3. **Figure 3a** shows a field-sketch of a cliff section. **Figure 3b** shows the detail of **Clast H** taken from **Rock G**.

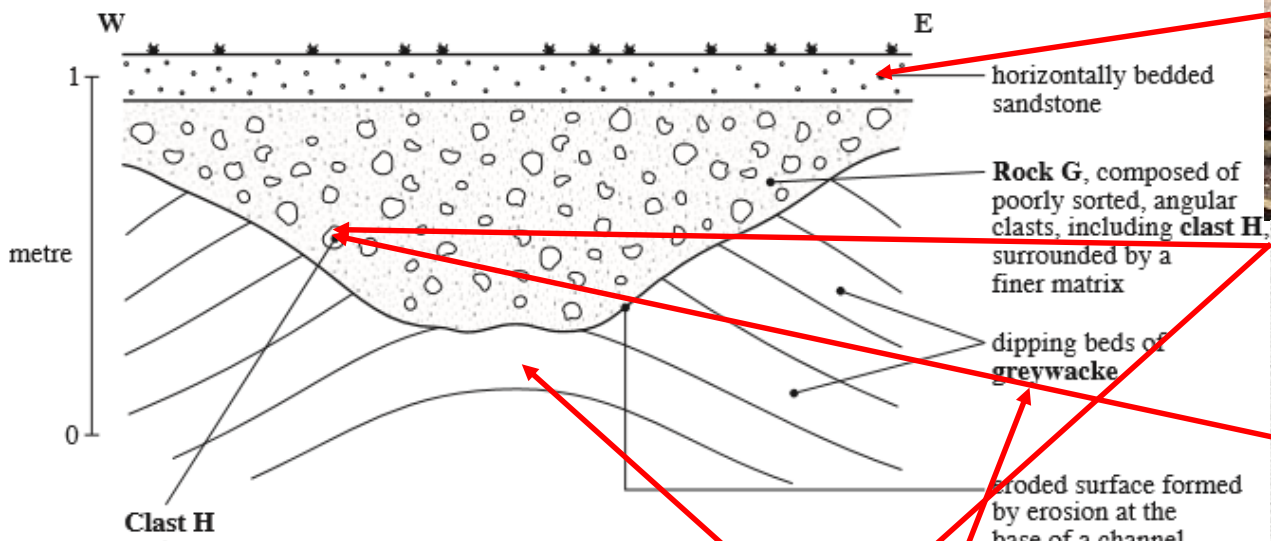
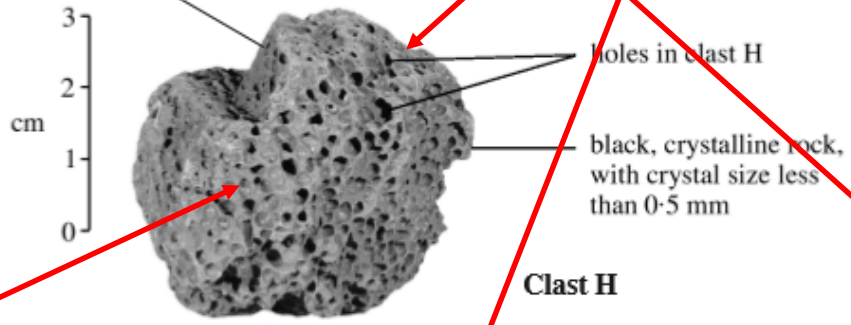


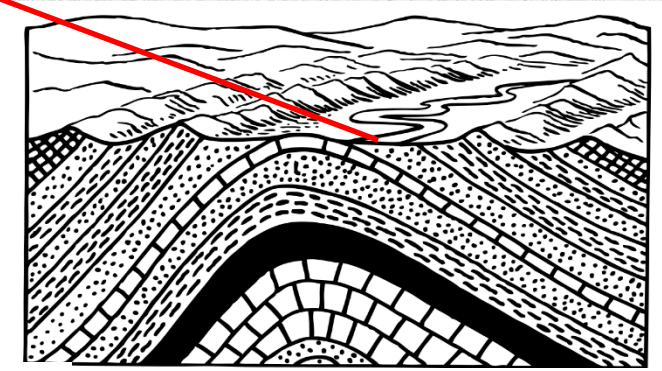
Figure 3a



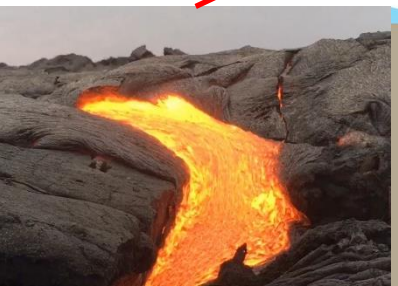
Clast H

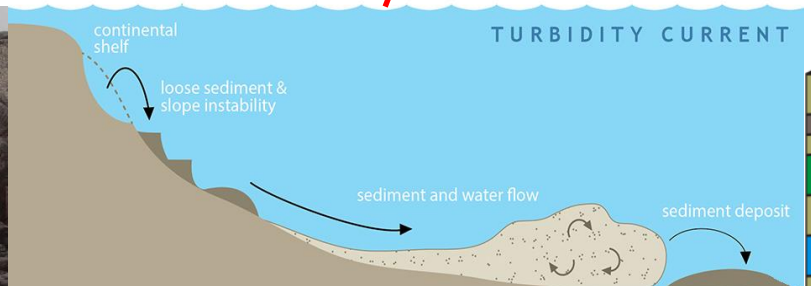
The law of included fragments

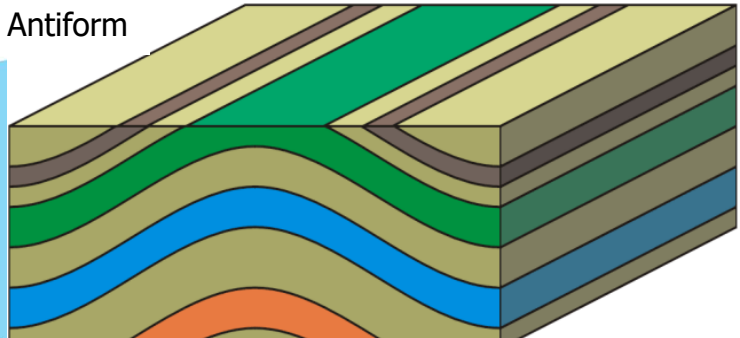
The fragments that make up a rock are older than the entire sample.



Antiform







Exam layout

Candidate Name	Centre Number	Candidate Number
		0

AS

GEOLOGY

COMPONENT 2

Foundation Geology

1 hours 30 minutes

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	14	
2.	14	
3.	14	
4.	17	
5.	14	
6.	17	
Total	90	

ADDITIONAL MATERIALS

In addition to this examination paper you will need a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets alongside each question or part-question. The assessment of the quality of extended response (QER) will take place in questions **5** and **6**.

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	14	
2.	14	
3.	14	
4.	17	
5.	14	
6.	17	
Total	90	

Six Data Response Questions – $1^1/_2$ hours
(15 minutes per question)

Breakdown of topics:

Topic 1 - KI1: Elements and Minerals

Topic 2 – KI1: The Rock Cycle (including Sedimentary rocks)

Topic 2 – KI2: Igneous and Metamorphic rocks

Topic 2 – KI3: Rock Deformation (folds, faults)

Topic 3 – KI1: Time and Change

Topic 3 – KI2: Dating of rocks and fossils

Topic 4 – KI1: Earth Structure

Topic 4 – KI2: Plate tectonics

Don't forget the mineral data sheet

Name	Cleavage/Fracture	Hardness	Density (gcm^{-3})	Streak	Lustre	Colour	Other diagnostic properties
Quartz RF	*none/conchoidal	7	2.65	scratches streak plate	vitreous	colourless, milky but variable	hexagonal prisms terminated by pyramids
Orthoclase Feldspar RF	*2 good, 90	*6	2.6	scratches streak plate	vitreous	flesh, pink, white	*simple twin
Plagioclase Feldspar RF	*2 good, 90	*6	2.7	scratches streak plate	vitreous	creamy-white, grey, colourless	*repeated multiple twin
Muscovite Mica RF	*1 perfect (basal)	*2.5	2.7-3.1	white	pearly	colourless or pale yellow, green or brown	*flaky
Biotite Mica RF	*1 perfect (basal)	*2.5-3	2.7-3.1	white	pearly	brown/black	*flaky
Hornblende RF	*2 good, 60/120	*5-6	3.0-3.5	scratches streak plate	vitreous	black, dark green	prismatic crystals
Augite RF	*2 good, 90	*5-6	3.2-3.5	scratches streak plate	vitreous	greenish black	prismatic crystals
Olivine RF	none/conchoidal	*6-7	3.2-4.3	scratches streak plate	vitreous	*olive green	
Chiastolite/ Andalusite	poor 1/ uneven fracture	7.5	3.1-3.3	scratches streak plate	vitreous	pearly grey/pink	needle crystals with square x-sections, black centre
Garnet	none	*6.5-7.5	3.5-4.3	scratches streak plate	vitreous	red/brown	*12 sided crystals - each face rhomb shaped
Calcite RF	*3 good, not at 90, perfect rhombs	*3	2.71	white	vitreous	colourless, white, tints	*effervesces with 0.5M HCl, rhombic shape
Fluorite	*4 good, parallel to octahedron	*4	3.0-3.2	white	vitreous	colourless purple/green/yellow	fluoresces in uv light, cubic or octahedral crystals
Halite	3 good, 90 cubic	*2.5	2.2	white	vitreous	colourless, white, often stained	*salty taste cubic crystals, often stained
Gypsum	1 good (basal)	*1.5-2	2.3	white	silky, pearly	colourless, white, often stained	fibrous or twinned crystals
Barites	2 good, 90	*3-3.5	*4.5	white	vitreous, resinous	white, pink	bladed crystals
Chalcopyrite	poor/conchoidal	4	4.2	*black	metallic	bronze yellow	*tarnished to peacock colours
Pyrite	none/conchoidal	*6	5.0	*greenish black	metallic	brass yellow	crystals often striated cubes
Galena	*3 good, 90 cubic	*2.5	*7.5	*lead grey	metallic	lead grey	cubic crystals
Haematite	poor/subconchoidal	*5.5-6.5	4.9-5.3	*cherry red	metallic-dull	red/black skin/steel grey	kidney shaped masses, fibrous

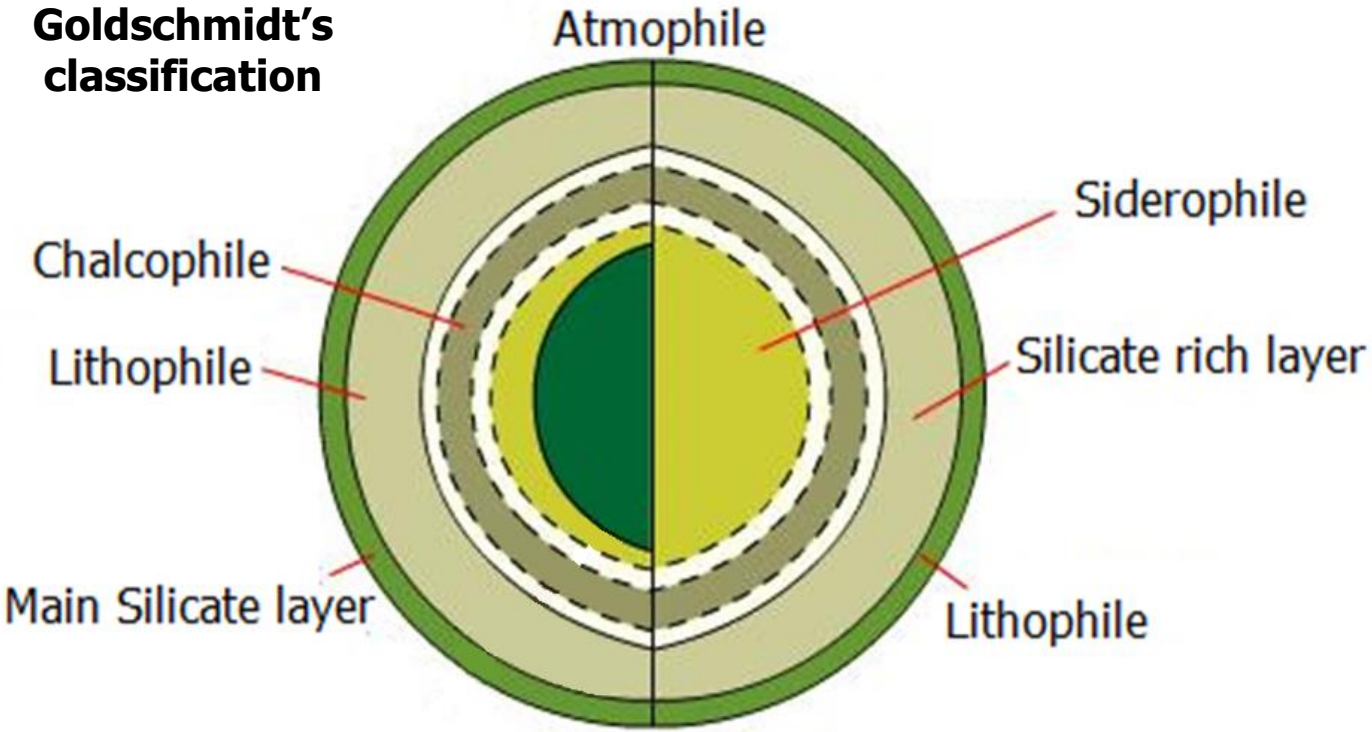
* - Useful property for diagnosis RF - Common rock-forming mineral

This table should <u>not</u> be memorised.

Marks in the examinations will be awarded for description of the outcomes of tests on minerals and, on some occasions, identification from test results.

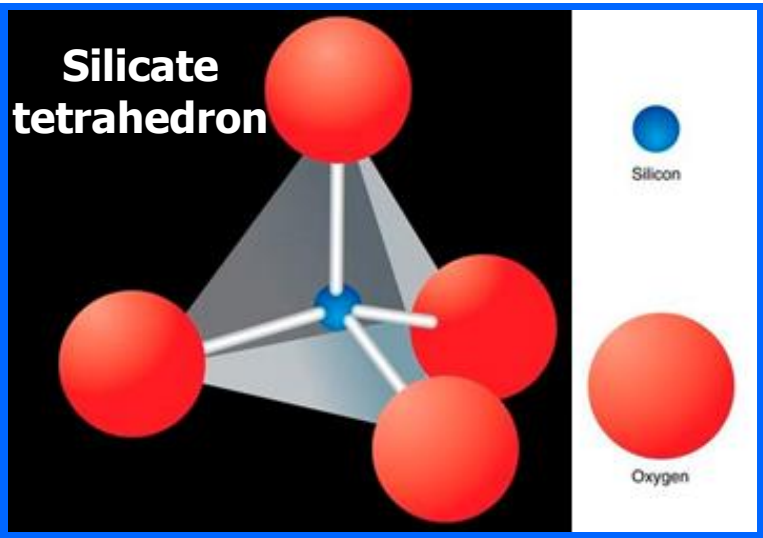
Topic 1 – Elements and Minerals

Goldschmidt's classification



Entire Earth
Iron-35%
Oxygen-30%
Silicon-15%
Magnesium-13%
Nickel-2%
Sulphur-2%
Calcium-1%
Aluminium-1%
Others-1%

Silicate tetrahedron



Silicate – any mineral with silicon in its structure. They account for about 92% of the crust and 75% of all minerals.

Chondrite

Topic 1 – Elements and Minerals

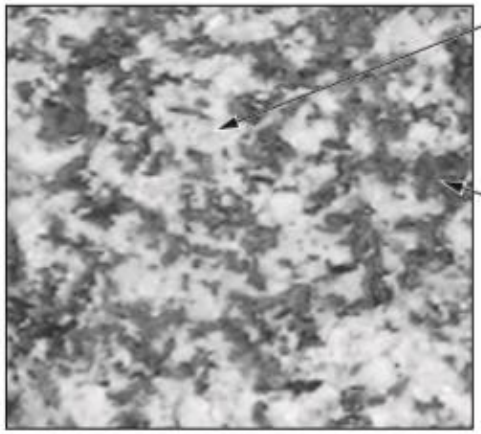
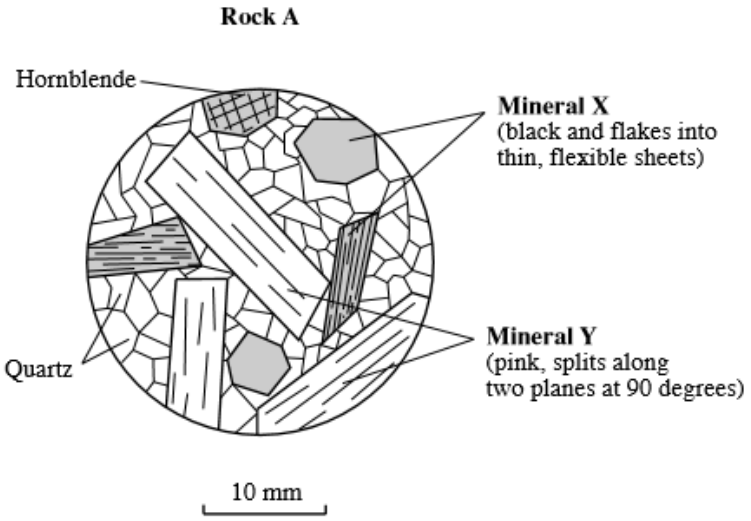


Figure 1d



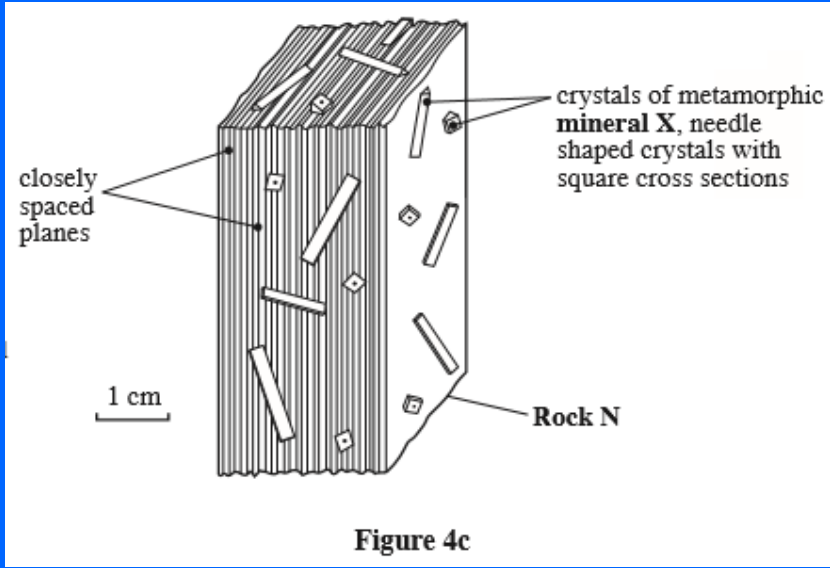


Figure 4c

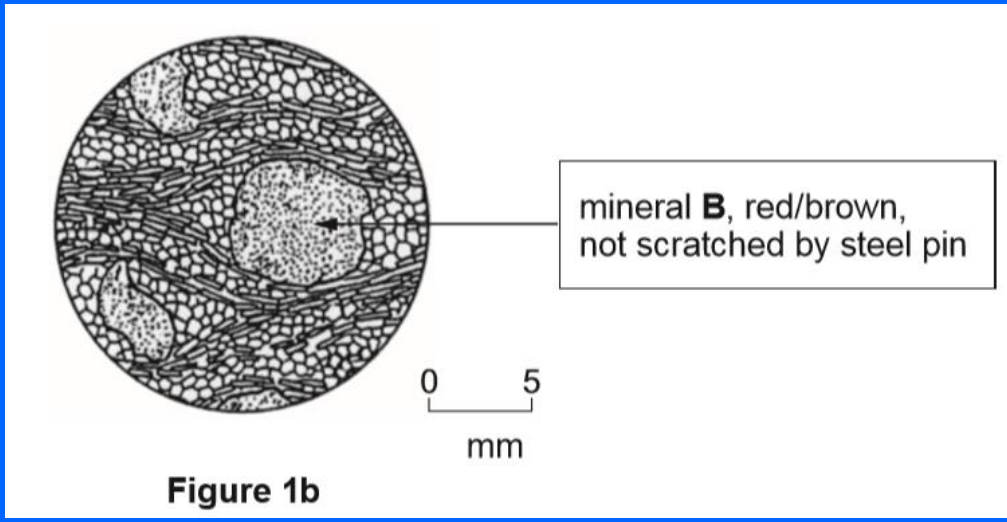


Figure 1b

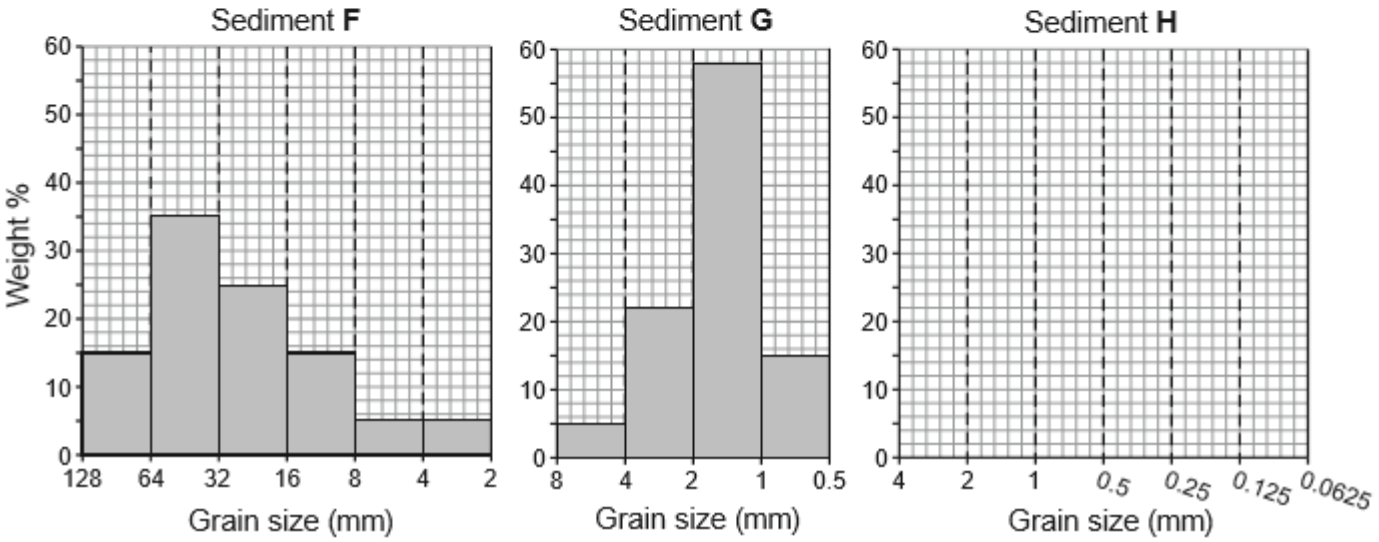
Topic 2 – Rock Cycle

4. **Table 4** shows the grain size distribution of three sediments (**F**, **G** and **H**) collected from a river.

Grain size (mm)	64 to 128	32 to 64	16 to 32	8 to 16	4 to 8	2 to 4	1 to 2	0.5 to 1	0.25 to 0.5	0.125 to 0.25	0.0625 to 0.125
Weight % sediment F	15	35	25	15	5	5					
Weight % sediment G					5	22	58	15			
Weight % sediment H									5	35	60

Table 4

(a) (i) Use the data from **Table 4** to construct a bar graph for sediment **H** in **Figure 4a**. [2]



Topic 2 – Rock Cycle

(b) **Figure 4b** shows a structure commonly found in sediments deposited by a current.

Figure 4c shows detail of the texture of the rock shown in **Figure 4b**.

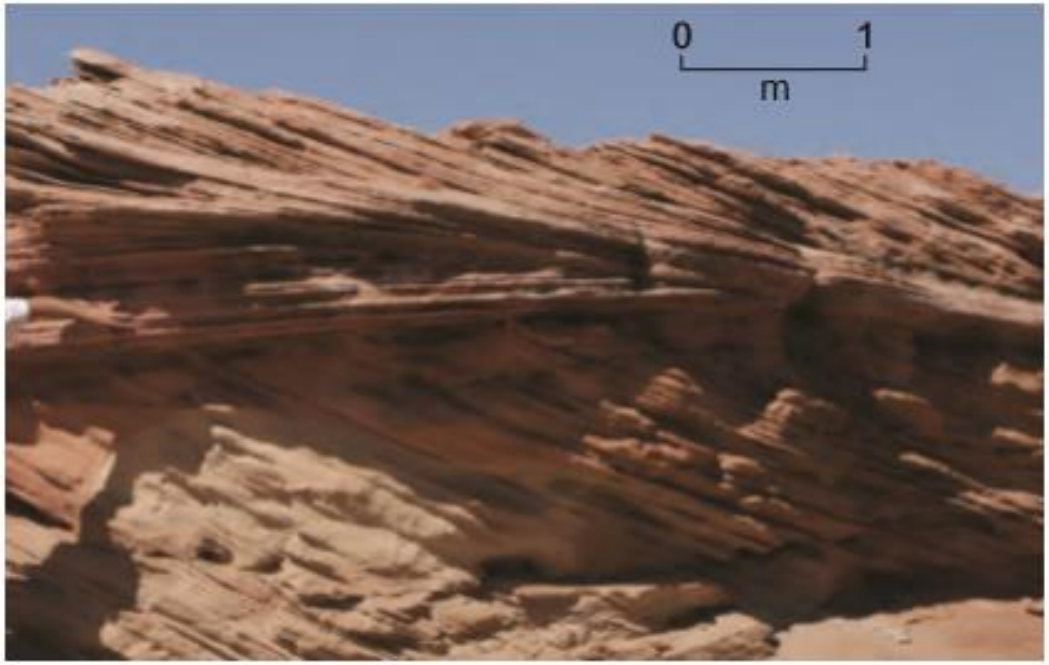


Figure 4b

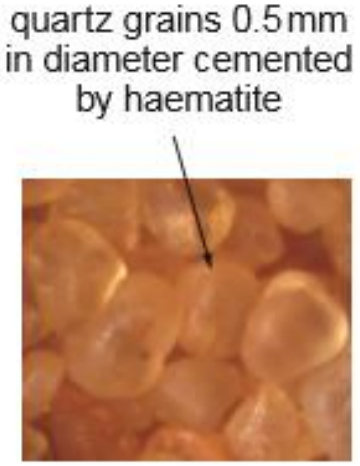


Figure 4c

Topic 2 – The Rock Cycle

2. **Figure 2** shows the geology of a cliff section.

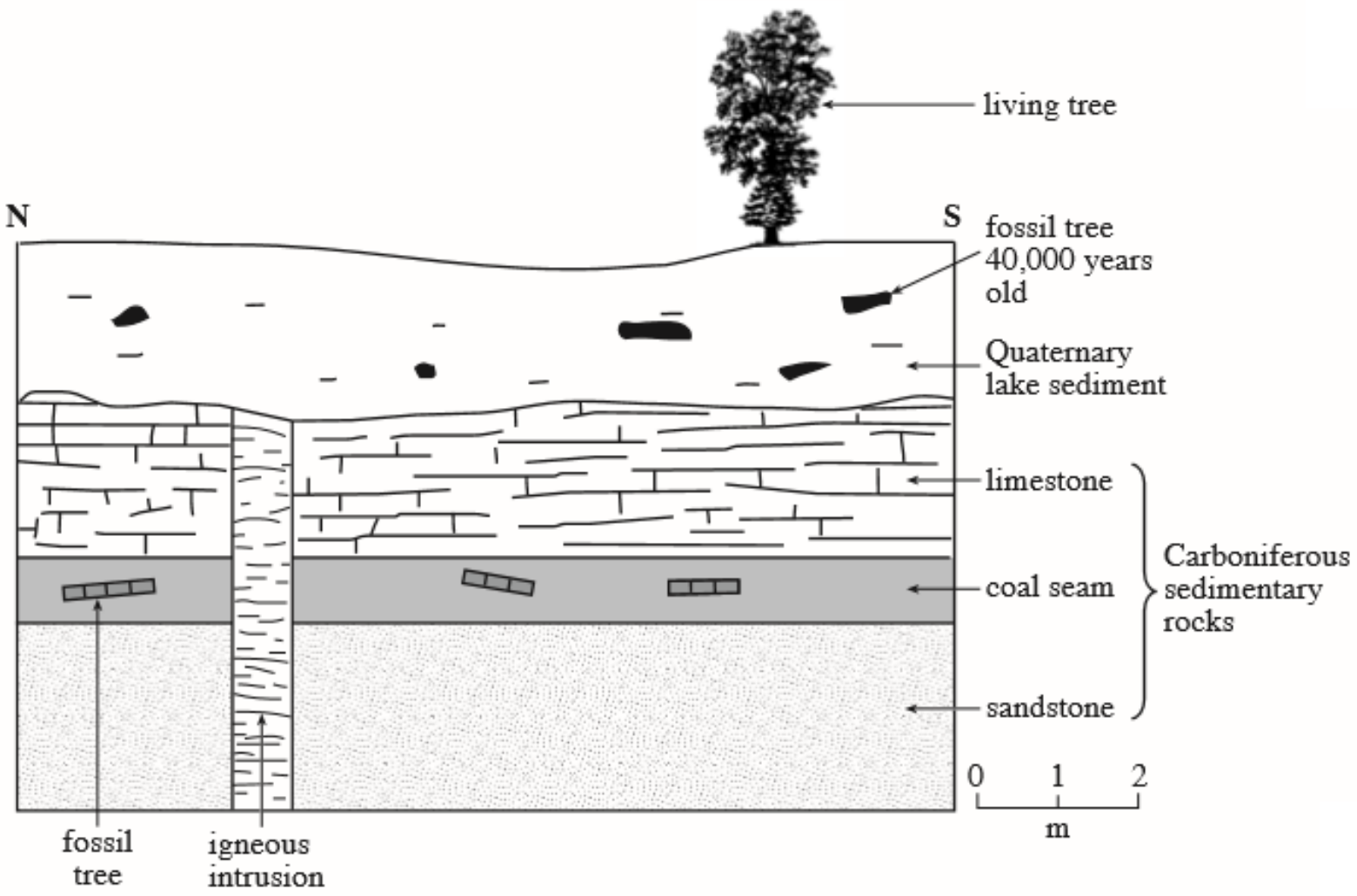


Figure 2

Topic 2 – The Rock Cycle

4. **Figure 4a** shows the polished surfaces of three rocks **D**, **E** and **F**.

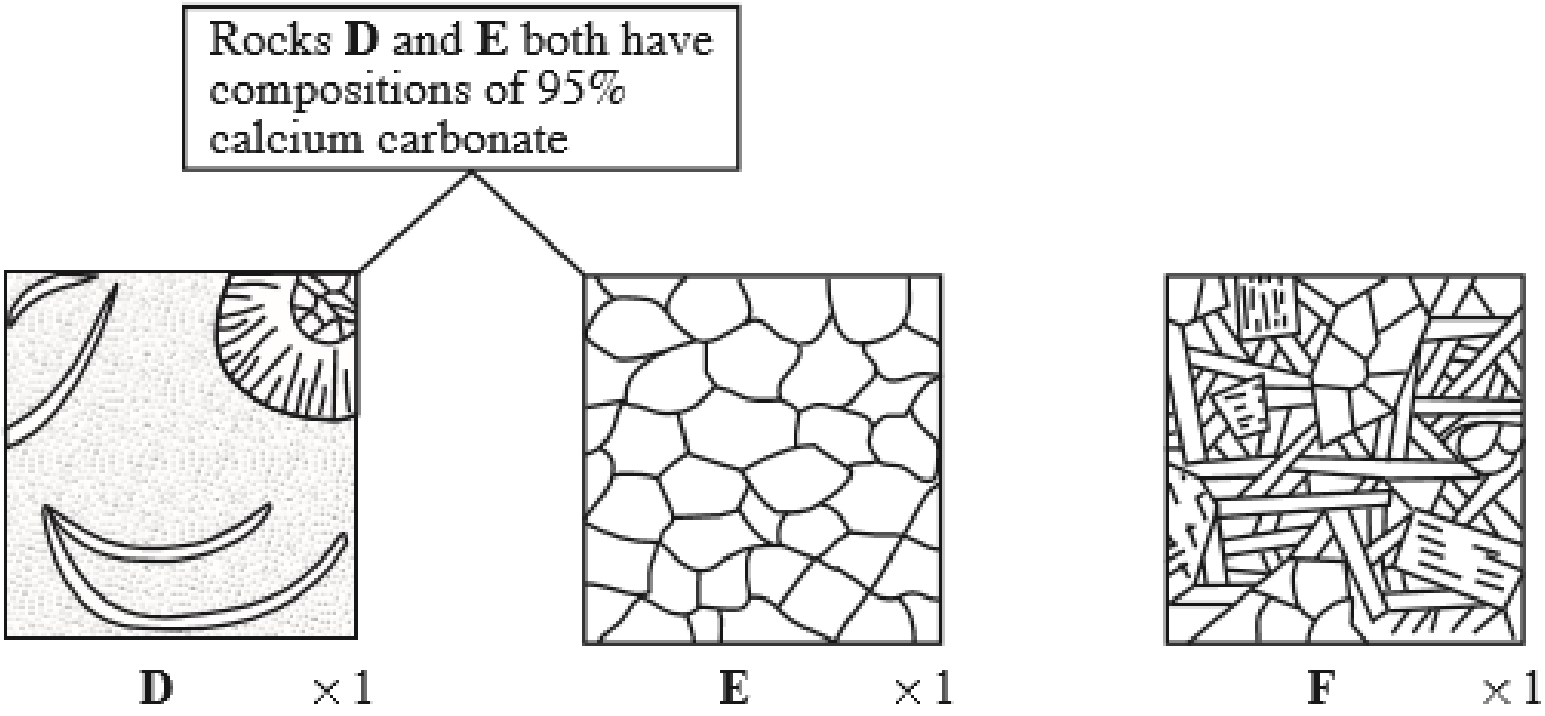


Figure 4a

Topic 2 – The Rock Cycle

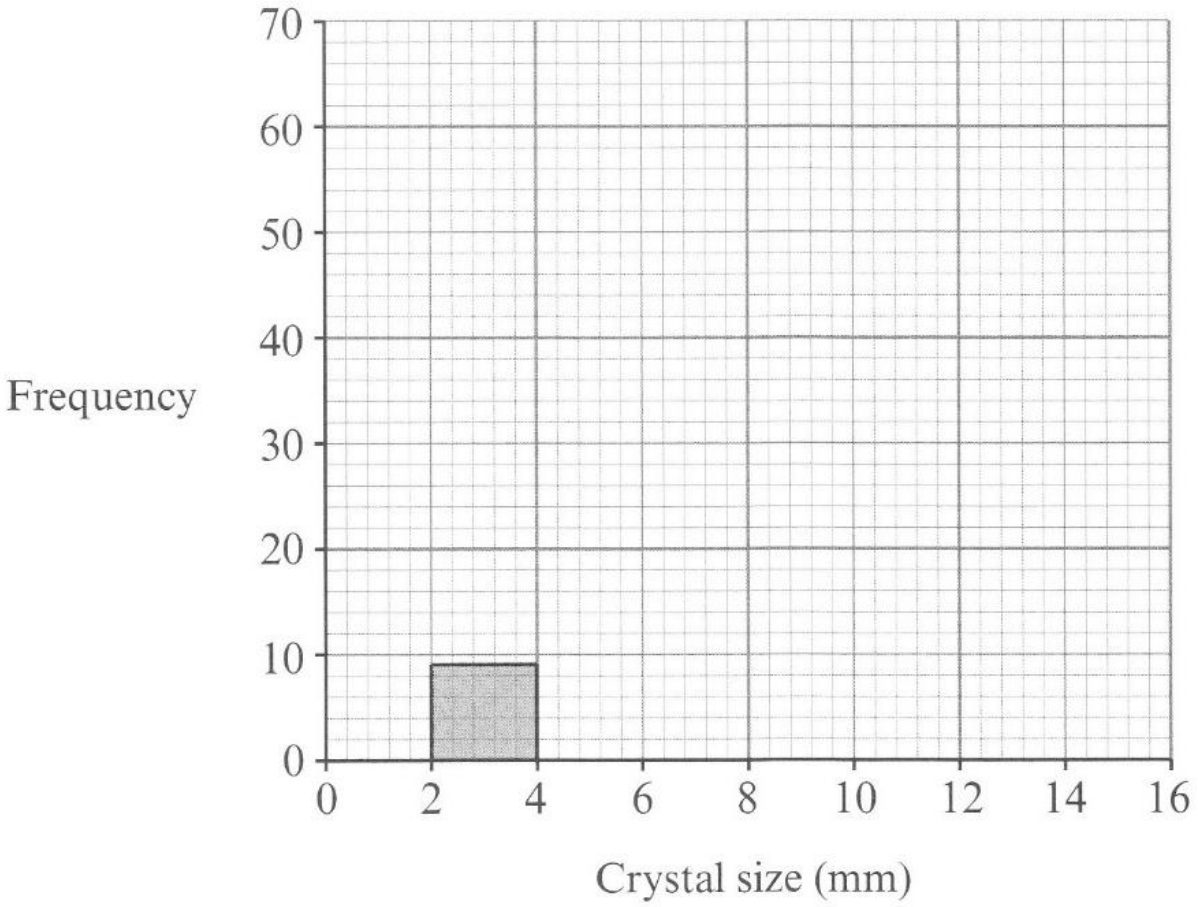


Figure 2b

re of igneous rock **E**. [3]

Crystal size (x) (mm)	Frequency
$0 < x \leqslant 2$	0
$2 < x \leqslant 4$	9
$4 < x \leqslant 6$	69
$6 < x \leqslant 8$	0
$8 < x \leqslant 10$	0
$10 < x \leqslant 12$	3
$12 < x \leqslant 14$	12
$14 < x \leqslant 16$	7

Table 2

6 9 12 15

mm

Topic 2 – The Rock Cycle

4. **Figure 4** is a graphic log showing the sedimentary features of a sequence of beds.

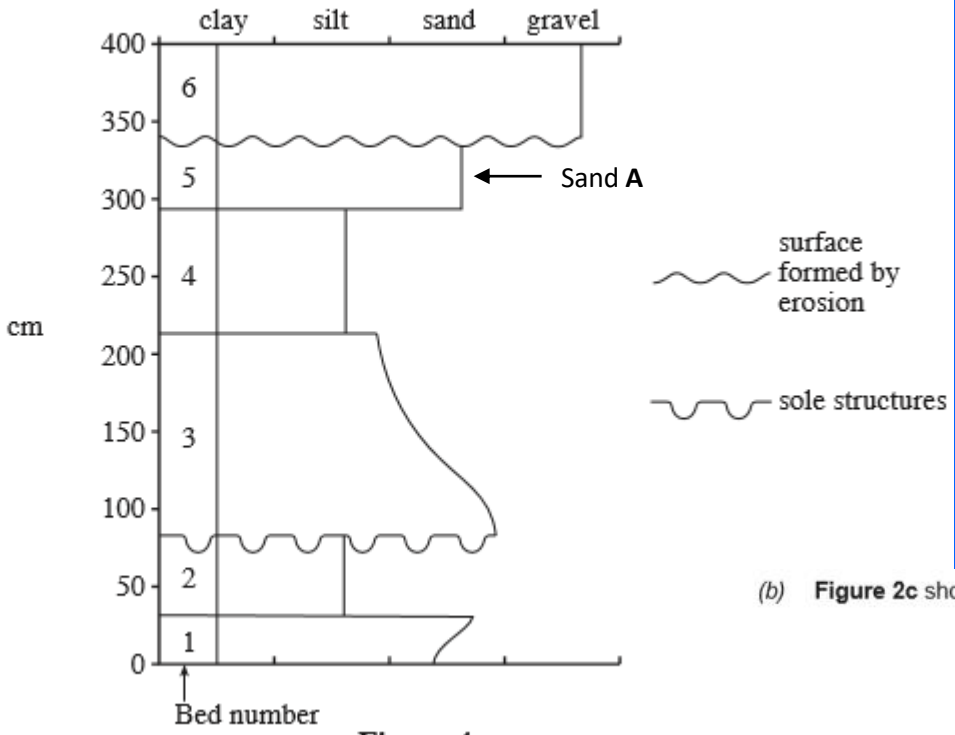


Figure 4

(b) **Figure 2c** shows sand **A**.

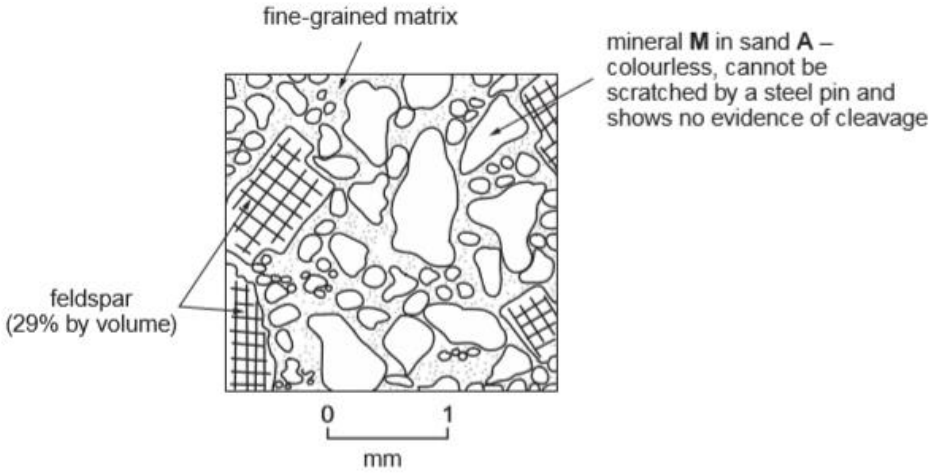


Figure 2c

Topic 2 - Igneous and Metamorphic Rocks

1. **Figure 1a** is a cross-section through a sill formed by the intrusion of two igneous bodies composed of rocks **A** and **B**. **Figure 1b** shows the variation in crystal size of the groundmass through the igneous bodies. **Figure 1c** shows a sample of rock **A** collected from locality **A** on **Figure 1a**.

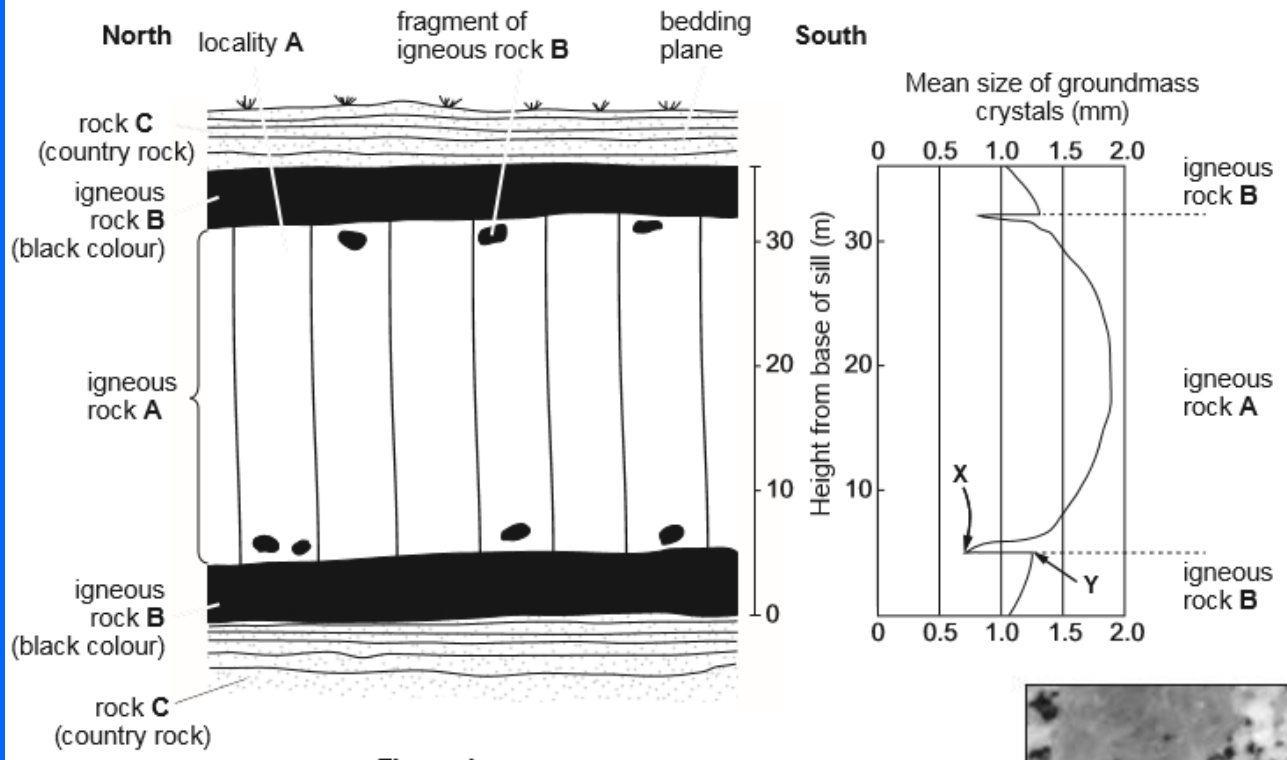


Figure 1a

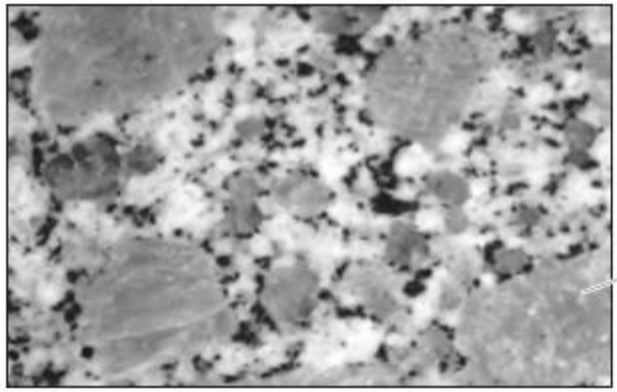


Figure 1c

Topic 2 - Igneous and Metamorphic Rocks

(b) **Figure 3b** is a field-sketch of a quarry face.

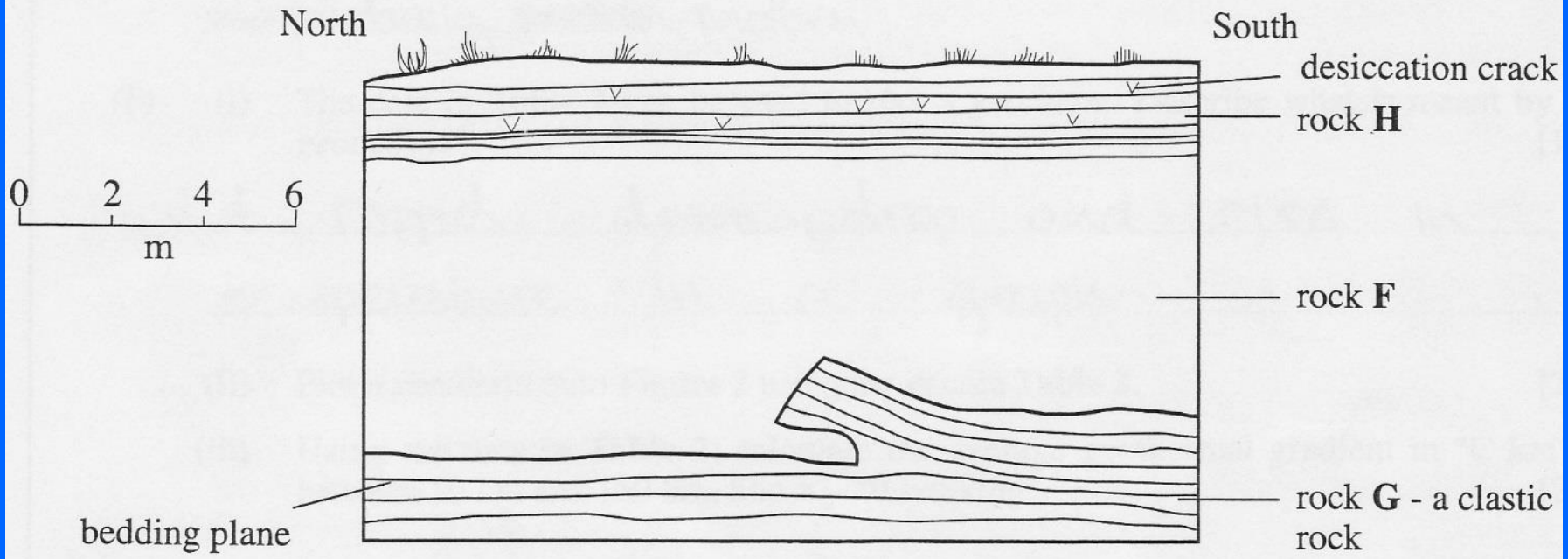


Figure 3b

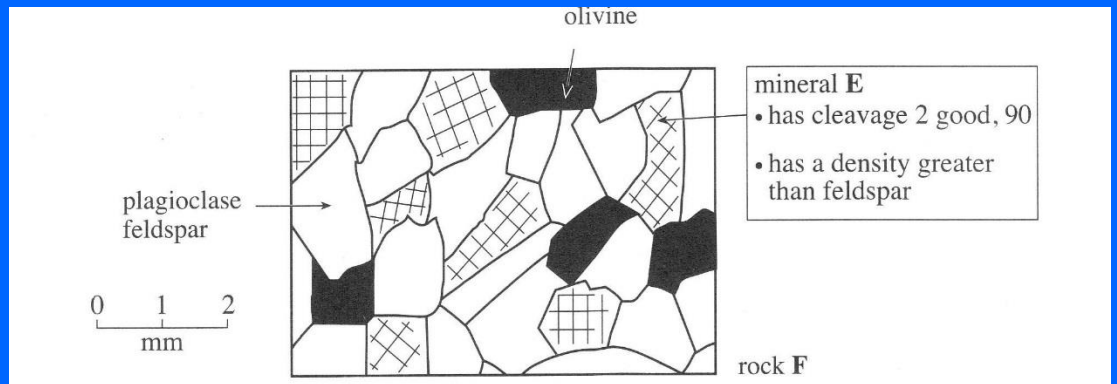
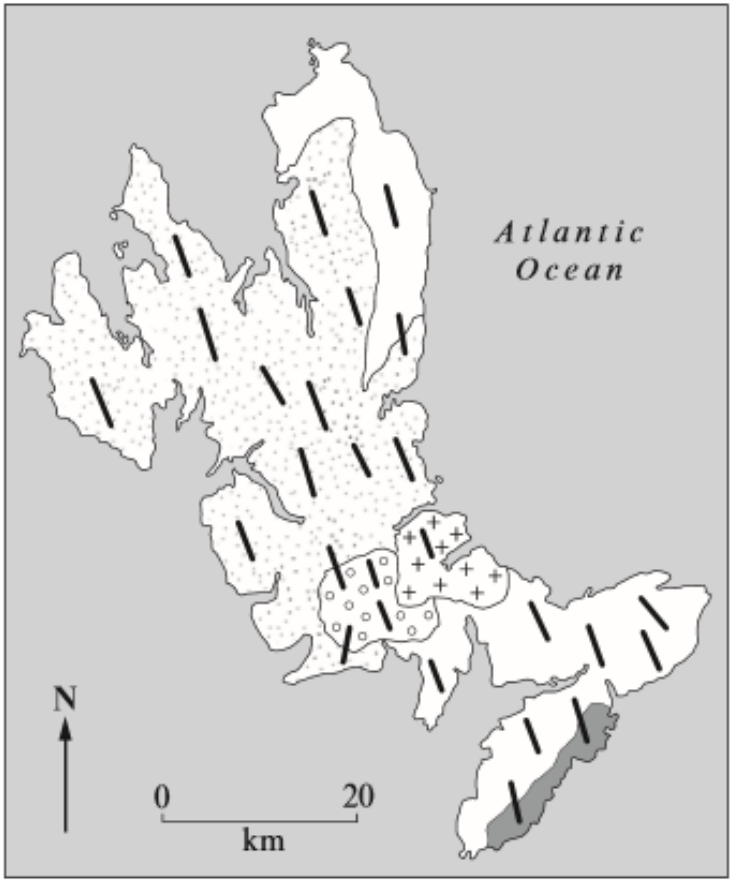


Figure 3a

Topic 2 - Igneous and Metamorphic Rocks

4. **Figure 4a** is a simplified geological map of the Isle of Skye. **Figure 4b** is a photomicrograph of rock **H**.



Key (not in order of age)

	gneiss (Precambrian)
	mafic lavas (Tertiary)
	silicic pluton (Tertiary)
	mafic pluton (Tertiary)
	discordant bodies of dolerite (Tertiary)
	other rocks

Figure 4a

Rock H

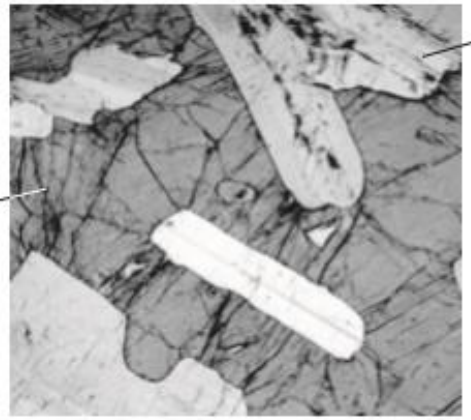


Figure 4b

Topic 2 - Igneous and Metamorphic Rocks

3. **Figure 3a** is a geological map. **Figure 3b** shows rock **K** collected from the solid geology within the area shown on **Figure 3a**.

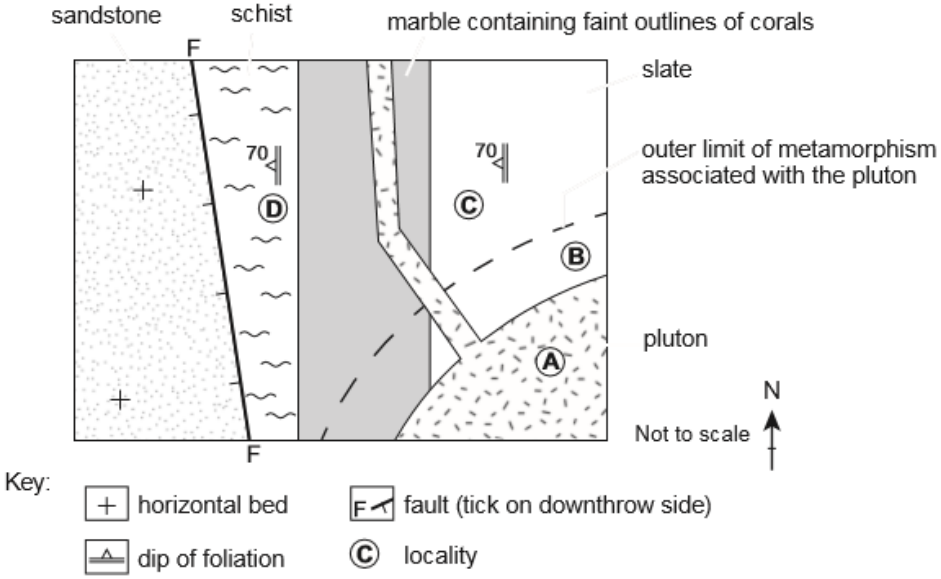


Figure 3a

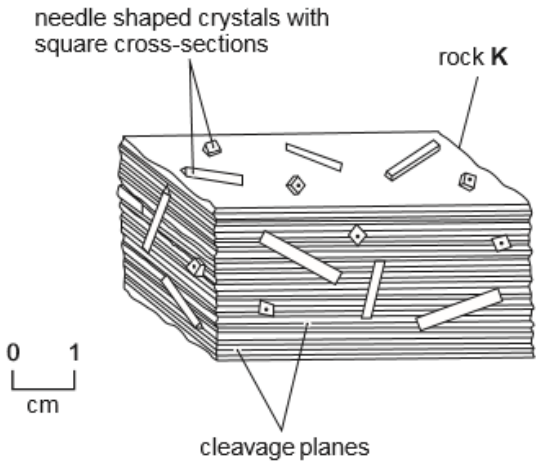


Figure 3b

Topic 2 - Igneous and Metamorphic Rocks

Figure 4b is a geological map. Rocks **D**, **E** and **F** in **Figure 4a** were all collected from solid outcrops in the area shown on **Figure 4b**.

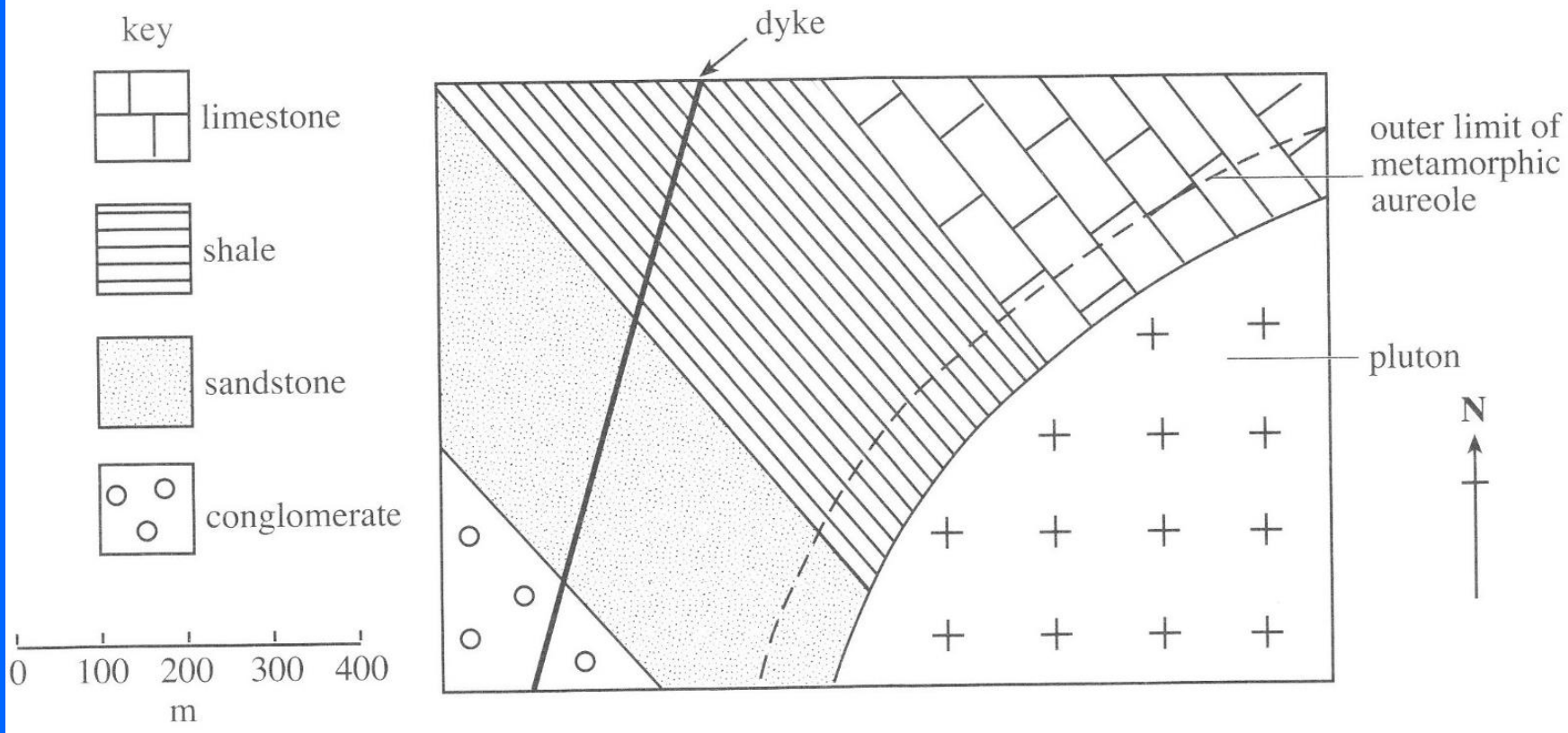
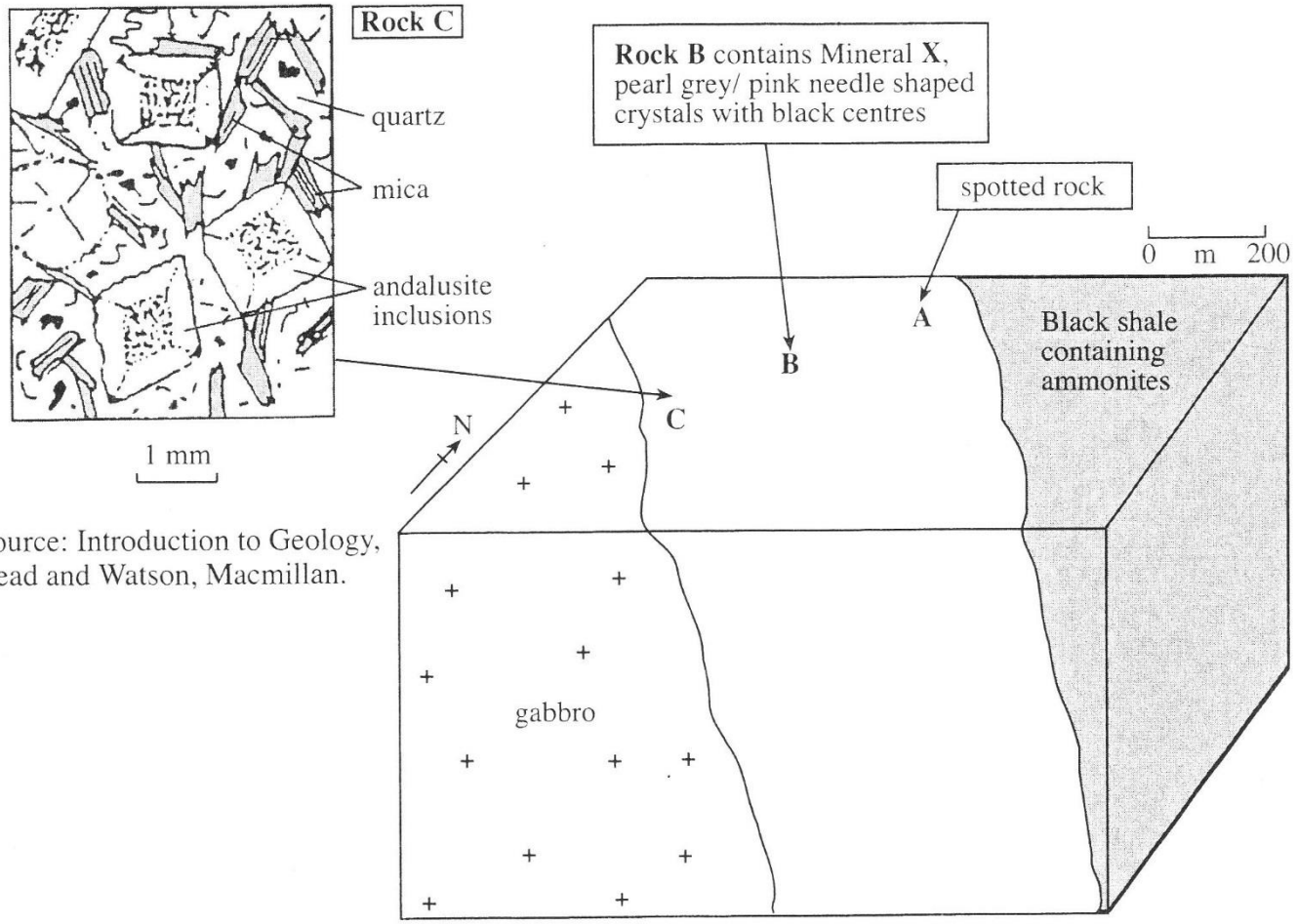


Figure 4b

Topic 2 - Igneous and Metamorphic Rocks

2. The geology of an area surrounding a gabbro pluton is shown in **Figure 2**, with a diagram of **Rock C** found at **Site C**.



Source: Introduction to Geology, Read and Watson, Macmillan.

Figure 2

Topic 2 - Igneous and Metamorphic Rocks

1. **Figure 1a** is a road cutting exposure showing the true dip of the sedimentary units.

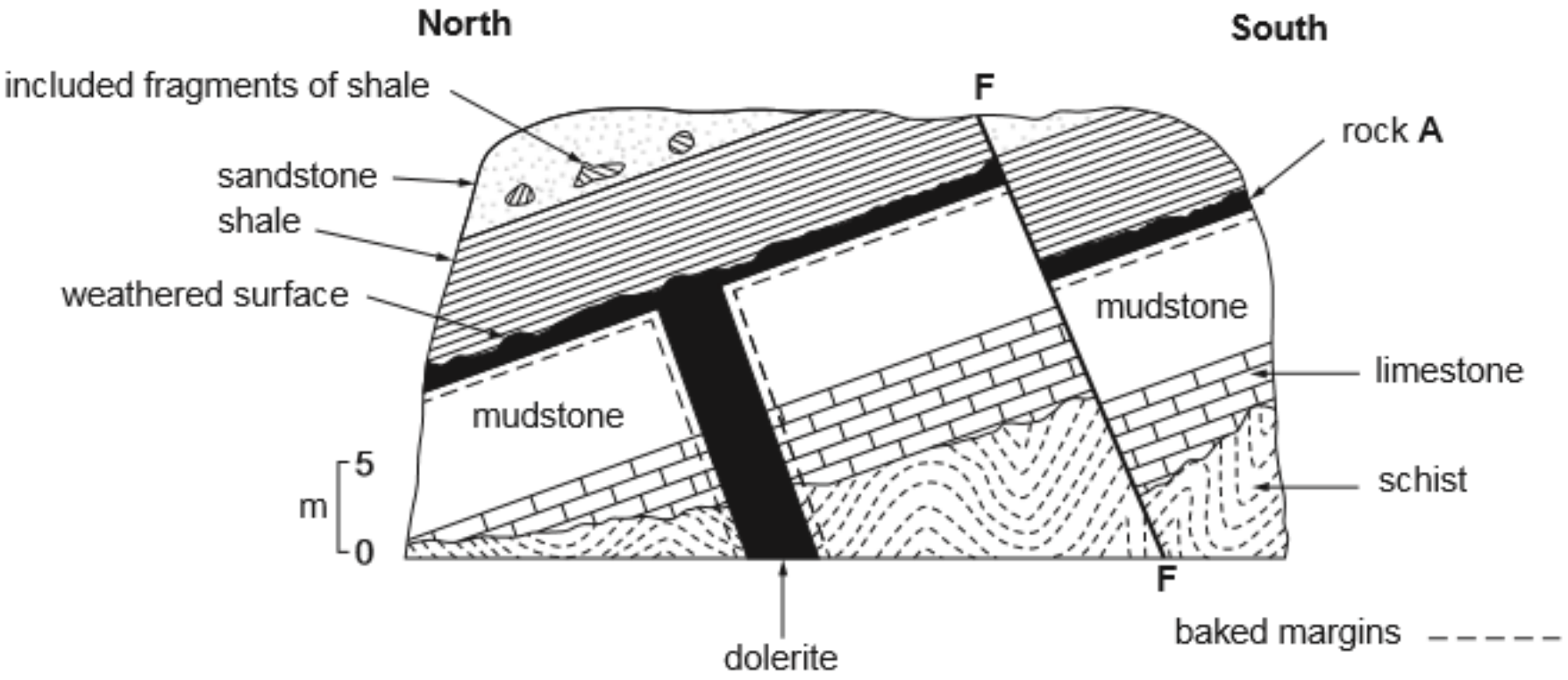


Figure 1a

Topic 2 - Igneous and Metamorphic Rocks

1. **Figure 1a** is a cliff section. **Figure 1b** is a photomicrograph view of the sandstone from locality **Y** indicated in **Figure 1a**.

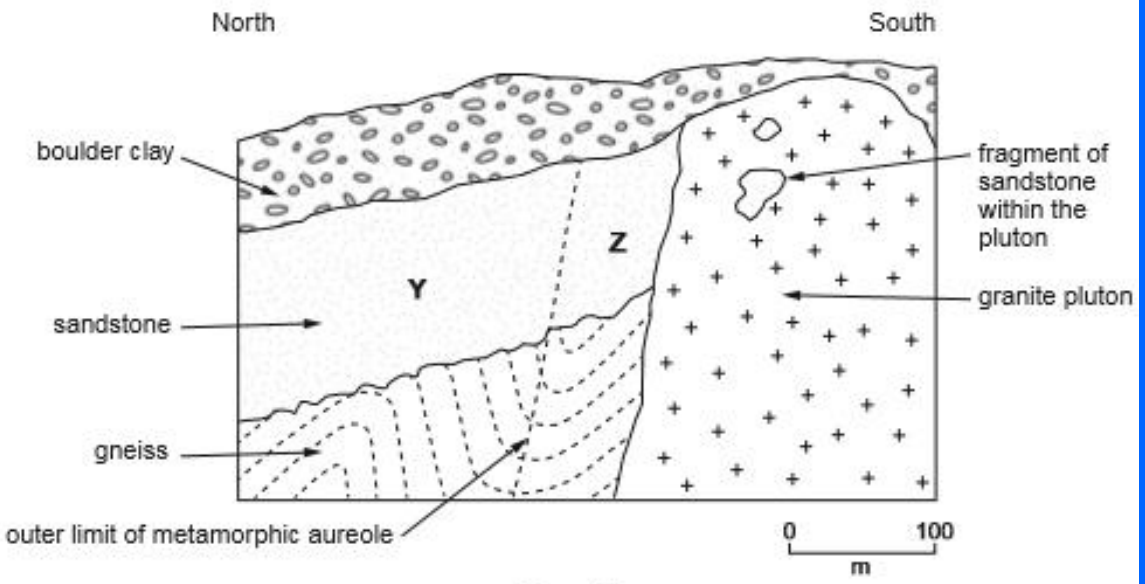


Figure 1a

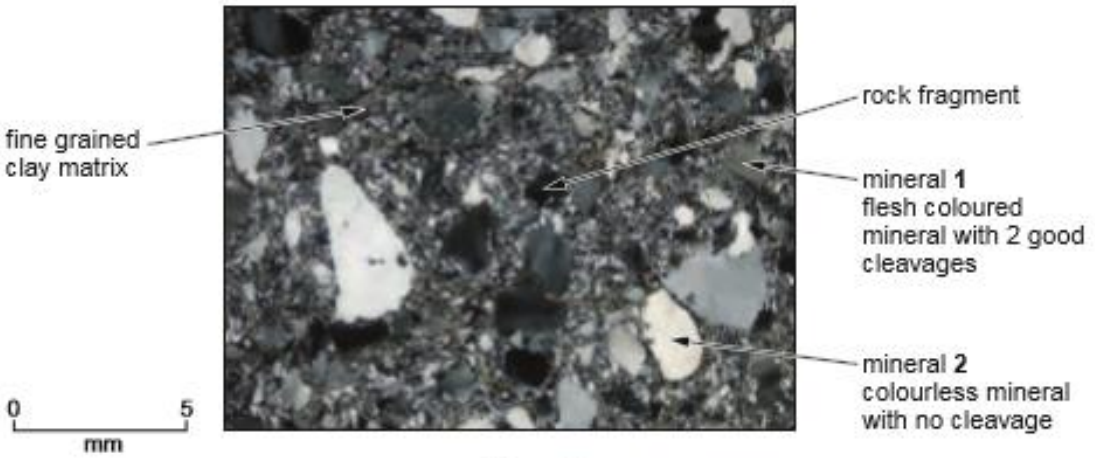


Figure 1b

Topic 2 - Igneous and Metamorphic Rocks

1. **Figure 1a** is a map showing an igneous rock intruded into orthoquartzite. **Table 1b** shows how the average crystal size varies between **A** and **B** on **Figure 1a**.

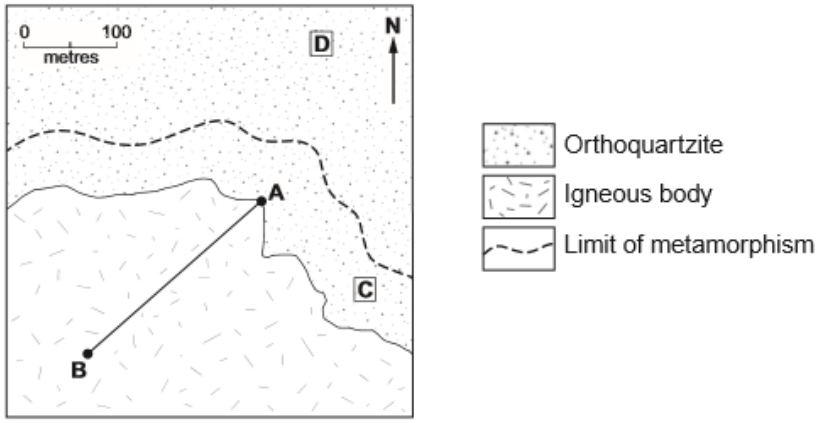


Figure 1a

Distance from **A** (metres)	0	50	100	150	200	250
Crystal size (millimetres)	0.5	5	6	7	7.5	8

Table 1b

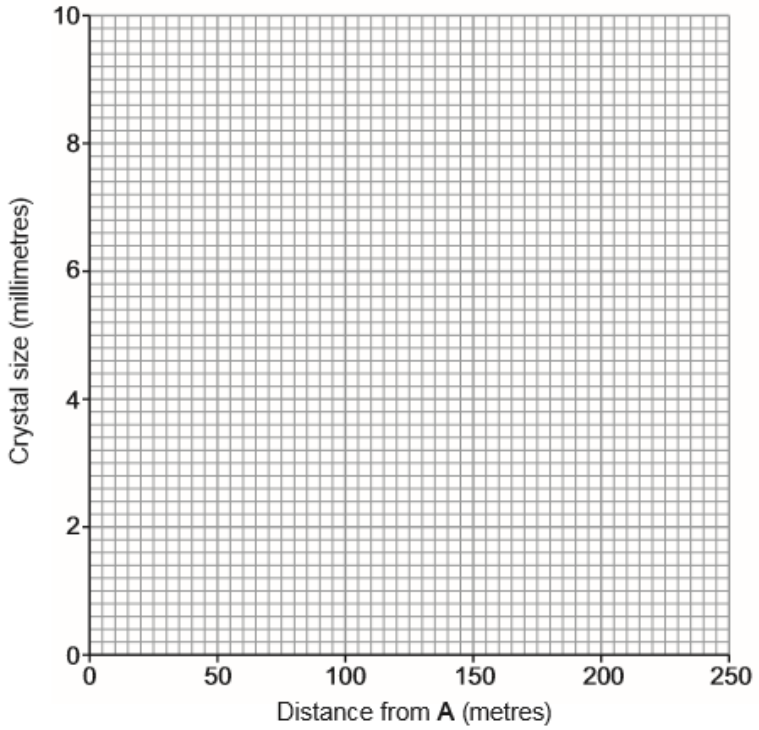


Figure 1c

Topic 2 – Rock Deformation

2. Figure 2 shows a cross section parallel to the true dip through an orogenic belt (not to scale).

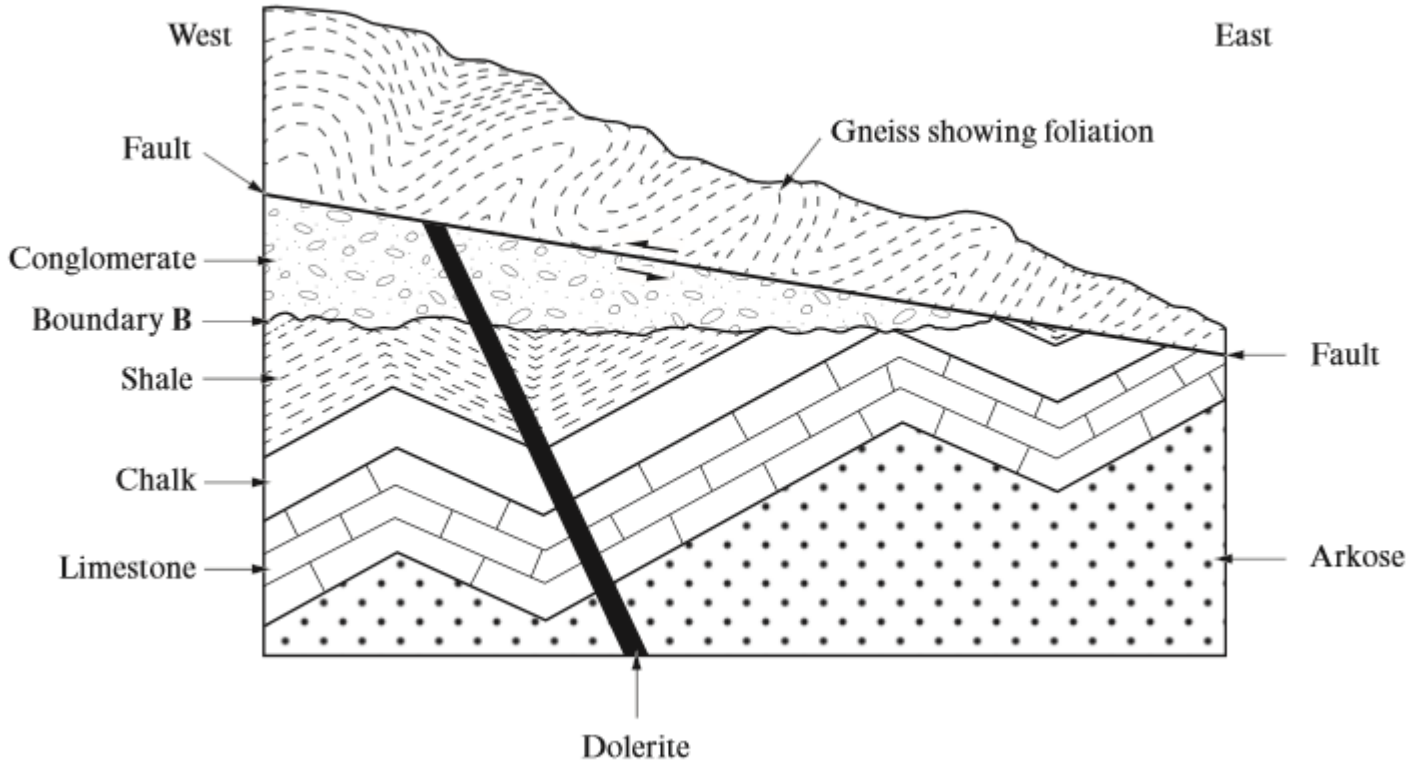
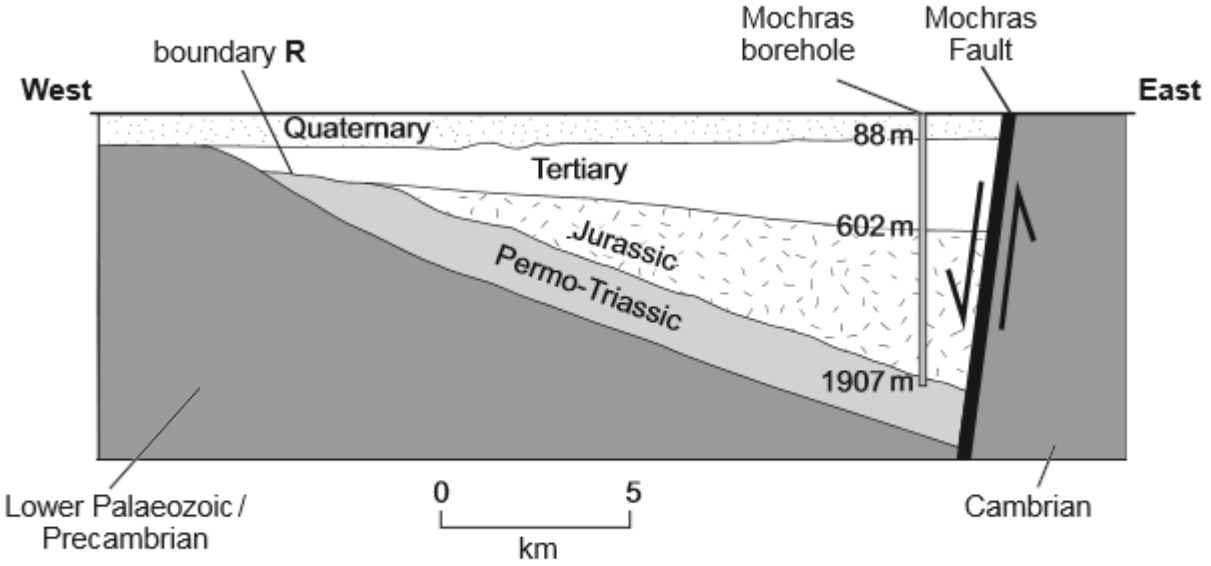


Figure 2

Topic 2 – Rock Deformation

4. **Figure 4a** is a cross-section of the geology of an area of western Wales. **Figure 4b** is the Geological Column.



Data shown within the borehole represent approximate depths from the surface and are not drawn to scale.

Figure 4a

Date (million years)	Period	Era
	QUATERNARY	CENOZOIC
2.6	TERTIARY	
66	CRETACEOUS	MESOZOIC
145	JURASSIC	
201	TRIASSIC	
252	PERMIAN	PALAEOZOIC
299	CARBONIFEROUS	
359	DEVONIAN	
419	SILURIAN	
443	ORDOVICIAN	
485	CAMBRIAN	
541	PRECAMBRIAN	

Figure 4b

Topic 2 – Rock Deformation

4. **Figure 4** shows the geology exposed in a cliff face.

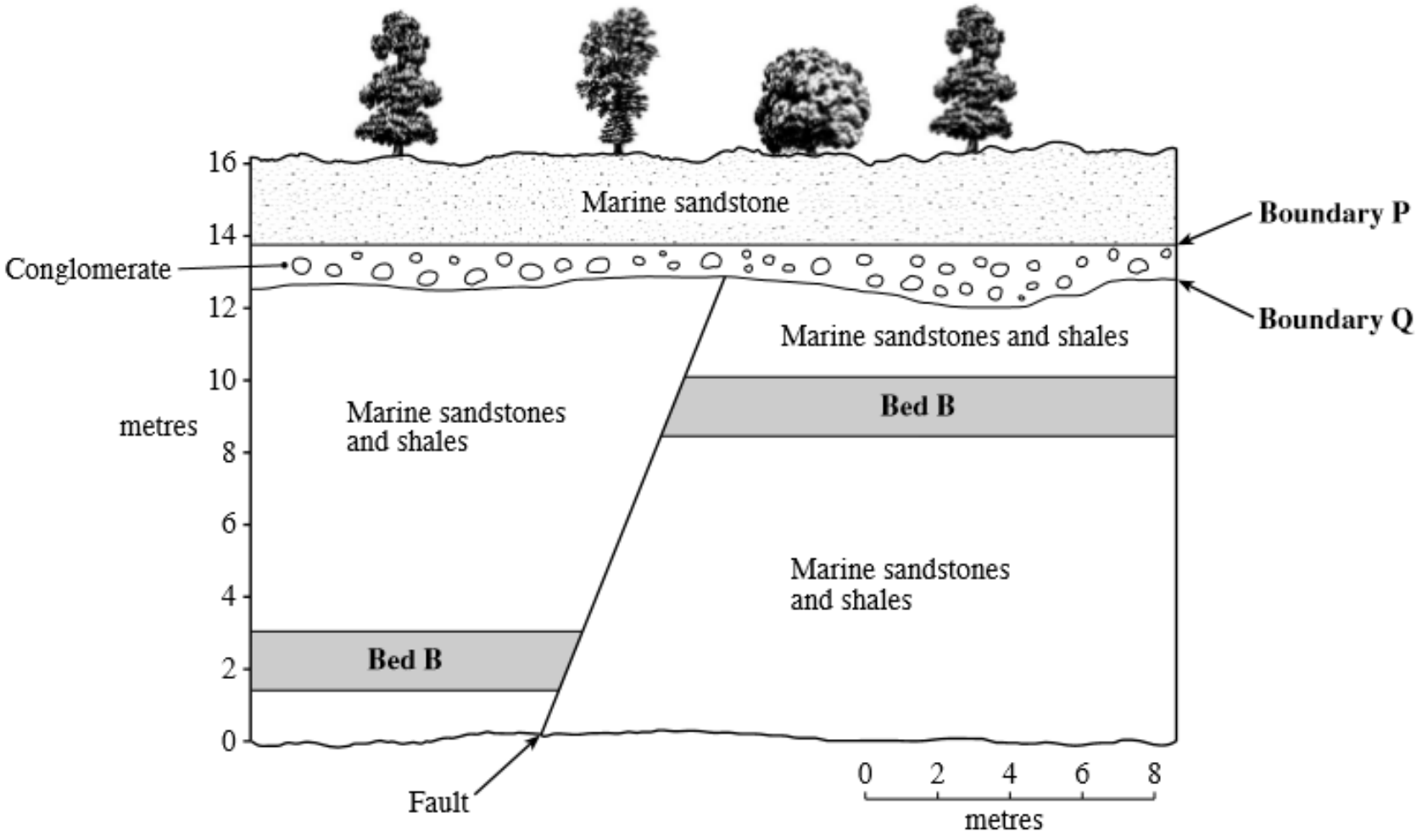


Figure 4

Topic 2 – Rock Deformation

4. **Figure 4** shows a partially completed field sketch of the geology of a road cutting.

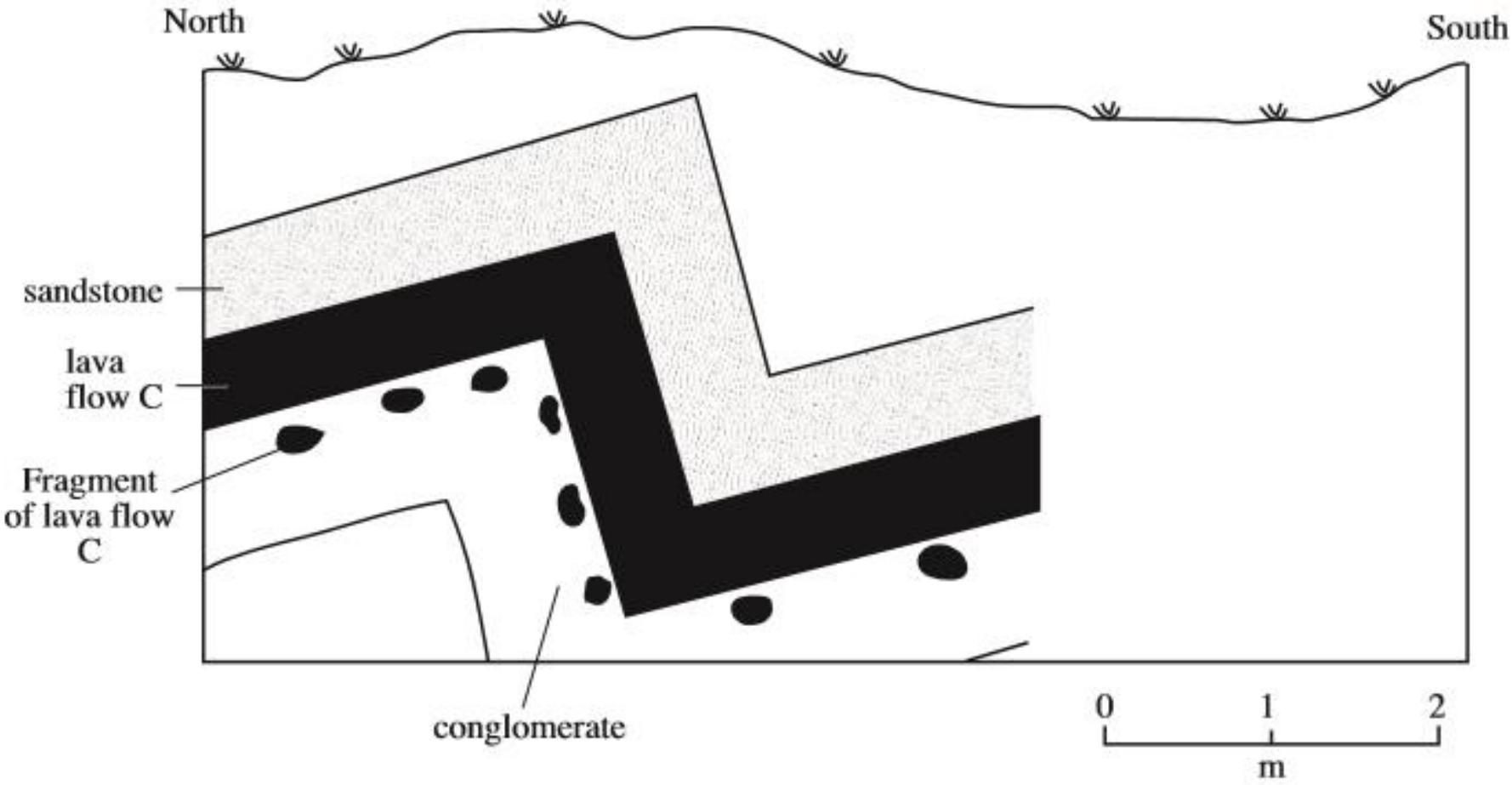


Figure 4

Topic 2 – Rock Deformation

(c) **Figure 4c** shows a block diagram of a second location.

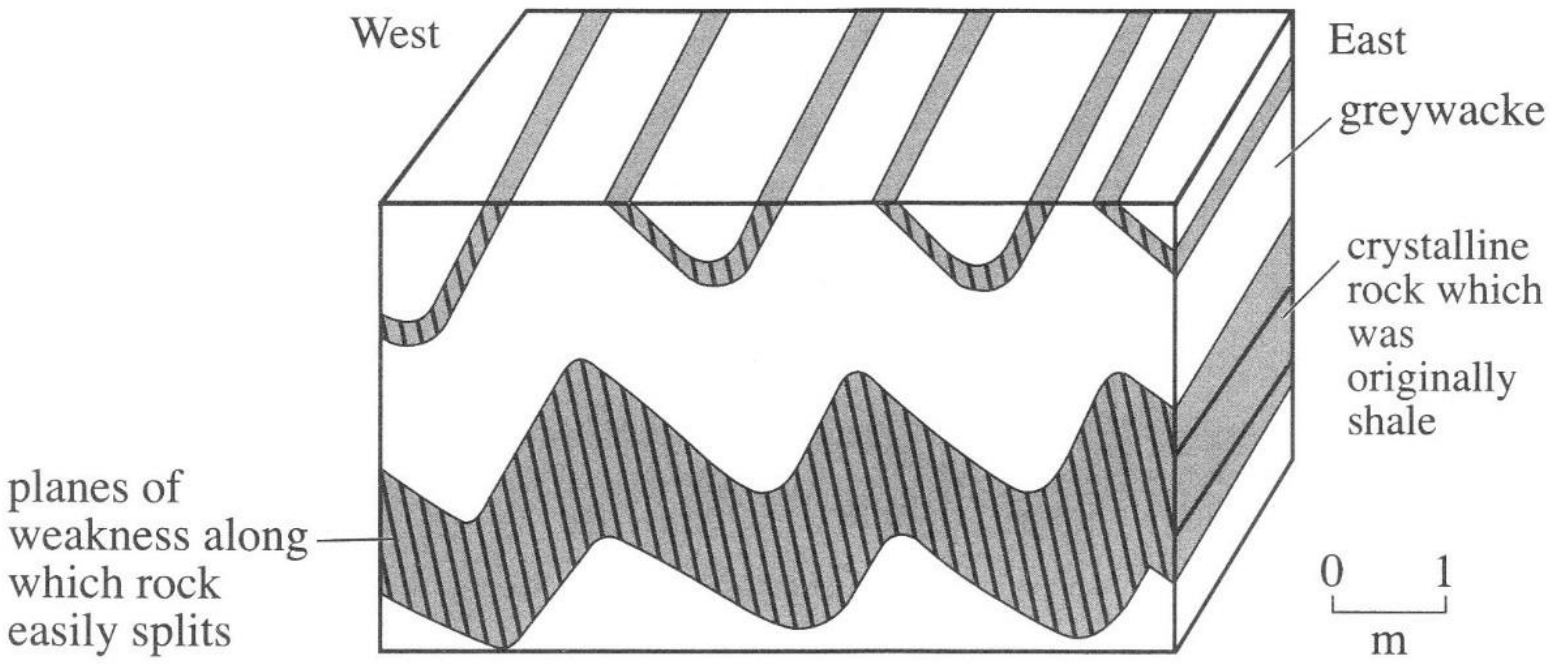


Figure 4c

Topic 2 – Rock Deformation

4. **Figure 4** is a **geological map**. The land in the area is flat.

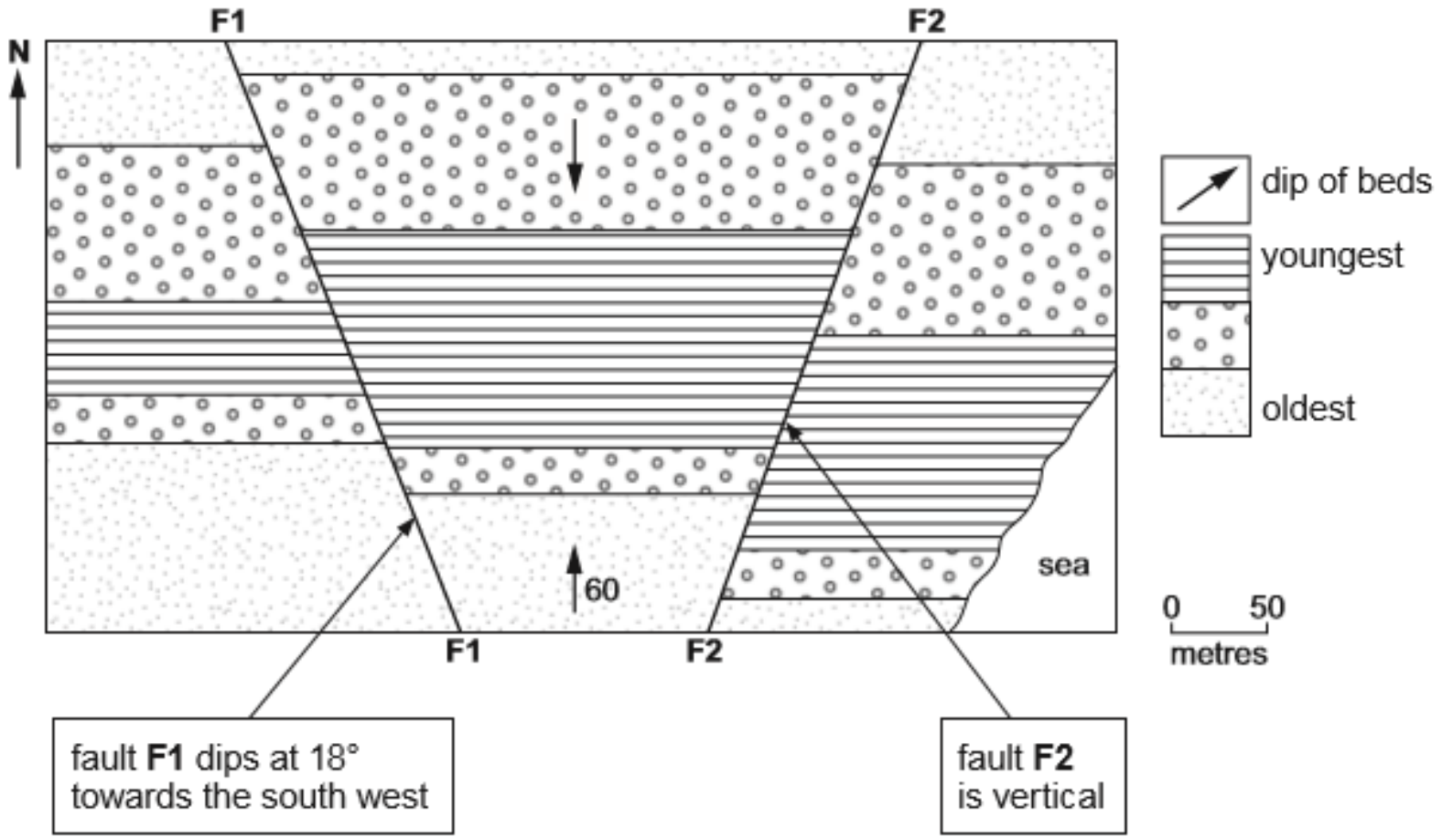


Figure 4

Topic 2 – Rock Deformation

4. **Figure 4a** is a block diagram of a folded sequence of sandstones and shales.

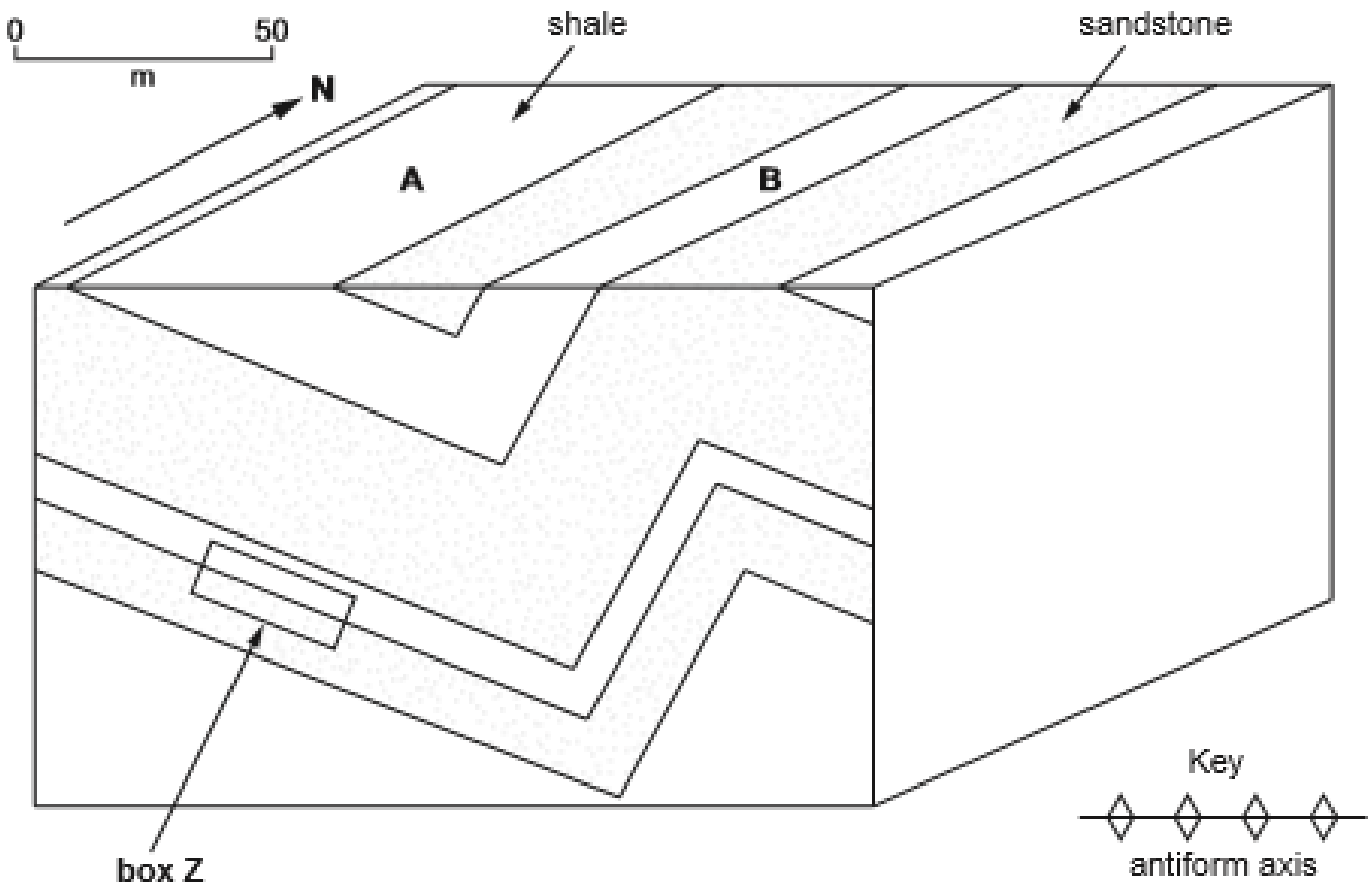


Figure 4a

Topic 2 – Rock Deformation

4. **Figure 4** is a **cross-section** showing the true dip of a sequence of sedimentary rocks exposed in a roadside cutting.

East

4. **Figure 4** is a **cross-section** showing the true dip of a sequence of sedimentary rocks exposed in a roadside cutting.

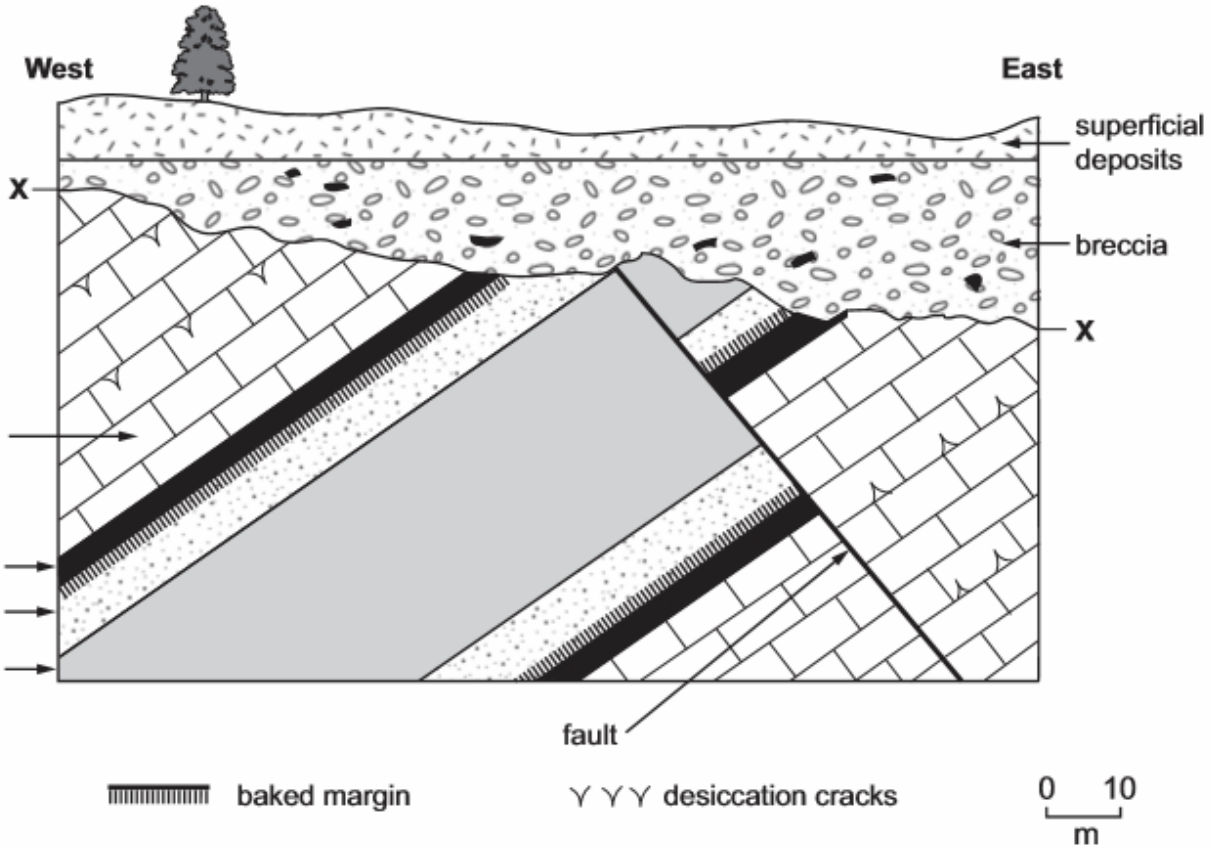


Figure 4

Topic 3 – Time and Change/Dating

3. **Figure 3a** is a cross-section at a cliff face showing the true dip of the beds. **Figure 3b** shows fossils found in the Jurassic limestone in **Figure 3a**. **Figure 3c** shows the detail of one fossil from **Figure 3b** where the outer shell has been removed.

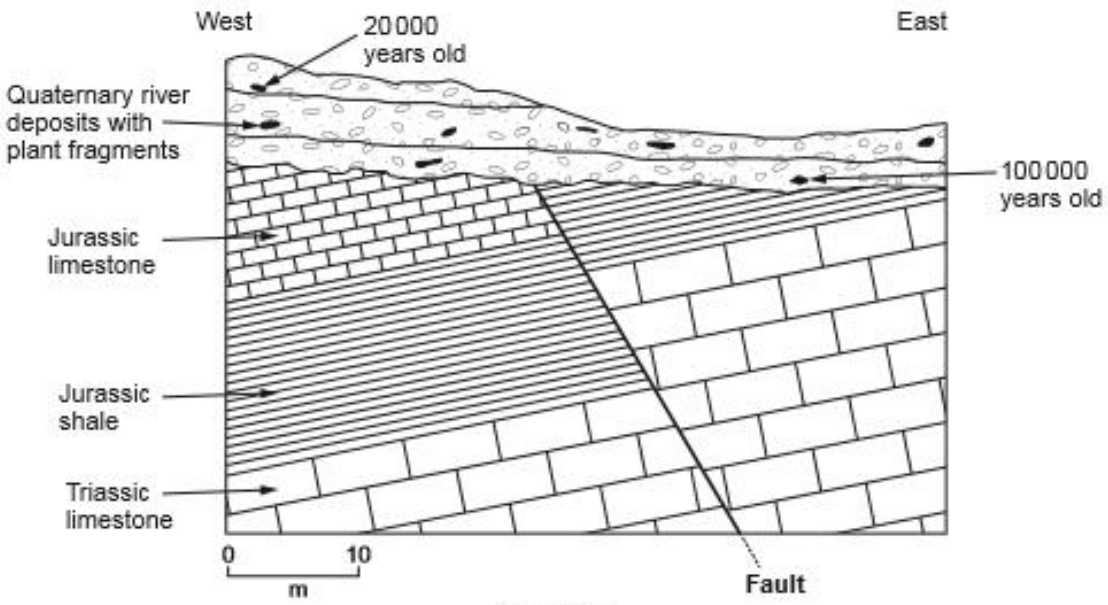


Figure 3a

Figure 3b

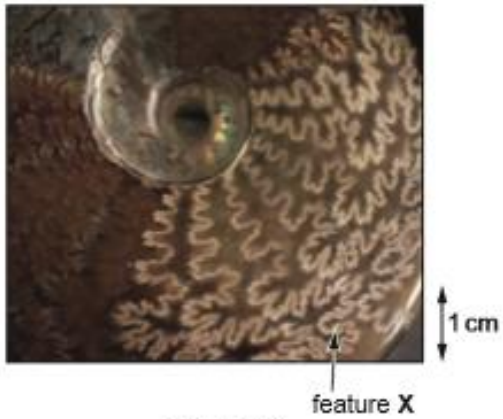


Figure 3c

Topic 3 – Time and Change

2. **Figure 2a** shows the geological histories of the brachiopod and bivalve fossil groups.

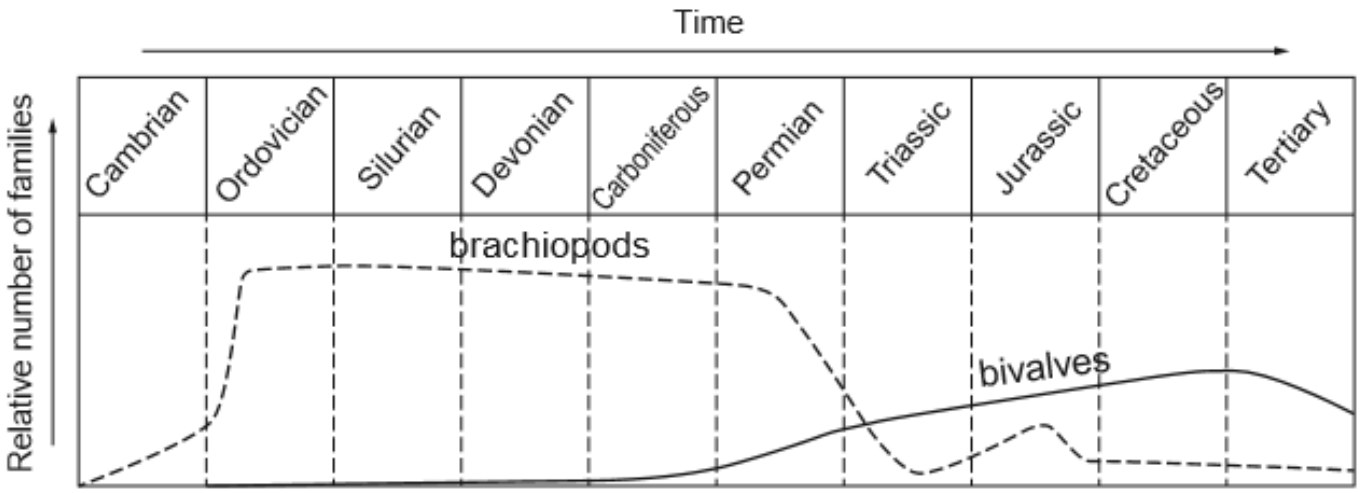
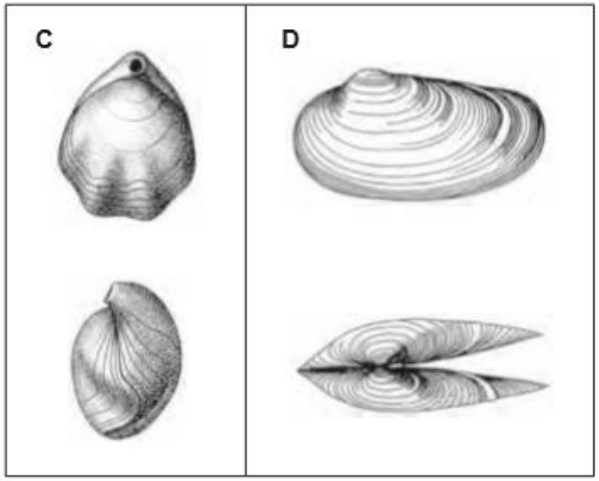


Figure 2a

(b) **Figure 2b** shows two fossil specimens (**C** and **D**) from different fossil groups.



(actual sizes)

Figure 2b

Topic 3 – Time and Change

1. **Figure 1a** shows the geological histories for trilobites and graptolites.

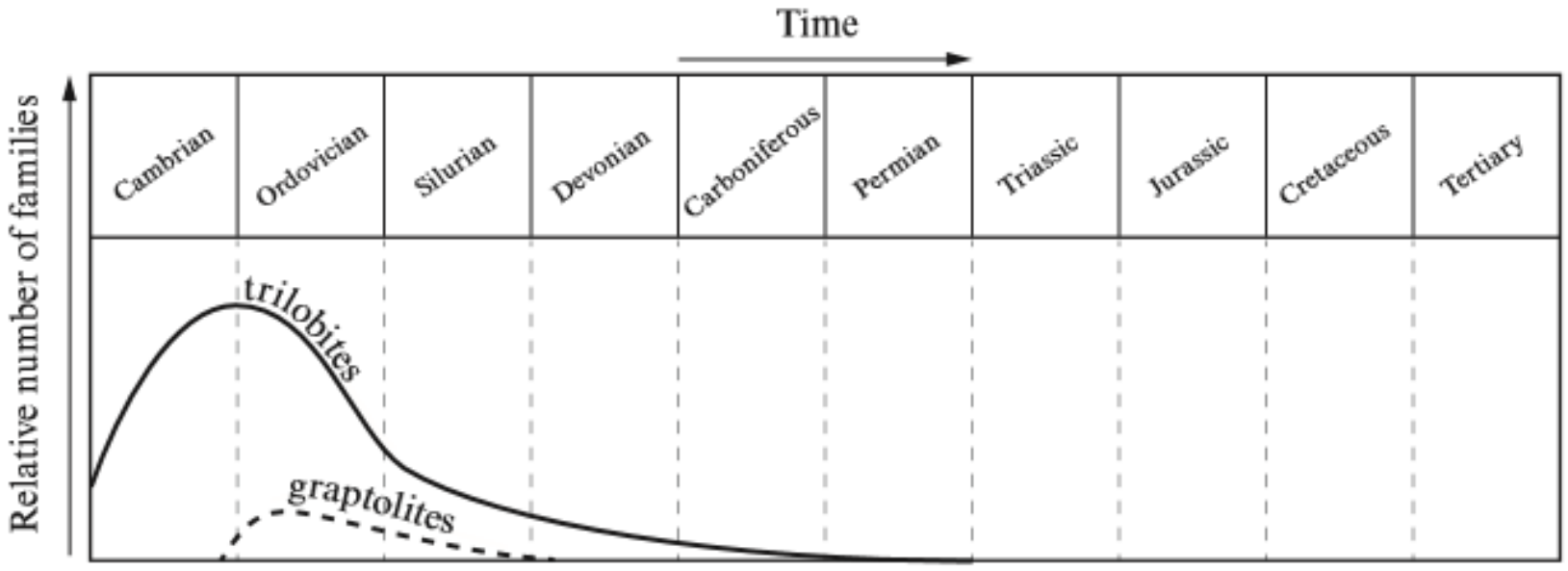


Figure 1a

Topic 3 – Time and Change/Dating

3. **Figure 3a** is a cross-section at a cliff face. **Figure 3b** shows fossil **G** collected from locality **G** on **Figure 3a**.

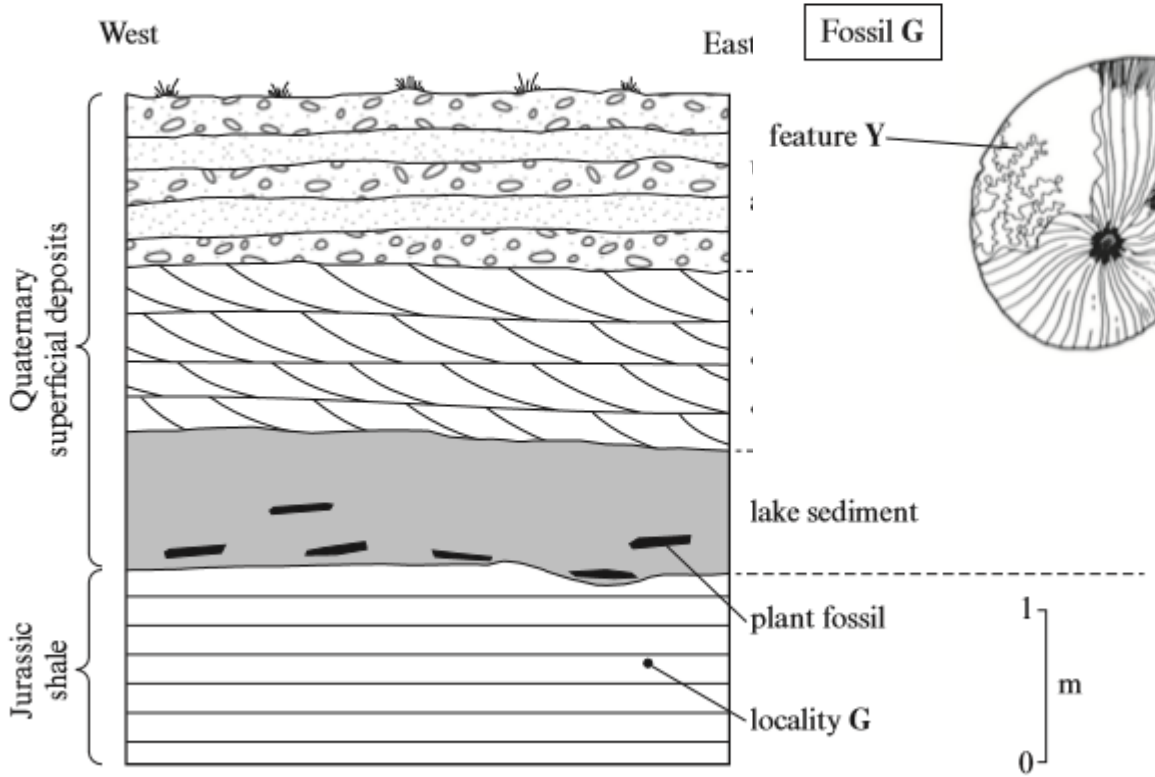


Figure 3a

Fossil **G**

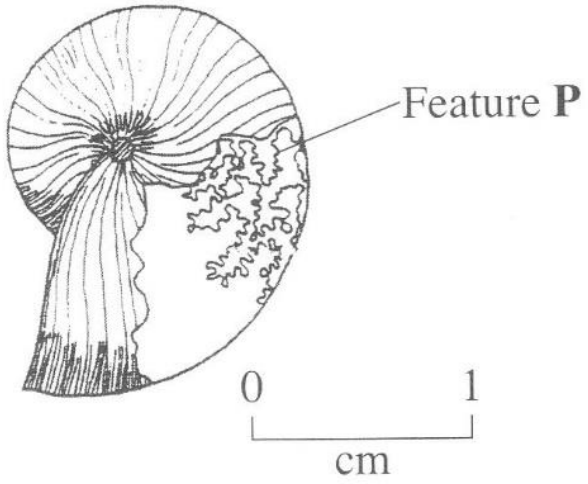
Figure 3b

Fossil **G** partly composed of mineral **P**

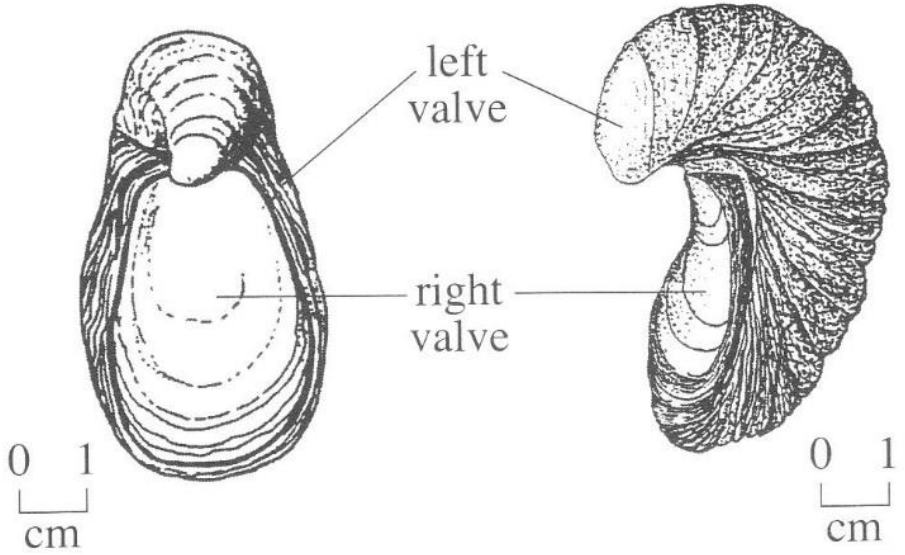
- a colourless mineral
- has a vitreous lustre
- is scratched by a copper coin
- does not taste salty

Topic 3 – Time and Change

4. **Figure 4a** shows two fossils from an assemblage preserved in a Jurassic limestone.



An ammonite



Gryphaea

Figure 4a

Topic 3 – Time and Change

3. **Figure 3a** is a sketch of a cliff face from which fossil specimens (some of which are drawn in **Figure 3b**) were recorded at the locations indicated. The rock sequence was found to be the correct way up.

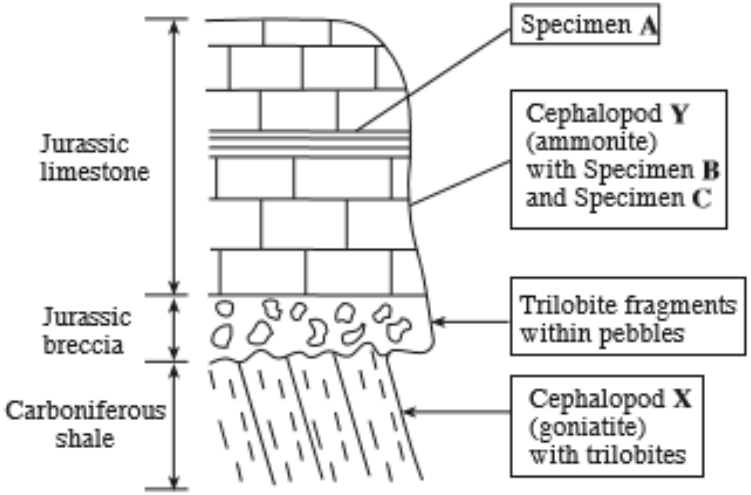
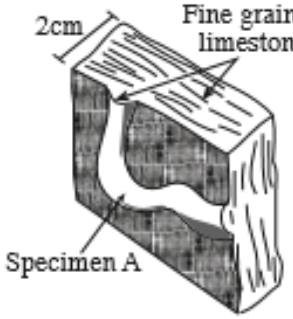


Figure 3a



Specimen A

Specimen B

Specimen C

Topic 3 – Time and Change/Dating

2. **Figure 2** shows a roadside rock exposure with the fossils and structures contained in each of the sedimentary units.

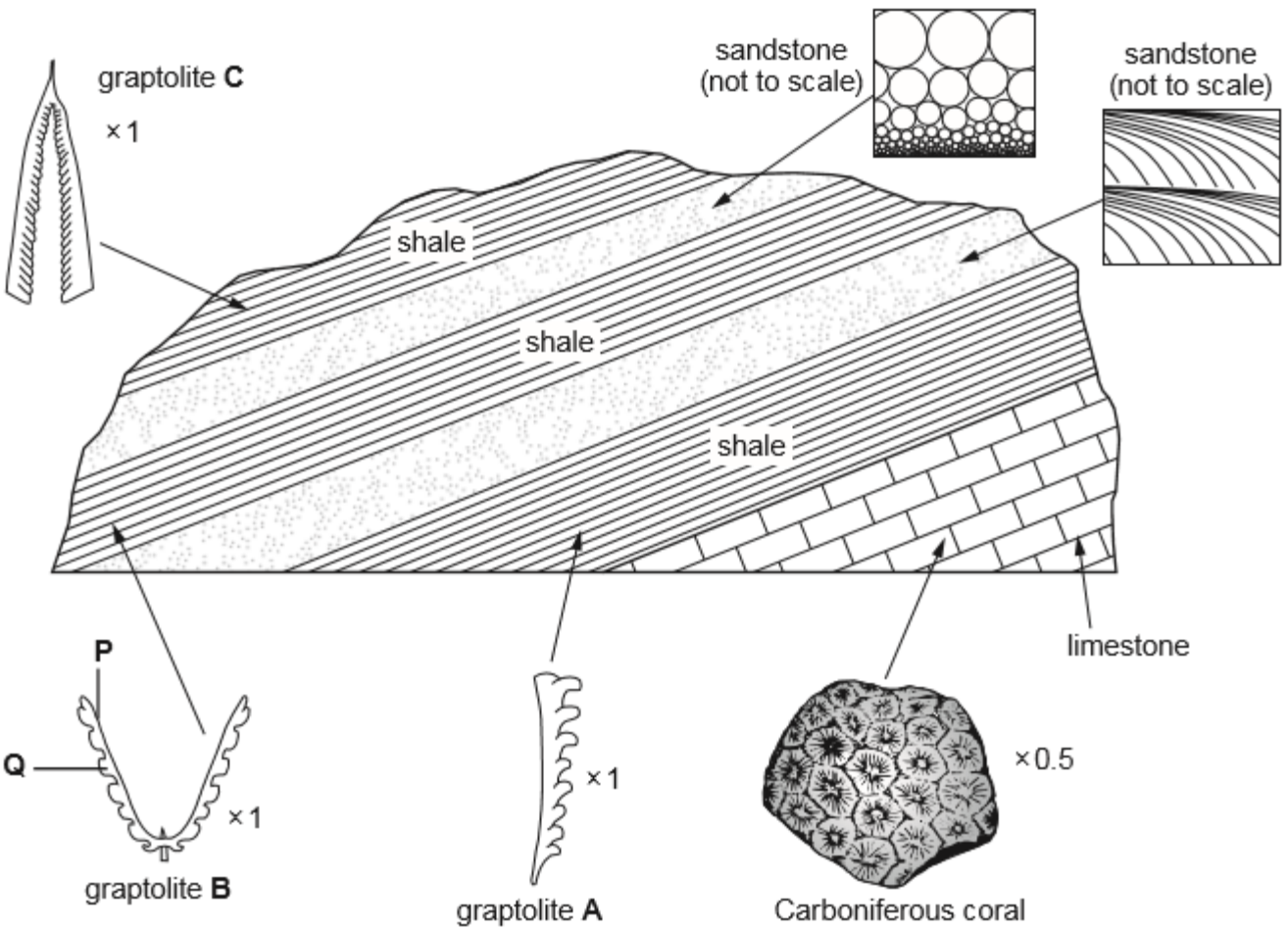


Figure 2

Topic 4 - Earth Structure/Plate Tectonics

6. **Figure 6a** shows the travel paths of P-waves and S-waves for an earthquake. **Figure 6b** shows a seismogram for the earthquake shown in **Figure 6a**.

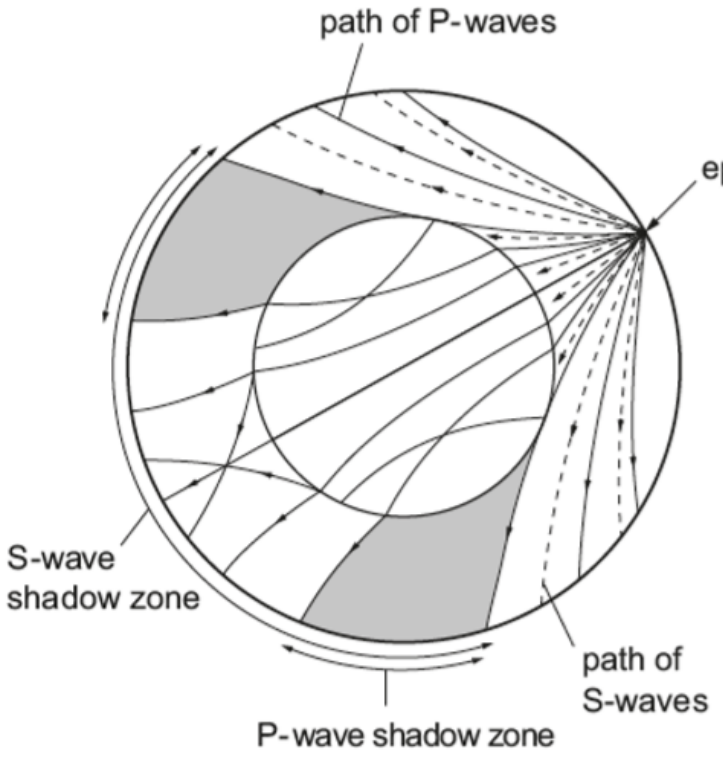


Figure 6a

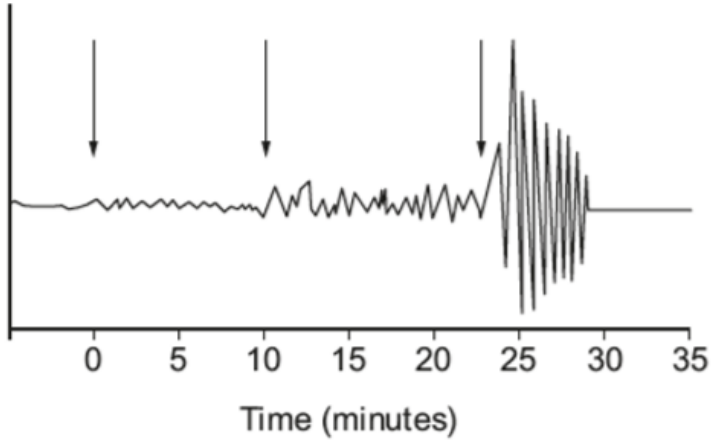


Figure 6b

Topic 4 - Earth Structure/Plate Tectonics

2. **Figure 2a** shows time/distance curves for P and S waves. **Figure 2b** shows P and S wave velocities plotted against increasing depth into the Earth.

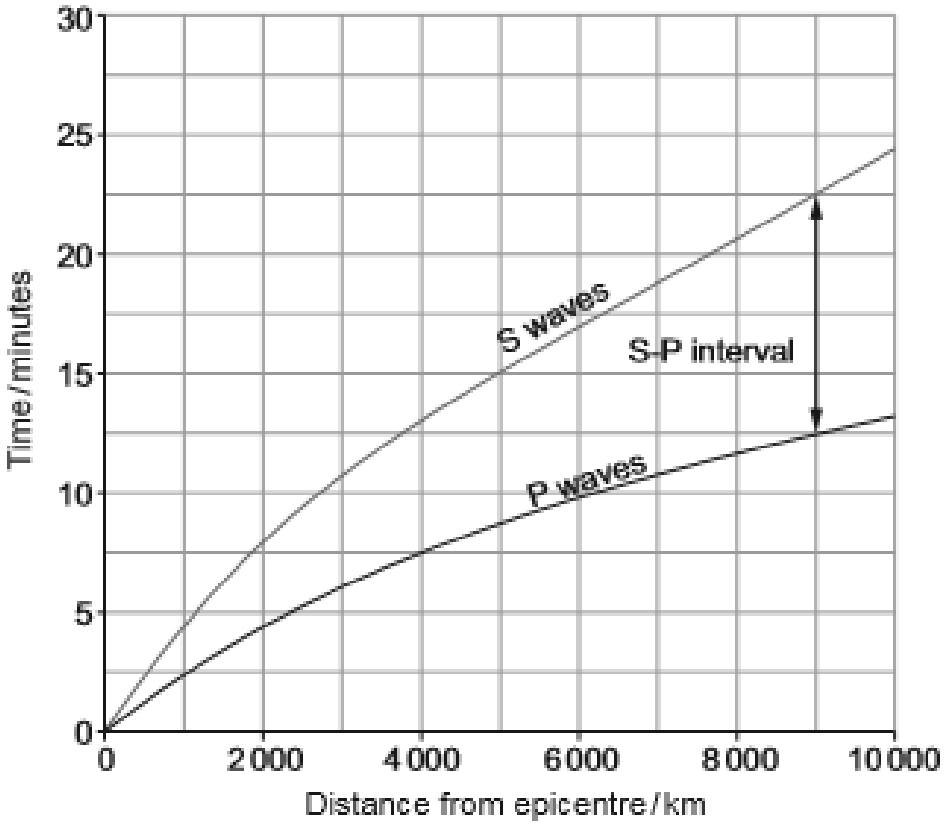


Figure 2a

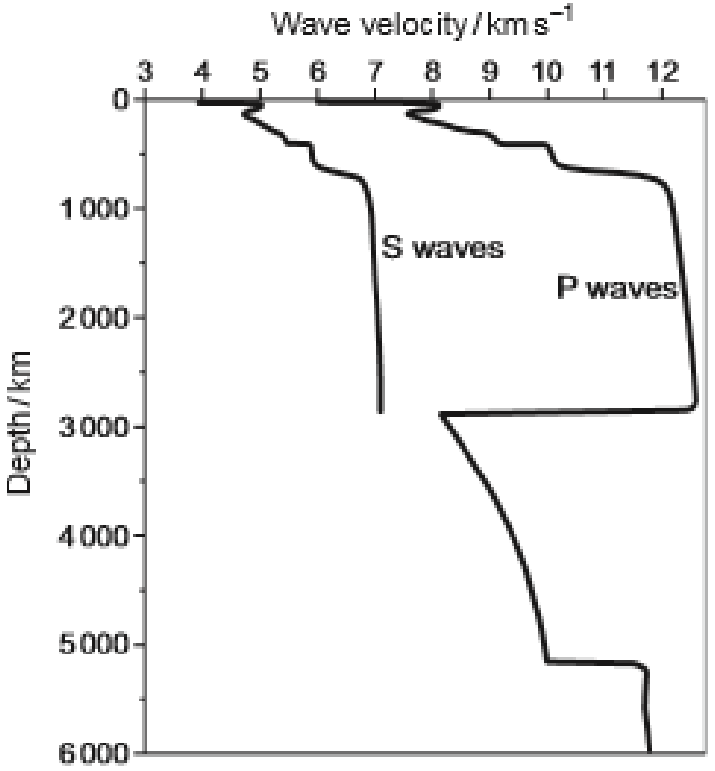


Figure 2b

Topic 4 - Earth Structure/Plate Tectonics

3. **Figure 3a** shows an ocean ridge with a simplified pattern of magnetic reversals in the rocks of the oceanic crust. **Figure 3b** shows the actual pattern of magnetic reversals in the oceanic crust of the Atlantic Ocean and **Figure 3c** shows the time scale for magnetic reversals in the oceanic crust over the last 4.5 million years.

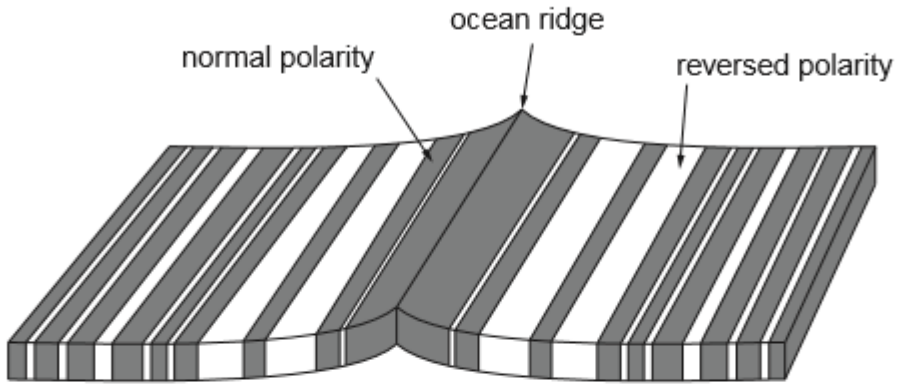


Figure 3a

Figure 3b

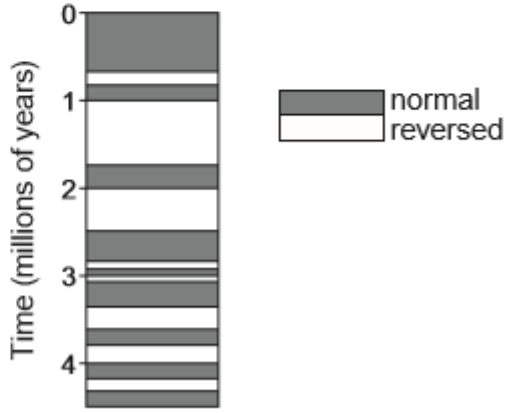


Figure 3c

Topic 4 - Earth Structure/Plate Tectonics

3. **Figure 3a** is a simplified map showing plate tectonic features of part of the western Pacific.

Figure 3b shows the depth of earthquake foci along line **X–Y** on **Figure 3a**.

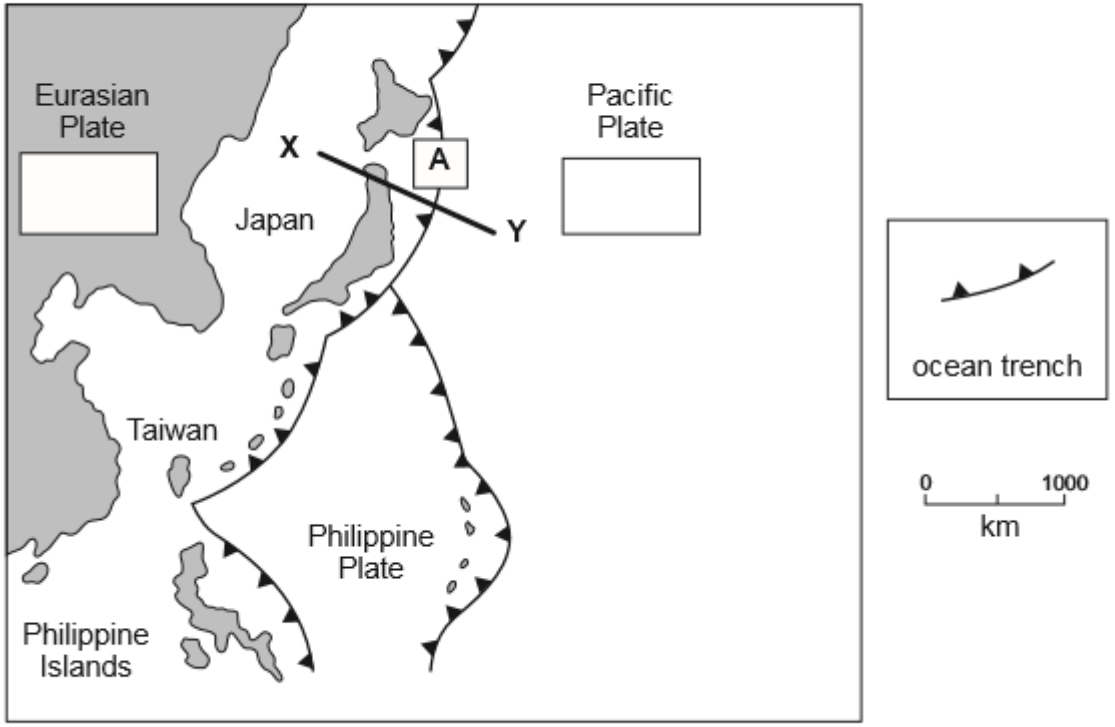


Figure 3a

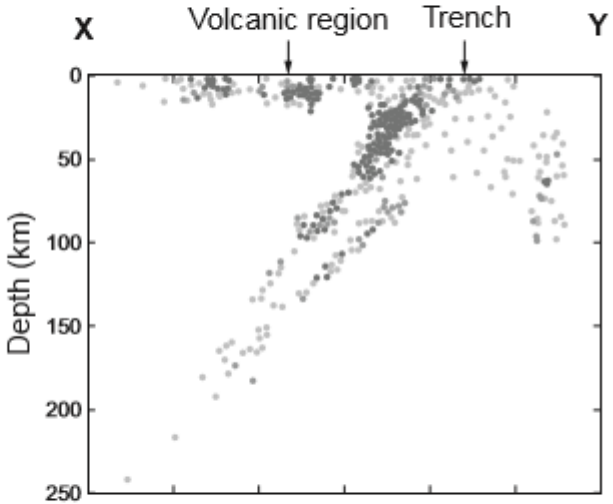


Figure 3b

Topic 4 - Earth Structure/Plate Tectonics

2. **Figure 2a** shows the velocity curves of two types of seismic wave in the continental crust and upper mantle. **Figure 2b** is a map showing four localities **E**, **F**, **G** and **H**.

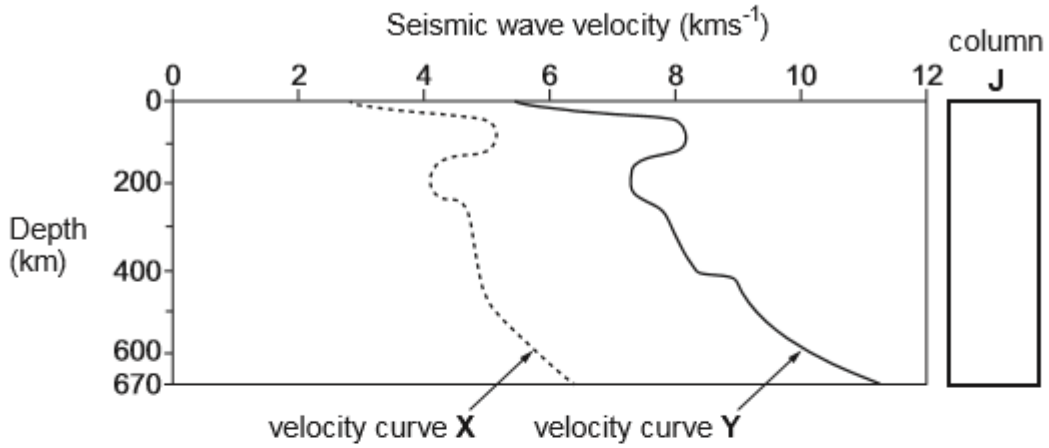


Figure 2a

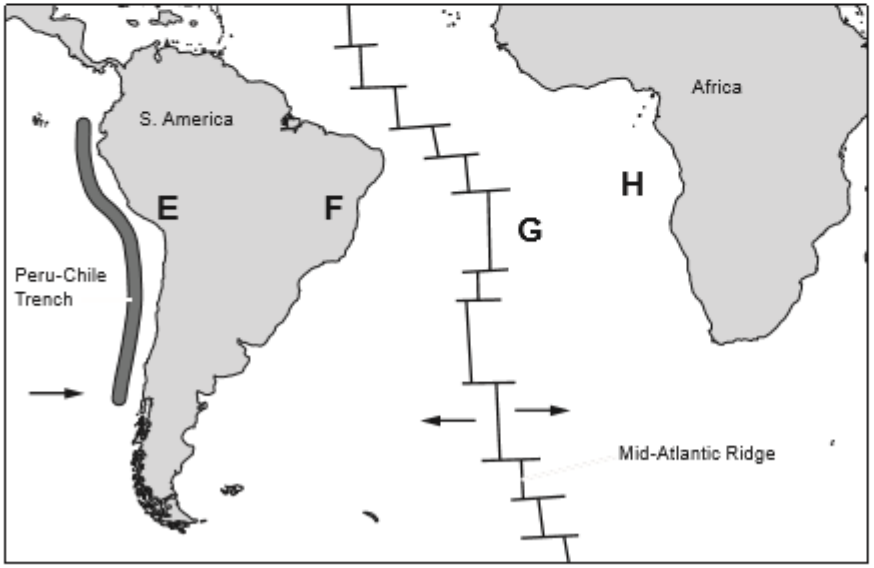


Figure 2b

Topic 4 - Earth Structure/Plate Tectonics

3. **Figure 3a** is a map showing South America and part of the Pacific Ocean. The Pacific sea floor is subdivided based on the age of ocean floor sediments.

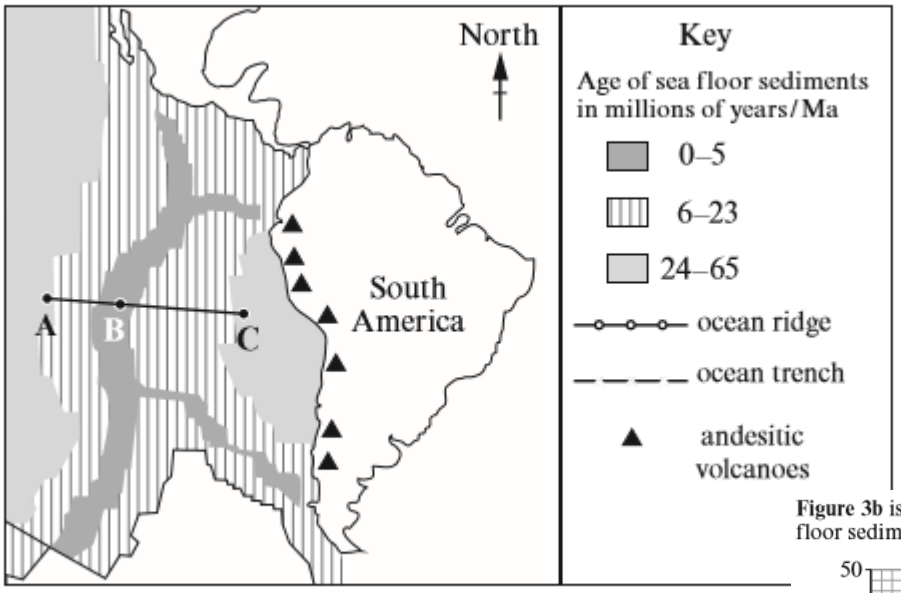


Figure 3a

Figure 3b is a graph of data collected along line **B-C** on **Figure 3a**, showing the age of ocean floor sediment based on microfossil content.

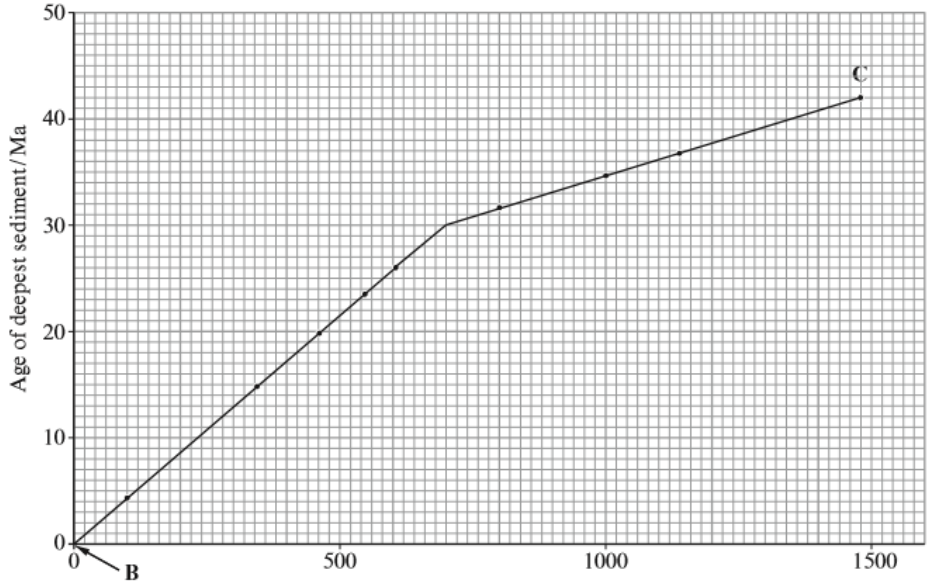


Figure 3b

Topic 4 - Earth Structure/Plate Tectonics

Figure 1a is a simplified map showing plate tectonic features of New Zealand.
Figure 1b is a simplified cross-section through the upper part of the Earth from west to east across the Kermadec Trench on **Figure 1a**.

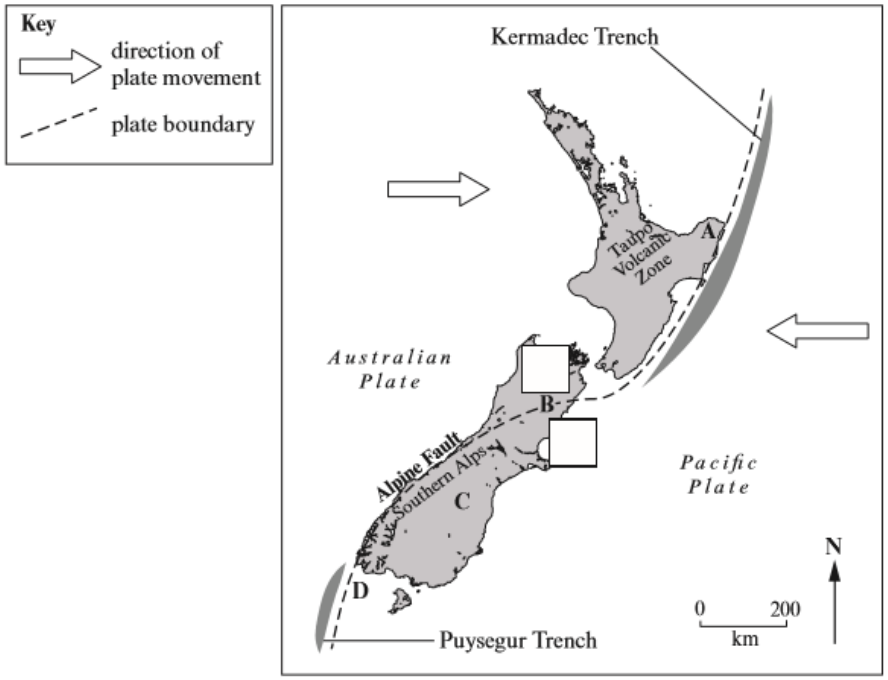


Figure 1a

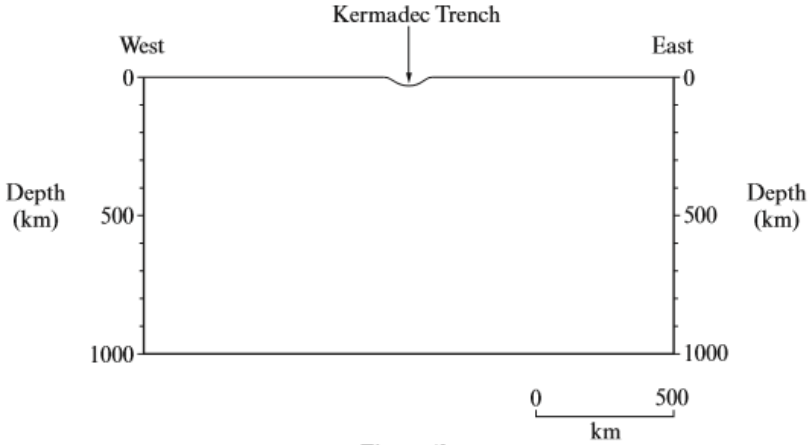


Figure 1b

Topic 4 - Earth Structure/Plate Tectonics

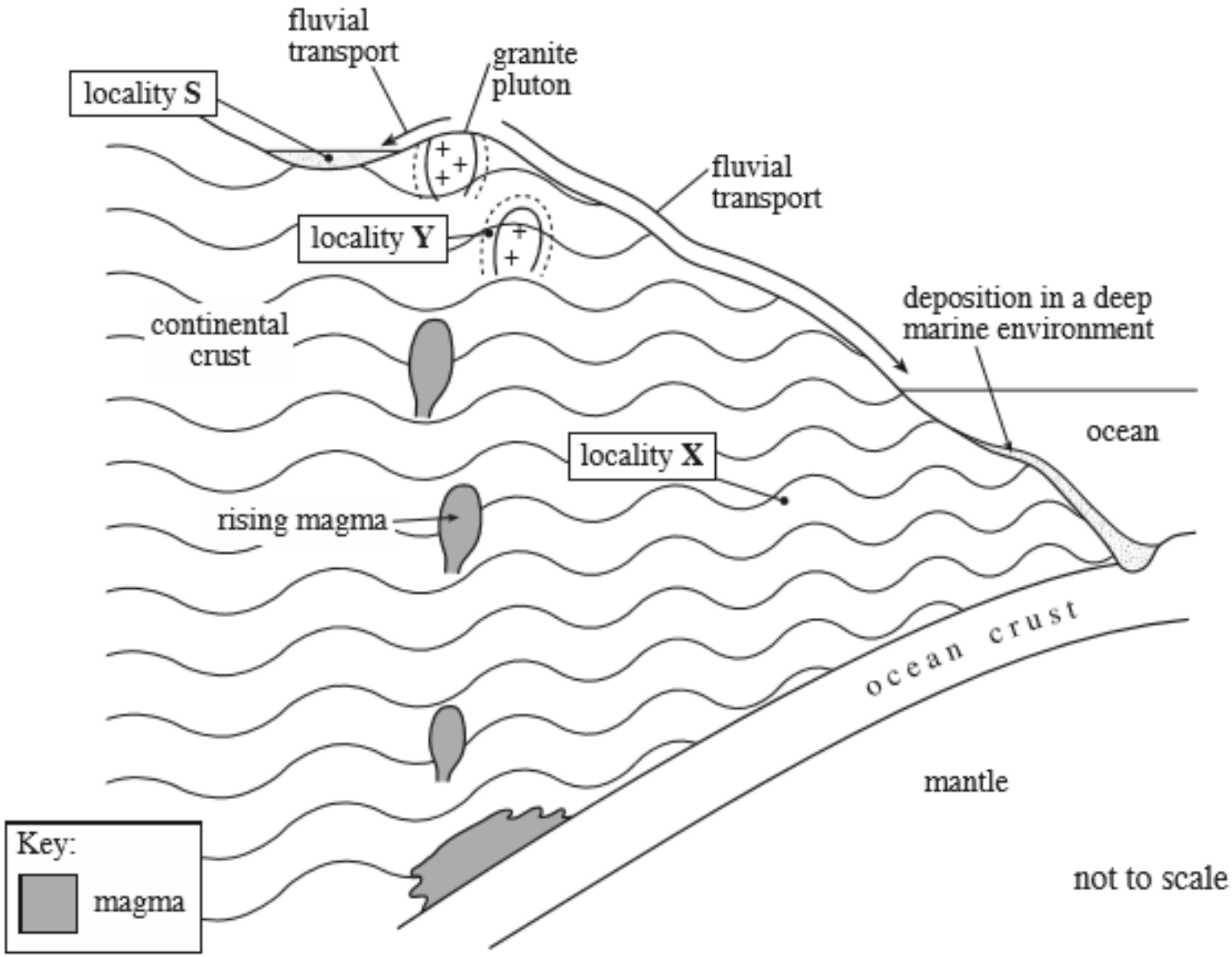


Figure 1b

Topic 4 - Earth Structure/Plate Tectonics

(c) The thickness of the sediments forming layer **P** varies across the Atlantic Ocean. The relative thickness of layer **P** at locality **A** on **Figure 1b** is plotted on the graph, **Figure 1c**.

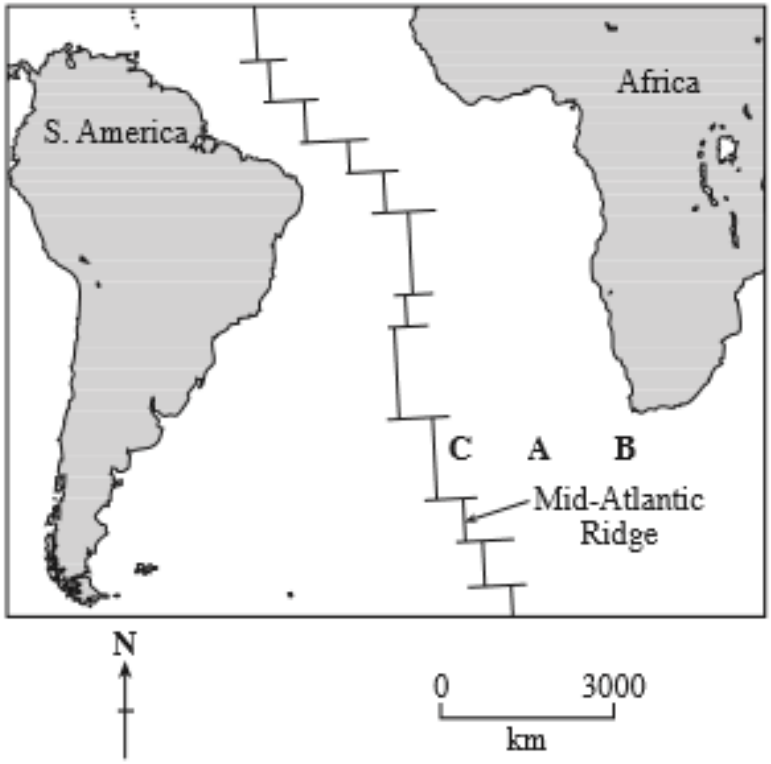


Figure 1b

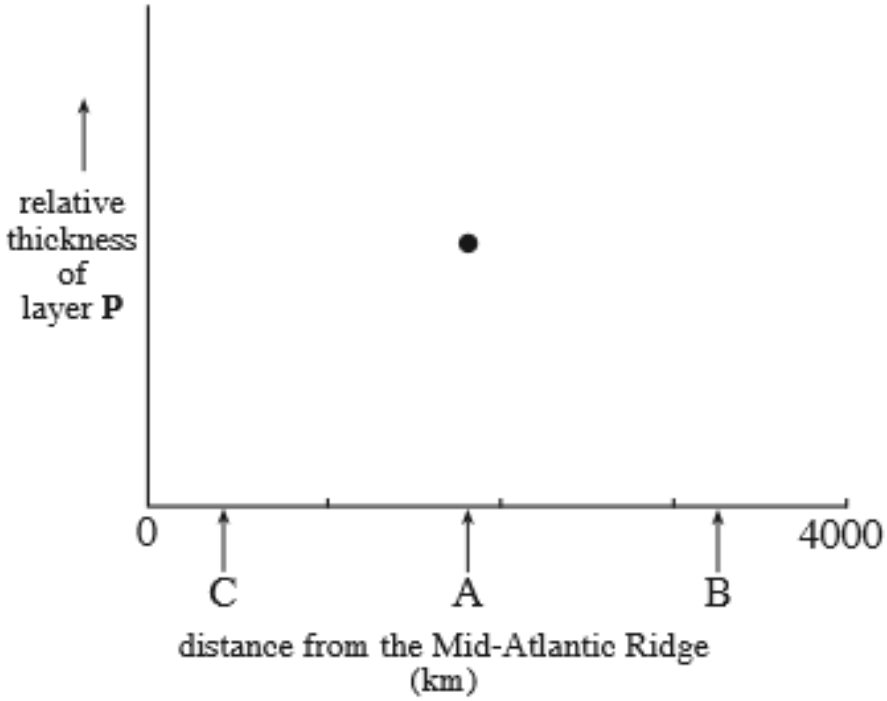


Figure 1c

Topic 4 - Earth Structure/Plate Tectonics

1. **Figures 1a** and **1b** give details of the plate tectonic setting of the Tonga Islands in the Pacific Ocean.

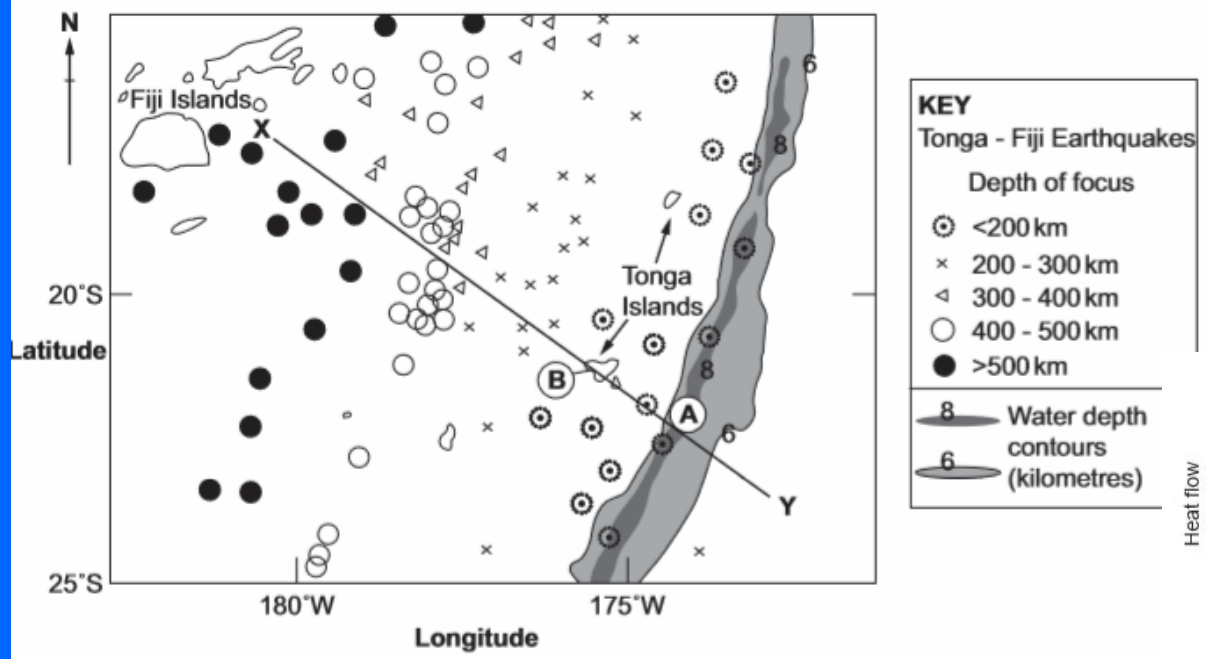
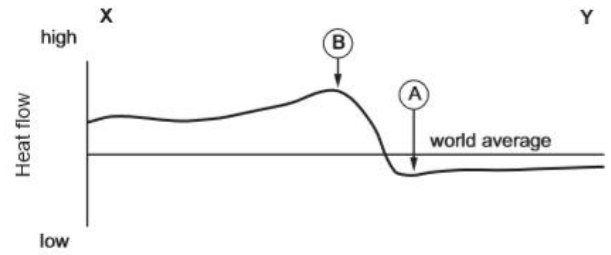


Figure 1a



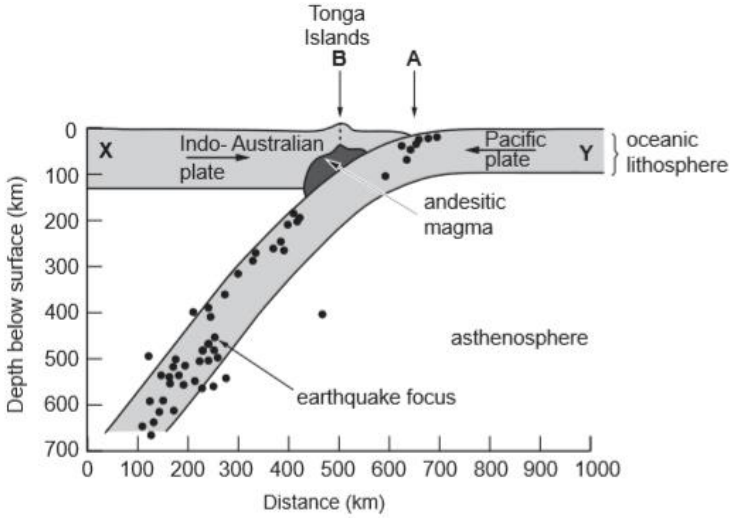


Figure 1b