

Surname	Centre Number	Candidate Number
Other Names		0



**GCSE**

4250/01



S16-4250-01

**GEOLOGY**

**Theory Paper**

**(Paper version of on-screen assessment)**

A.M. WEDNESDAY, 25 May 2016

1 hour 30 minutes

For Examiner's use only		
Section	Maximum Mark	Mark Awarded
1.	11	
2.	15	
3.	9	
4.	19	
5.	15	
6.	18	
7.	13	
<b>Total</b>	<b>100</b>	

**ADDITIONAL MATERIALS**

In addition to this examination paper you will need a:

- Data Sheet;
- calculator.

**INSTRUCTIONS TO CANDIDATES**

Use black ink or black ball-point pen.

Answer **all** questions.

Write your answers in the spaces provided.

**INFORMATION FOR CANDIDATES**

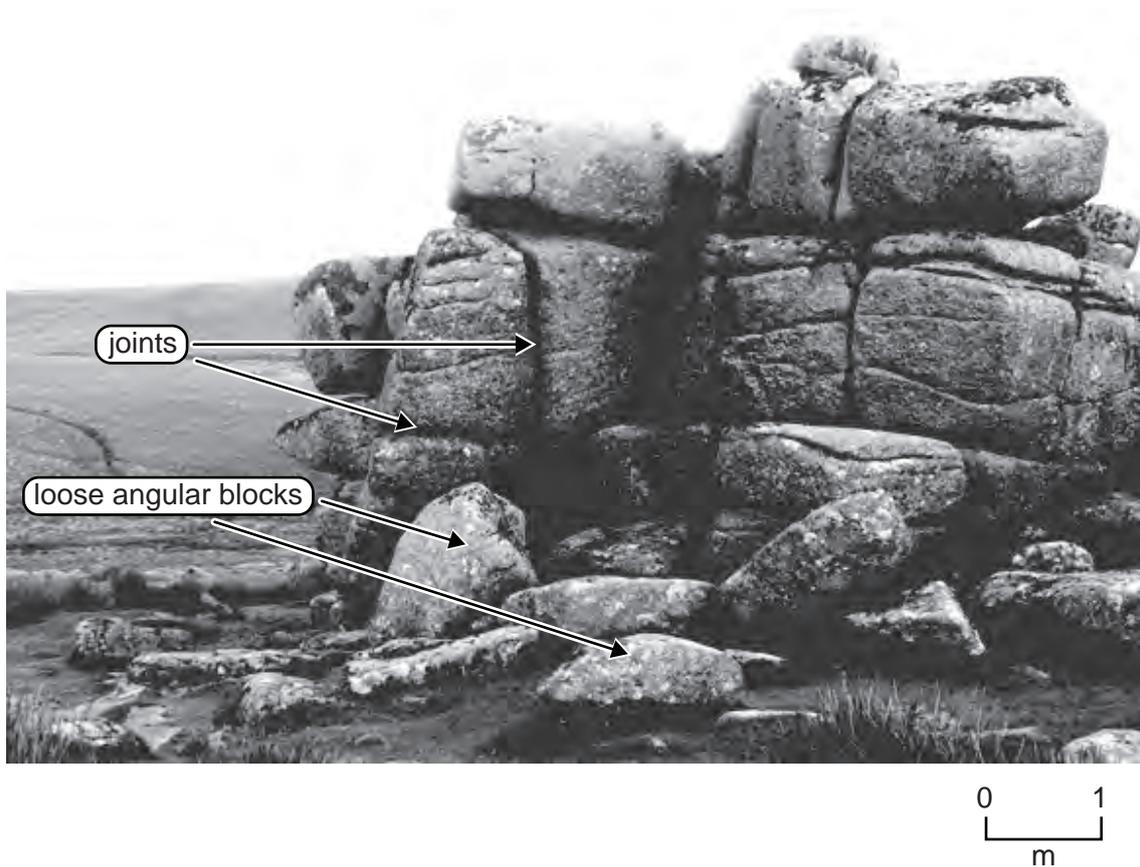
The number of marks is given in brackets alongside each question.

You are reminded that assessment will take into account the quality of written communication (QWC) used in your answers to **Section 2 Q4** and **Section 4 Q7**.

Answer all questions in each section.

**Section 1 – answer questions 1-5**

**Figure 1** shows a granite exposure on Dartmoor in south west England.



**Figure 1**

1. Which **one** of the following best describes the jointing in the granite? Tick (✓) only **one** box. [1]

joints are in one direction

joints are approximately horizontal and vertical

joints are dipping at a low angle

the granite shows columnar jointing

jointing is randomly orientated

2. Describe the **physical weathering process** which most likely produced the loose angular blocks of rock at the base of the exposure in **Figure 1**. [3]

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3. Which **two** of the following are **NOT** weathering processes? Tick (✓) only **two** boxes. [2]

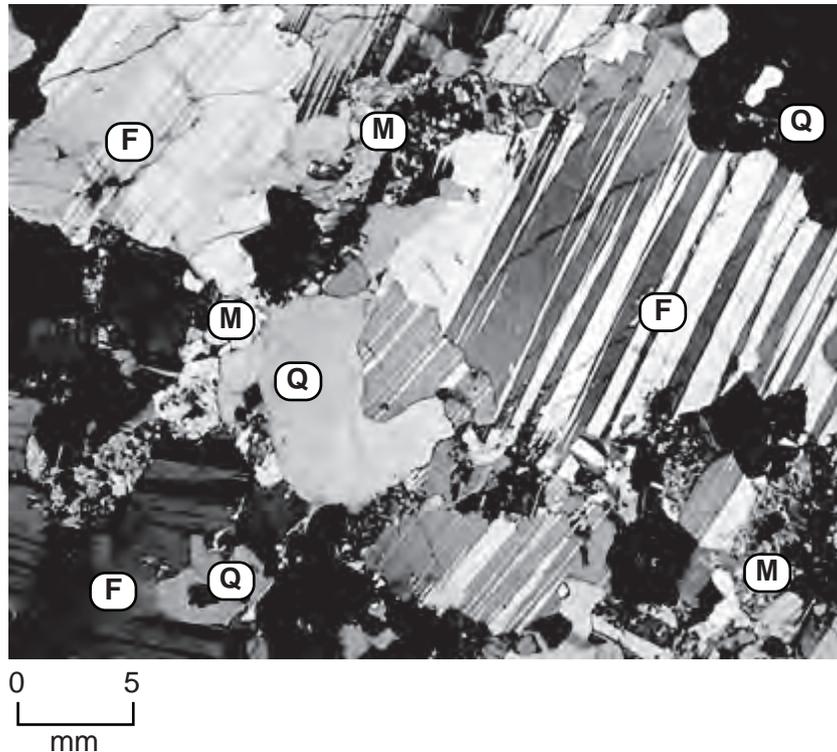
- removal of weathered material by water, ice, wind or gravity
- breaking down of minerals by the organic acids in soil
- reaction of calcite with weak acids produced by the dissolving of carbon dioxide in water
- forcing apart of bedding planes by tree roots
- alteration of granite to form clay and soluble products
- wearing down of sand grains by collision with other grains

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**Figure 2** is a microscope view of a specimen of granite.

**Key**

- (Q) quartz  
(F) feldspar  
(M) mica



**Figure 2**

4. Which **two** of the following statements about the granite in **Figure 2** are **correct**?  
Tick (✓) only **two** boxes.

[2]

crystals are interlocking and show alignment

crystal size is fine

the texture suggests two stages of cooling

the texture suggests slow cooling at depth

feldspar is the most abundant mineral with less quartz and mica

the minerals are formed by crystallisation from pore waters

5. Using evidence from **Figure 2** and the **Data Sheet**, explain why granite forms upland areas in Britain. [3]

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## Section 2 – answer questions 1-7

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Figure 3 shows the extent of Arctic sea ice in 1980 and 2012.

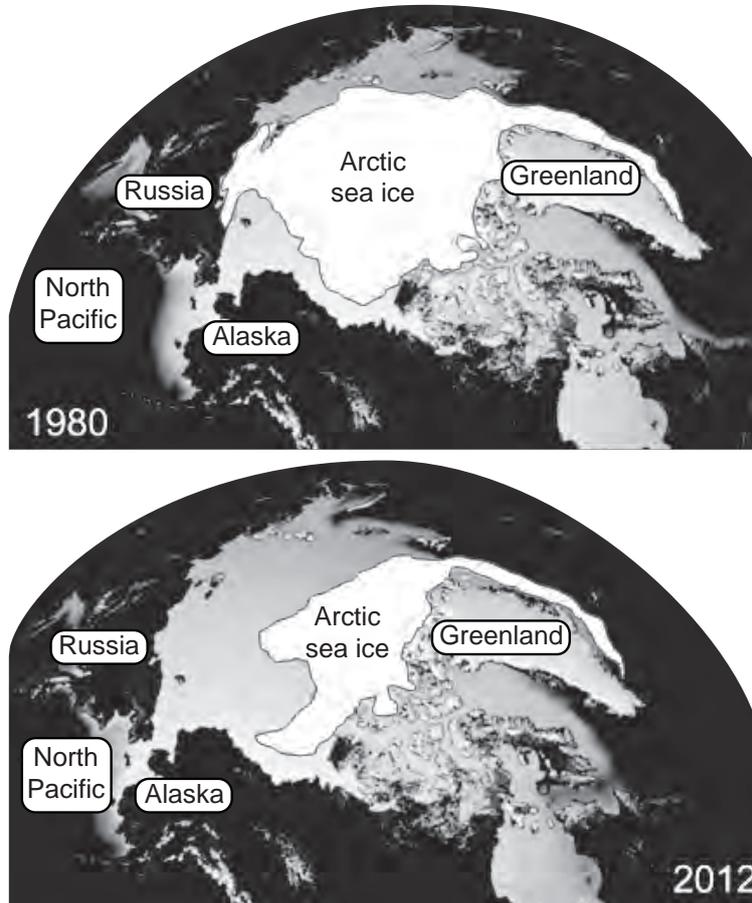


Figure 3

1. Which **two** of the following statements about the Arctic sea ice between 1980 and 2012 are **correct**? Tick (✓) only **two** boxes. [2]

between 1980 and 2012 the area covered by sea ice was reduced by approximately 5%

in 1980 the area covered by sea ice was 50% less than in 2012

Alaska had more ice in 2012 than 1980

between 1980 and 2012 the area covered by sea ice was reduced by approximately 50%

there was less ice on the north coast of Russia in 2012 than in 1980

in 1980 there was sea ice in the North Pacific

2. Explain **one** reason for the change in Arctic sea ice.

[2]

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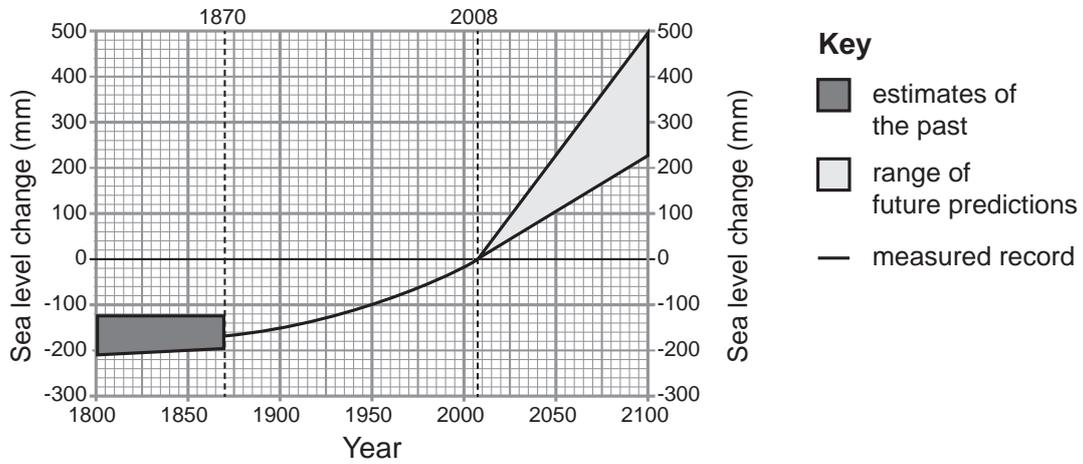
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**Figure 4** shows the measured sea level changes from 1870 to 2008 and predictions about future changes in sea level.



**Figure 4**

3. Which **two** of the following statements about **Figure 4** are **correct**? Tick (✓) only **two** boxes.

[2]

- in 2100 sea level could be 500 mm higher than 2008
- projections of future rises in sea level vary by almost 300 cm in 2100
- in 1950 sea level was approximately 100 mm higher than 2008
- sea level will be at least 30 m higher in 2100 than it was in 1950
- projections of future rises in sea level vary by almost 500 mm in 2100
- in 1950 sea level was approximately 10 cm lower than 2008

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Figure 5 shows a raised beach on the west coast of Scotland.

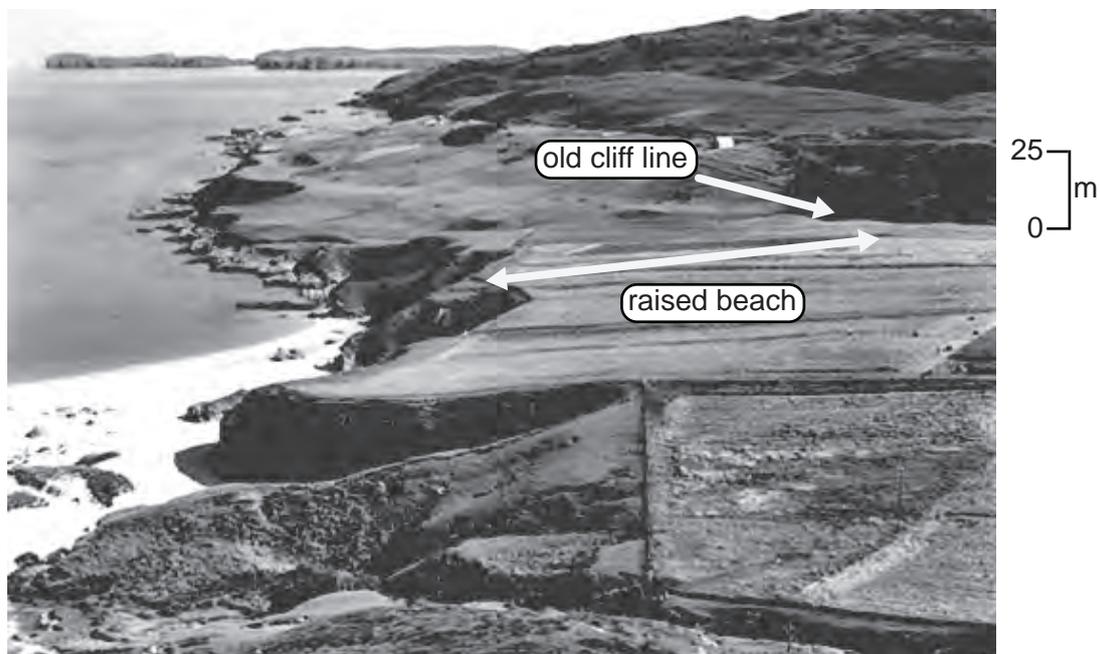


Figure 5

4. Explain how raised beaches may have formed during the Pleistocene as a result of relative changes in sea level. [4 QWC]

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5. Which **one** of the following statements is **correct**? Tick (✓) only **one** box.

[1]

reduction of ice cap albedo accelerates global cooling

decreasing ice volume reduces carbon dioxide in the atmosphere

burial of limestone increases carbon dioxide in the atmosphere

the enhanced greenhouse effect is caused by increased carbon dioxide in the atmosphere from burning fossil fuels

polar ice cores provide evidence of carbon dioxide increasing in the atmosphere as far back as 60 Ma (million years)

6. Which **two** of the following are examples of carbon sequestration? Tick (✓) only **two** boxes. [2]

emission of smoke by coal fired power stations

global cooling

the injection of carbon dioxide into exhausted oil traps

increased use of renewable energy

absorption of carbon dioxide by plants during photosynthesis followed by burial

increased electricity generation from nuclear power

7. Explain how volcanic emissions cause climate change.

[2]

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Section 3 – answer questions 1-5

Figure 6 shows a quarry face.

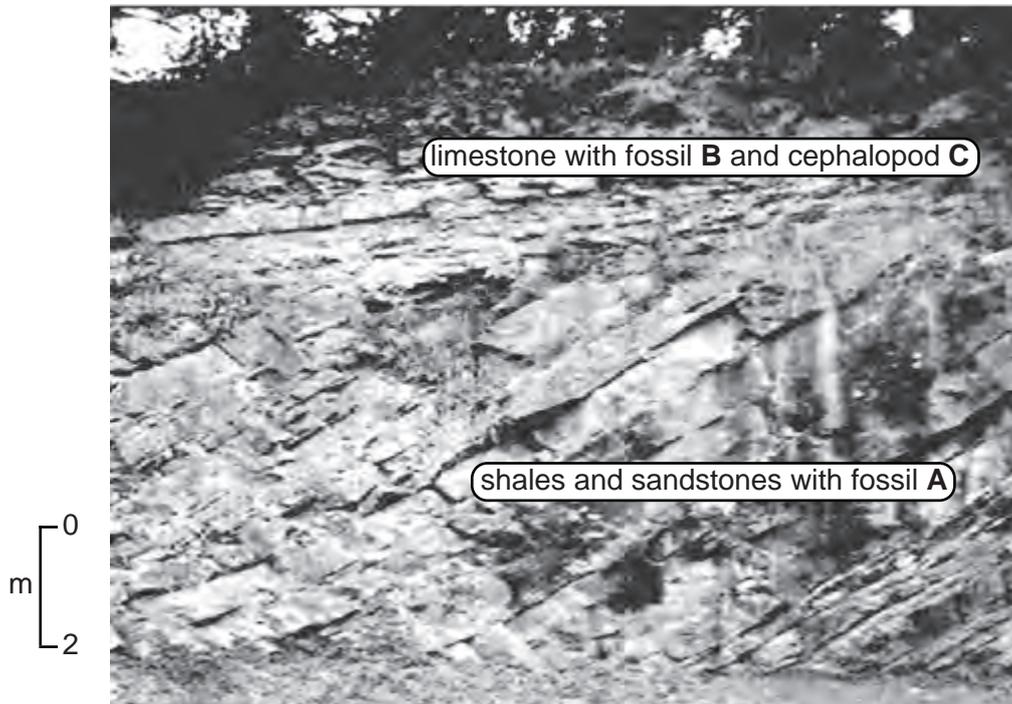


Figure 6

Figure 7 shows fossil A collected from the shales and sandstones in Figure 6.

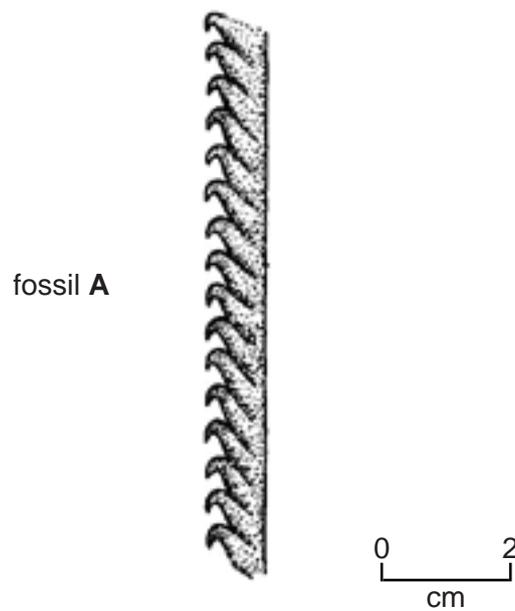


Figure 7

1. Name the group to which fossil **A** belongs. Tick (✓) only **one** box.

[1]

- trace fossil
- coral
- trilobite
- plant
- graptolite
- vertebrate

2. Explain how changes in **one** morphological feature of fossil **A** can be used for the relative dating of rocks. [2]

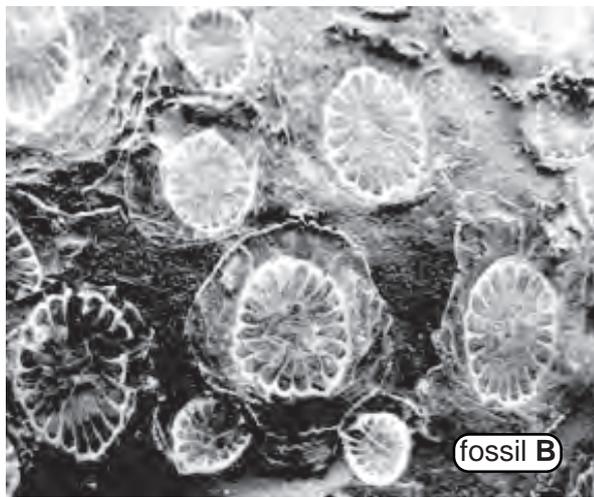
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Figure 8 shows fossil B and cephalopod C collected from the limestone in Figure 6.



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cm



0 2  
cm

Figure 8

3. Name the group to which fossil B belongs. Tick (✓) only one box.

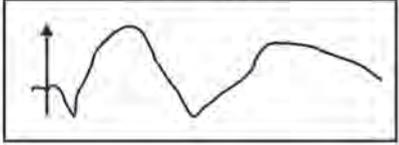
[1]

- |              |                          |
|--------------|--------------------------|
| trace fossil | <input type="checkbox"/> |
| coral        | <input type="checkbox"/> |
| trilobite    | <input type="checkbox"/> |
| plant        | <input type="checkbox"/> |
| graptolite   | <input type="checkbox"/> |
| vertebrate   | <input type="checkbox"/> |

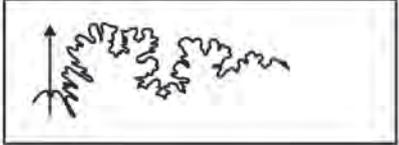
4. Variation in the suture line of fossil cephalopods is used for the relative dating of rocks. Write the correct suture type, **1**, **2** or **3**, for each fossil cephalopod in its correct position in **Table 1**. [2]

suture type

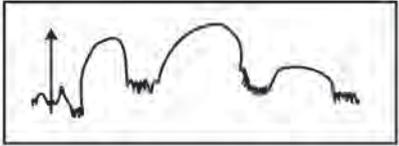
1



2



3



youngest	↑	ammonite	
oldest	↓	ceratite	
		goniatite	

**Table 1**

5. Explain why fossil **B** is a better indicator of the environment of deposition of the limestone than fossil cephalopod **C**. [3]

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**Section 4 – answer questions 1-7**

A turbidity current was triggered by an earthquake and cut through a number of telephone cables on the ocean floor. **Table 2** shows the time between cable breaks. The time of the earthquake is set at 0 minutes.

<b>Cable position</b>	<b>Time between cable breaks (minutes)</b>	<b>Average velocity of turbidity current (km/minute)</b>
<b>cable 1</b> 140 km from the epicentre at the top of the continental slope	56	2.5
<b>cable 2</b> 210 km from cable 1 at the bottom of the continental slope	120	1.75
<b>cable 3</b> 270 km from cable 2 on the abyssal plain	358	0.75
<b>cable 4</b> 40 km from cable 3 on the abyssal plain	80	

**Table 2**

1. Calculate the average velocity (km/minute) of the turbidity current between cables 3 and 4. You **must** show your working. Circle the correct value below. [2]

0.35                  2.0                  0.5                  0.7                  1.0

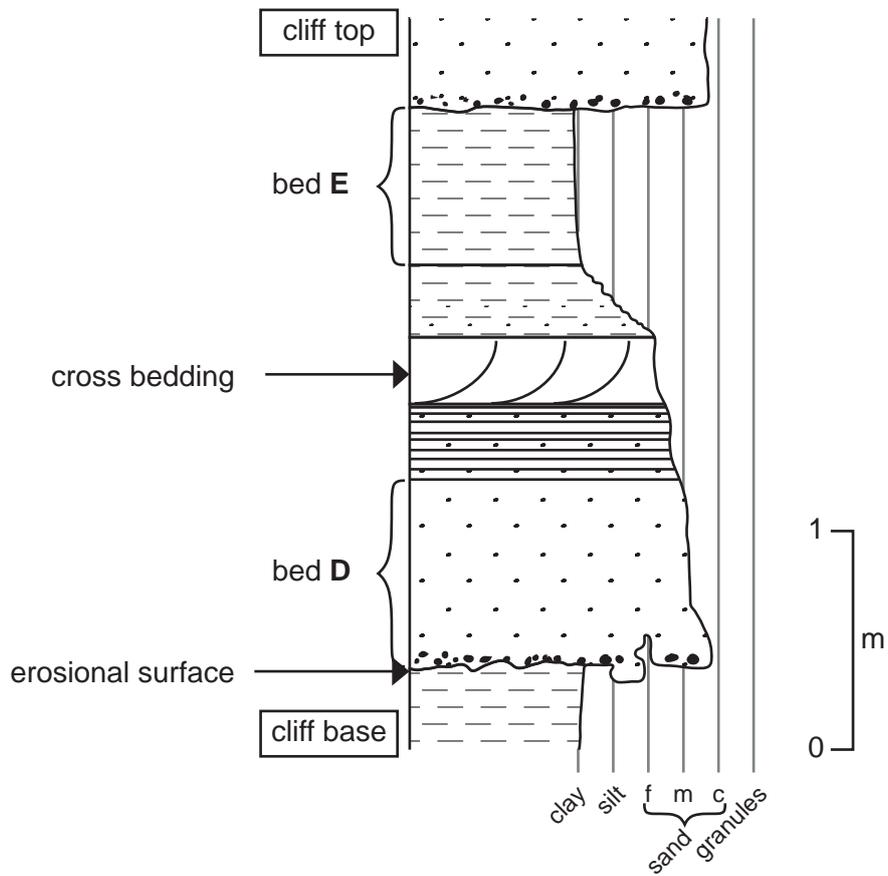
2. Give **one** reason for the change in the velocity of the turbidity current. [1]

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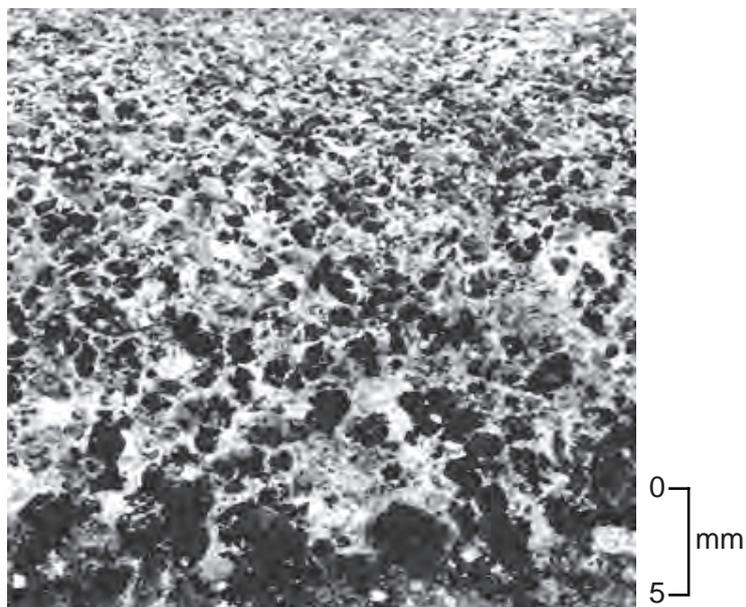
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**Figure 9** is a graphic log showing a sedimentary sequence from a turbidite in a cliff face.



**Figure 9**

**Figure 10** shows the sedimentary structure seen in bed D in **Figure 9**.



**Figure 10**

3. Which **two** of the following statements about the sedimentary structure in **Figure 10** are **correct**?  
Tick (✓) only **two** boxes. [2]

the structure shows ripple marks

the structure is finely laminated

the grains fine downwards

the bed is inverted

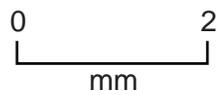
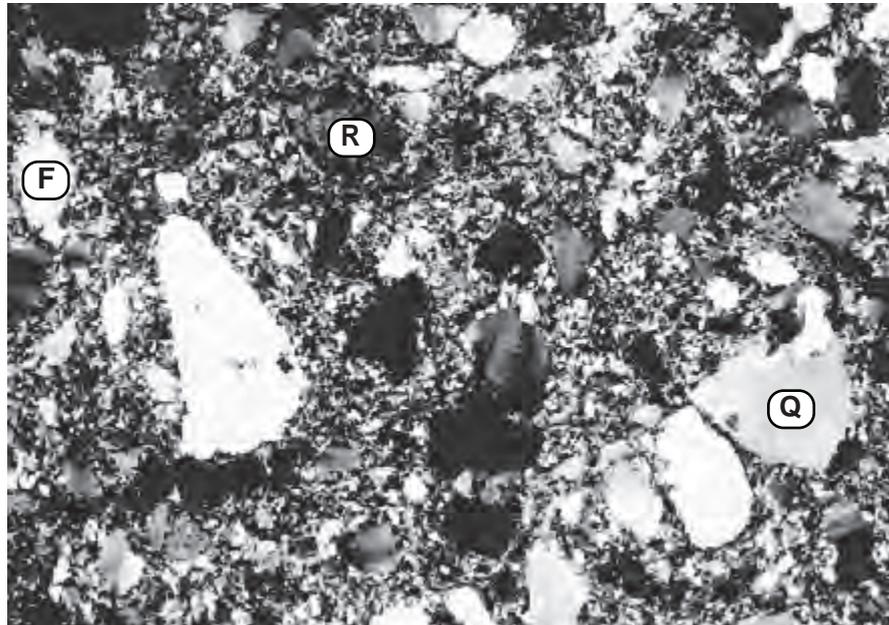
the grains fine upwards

the structure is graded bedding

Figure 11 is a microscope view of a rock sample from bed D in Figure 9.

**Key**

- Ⓚ quartz
- ⓕ feldspar
- Ⓡ rock fragment



**Figure 11**

4. Describe the texture of rock D. Tick (✓) only **three** boxes.

[3]

- crystalline
- clast Q is an angular fragment
- well sorted
- coarse-grained clasts
- poorly sorted
- medium-grained clasts
- foliated

5. Explain how the change in grain size between beds **D** and **E** in **Figure 9** is related to the energy of the currents that deposited them. [3]

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6. Draw a line from each of the following rock descriptions to the correct geological time. [4]

turbidites and black graptolitic shale	Mesozoic
till and flood basalts	Lower Palaeozoic
limestones and clays with ammonites present	Upper Palaeozoic
coral limestone overlain by coal and cross-bedded well sorted sandstones	Cenozoic

7. Explain how evidence from rocks **and** fossils indicates that the latitude of Britain has changed over time. [4 QWC]

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Section 5 – answer questions 1-7

Figure 12 is geological map.

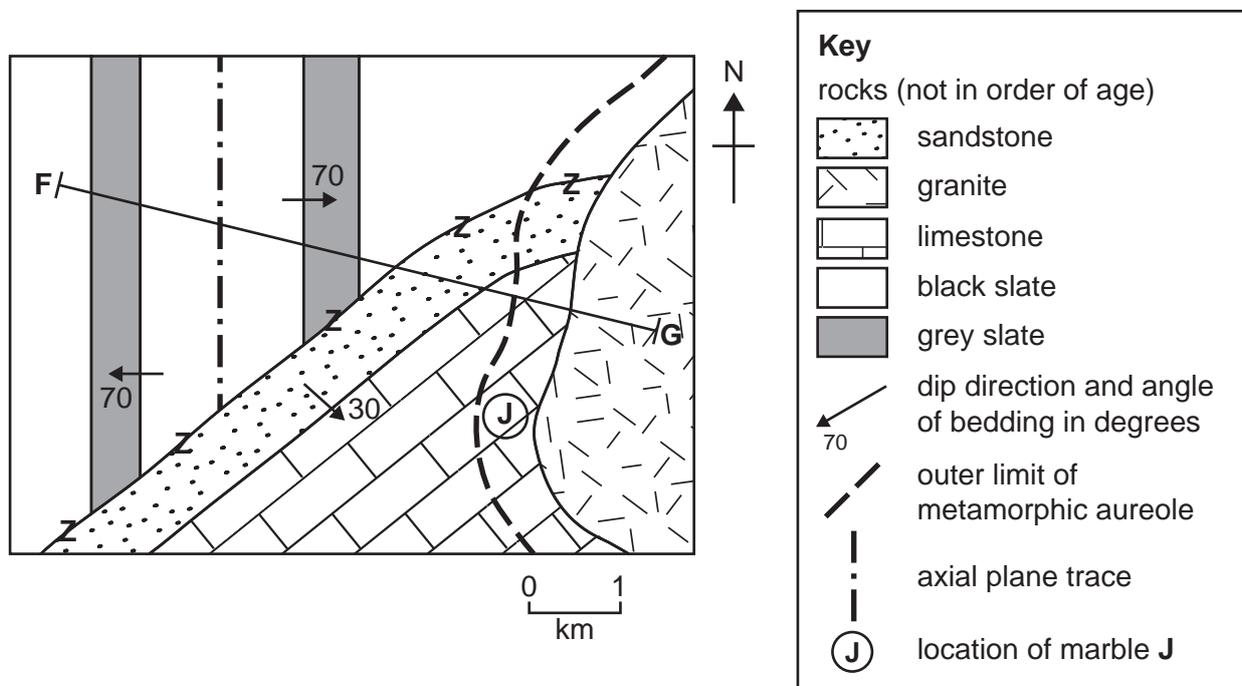
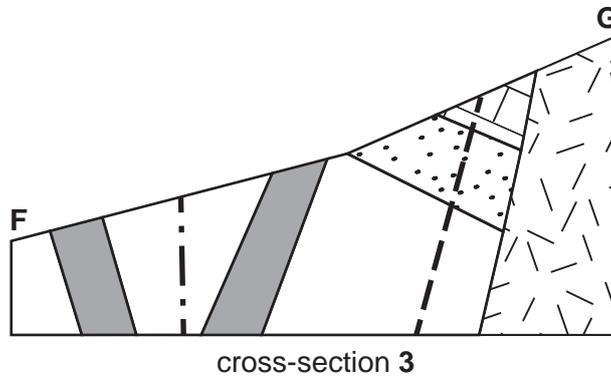
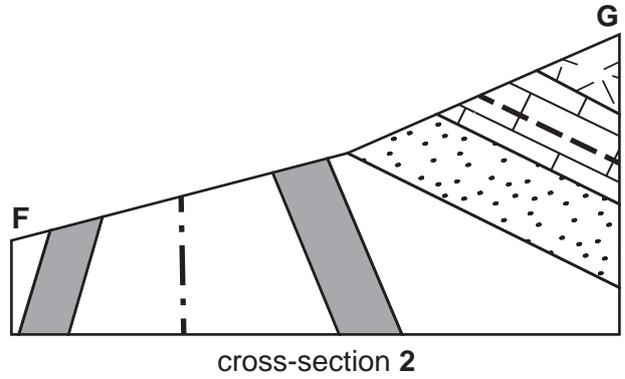
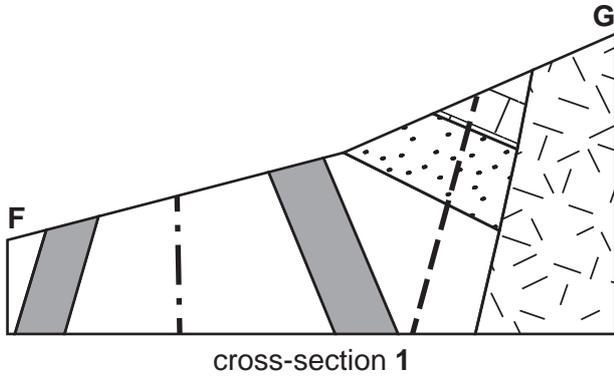


Figure 12

1. Which **two** of the following statements about **Figure 12** are **correct**? Tick (✓) only **two** boxes. [2]

- boundary **Z-Z** is a metamorphic aureole
- the outcrop of the granite is discordant
- the limbs of the fold have different angles of dip
- the outcrop of the granite is concordant
- boundary **Z-Z** is an unconformity
- the granite is a dyke intrusion

2. Which **one** of the three cross-sections (1-3) best represents the geology along the line of section F-G in Figure 12? Give **two** reasons for your answer. [3]



Cross-section

Reasons

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3. List the relative ages of the following events in **Figure 12** by writing each of them in their correct position in **Table 3**. [2]

uplift and erosion of black and grey slate	deposition of sandstone and limestone
intrusion of granite	folding of black and grey slate

	youngest ↑ oldest

**Table 3**

4. Name the most appropriate method to determine the age of the sandstone relative to the limestone in **Figure 12**. Tick (✓) only **one** box. [1]

- cross-cutting relationship
- radiometric dating
- superposition of strata
- lateral continuity
- included fragments

5. Which **two** of the following statements about the black and grey slate in **Figure 12** are **correct**?  
Tick (✓) only **two** boxes. [2]

the strike direction of the cleavage in the slates would be **N-S**

in **Figure 12** slate is the rock which is formed at the highest temperature

slate is formed by recrystallisation of sandstone

slate is formed by the contact metamorphism of shale

the strike direction of the cleavage in the slates would be **E-W**

slate is formed by regional metamorphism

Figure 13 is a microscope view of marble J from location (J) in Figure 12.

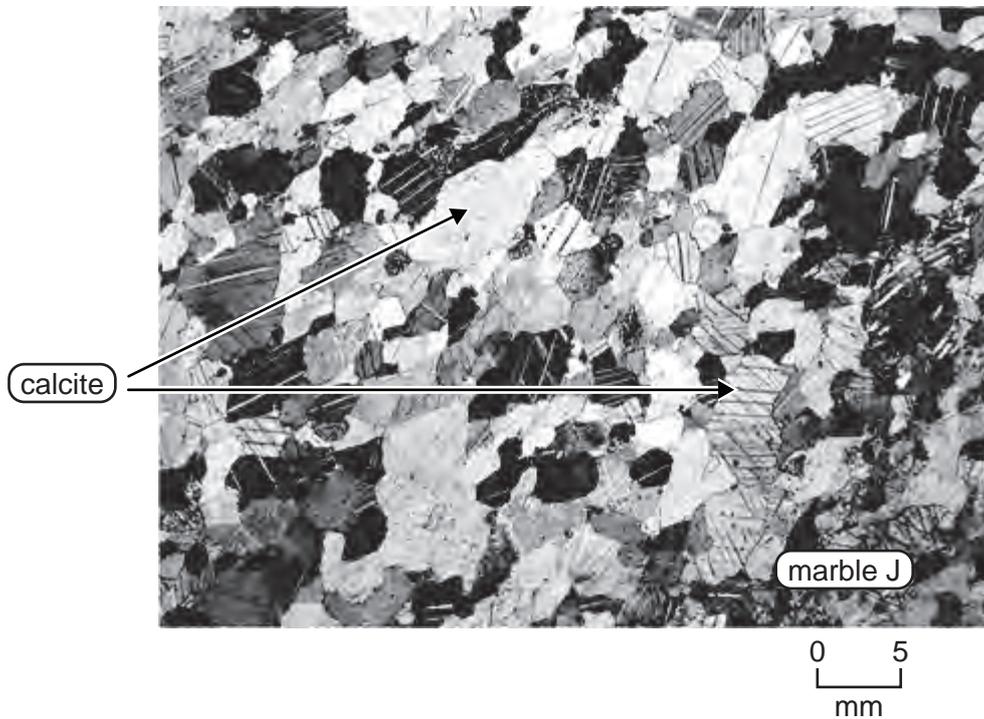


Figure 13

6. Which **two** of the following statements about marble J are **correct**? Tick (✓) only **two** boxes.

[2]

crystalline

foliated

fragmental

schistose texture

non-foliated

mineral size is fine

the minerals are formed by crystallisation from a melt

Figure 14 is a graph showing the temperature and pressure conditions for metamorphism.

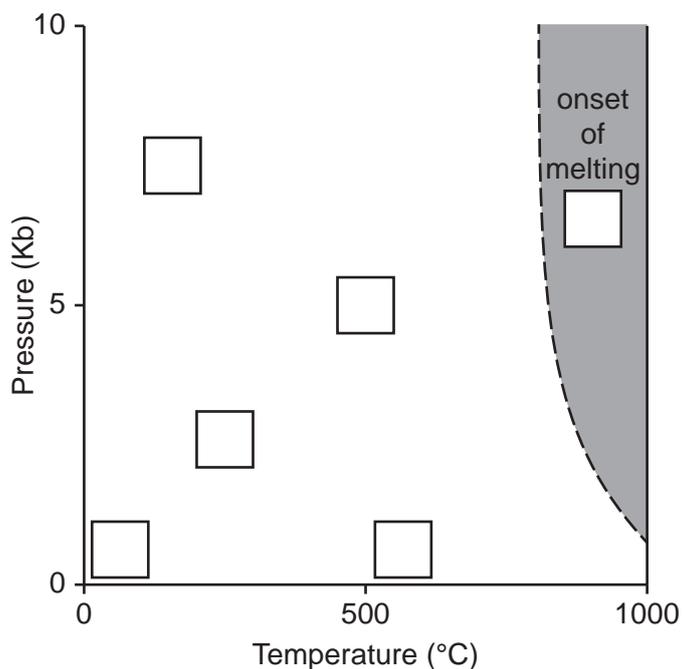


Figure 14

7. Write the letter **J** into the correct empty box in **Figure 14** to show the most likely pressure and temperature conditions for the formation of marble **J** in **Figure 12**.

Using evidence from **both Figures 12 and 13**, explain **two** reasons for your answer. [3]

Reasons

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Section 6 – answer questions 1-7

Figure 15 is a map of Indonesia showing the plate boundary between the Eurasian and Indo-Australian plates.

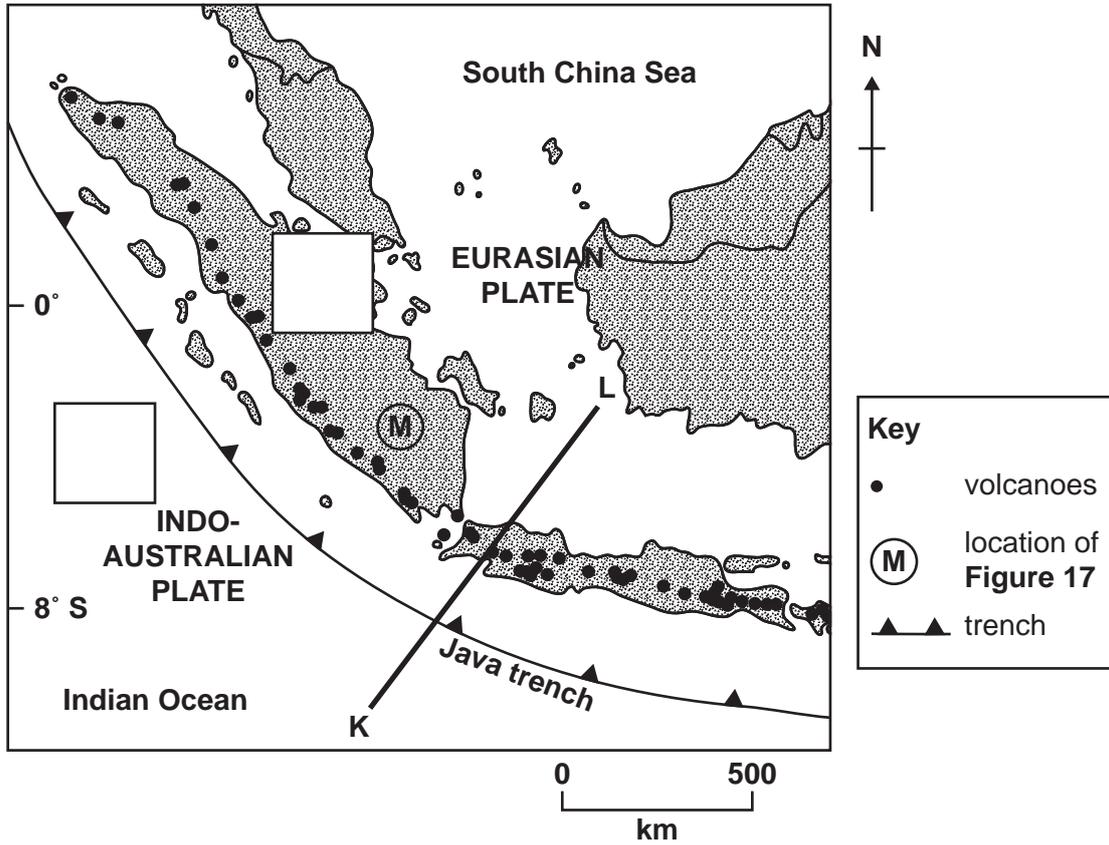


Figure 15

Figure 16 shows the depth of earthquake foci along the line K-L in Figure 15.

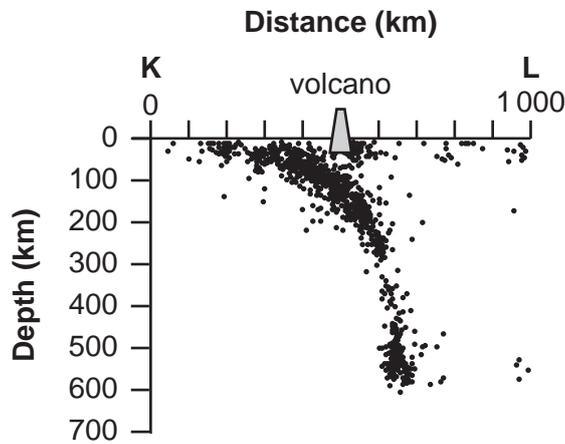


Figure 16

1. Which **two** of the following statements about the plate boundary shown in **Figures 15 and 16** are **incorrect**? Tick (✓) only **two** boxes. [2]

earthquakes show the position of a rift valley

Indonesia is an arc shaped group of islands

earthquakes show the position of a subduction zone

earthquakes get progressively deeper away from the trench

a group of shallow earthquakes occur beneath the volcano

earthquakes are deepest under the trench

2. Selecting from the choice below draw an arrow in **both** of the empty boxes in **Figure 15** to show the directions of relative plate movement at those locations. [1]



3. Draw a line from each of the following igneous rocks to their **most likely** region of formation. [3]

	at a depth of 10 km within a fold mountain chain
andesitic lava	at a depth of 10 km below the ocean floor
basalt with pillow structures	at the surface of an island arc system
granite batholith	at the axis of a mid-ocean ridge
	at a depth of 35 km below the axis of a mid-ocean ridge

4. Which **two** of the following statements about volcanic activity are **correct**?  
Tick (✓) only **two** boxes.

[2]

- basalt magmas produce steep sided central vent volcanoes
- the higher the viscosity of the magma the steeper the volcanic cone
- basalt magmas flow easily over wide areas due to their high viscosity
- magma which erupts under water always forms fissure eruptions
- lower viscosity magmas are more explosive
- andesites produce explosive volcanoes

5. Draw a line from each of the following terms used in mineral prospecting to the correct description. [3]

- |                      |   |
|----------------------|---|
|                      | waste minerals found with useful minerals               |
| ore minerals         | all naturally occurring elements or compounds           |
| semi-precious stones | the amount of ore that can be extracted at a profit     |
| gangue minerals      | minerals containing valuable metal                      |
|                      | minerals which are rare and valued for their appearance |

Figure 17 is a simplified geological map of an area at location M in Figure 15.

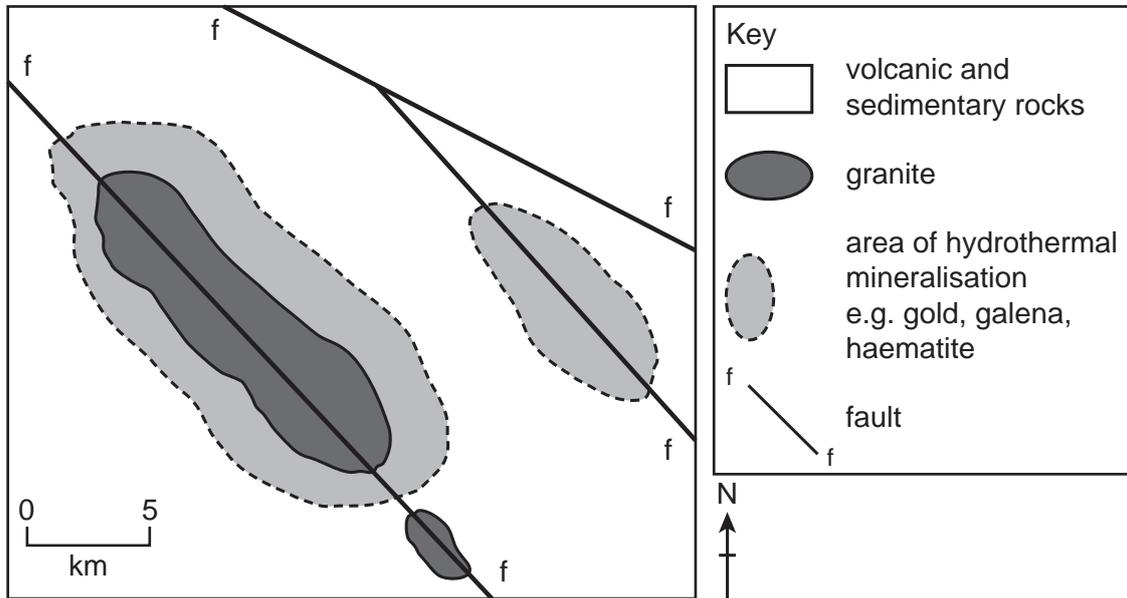


Figure 17

6. Using evidence from Figure 17, explain how the hydrothermal minerals formed.

[4]

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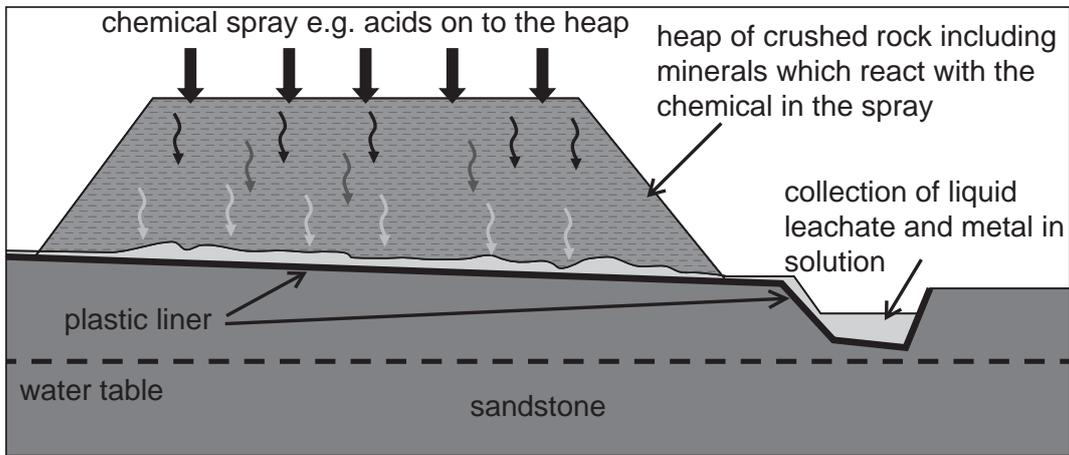
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Figure 18 shows one method of processing rock to extract metals.



not to scale

Figure 18

7. State **one** environmental problem associated with the method of processing shown in **Figure 18** and explain **one** measure that has been taken to prevent it. [3]

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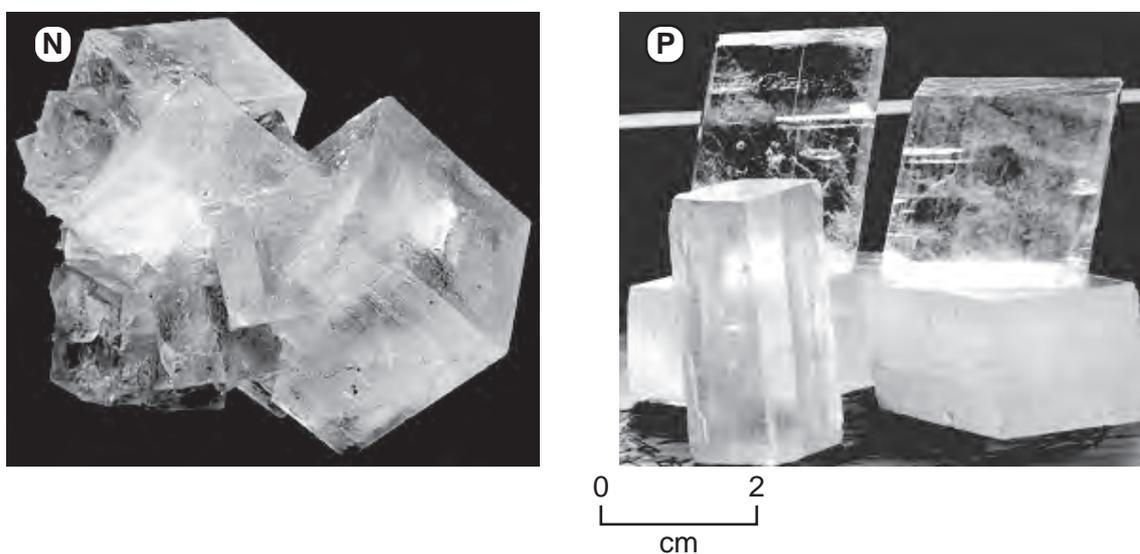
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## Section 7 – answer questions 1-7

Figure 19 shows two minerals (**N** and **P**) and some of their properties.



**Mineral N**  
scratched by copper coin and by  
mineral **P**  
3 good cleavages at right angles

**Mineral P**  
scratched by copper coin and  
scratches mineral **N**  
3 good cleavages not at right angles

Figure 19

1. Using the **Data Sheet**, identify the two minerals in **Figure 19**.  
Select your answers from the following list.

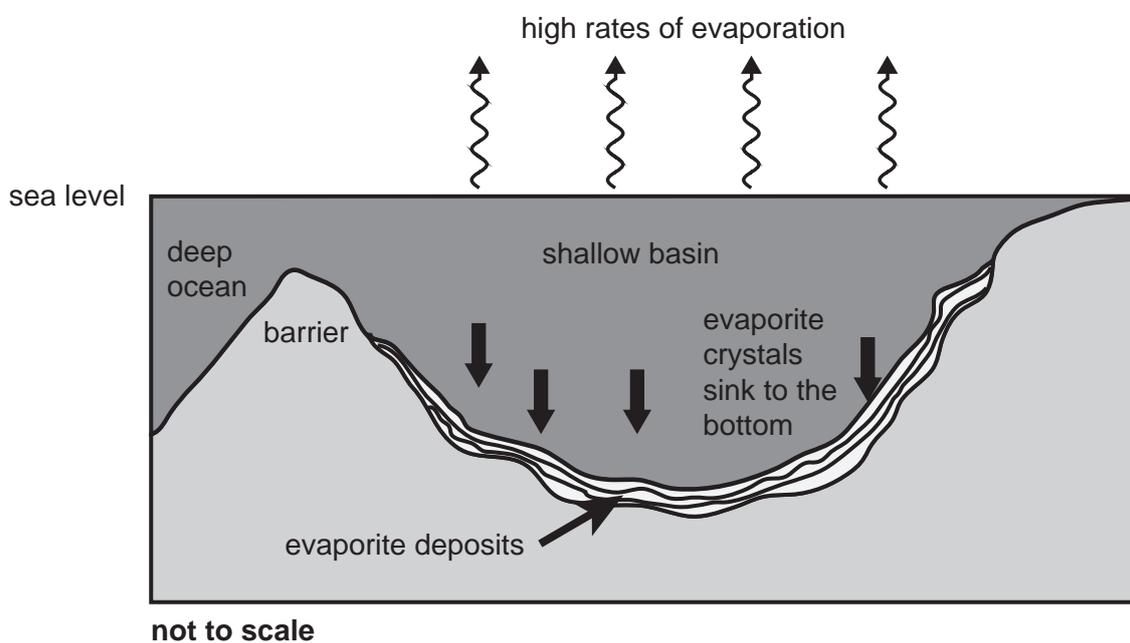
[2]

quartz    feldspar    mica    halite    calcite    haematite    galena    garnet

Mineral **N** .....

Mineral **P** .....

**Figure 20** is a model showing how thick evaporite deposits can form.



**Figure 20**

2. Which **two** of the following statements about the formation of evaporite deposits in **Figure 20** are **incorrect**? Tick (✓) only **two** boxes. [2]

- |   |                          |
|---|--------------------------|
| evaporation in the deep ocean will produce thicker evaporite deposits                             | <input type="checkbox"/> |
| evaporite formation requires a supply of saline water   | <input type="checkbox"/> |
| evaporite formation requires a warm and dry climate   | <input type="checkbox"/> |
| a temporary barrier to the ocean allows an increase of salinity of the water in the shallow basin | <input type="checkbox"/> |
| slow subsidence of the shallow basin would not allow thick evaporites to form                     | <input type="checkbox"/> |
| evaporites form by crystallisation from saturated solution  | <input type="checkbox"/> |

Figure 21 shows a geological cross-section where oil traps may be found.

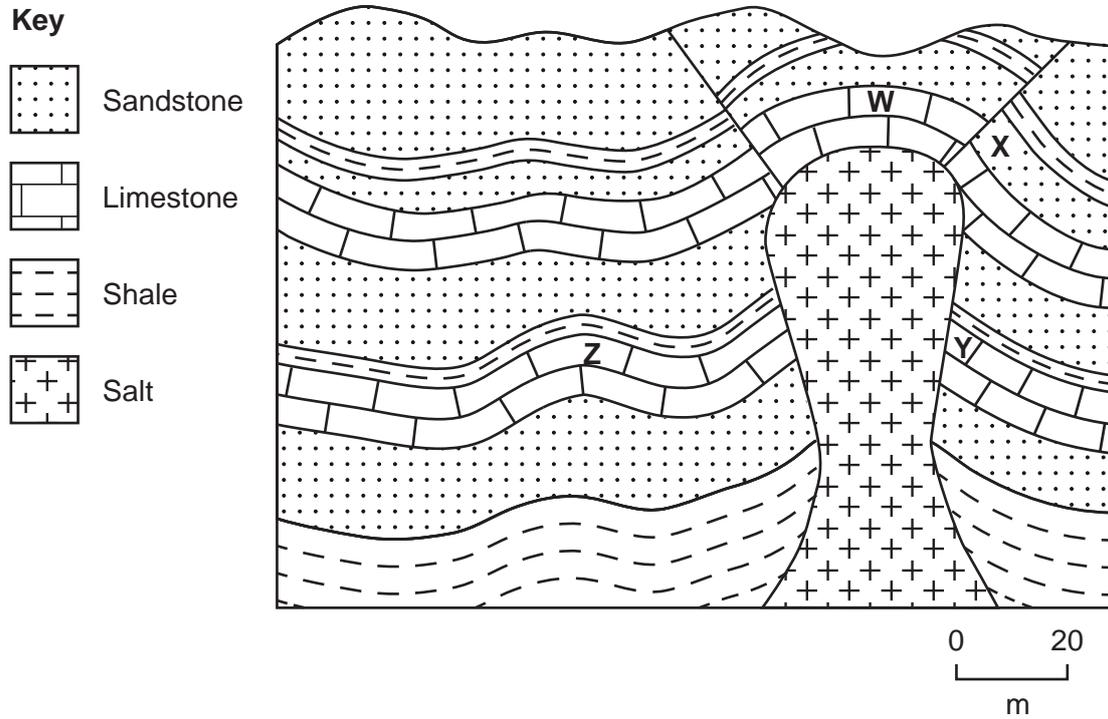


Figure 21

3. In which **one** of the following pairs of locations in **Figure 21** might oil and gas accumulate in **both** locations? Tick (✓) only **one** box. [1]

- W and Y
- Y and Z
- W and Z
- X and Y
- X and Z
- W and X

4. Which **one** of the following pairs of properties is **most** desirable for an oil **reservoir** rock?  
Tick (✓) only **one** box

[1]

low permeability and high porosity

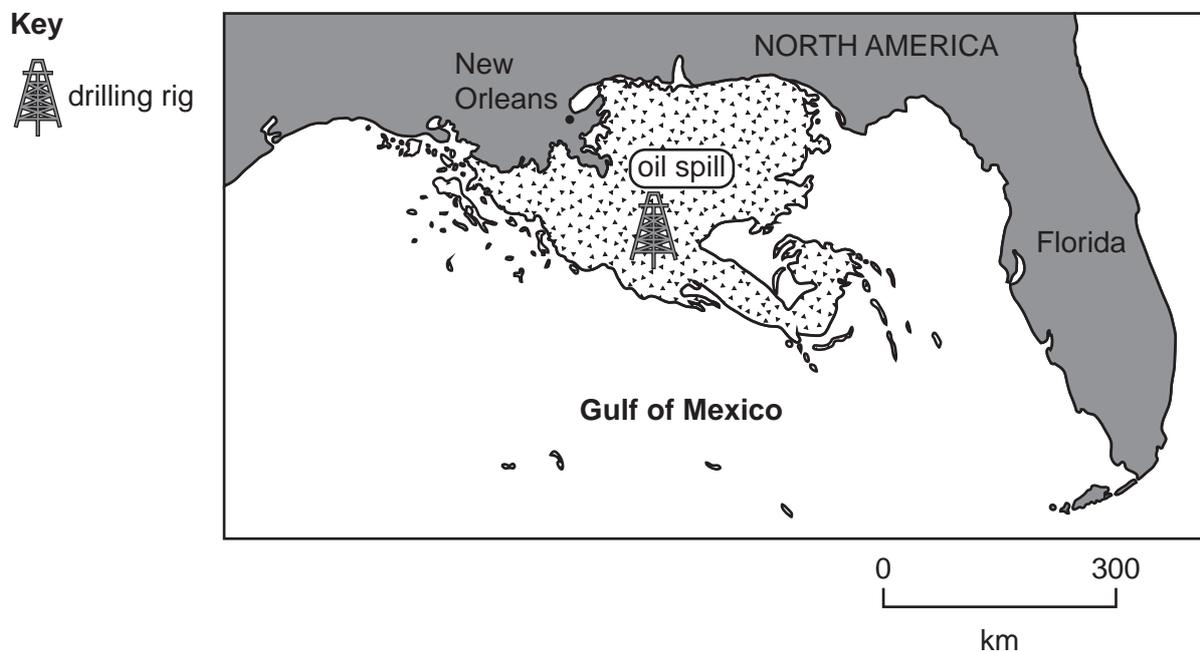
low porosity and high permeability

high porosity and high permeability

low permeability and low porosity

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In April 2010 a gas release and explosion (blowout) destroyed a drilling rig and well head in the Gulf of Mexico, killing 11 people. **Figure 22** is a map showing the location of the Deepwater Horizon drilling rig and resulting oil spill.



**Figure 22**

**Table 4** shows how much oil was recovered from the well and what happened to the spilled oil (figures in thousands of barrels).

recovered from the well	800
<b>spilled oil</b>	
washed onshore or sunk to the bottom	1 120
evaporated	1 220
dispersed naturally	640
dispersed by chemicals	780
removed by clean-up operations (burned and skimmed)	440

**Table 4**

5. What percentage of the total oil released was recovered from the well? Show your working. [2]

Percentage = ..... %

6. Describe **one** method of prospecting for oil and natural gas in deep water such as the Gulf of Mexico. [3]

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7. Describe **one** environmental consequence of an oil and gas leak in the Gulf of Mexico. [2]

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**END OF PAPER**



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**GEOLOGY  
DATA SHEET**



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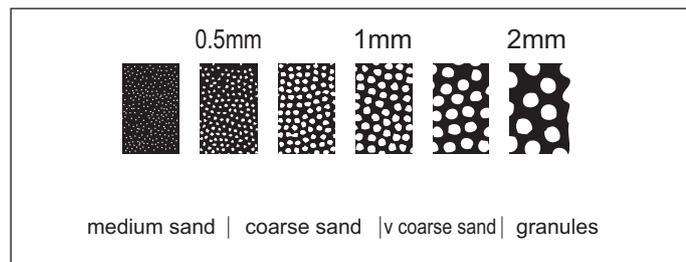
A.M. WEDNESDAY, 25 May 2016

## Physical properties of minerals in hand specimen

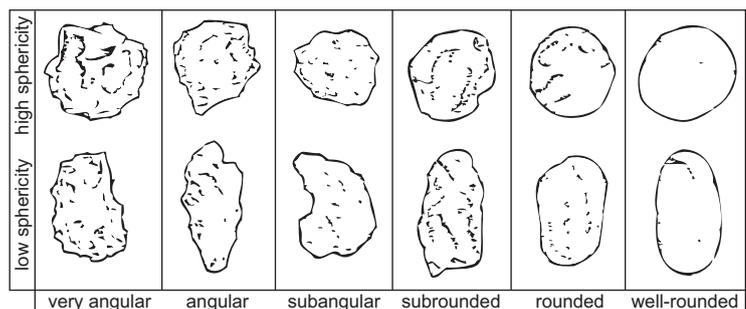
<i>Name</i>	<i>Hardness (Mohs' Scale)</i>	<i>Typical Colour</i>	<i>Streak</i>	<i>Lustre</i>	<i>Cleavage (number of directions)</i>
Quartz	7	colourless or white	scratches streak plate	glassy	none
Feldspar	6	white	scratches streak plate	pearly to glassy	2 good
Mica	2½	silvery or brown	white	pearly to glassy	1 good
Halite	2½	white	white	glassy	3 good
Calcite	3	white	white	glassy	3 good
Haematite	5½	black or red-brown	red-brown	metallic or dull	none
Galena	2½	grey	grey	metallic	3 good
Garnet	7	red	white	glassy	none

<b>Mohs' scale of hardness</b>		
<i>Mineral/hardness</i>		<i>Common equivalent</i>
Diamond 10		
Corundum 9		
Topaz 8		
Quartz 7		
Orthoclase feldspar 6	← steel pin	
Apatite 5		
Fluorite 4		
Calcite 3	← copper coin	
Gypsum 2	← finger nail	
Talc 1		

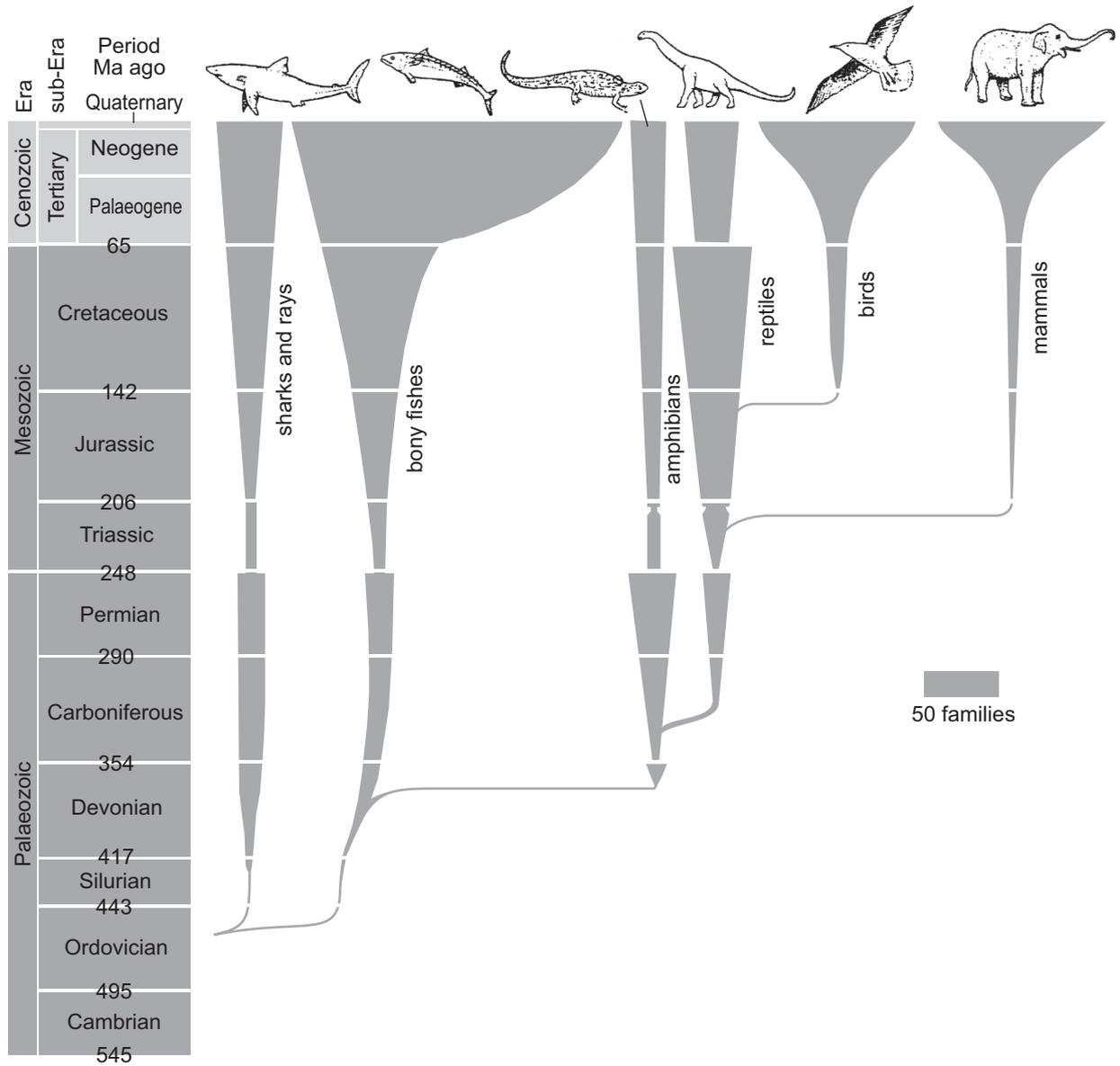
## Grain size scale



## Grain shape and sphericity scale



### Geological ranges of vertebrates





**GCSE**

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**GEOLOGY  
DATA SHEET**

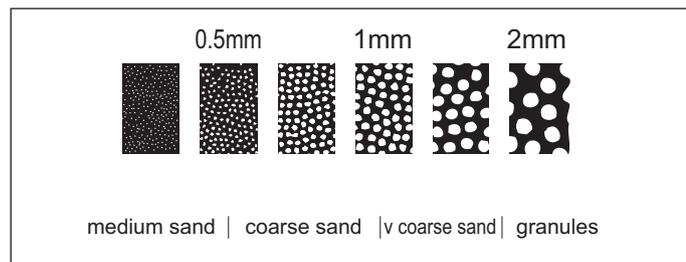
A.M. WEDNESDAY, 25 May 2016

## Physical properties of minerals in hand specimen

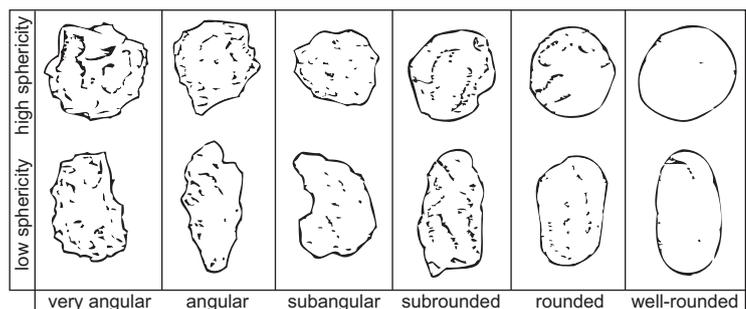
Name	Hardness (Mohs' Scale)	Typical Colour	Streak	Lustre	Cleavage (number of directions)
Quartz	7	colourless or white	scratches streak plate	glassy	none
Feldspar	6	white	scratches streak plate	pearly to glassy	2 good
Mica	2½	silvery or brown	white	pearly to glassy	1 good
Halite	2½	white	white	glassy	3 good
Calcite	3	white	white	glassy	3 good
Haematite	5½	black or red-brown	red-brown	metallic or dull	none
Galena	2½	grey	grey	metallic	3 good
Garnet	7	red	white	glassy	none

Mohs' scale of hardness		
Mineral/hardness		Common equivalent
Diamond 10		
Corundum 9		
Topaz 8		
Quartz 7		
Orthoclase feldspar 6	←	steel pin
Apatite 5		
Fluorite 4		
Calcite 3	←	copper coin
Gypsum 2	←	finger nail
Talc 1		

## Grain size scale



## Grain shape and sphericity scale



### Geological ranges of vertebrates

