.

Grey mineral ....

White mineral ....
[2]

Many candidates correctly identified Quartz and a Feldspar mineral. A few candidates wrote the correct minerals the wrong way around. Those candidates who did not get this mark, most commonly chose Calcite as a response for the Feldspar and Galena for Quartz.

Misconception

Some candidates identified the grey mineral as Galena; the colour would be the factor leading them to this suggestion. The white mineral was often identified as Calcite, due to its white colour and having cleavage.

Assessment for learning

Practical sessions using unnamed mineral specimens requiring candidates to identify a range of diagnostic features. Pre prepared sheets in the format of question (1 (a) (ii)) showing some of the diagnostic features of minerals. The same principle could be applied to rock identification.

Question 1 (a) (iii)

(iii) **Fig. 1.1** in the **Insert** shows a photograph of rock **C** taken in the field.

Sketch the sedimentary structure shown in the photograph. Include labels in your sketch.

[2]

Most candidates identified this photograph as one showing graded bedding. Most diagrams showed a rock where the grains drawn illustrated a clear decrease in grain size from the base of the diagram to the top.

Most candidates drew a diagram which did not fill the box, this is acceptable as it can take a lot of time to draw this sedimentary structure. If the candidate has recognised graded bedding and made an accurate attempt to draw it, the size of the diagram would not be an issue. A very small number made their diagrams very small, less than a tenth of the available space, which hindered their ability to illustrate the full variation across the rock in the photograph.

Most candidates did not get the mark for labelling. Diagrams generally had a good number of labels relating to grain sizes such as; graded bedding, finer grains (labelled at the top), coarser grained (labelled at the base), arrows with either fining upwards or coarsening upwards indicated but all of these options came from the same marking point. Two marking points were needed to gain the mark. Use of a scale or reference to the shape of the grains would achieve this second mark.

Question 1 (b) (i)

(b) **Fig. 1.2** shows a thin-section diagram of Jurassic Oolite.

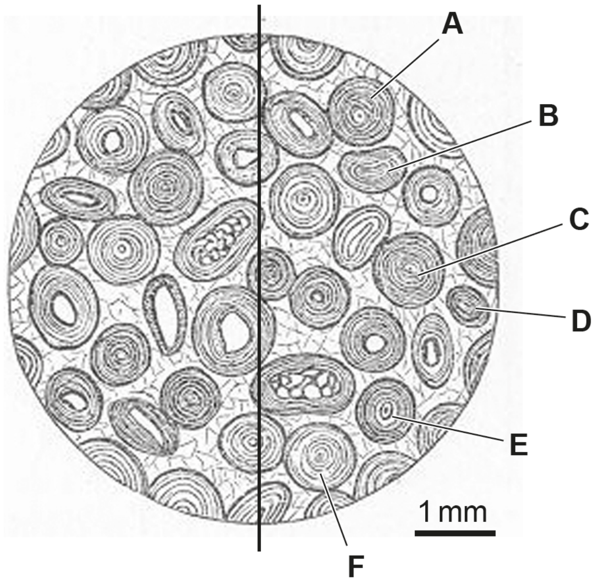


Fig. 1.2

(i) Annotate **Fig. 1.2** to show the key features of this oolite.

Write your annotations on the left-hand side of the thin-section diagram. **[2]**

Ooliths, concentric layers of $CaCO_3$ and nucleus or sand grain/ shell fragment labelled for the nucleus were well known by a majority of candidates.

Question 1 (b) (ii)

(ii) Measure the maximum diameter of the grains labelled **A** to **F** on **Fig. 1.2** and calculate the mode. Write your measurements in the table.

Grain	Maximum diameter
A	
B	
C	
D	
E	
F	
Mode	

[2]

Most candidates had no difficulty in measuring the grains within the required level of accuracy. Marks were lost for not including the units of measurements or using the wrong units. It was quite common to see 9cm/9mm instead of 0.9mm. A significant minority of candidates did not know what the mode was and provided a mean instead.

Question 1 (b) (iii)

(iii) Calculate the magnification of the thin-section diagram.

Magnification = ... **[2]**

Most candidates were able to work out that magnification was 10x. A few achieved the wrong answer but had written out the equation; magnification= size of object /size of real object and so achieved 1 mark.

Question 1 (c)*

(c)* Describe the similarities and differences that could be observed in the field between bioclastic and reef limestones.

In your answer you should describe the depositional environment for each limestone and refer to a named sedimentary basin where they could both be found.

....

....

....

....

....

.... **[6]**

Reef limestones were well known with much good reference to corals being the dominant fossil group and the environment of formation in shallow tropical seas. Many candidates linked them to the Welsh basin and in particular the Wenlock limestone. Level 3 answers commented on rugose and tabulate corals being the orders which would be found.

There was less focus on their structure being massive as part of a reef and the corals being in life position.

Bioclastic limestones were less well known and many candidates wrote an account of the chalk.

Good Level 2 and 3 answers would integrate comments about both types of limestone to show what similarities they had and their differences.

A major requirement with this type of question is field work observations. There was opportunity for candidates to write about the colours, bedding, hardness, mineral content and type of cement for the two limestones further encouraging similarities and differences to be noted.

Misconception

Many candidates thought Bioclastic limestone was another name for chalk. Others that it was a non-fossiliferous limestone as opposed to the reef limestone.

Assessment for learning

Field skills will be useful for this style of question and any opportunity candidates get to carry out field rock descriptions will help to prepare them for this type of assessment.

Laboratory practicals can also help when a group of unknown specimens can be presented for candidates to carry out "field" rock descriptions.

Question 2 (a)

2 **Fig. 2.1** in the **Insert** shows a photograph of a hand specimen taken from an igneous outcrop.

(a) Using specific igneous terminology, describe the texture shown in the photograph in **Fig. 2.1**.

....

....

....

....

....

.... **[3]**

Most candidates identified Porphyritic texture from the photograph.

To achieve further marks there was a requirement for a practical style identification of the minerals present. The large pink phenocrysts needed to be identified as Orthoclase/K/ Potash feldspar due to the colour. Whilst the slightly smaller but still coarse white crystals were Plagioclase. Quartz could be identified as grey/colourless/medium sized/groundmass and Biotite (mica) as black/fine grained/groundmass.

Misconception

Many candidates showed a tendency to explain the formation of this texture, rather than provide a field type identification of what they could observe.

Assessment for learning

Candidates should be given opportunities to study colour images of a variety of rock types and encouraged to carry out field work style identification and description of what they can see. By analysing the photographs, evaluating what they see candidates should be encouraged to name minerals, textures and rocks concluding why they made those decisions.

Fieldwork is the ideal opportunity for this to be carried out at numerous different localities during the duration of the trip.

Question 2 (b)

(b) Explain the process or processes that formed the texture shown in **Fig. 2.1**.

....

....

....

....

.... **[2]**

Many candidates were aware that this texture is the result of two stages of cooling and that this produces the different sizes of crystals seen. To achieve full marks candidates needed to explain that the reason for this difference in crystal size was due to the magma moving during its cooling history. Candidates needed to show knowledge of the plutonic cooling taking a long time followed by the magma changing location closer to the surface for quicker cooling. This photograph showed a rock which was uplifted to hypabyssal depths as the crystals were too large to have cooled extrusively.

Exemplar 1

(a) Using specific igneous terminology, describe the texture shown in the photograph in **Fig. 2.1**.

Fig. 2.1 shows a porphorytic texture with two distinct crystal sizes. The larger phenocrysts are an orange colour and are largly rectangular in shape suggesting they are likely orthoclase feldspar. The finer crystals in the ground mass consist of a number of minerals with the grey crystals likely being quartz and the black crystals possibly being biotite. **[3]**

The first exemplar shows the type of response expected for Question 2 (a) which would gain maximum marks; in this response the candidate refers to colour and size of the different minerals which are appropriately named.

(b) Explain the process or processes that formed the texture shown in **Fig. 2.1**.

larger phenocrysts formed during slower cooling periods when crystals had more time to develop. finer ground mass forms during faster periods of cooling. The large rock experiences different temperatures causing change in rate of cooling.

[2]

The second exemplar gained 1 mark; explaining how larger crystals formed but did not explain that magma moved during its cooling. Finer crystals are described forming faster but no reason for this given.

Question 2 (c)*

(c)* Describe the processes involved in the evolution of magma to produce rocks of varying compositions.

[6]

Many candidates had good knowledge of a range of igneous processes such as magmatic differentiation including fractional crystallisation, gravity settling and filter pressing. There was good awareness of the early formed minerals in the discontinuous reaction series and how this could deplete the magma in Fe and Mg to produce a more silica rich magma.

Many candidates were also aware of Magma mixing, stoping and assimilation.

Some Level 3 responses linked fractional crystallisation to the formation of layered intrusions such as the Palisades Sill or the varying composition of lava erupted from Hekla. Others outlined plagioclase changing from a Ca rich centre of crystals to a Na rich outer part.

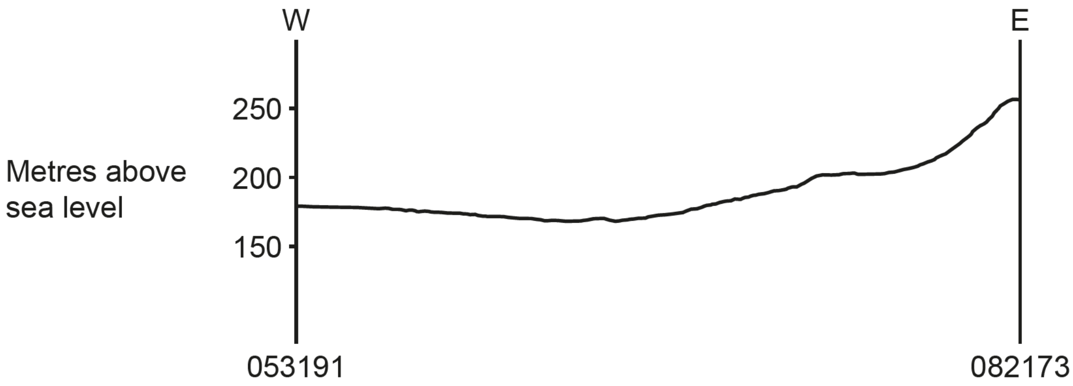
Misconception

Several candidates wrote an account of magma generation at different plate tectonic settings or an account of the main characteristics of the four igneous rock groups focusing upon the silica content of each rock group.

Question 3 (a) (i)

3 The 1:50 000 scale geological map excerpt (Whitehaven), **Fig. 3.1** in the **Insert**, should be used for this question.

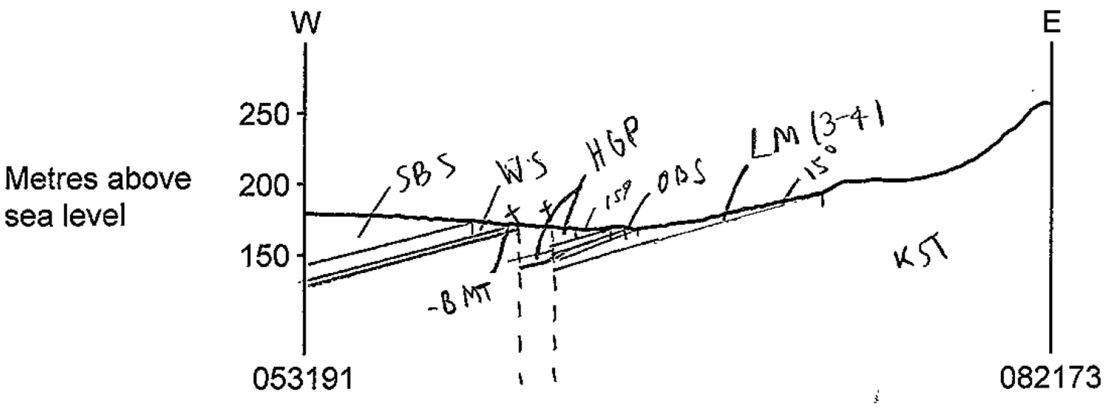
(a) (i) On the topographic sketch profile below, draw and label a cross-section of the solid geology from grid reference 053191 in the West to 082173 in the East. These grid references have been marked in yellow on the map.



[3]

Most candidates made an attempt to plot the 15 degree dip of the Carboniferous sequence. A few recognised the unconformable sequence in the western part of the section and/or the steep 80 degree dip in the eastern sector. High level responses also showed the two western faults downthrowing to the west with the carboniferous beds offset as a result. A reasonable number picked up the faulted contact between the blue coloured LMS and lilac KSt.

Exemplar 2



This is an example of a good cross section. Whilst the 80 degree dip and fault in the eastern section of the section have been missed, and the unconformable beds in the west, the two western faults are included, downthrown is clearly indicated by the plotting of offset beds and the beds are labelled.

Question 3 (a) (ii)

(ii) Using the map and a dip of 15°, calculate the true thickness of the Great Scar Limestone Group.

Thickness = ... m **[3]**

Candidates found this to be a demanding question. Some showed their workings and gained credit for attempting to work out either "L"; the apparent thickness or "h"; the height difference. A few began to use cos15 or sin15 but very few used the full equation.

OCR support

Download the OCR Geology Mathematical Skills Handbook for additional support and guidance.

Question 3 (a) (iii)

(iii) Using the correct geological terminology, fully describe the relative movement of the faults shown on your cross section. Give **one** piece of supporting evidence.

Movement ....

....

Evidence ....

.... **[2]**

A number of candidates recognised the presence of dip-slip faults and there were some alternative wordings on the mark scheme which were also acceptable. A lot of candidates put their evidence into the movement section but were still credited as having a correct response.

Question 3 (b)

(b) Comment on the distribution of metallic deposits that are found in the rocks shown in the south-east portion of the map.

....

....

....

....

.... **[2]**

The most common response for this question was the observation that the metallic deposits were primarily to be found in the one rock type, that being KSt. Few made the connection that the metals lay along faults and fewer still made the observation that the deposits were linear/ trending NW-SE or parallel to each other.

There seemed to be some confusion over the focus of the question and many missed the requirement to comment on the "distribution" instead outlining their formation.

Question 3 (c)

(c) State a grid reference where you may find further metallic deposits of the same type.

.... **[1]**

Many candidates provided a suitable 6 figure grid reference for this question. A few candidates gave only a 4 figure reference.

The biggest confusion was candidates not giving a grid reference away from the SE corner where they had been directed in Question 3 (b).

Misconception

Misreading the question, in this case the grid reference required was to be "where you may find further metallic deposits of the same type". As a result, candidates could not be credited with grid references from the SE corner of the map but had to look for other locations of the rock KSt.

Question 3 (d)

(d) In this area, coal mining has taken place in the Carboniferous strata.

Outline possible mitigations that could be used to reduce the geohazard risks associated with historical coal mining when constructing new buildings on the surface.

....

....

....

....

.... **[2]**

Many candidates performed well on this question and back filling of the mine was the most popular response. A number also outlined Raft Foundations. Answers were usually successfully linked to the requirement of reducing subsidence/collapse of the mine once the building was carried out.

Question 4 (a)

4 A student wanted to investigate the quality of some copper ore minerals in the laboratory to see if they had a content which approached that of an economic ore deposit.

The student had three pieces of malachite (copper carbonate ore) as hand specimens **A**, **B** and **C**. The student decided to measure the loss of mass of crushed samples of ore when reacted with 1M HC*l* (hydrochloric acid). The loss of mass equates to the loss of CO_2 from the ore during the reaction.

Method:

- each sample was crushed
- 2 g of each crushed sample **A**, **B** and **C** were placed onto separate pieces of paper
- a 250 ml beaker was placed on an electronic balance
- 50 ml of 1M HC*l* was added to the beaker
- the balance was tared (set to zero)
- sample **A** was added to the beaker and left for 6 minutes
- the loss of mass was recorded in g
- the experiment was repeated using samples **B** and **C**.

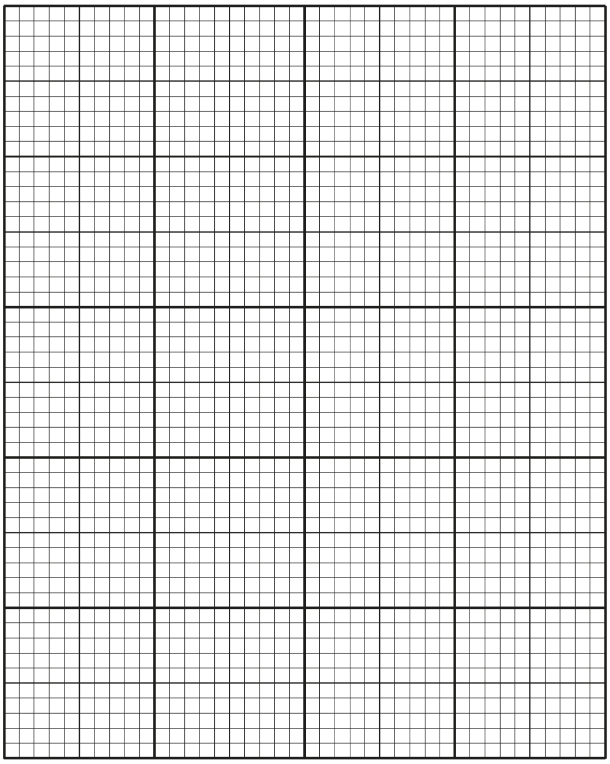
It is assumed that the reaction is complete after 6 minutes.

Pure malachite loses 19.9% of its mass by the evolution of CO_2 during the experiment.

The table shows the student's results.

	Sample		
	A	**B**	**C**
Mass of sample (g)	2.00	2.00	2.00
Loss of mass (g)	0.22	0.02	0.37
Pure malachite in a 2 g sample (%)	55.28	5.00	92.96

(a) Plot the results on a graph, loss of mass (g) against calculated percentage of pure malachite. Draw a line of best fit.



[3]

Most candidates achieved 2 or 3 marks on this question. A significant number made their plotting more demanding by using awkward scales. This caused them difficulties with accurately locating their points within the acceptable tolerance.

The best scale was to use all of the grid provided, with the % of pure malachite along the y axis at intervals of 20% and the mass loss in g along the x axis in intervals of 0.1g.

Assessment for learning

Candidates need to use the grid provided for them to their advantage. Using any scale which does not use the full grid should indicate that they are making it more difficult to plot.

Practise with plotting data on pre provided grids could help. Many centre based tasks from past exam series have a suitable range of data which could make useful class exercises.

Question 4 (b)

(b) Circle on the graph the position of the purest sample. **[1]**

Most candidates correctly identified sample C.

Question 4 (c)

(c) Using your graph, determine the purity of a copper sample with a loss of mass of 0.15 g.

.... **[1]**

Knowledge of graph interpretation was strong with most gaining this mark.

Question 4 (d)

(d) Give **one** reason why this method may not yield accurate results.

....

.... **[1]**

Most candidates were able to identify potential errors which might occur during the experiment such as loss of mass upon transferring the sample from the paper to the balance, issues with the balance, impurities affecting the result or the reaction not been complete within six minutes. This latter choice showed that candidates had carefully read the information provided.

A significant number of candidates though mis-interpreted the question and instead of answering about the "method…not yielding accurate results" focussed instead on graph plotting being the cause of errors. Often these were candidates who had used a complex scale and would therefore have found it difficult to accurately plot their points in Question 4 (a).

Misconception

Careful reading of the question should help candidates to realise how to structure their answer by picking out the term "method" rather than "results" or "graph".

Assessment for learning

Use of previously issued Centre based tasks is a potential valuable source of material. These tasks have a lot of exercises which use laboratory based experiments. These previous assessments provide plenty of opportunity for candidates to gain experience with this type of question. There will be opportunities to work out data, plot and interpret it. There are usually follow up questions about the reliability of the data and issues the method may have created.

Question 4 (e)

(e) The table shows the top five highest grade open pit copper deposits in the world.

Location	Copper grade reserves %
Las Cruces, Spain	5.03
KOV, Democratic Republic of the Congo	4.20
Kinsevere, Democratic Republic of the Congo 2	3.55
Sepon, Laos	2.79
Antas, Brazil	2.58

Using this data and the data from the student's investigation, explain which sample, **A**, **B** or **C**, is most likely to form an economic ore deposit in a large copper pit.

....

....

....

....

.... **[2]**

This question required candidates to link their answer to the data provided in the table. Most candidates accurately identified sample B and then made the link between sample B having a malachite percentage of 5% which was the closest to the five examples of open pit copper reserves shown in the table.

There was allowance for candidates who opted to choose sample C; to gain maximum marks. Candidates needed to comment on C being considerably higher than the examples shown in the table and therefore if found in nature would prove excessively profitable.

Exemplar 3

C because it has the greatest amount of pure malachite in the sample and therefore is likely to be more economic to mine as the amount of malachite produced is greater. C has a grade of 92.96 % in sample but largest grade mine is 5.03% so is likely to be economic to mine **[2]**

This shows the type of response needed to gain 2 marks if C is chosen as the best sample.

Question 5 (a) (i)

5 (a) A mineral exploration company are analysing data to find a viable copper ore deposit. **Fig. 5.1** shows stream sediment analysis data within the area of interest.

The data shown indicates concentration of copper in parts per million (ppm).

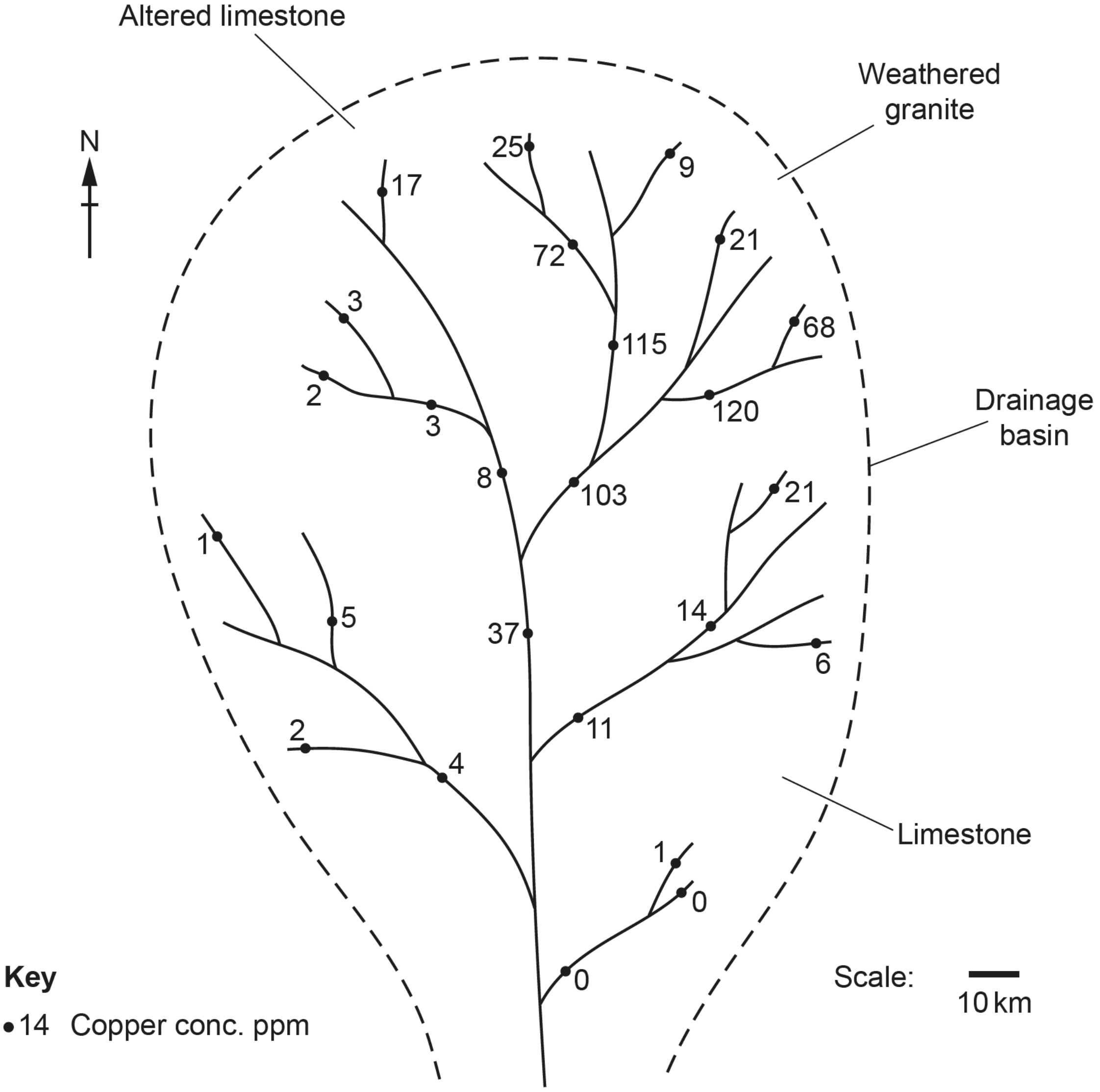


Fig. 5.1

(i) **Circle** an area **on Fig. 5.1** that shows an anomalous level of copper in the stream sediments. **[1]**

Many candidates identified the area where copper levels were higher than usual. In order to gain the mark, they needed to circle a wide enough area, to include the three locations where concentrations exceeded 100 ppm. Candidates also needed to show understanding of how the copper was transported from its source. This meant that circles crossing neighbouring catchments were not accepted.

Question 5 (a) (ii)

(ii) **Shade** an area **on Fig. 5.1** where the copper ore deposit is most likely to be found. **[1]**

Many candidates did not recognise the link between the granite and the copper mineralisation or that the copper was transported downstream from its source. Therefore, relatively few correctly identified the location as being upstream of the anomalous readings but downstream of the weathered granite.

Question 5 (a) (iii)

(iii) The ore deposit was found to contain 4% copper.

Calculate the concentration factor of this ore deposit, assuming the average crustal abundance of copper is 0.0068%.

Give your answer to **2** decimal places.

Concentration factor = ... **[2]**

Most candidates correctly carried out this calculation and rounded their answer to two decimal places. A small minority did not round their answer correctly but gained some credit for showing the correct working.

Question 5 (b)

(b) State and explain **two** possible issues that would affect the economic viability of extracting a proven reserve of a metal ore.

....

....

....

....

....

.... **[4]**

A significant number of candidates wrote very detailed responses showing a sound awareness of a number of issues which would affect the economic viability of extracting a known reserve of metal ore. The most popular choices were; the differing hardness of the country rocks, depth of burial and size/purity of the deposit.

Another popular choice was cut off grade, although this was not always explained in as much depth as the previously listed options. Many candidates wrote vague comments about cut-off grade affecting the price without giving an example to explain their point.

Question 5 (c)

(c) **Fig. 5.2** shows the froth flotation method of separating metal ore.

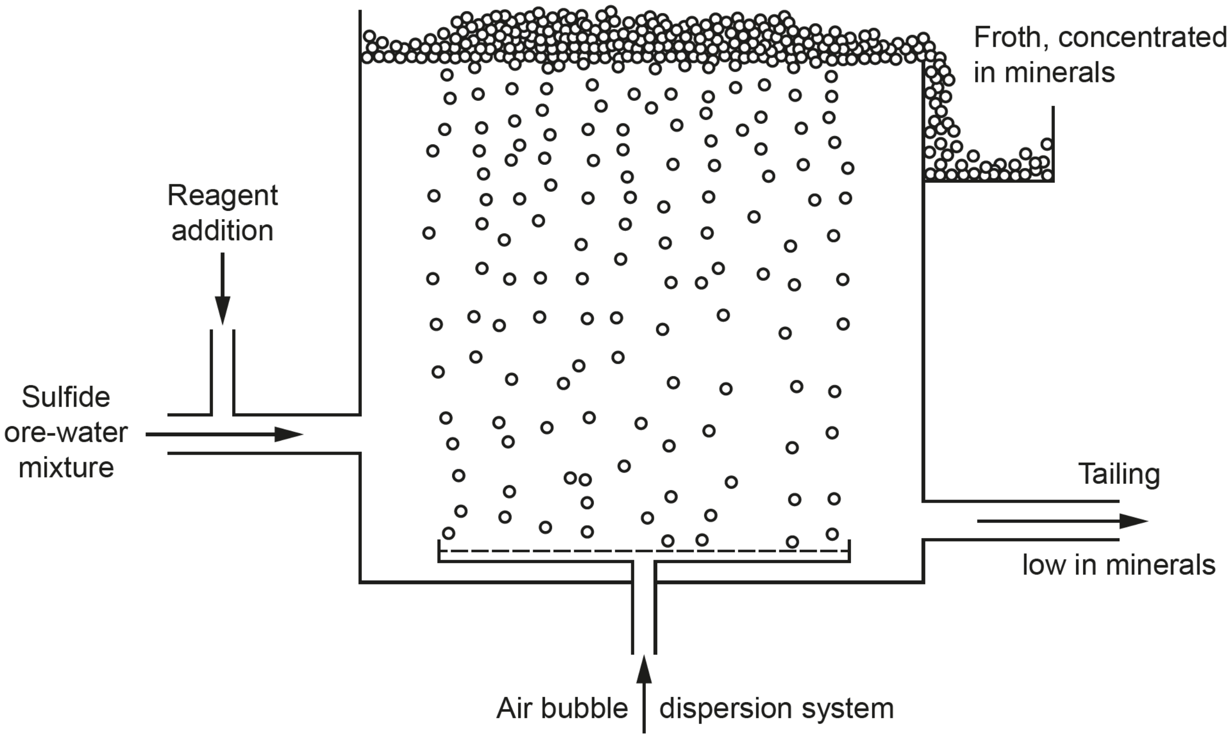


Fig. 5.2

Explain how this process concentrates the metal ore.

....

....

....

....

.... **[2]**

This method of ore extraction was very well-known by the majority of candidates and some excellent responses were seen. A significant number of candidates outlined the whole process in considerable detail.

A smaller number were not as confident with this technique, but there was strong evidence that most had studied the diagram and tried to use it to inform their response.

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