



# 2013 GEOLOGY

FOR OFFICE USE ONLY

SUPERVISOR CHECK

RE-MARKED

ATTACH SACE REGISTRATION NUMBER LABEL TO THIS BOX

Friday 15 November: 1.30 p.m.

Time: 2 hours

Pages: 25  
Questions: 24

Examination material: one 25-page question booklet  
one 8-page script book  
one multiple-choice answer sheet  
one SACE registration number label

Approved dictionaries and calculators may be used.

### Instructions to Students

- You will have 10 minutes to read the paper. You must not write in your question booklets or script book or on your multiple-choice answer sheet, or use a calculator during this reading time but you may make notes on the scribbling paper provided.
- This paper is in three sections:
  - Section A: Multiple-choice Questions** (Questions 1 to 15)  
Answer this section on the separate multiple-choice answer sheet, using black or blue pen.  
Answer **all** questions in Section A.
  - Section B: Short-answer Questions** (Questions 16 to 23)  
Answer this section in the spaces provided in this question booklet.  
Answer **all** questions in Section B.
  - Section C: Extended-response Question** (Question 24)  
Answer this question in the separate script book.  
*Include at least one field example and at least one well-labelled diagram.*
- The allocation of marks and the suggested (approximate) allotment of time are as follows:
 

Section A	30 marks	30 minutes
Section B	70 marks	70 minutes
Section C	20 marks	20 minutes
Total	120 marks	120 minutes
- The geological time-scale is on page 25. You may remove it from this booklet before the examination begins.
- Attach your SACE registration number label to the box at the top of this page. Copy the information from your SACE registration number label into the boxes on your multiple-choice answer sheet and on the front cover of your script book.
- At the end of the examination, place your script book and multiple-choice answer sheet inside the back cover of this question booklet.

**STUDENT'S DECLARATION ON THE USE OF  
CALCULATORS**

By signing the examination attendance roll I declare that:

- my calculators have been cleared of all memory
- no external storage media are in use on these calculators.

I understand that if I do not comply with the above conditions for the use of calculators I will:

- be in breach of the rules
- have my results for the examination cancelled or amended
- be liable to such further penalty, whether by exclusion from future examinations or otherwise, as the SACE Board of South Australia determines.

## SECTION A: MULTIPLE-CHOICE QUESTIONS (Questions 1 to 15)

(30 marks)

Answer **all** questions in this section.

Each of the multiple-choice questions in Section A involves choosing from four alternative answers. Read each question carefully. Then indicate the **one** alternative that you consider best answers the question by shading the bubble by the appropriate letter alongside the question number on the multiple-choice answer sheet. Use black or blue pen. It is in your interest to give an answer to every question in this section of the paper, as no marks are deducted for incorrect answers. Each question is worth 2 marks. You should spend about 30 minutes on this section.

1. Refer to the following photograph, which shows an erosion process:



The most significant agent of erosion in this situation is:

- J. gravity.
- K. water.
- L. wind.
- M. ice.

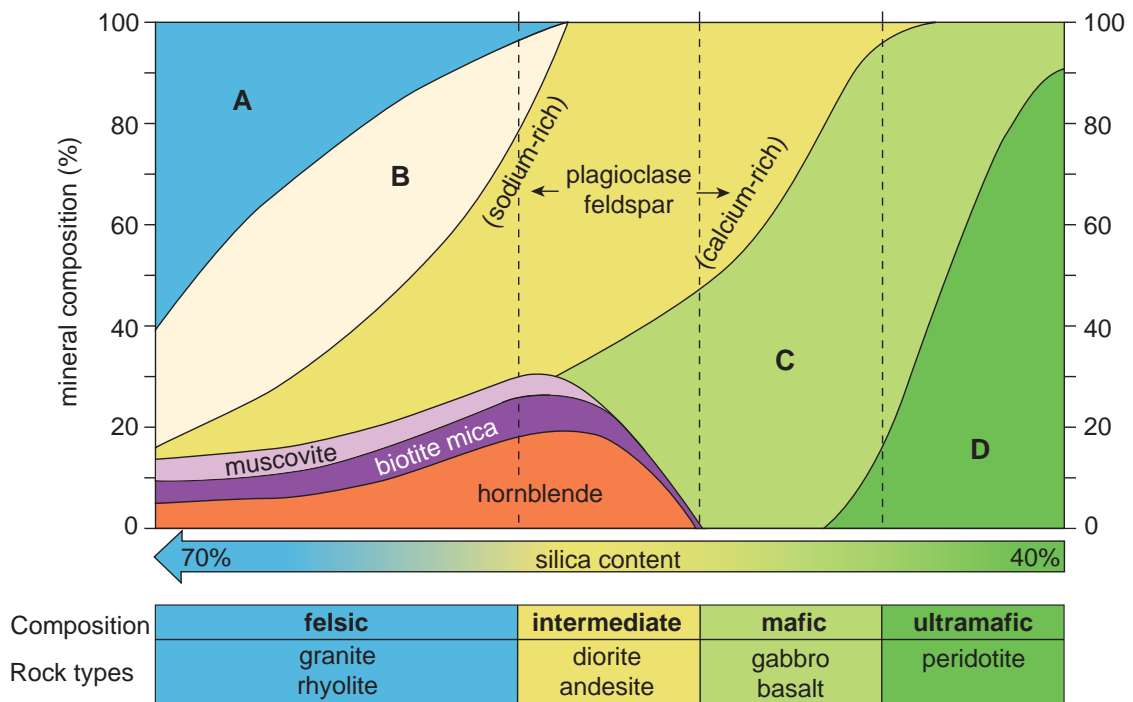
2. There are nine common rock-forming minerals.  
Which one of the following statements about them is correct?
- J. They are all silicates.
  - K. Some are metallic ores.
  - L. Some are chemically unstable at the Earth's surface.
  - M. They all weather to form clays at the Earth's surface.
3. Quartz is commonly found in sedimentary rocks because it:
- J. is not found in the mantle.
  - K. is resistant to weathering.
  - L. does not possess any cleavage planes.
  - M. is commonly found in igneous rocks.
4. Which one of the following terms identifies a small, dark, glassy object produced by the impact of an extraterrestrial body?
- J. Meteorite.
  - K. Coesite.
  - L. Iridium.
  - M. Tektite.
5. Refer to the following diagram, which shows stratigraphic columns at three locations within 1 km of each other. The strata have not been overturned:



The reason that the fossil in strata 3 does not occur at location C is most likely because:

- J. climate change caused the sea level to fall.
- K. the sea in which it lived did not reach that location.
- L. a period of erosion occurred before the fossil in strata 9 was deposited.
- M. a period of erosion occurred after the fossil in strata 9 was deposited.

6. Refer to the following diagram, which shows minerals present in common igneous rocks:



Source: Adapted from I.F. Clark & B.J. Cook (eds), *Geological Science: Perspectives of the Earth*, Australian Academy of Science, Canberra, 1983, p. 154

Which one of the following alternatives correctly names the minerals that are labelled A, B, C, and D in the diagram?

	A	B	C	D
J.	orthoclase feldspar	olivine	augite	quartz
K.	olivine	quartz	augite	orthoclase feldspar
L.	quartz	augite	orthoclase feldspar	olivine
M.	orthoclase feldspar	quartz	augite	olivine

7. An essential characteristic of metamorphic change is that it:

- J. happens very quickly.
- K. occurs in molten rock.
- L. occurs in the solid state.
- M. always changes the chemical composition of rocks.

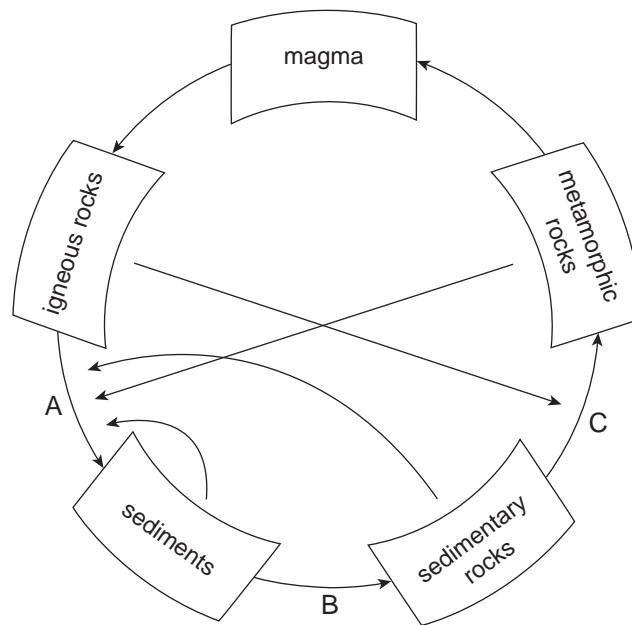
8. A seismic survey is used in exploration most often to determine:
- J. the presence or absence of ore minerals associated with petroleum.
  - K. the presence or absence of a petroleum deposit.
  - L. whether there are rock structures that could trap petroleum.
  - M. whether there have been changes in petroleum deposits over time.
9. The most suitable site for a high-rise building would be:
- J. a levelled, rehabilitated quarry containing clean fill covered with topsoil.
  - K. gently sloping, thickly bedded quartz sandstone covered with sandy soil.
  - L. a well-vegetated sand dune between a lake and the ocean.
  - M. gently sloping, deeply weathered shale overlooking a river mouth.
10. Refer to the following photograph, which shows an extrusive igneous land-form with a basal diameter of 10 km:



This land-form is most likely a:

- J. flood basalt.
- K. cinder cone.
- L. composite cone.
- M. shield cone.

11. Refer to the following diagram, which represents the rock cycle:



Which one of the following alternatives best describes the processes occurring at A, B, and C in the diagram above?

	A	B	C
J.	burial with cementation	burial with intense heat and pressure	weathering, erosion, and deposition
K.	weathering, erosion, and deposition	burial with cementation	burial with intense heat and pressure
L.	burial with intense heat and pressure	burial with cementation	cooling and uplift
M.	weathering, erosion, and deposition	burial with intense heat and pressure	cooling and crystallisation

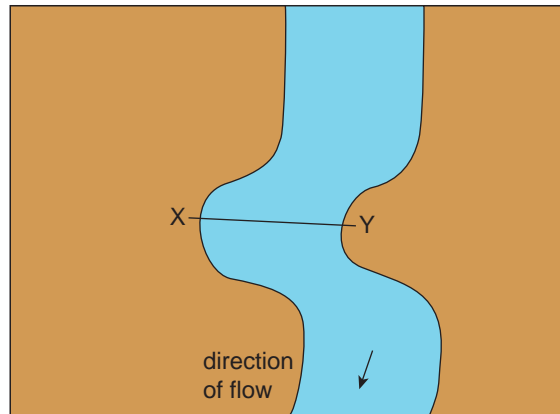
12. Which one of the following is least likely to cause the contamination of groundwater?

- J. Flooding of tailings dams at mine sites.
- K. Washing down of dairy cow yards and animal feedlots.
- L. Extraction of geothermal energy.
- M. Fracking for the extraction of coal seam gas.

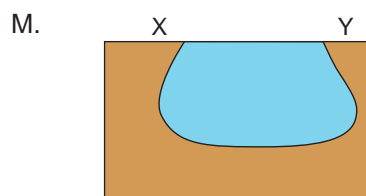
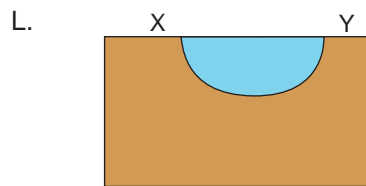
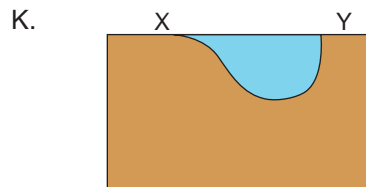
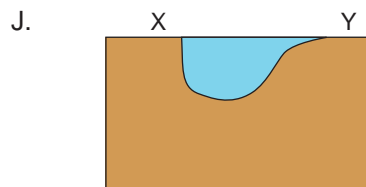
13. The half-life of a radioactive isotope refers to the:

- J. time taken for it to decay to half of its original mass.
- K. relative mass remaining after half a million years.
- L. time taken for the mass of daughter products to decrease by half.
- M. time taken for half of the parent isotope to form.

14. Refer to the following diagram, which shows an aerial view of a meandering river with the direction of flow indicated:

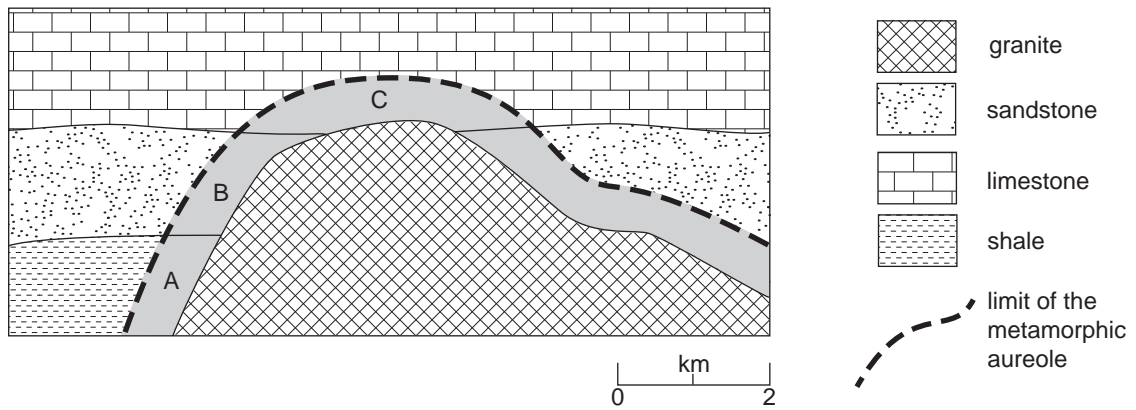


Which one of the following is most likely to be the cross-section through XY?





15. Refer to the following diagram, which shows a geological cross-section:



Which one of the following alternatives correctly names rocks A, B, and C?

	A	B	C
J.	hornfels	marble	quartzite
K.	slate	gneiss	marble
L.	slate	marble	quartzite
M.	hornfels	quartzite	marble

**SECTION B: SHORT-ANSWER QUESTIONS** (Questions 16 to 23)

(70 marks)

Answer **all** questions in this section. Write your answers in the spaces provided under each question. The allocation of marks is shown in brackets at the end of each part of each question. You should spend about 70 minutes on this section.

16. Refer to the following photograph, which shows a boundary between two different rock types, labelled A and B:



(a) (i) Identify which of the two rock types, A or B, appears to be less resistant to erosion.

\_\_\_\_\_ (1 mark)

(ii) State one feature of the rock you identified in part (a)(i) that might cause it to have low resistance to erosion.

\_\_\_\_\_  
\_\_\_\_\_ (1 mark)

(b) A geologist believes that the boundary between rocks A and B may once have been the bed of a fast-flowing river. State two forms of evidence in the photograph that support this claim.

(i) \_\_\_\_\_ (1 mark)

(ii) \_\_\_\_\_ (1 mark)

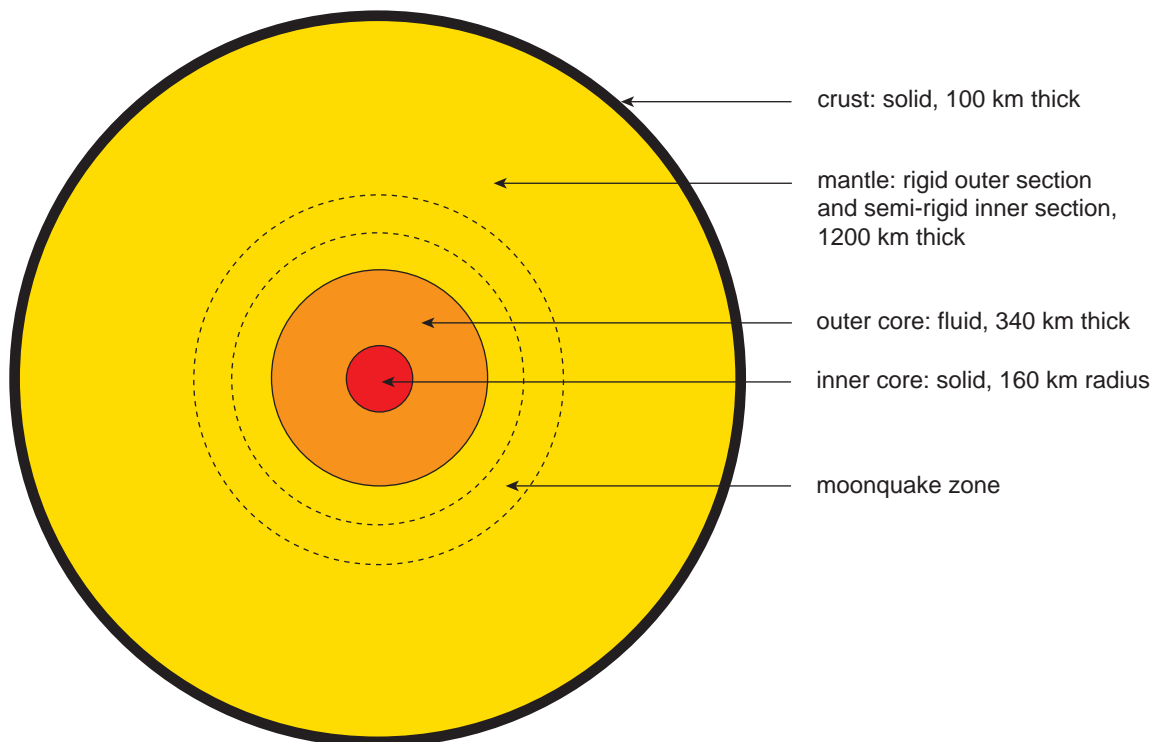
(c) (i) Which one of the locations labelled on the photograph (1, 2, 3, or 4) is most likely to contain alluvial gold? Circle your answer below:

1                      2                      3                      4                      (1 mark)

(ii) Explain why gold is most likely to be found at this location.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2 marks)

17. Refer to the following diagram, which shows a cross-section of the Earth's moon:



The moon has a radius of approximately 1800 km, very little atmosphere, and no tectonic plates. Within the mantle is the 'moonquake zone', which is where seismic activity occurs. When energy is released vibrations are felt on the surface. These moonquakes are generally much milder than earthquakes.

(a) Identify two similarities between the internal structure of the moon and that of the Earth.

(i) \_\_\_\_\_  
\_\_\_\_\_ (1 mark)

(ii) \_\_\_\_\_  
\_\_\_\_\_ (1 mark)

(b) Identify two differences between the internal structure of the moon and that of the Earth.

(i) \_\_\_\_\_  
\_\_\_\_\_ (1 mark)

(ii) \_\_\_\_\_  
\_\_\_\_\_ (1 mark)

(c) Using the information given about the moon, describe two reasons why the surface of the moon remains relatively unchanged whereas the surface of the Earth is constantly changing.

(i) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2 marks)

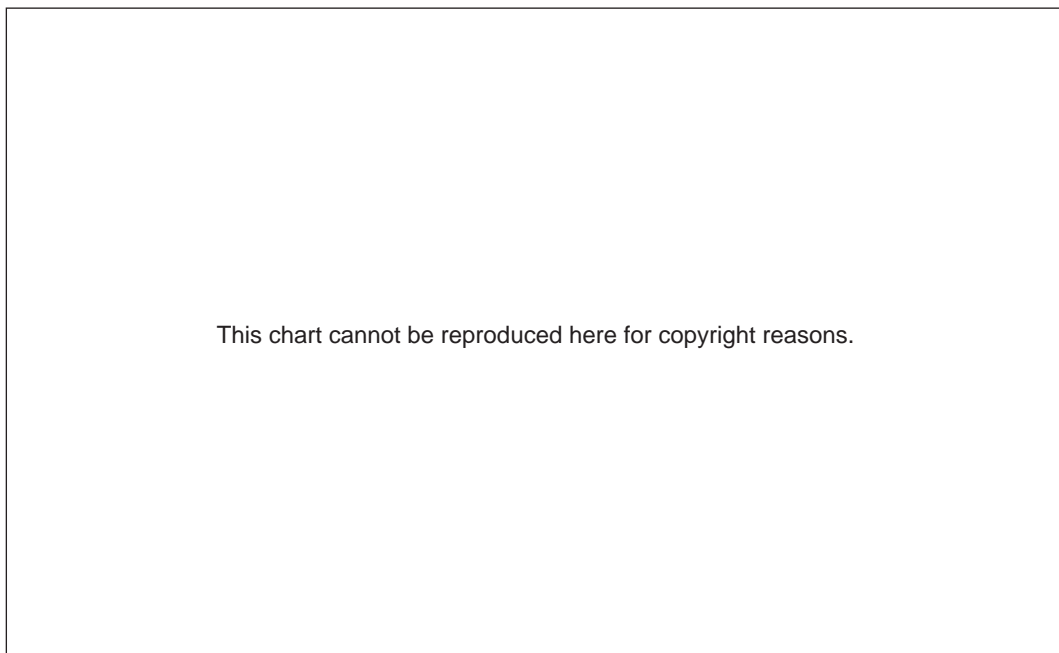
(ii) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2 marks)

18. Refer to the following table, which shows the geological periods during which several members of a class of animals known as cephalopods existed. This class includes animals living today, such as octopi and squid, as well as extinct animals, such as ammonites:

Cephalopod group	Geological period range
ammonites	Devonian to Cretaceous
belemnites	Jurassic to Cretaceous
ceratites	Triassic
goniatites	Devonian to Permian
nautiloids	since early Devonian
octopods	since early Jurassic
orthocones	Ordovician to Devonian
teuthids	since early Devonian

- (a) In the following chart, shade the areas that represent the geological periods during which each group of animals existed.

*The time range during which the nautiloids existed has been shaded as an example.*



Source: Adapted from Oregon Public Broadcasting and PBS 2001, 'Relative dating: telling time using fossils', *American Field Guide*, viewed 5 June 2013, <<http://www.pbs.org/americanfieldguide/teachers/fossils/fossils.pdf>>

(2 marks)

(b) Use the geological time-scale (page 25) to state the age range, in millions of years, of a rock that contains the following groups of fossils:

(i) Teuthids: \_\_\_\_\_ (1 mark)

(ii) Orthocones and teuthids: \_\_\_\_\_ (1 mark)

(c) Explain why a rock that contains several fossil types is more useful for dating rocks than a rock that contains only one fossil type.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2 marks)

(d) One of the most prolific periods for oil formation was the Cretaceous period, during which significant quantities of marine algae died and accumulated on the sea floor.

(i) Name the cephalopod group that would provide the most useful information to a petroleum geologist.

\_\_\_\_\_ (1 mark)

(ii) Give a reason for your answer to part (d)(i).

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (1 mark)

19. Refer to the following table, which shows average concentrations of carbon dioxide (CO<sub>2</sub>, in ppm) in air samples taken daily from the summit of Mauna Loa (a Hawaiian volcano) at regular intervals between 2010 and 2013:

Year	Month	Concentration of CO <sub>2</sub> (ppm)
2010	February	389.9
	June	392.2
	October	387.2
2011	February	391.8
	June	393.7
	October	388.9
2012	February	393.6
	June	395.8
	October	391.0
2013	February	396.8
	June	398.6

Source: Adapted from Keeling, C.D. & Tan, P. 2013, CO<sub>2</sub> expressed as a mole fraction in dry air, micromol/mol, abbreviated as ppm, National Oceanic and Atmospheric Administration, United States of America, viewed 17 June 2013, <ftp://ftp.cmdl.noaa.gov/ccg/co2/trends/co2\_mm\_mlo.txt>

(a) Using the following grid, draw a line graph connecting all of the data shown in the table. Complete the labelling of both axes.



(5 marks)



(b) Suggest a likely cause of the short-term periodic fluctuations in the concentration of CO<sub>2</sub>.

\_\_\_\_\_

\_\_\_\_\_ (1 mark)

(c) (i) State the overall trend in the level of CO<sub>2</sub> concentration that is evident during this time period.

\_\_\_\_\_

\_\_\_\_\_ (1 mark)

(ii) Describe one human activity that may be linked to this trend in CO<sub>2</sub> concentration.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ (2 marks)

(iii) Explain how this trend in CO<sub>2</sub> concentration has influenced the change in the average temperature of the Earth's atmosphere in the last 200 years.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ (2 marks)

(d) Sampling of air is one method of obtaining data about atmospheric composition.

(i) Describe one factor that scientists would need to consider when selecting a suitable site from which to take air samples.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ (2 marks)

(ii) Name one sampling method used to obtain data about both atmospheric composition and climatic changes over geological time.

\_\_\_\_\_ (1 mark)

20. Refer to the following photographs, which show the Hughes pump house and chimney at the historical Moonta copper mines:



As they were in c.1910

Source: © National Trust; Mines and Energy



As they are today

These mines are located in the township of Moonta on the Yorke Peninsula in South Australia. During the early 1900s these were the most prosperous mines in South Australia but by 1923 they had closed down. The Moonta copper mines area is now a South Australian heritage site.

(a) (i) State whether there was a 'mineral deposit' or an 'ore body' at the Moonta site in c.1910.

\_\_\_\_\_ (1 mark)

(ii) Give a reason for your answer to part (a)(i).

\_\_\_\_\_  
\_\_\_\_\_ (1 mark)

(b) Name two copper minerals that could have been mined at the Moonta site.

(i) \_\_\_\_\_ (1 mark)

(ii) \_\_\_\_\_ (1 mark)

(c) Investigations of the extent and grade of the deposit remaining at the Moonta site are currently being considered.

(i) Describe the most likely reason why a local historical society might oppose these investigations.

---

---

---

---

(2 marks)

(ii) Describe two different arguments that a mining company might use to support their application for an exploration licence.

(1) \_\_\_\_\_

---

---

---

(2 marks)

(2) \_\_\_\_\_

---

---

---

(2 marks)

21. Refer to the following newspaper article, which describes gas leakage at the Tara Gas Field:



Source: Adapted from Cubby, B. 2012, 'Methane leaking from coal seam gas field, testing shows', *Sydney Morning Herald*, viewed 9 May 2013, <<http://www.smh.com.au/environment/climate-change/methane-leaking-from-coal-seam-gas-field-testing-shows-20121114-29c9m.html>>

(a) Name the main component of coal seam gas.

\_\_\_\_\_ (1 mark)

(b) Calculate the relative concentration of methane inside the Tara Gas Field compared with the average background level.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2 marks)

(c) Explain why the leaking of methane into the atmosphere is considered a potentially serious environmental issue.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2 marks)

(d) State one other possible source of methane in agricultural regions.

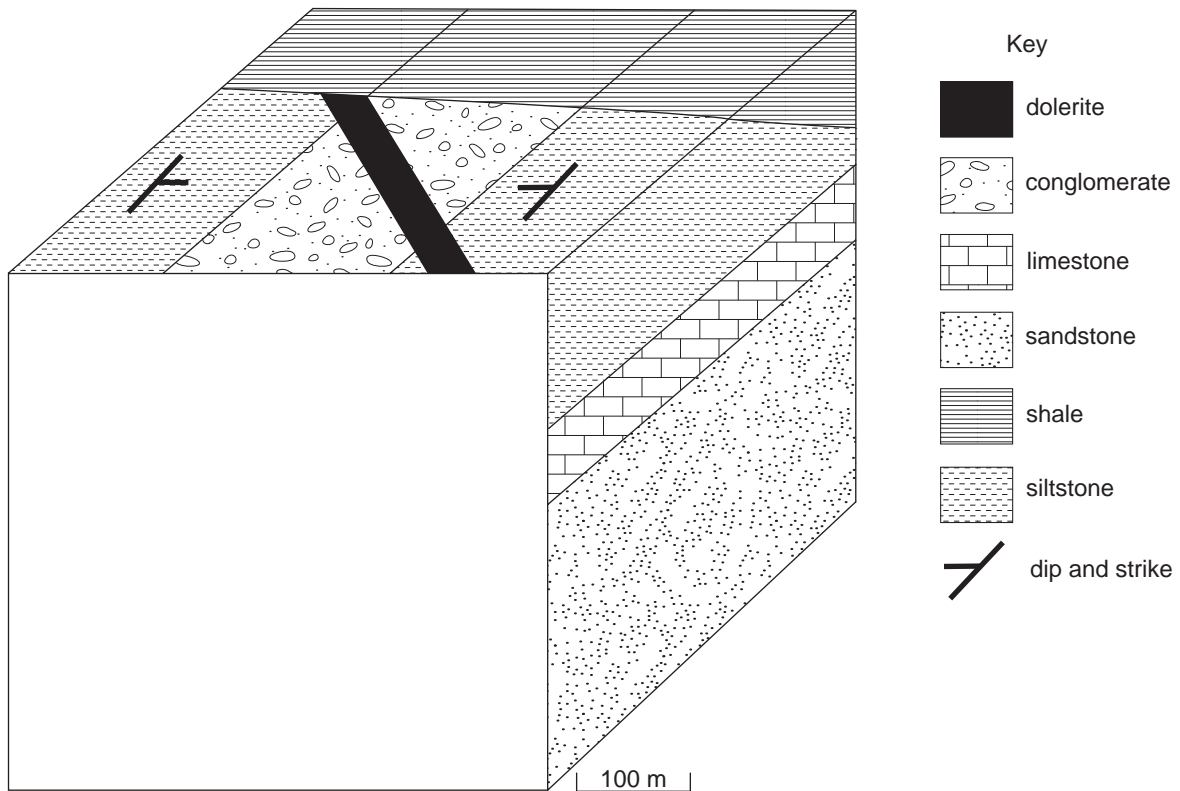
\_\_\_\_\_ (1 mark)

(e) State two reasons why coal seam gas might be considered a better fuel than brown coal for electricity generation.

(i) \_\_\_\_\_  
\_\_\_\_\_ (1 mark)

(ii) \_\_\_\_\_  
\_\_\_\_\_ (1 mark)

22. Refer to the following incomplete block diagram:



(a) Complete the front face of the block diagram. (4 marks)

(b) Draw in the fold axis on the front face of the block diagram. (2 marks)

(c) Mark an unconformity on the top face of the block diagram. (1 mark)

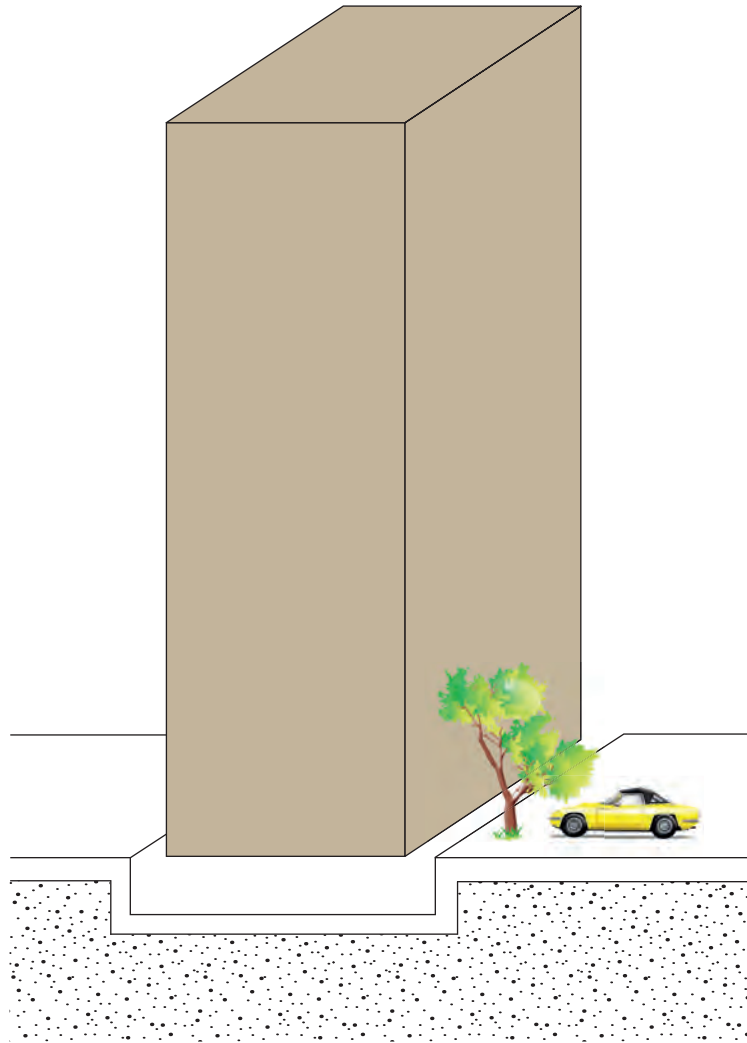
(d) Name the type of fold present.  
 \_\_\_\_\_ (1 mark)

(e) Name the oldest rock in the block diagram.  
 \_\_\_\_\_ (1 mark)

(f) Name the youngest rock in the block diagram.  
 \_\_\_\_\_ (1 mark)

(g) State a reason for your answer to part (f).  
 \_\_\_\_\_  
 \_\_\_\_\_ (1 mark)

23. As a geological engineer you have been asked to include features in the design of a high-rise building that will make it more resistant to damage during an earthquake.



(a) Describe two features that will protect a high-rise building during an earthquake.

(i) \_\_\_\_\_  
\_\_\_\_\_ (1 mark)

(ii) \_\_\_\_\_  
\_\_\_\_\_ (1 mark)

(b) Sketch and label these two features on the simplified diagram above. (2 marks)

**SECTION C: EXTENDED-RESPONSE QUESTION** (Question 24)

(20 marks)

*Answer this section in the separate script book. You should spend about 20 minutes on this section.*

*You should present a clear, logical, and well-illustrated response to this question. Include at least one field example and at least one well-labelled diagram.*

24. Rocks and sediments are deformed by natural stresses in the Earth's crust and upper mantle.

Describe:

- the different conditions under which rocks bend or break
- a petroleum trap that results from deformation
- different forms of deformation at a convergent plate boundary
- how deformation can cause geological hazards.



You may remove this page from the question booklet by tearing along the perforations so that you will have the information in front of you for easy reference.

### THE GEOLOGICAL TIME-SCALE

Eon	Era	Period	Epoch	Date at boundary (million years)
Phanerozoic	Cenozoic	Quaternary	Holocene	0.01
			Pleistocene	
		Neogene	Pliocene	2.6
			Miocene	5
				24
		Palaeogene	Oligocene	35
			Eocene	55
				65
				65
	Mesozoic	Cretaceous	145	
		Jurassic	210	
		Triassic	250	
			250	
		Permian	300	
		Carboniferous	350	
		Devonian	400	
	Palaeozoic	Silurian	440	
		Ordovician	500	
Cambrian		540		
		540		
Ediacaran		600		
		600		
		600		
Precambrian	Proterozoic		2500	
	Archaean		4500	

Source: Adapted from Cohen, K.M., Finney, S. & Gibbard, P. 2013, *International Chronostratigraphic Chart*, International Commission on Stratigraphy, viewed 26 June 2013, <[www.stratigraphy.org/ICSchart/ChronostratChart2013-01.pdf](http://www.stratigraphy.org/ICSchart/ChronostratChart2013-01.pdf)>