



NSW Education Standards Authority

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Centre Number

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Student Number

2024 HIGHER SCHOOL CERTIFICATE EXAMINATION

Earth and Environmental Science

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- Calculators approved by NESAs may be used
- A Geological Time Scale is provided at the back of this paper
- Write your Centre Number and Student Number at the top of this page

Total marks:
100

Section I – 20 marks (pages 2–11)

- Attempt Questions 1–20
- Allow about 35 minutes for this section

Section II – 80 marks (pages 13–36)

- Attempt Questions 21–35
- Allow about 2 hours and 25 minutes for this section

Section I

20 marks

Attempt Questions 1–20

Allow about 35 minutes for this section

Use the multiple-choice answer sheet for Questions 1–20.

- 1 Which of the following occurred during the Ediacaran Period?
 - A. Initial oxygenation of the atmosphere
 - B. Fossilisation of multicellular organisms
 - C. Massive volcanic eruptions in the Siberian traps
 - D. A steady increase in global temperatures continuing to today

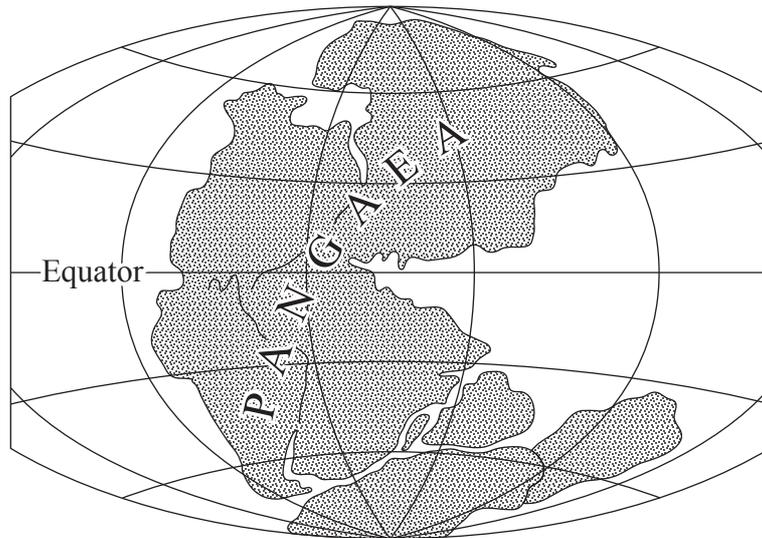
- 2 What leads to the formation of an east coast low?
 - A. Decreasing air pressure over ocean waters
 - B. A sudden change in wind direction and decrease in strength
 - C. Cycling of droplets from lower to higher altitude within a cloud
 - D. Water vapour condensing as it moves up and over a high mountain range

- 3 Which of the following is a feature of communities around black smokers?
 - A. Food webs using energy from photosynthesis
 - B. Biosedimentary structures including stromatolites
 - C. Organisms using energy derived from volcanic chemicals
 - D. Biochemical processes modelled by Harold Urey and Stanley Miller

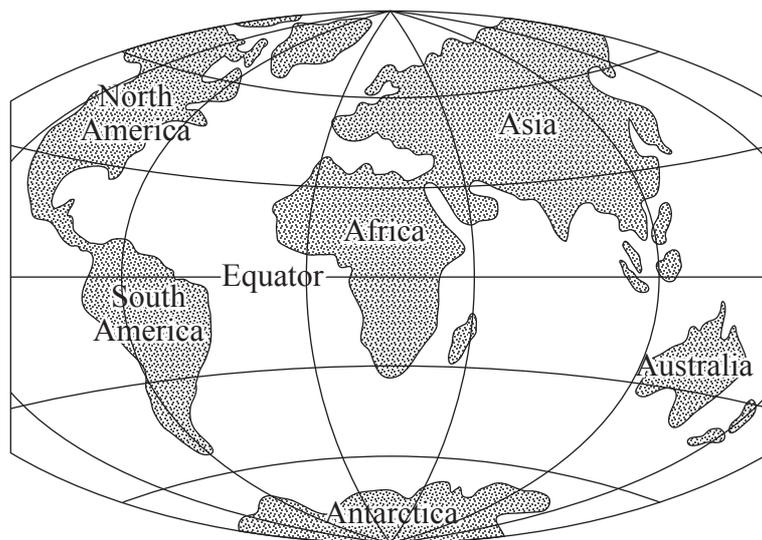
- 4 Which of the following is a human activity that could increase the frequency and magnitude of landslides?
 - A. Engaging in extensive logging on hillsides
 - B. Destabilising waterlogged soil by prolonged rainfall
 - C. Loosening material on steep slopes by seismic vibrations
 - D. Converting farmland for suburban development on river flats

- 5 Which of the following provides ancient evidence of variations in global temperatures?
- A. Dendrochronology
 - B. Gas bubbles in ice cores
 - C. Pollen grains in sedimentary rocks
 - D. Isotopic ratios in stalactites and stalagmites
- 6 When did the Ordovician Period occur?
- A. 430 → 500 Ma BP
 - B. 490 → 440 Ma BP
 - C. 500 → 420 Ma BP
 - D. 550 → 250 Ma BP
- 7 What is the purpose of disaster warning systems in areas with high earthquake risk such as Japan and California?
- A. To help people prepare an emergency survival kit
 - B. To give people sufficient time to evacuate major cities
 - C. To ensure buildings are designed to survive the effects of ground movements
 - D. To initiate emergency responses such as switching on backup power generators
- 8 Why is scientific research into climate adaptation strategies essential?
- A. To reverse the changes in climate
 - B. To reduce dependence on non-renewable resources
 - C. To develop action plans to respond to changes in climate
 - D. To limit temperature increases to internationally agreed targets

- 9 The maps show the rearrangement of Earth's continents from the Permian Period to the present day.



Permian Period



Present day

© United States Geological Survey.

The present day global climate is warmer and wetter than at the time of the Pangaea supercontinent.

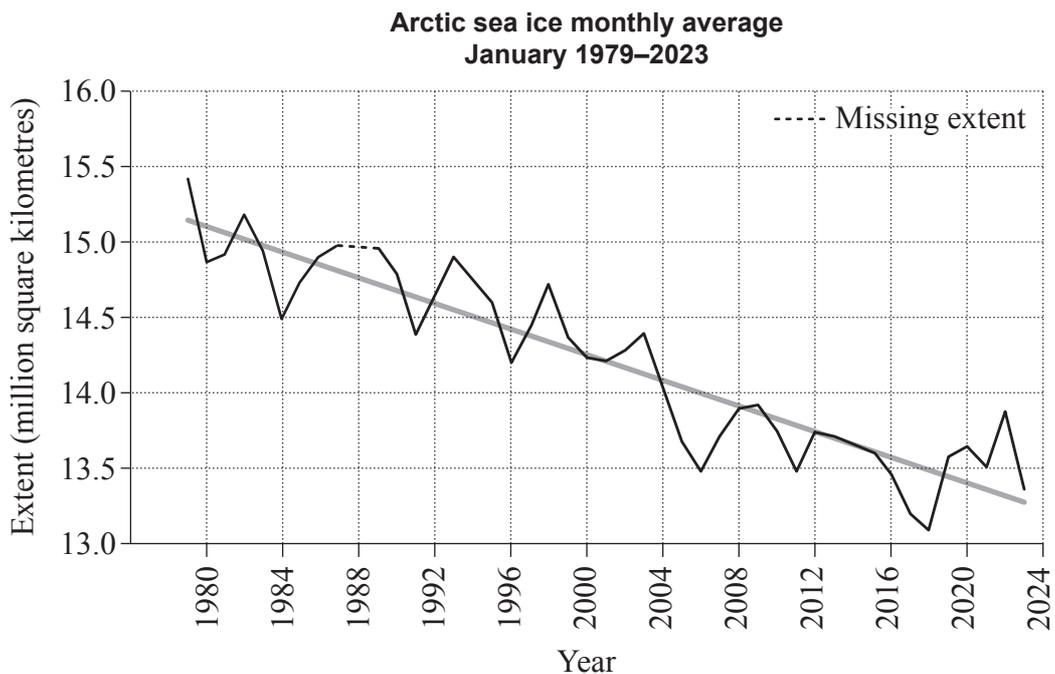
Which of the following is the most likely cause for these changes in climate over this time period?

- A. Changes to ocean circulation
- B. Reduction in polar ice coverage
- C. Volcanic activity during the Permian Period
- D. Increased greenhouse gas production due to early industrial activity

- 10 Which pair of statements comparing the natural and anthropogenic greenhouse effects is correct?

	<i>Natural greenhouse effect</i>	<i>Anthropogenic greenhouse effect</i>
A.	Caused by greenhouse gases trapping UV radiation in the atmosphere	Caused by greenhouse gases emitted through human activities
B.	Keeps Earth at a suitable temperature to sustain life	Sustains Earth's present levels of biodiversity
C.	Some incoming solar radiation is trapped by atmospheric greenhouse gases	All incoming solar radiation is trapped by atmospheric greenhouse gases
D.	Greenhouse gas levels vary over time through environmental processes	Greenhouse gases accumulate faster than environmental processes can remove them

- 11 Data collected from satellites is used to measure the extent of sea ice in the Arctic.

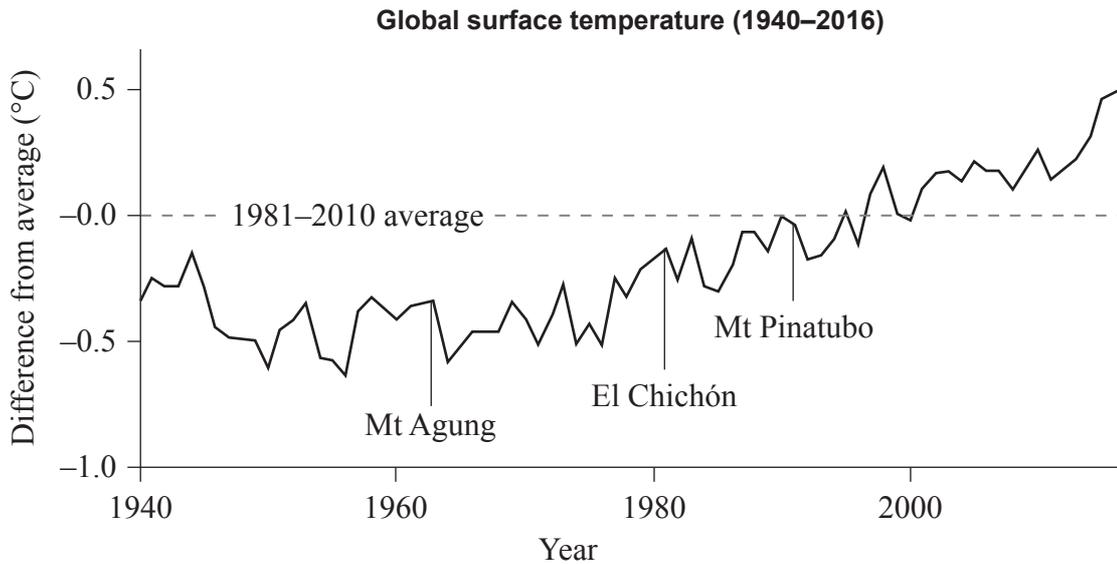


Graph courtesy of the National Snow and Ice data Center, University of Colorado, Boulder.

Which of the following predictions regarding the extent of Arctic sea ice can be inferred from these data and your understanding of climate change?

- A. It will stabilise at 13.5 million square kilometres.
- B. It will fall below 13 million square kilometres by 2032.
- C. It will fall by 0.425 million square kilometres each year.
- D. It will continue to fall and disappear completely by 2032.

- 12 Changes in global surface temperature associated with three major volcanic eruptions are indicated on the graph.

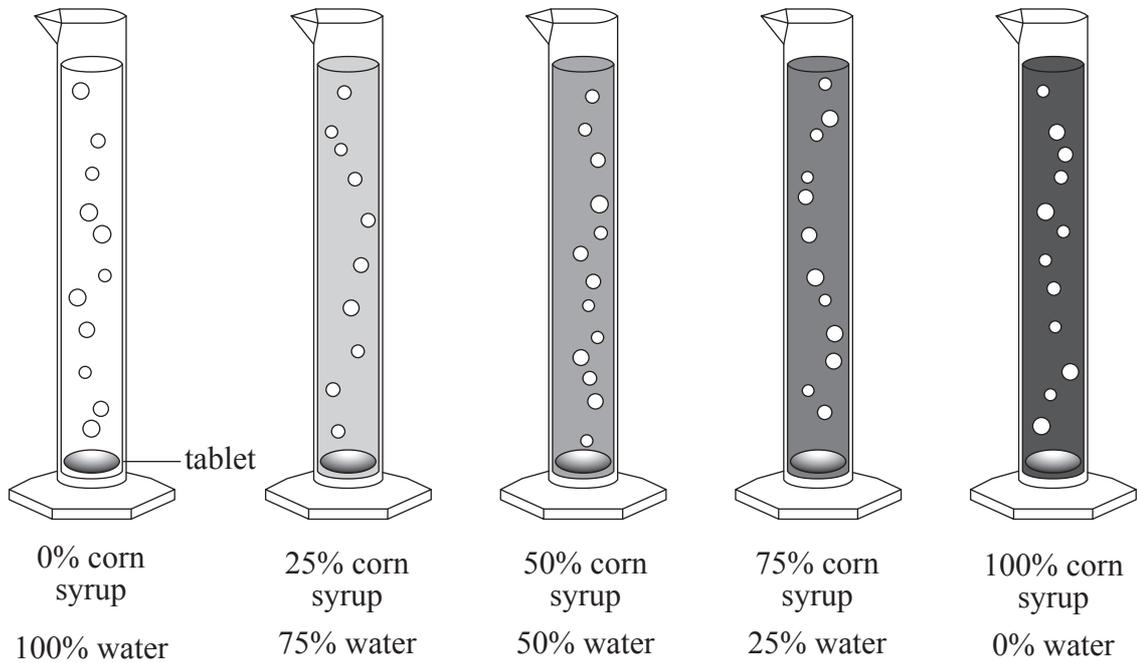


© Global Surface Temperature Graph – National Centers for Environmental Information – part of NOAA.

Which statement correctly links these eruptions to changes in global surface temperature?

- A. Effusive eruptions produced large ash clouds that spread globally.
- B. Sulfur dioxide emissions formed sulfuric acid aerosols in the stratosphere.
- C. Large amounts of carbon dioxide were released into the atmosphere which caused cooling.
- D. One volcano only affected local climate but the combined activity of Mt Agung, El Chichón and Mt Pinatubo affected the whole planet.

- 13 A student wanted to investigate the relationship between viscosity of magma and explosivity due to the pressure of trapped gases. They set up the following experiment as a model to compare the speed of bubbles travelling through the liquid. Each measuring cylinder contained a tablet to generate bubbles.



Which statement about the investigation is correct?

- A. The results will be reliable.
- B. The results will be accurate.
- C. The dependent variable is the rate of bubble production.
- D. The independent variable is the composition of the liquid.

Use the following information to answer Questions 14–16.

A student decided to conduct a practical investigation into the composition of the waste in his red (landfill) bin.

He audited the rubbish in his red bin prior to putting it out for collection each week, in the hope of determining where he could reduce his contribution to landfill.

Mass of waste per week by type

WASTE TYPE	MASS (kg)				
	<i>Week 1</i>	<i>Week 2</i>	<i>Week 3</i>	<i>Week 4</i>	<i>Average</i>
Recyclables	0.5	1.0	1.0	0.6	0.8
Food scraps	2.5	3.3	3.4	2.1	2.8
General rubbish	3.0	2.6	2.7	3.1	2.9
TOTAL	6.0	6.9	7.1	5.8	6.5

14 Which strategy would see the largest reduction in the student’s contribution to landfill?

- A. Recycling
- B. Composting
- C. Purchasing second-hand items
- D. Cancelling newspaper subscriptions

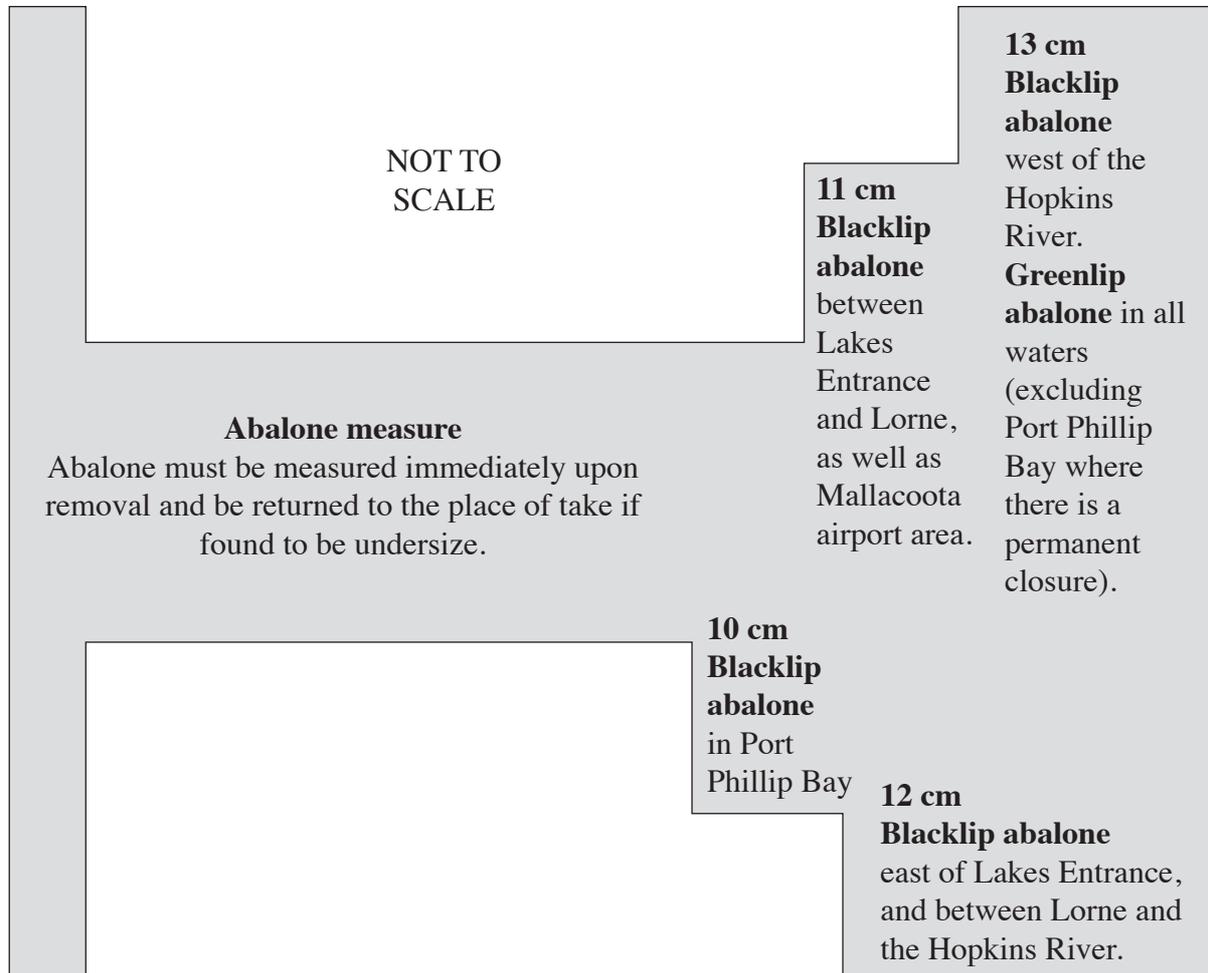
15 Which row of the table correctly identifies the variables for this investigation?

	<i>Independent variable</i>	<i>Dependent variable</i>	<i>Controlled variable</i>
A.	Type of waste	Number of weeks measured	Mass of waste
B.	Number of days of waste audited	Mass of waste	Type of waste
C.	Mass of waste	Type of waste	Number of weeks measured
D.	Type of waste	Mass of waste	Number of days of waste audited

- 16** The reliability of this investigation could be determined by
- A. using the same set of digital scales for each measurement.
 - B. ensuring that the same number of people are living in the household each week.
 - C. undertaking the same investigation across another four weeks and comparing the data.
 - D. using a neighbour to record the data so that the student doesn't change his waste habits during the investigation.
- 17** Which of the following features of Earth's orbit around the Sun causes the most rapid variations in climate?
- A. Tilt of Earth's axis (obliquity)
 - B. Wobble of Earth's axis (precession)
 - C. Shape of Earth's orbit (eccentricity)
 - D. Earth's distance from the Sun (proximity)
- 18** Models of the plate tectonic supercycle describe the breakup of a supercontinent into smaller continents. Two of these continents have been moving apart at an average speed of 4.7 cm/year, and are now 4000 km apart.
- During which geological period did these two continents start to separate?
- A. Cretaceous
 - B. Neoproterozoic
 - C. Paleogene
 - D. Triassic

Use the following information to answer Questions 19–20.

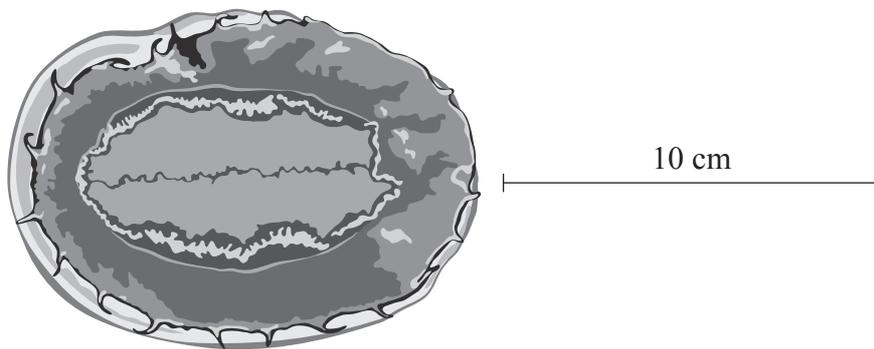
Abalone is a shellfish that lives in coastal waters and is considered a delicacy to eat. The measuring tool shown is used by non-commercial abalone divers in Victoria as a strategy to prevent overharvesting. The tool is placed over the abalone shell to measure its length.



© The Scuba Doctor Dive Shop – scubadoctor.com

- 19 What can be inferred from the tool about blacklip abalone?
- A. They reach sexual maturity at 13 cm in length.
 - B. They grow larger in size than greenlip abalone.
 - C. They are more threatened by overharvesting than are greenlip abalone.
 - D. They are more abundant in Port Phillip Bay than in other identified locations.

20 Examine the scale diagram showing a blacklip abalone caught in Victoria.



© Tasmanian Government: Image Peter Gouldthorpe.

Which of the following statements is true?

- A. This specimen was illegally caught in Port Phillip Bay.
- B. This specimen was legally caught west of the Hopkins River.
- C. This specimen could have been legally caught east of Lakes Entrance.
- D. This specimen could only have been legally caught in the Mallacoota Airport area.

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Centre Number

Earth and Environmental Science

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Student Number

Section II Answer Booklet

80 marks

Attempt Questions 21–35

Allow about 2 hours and 25 minutes for this section

Instructions

- Write your Centre Number and Student Number at the top of this page.
 - Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
 - Show all relevant working in questions involving calculations.
 - Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.
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Please turn over

Question 21 (2 marks)

Outline a named strategy for managing solid waste.

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Strategy:

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Question 22 (4 marks)

Assess the present and likely future use of a named resource.

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Resource:

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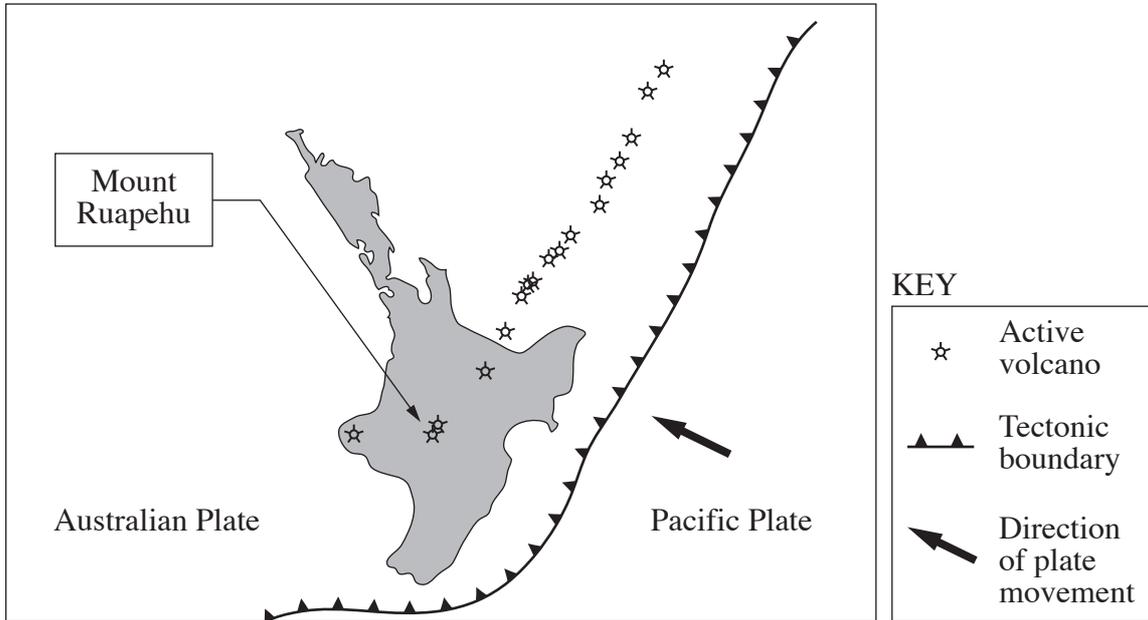
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Question 23 (12 marks)

(a) Mount Ruapehu is the largest active volcano in New Zealand.

4

Figure 1: Tectonic setting of Mount Ruapehu – North Island New Zealand



© <https://www.wakatoregion.govt.nz/services/regional-hazards-and-emergency-management/earthquakes>

Explain the tectonic processes that led to the formation of Mount Ruapehu.

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Question 23 continues on page 16

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Question 23 (continued)

The area around Mount Ruapehu has become a tourist destination popular with hikers and campers. In winter, ski fields operate on the mountain. Figures 2 and 3 are infographics produced for visitors to Mount Ruapehu.

Due to copyright restrictions, this material cannot be displayed until permission has been obtained.

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Question 23 continues on page 17

Question 23 (continued)

- (b) Explain TWO likely hazards that could be caused by an eruption at Mount Ruapehu. 4

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- (c) Assess the extent to which both hazard mapping and public education can help to protect visitors to Mount Ruapehu. Refer to Figures 2 and 3 in your response. 4

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End of Question 23

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Question 24 (3 marks)

Explain an impact of rising sea levels on the distribution of species.

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Question 25 (3 marks)

Explain how a community initiative could manage a resource sustainably.

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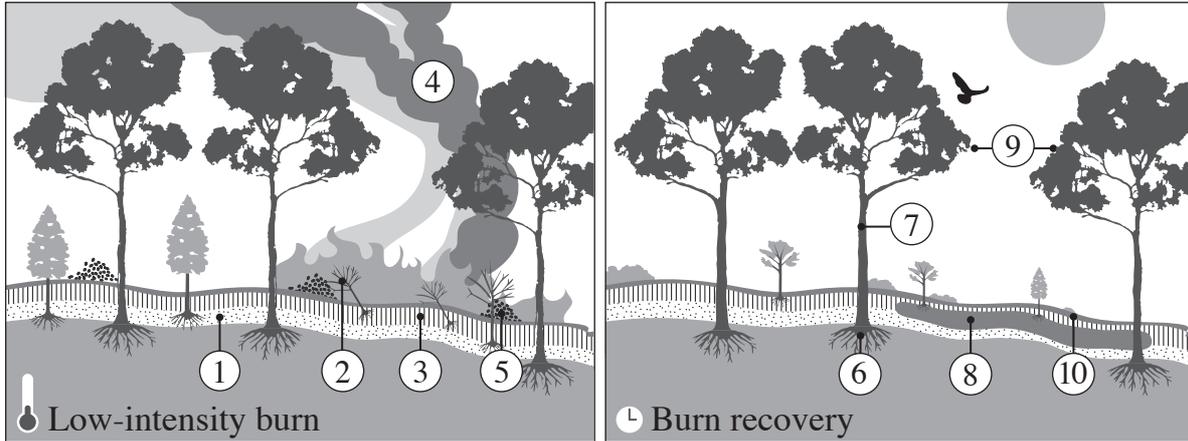
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Question 27 (4 marks)

Cultural burning includes low-intensity burns and is practised by Aboriginal and Torres Strait Islander Peoples. This practice cares for Country/Place and may reduce the frequency of high-intensity burns. The effects of low and high-intensity burns is shown in the diagrams.

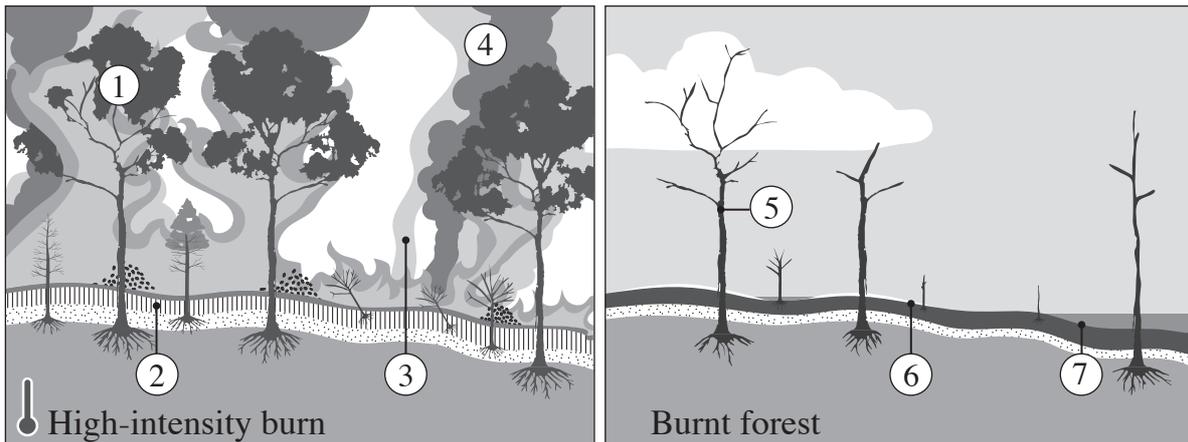
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Low-intensity fire (cultural burning)



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|--------------------------------------|------------------------------|
| ① Mineral soil | ⑥ Ongoing carbon capture |
| ② Ladder fuels (eg branches) | ⑦ Thicker bark |
| ③ Decaying leaf litter | ⑧ Nutrient-rich mineral soil |
| ④ CO ₂ release | ⑨ Fire break |
| ⑤ Fine fuels (eg twigs, dead leaves) | ⑩ New plants |

High-intensity fire



- | | |
|---------------------------|-------------------------|
| ① Canopy destroyed | ⑤ Little carbon capture |
| ② Burned leaf litter | ⑥ Ash |
| ③ Nutrients lost | ⑦ Water resistant soil |
| ④ CO ₂ release | |

Sködt McNalty/CBC Licensing

Question 27 continues on page 21

Question 27 (continued)

Explain the importance of cultural burning as a process to support sustainability. Refer to both diagrams in your answer.

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End of Question 27

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Question 28 (6 marks)

On 22 February 2011, there was a magnitude 6.3 earthquake in Christchurch, New Zealand. This caused significant damage to buildings and infrastructure in the city.

Houses in suburbs built on the sediments alongside the river were damaged by liquefaction. Liquefaction occurs when ground motion makes soil behave like a fluid. These houses were demolished and the suburbs rezoned for no future construction.

- (a) Justify the use of different building codes in varied tectonic settings to minimise the impact of earthquakes. 3

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- (b) Explain how ONE building technology can be used to reduce the damage due to a natural disaster occurring in a built environment. 3

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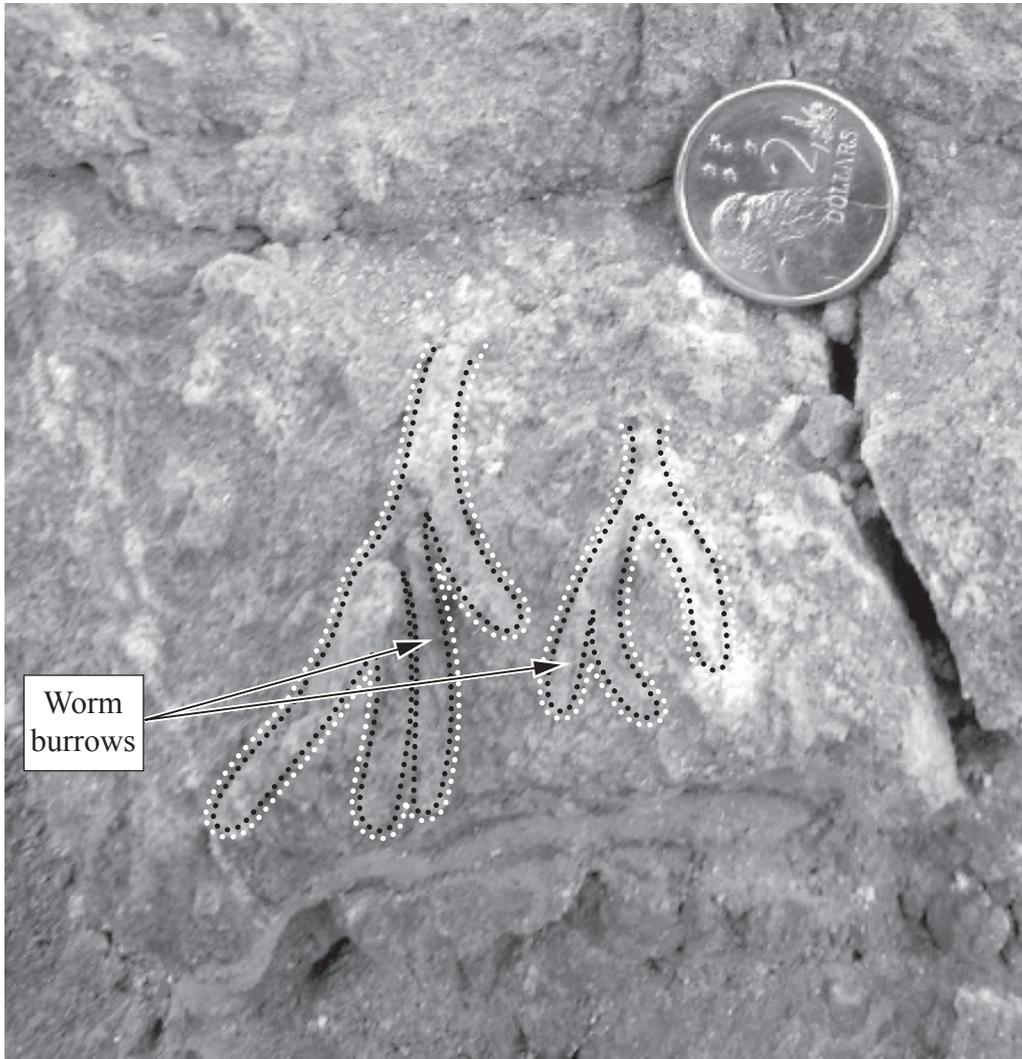
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Question 29 (6 marks)

This image shows outlined ‘piperock structures’, which are trace fossils of worm burrows, from 560 Ma BP.



(a) Why did the photographer include a coin in the image?

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Question 29 continues on page 25

Question 29 (continued)

- (b) Outline the formation process for trace fossils such as the piperock structures. 2

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- (c) Explain the suitability of relative dating and absolute dating procedures for determining the age of fossils such as the piperock structures shown. 3

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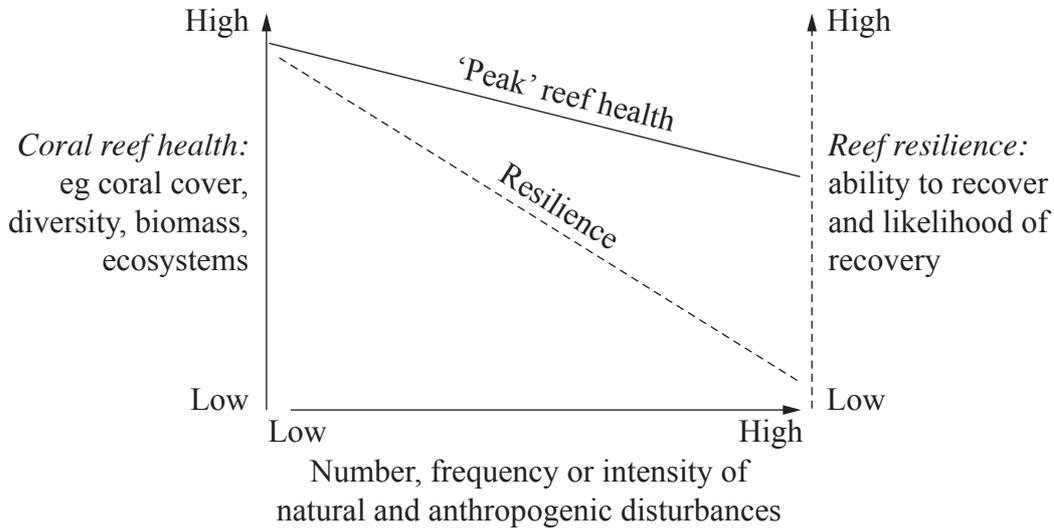
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Question 30 (5 marks)

Coral reefs support one of the most diverse ecosystems, and protect coastlines from damage. Recent bleaching episodes in coral reefs indicate their susceptibility to changing ocean conditions. The relationship between reef resilience and reef health is given in the infographic.



© Conservation Gateway – The Nature Conservancy.

- (a) Identify ONE disturbance which could reduce reef resilience. 1

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- (b) Outline the relationship between the state of a coral reef and its resilience. 2

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- (c) Propose a reason for the change in 'peak' reef health identified in the infographic. 2

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Question 31 (4 marks)

The oldest known evidence for photosynthetic cyanobacteria are Archaean stromatolite fossils found in just a few locations globally, including Western Australia.

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Evaluate the use of these stromatolite fossils as index fossils.

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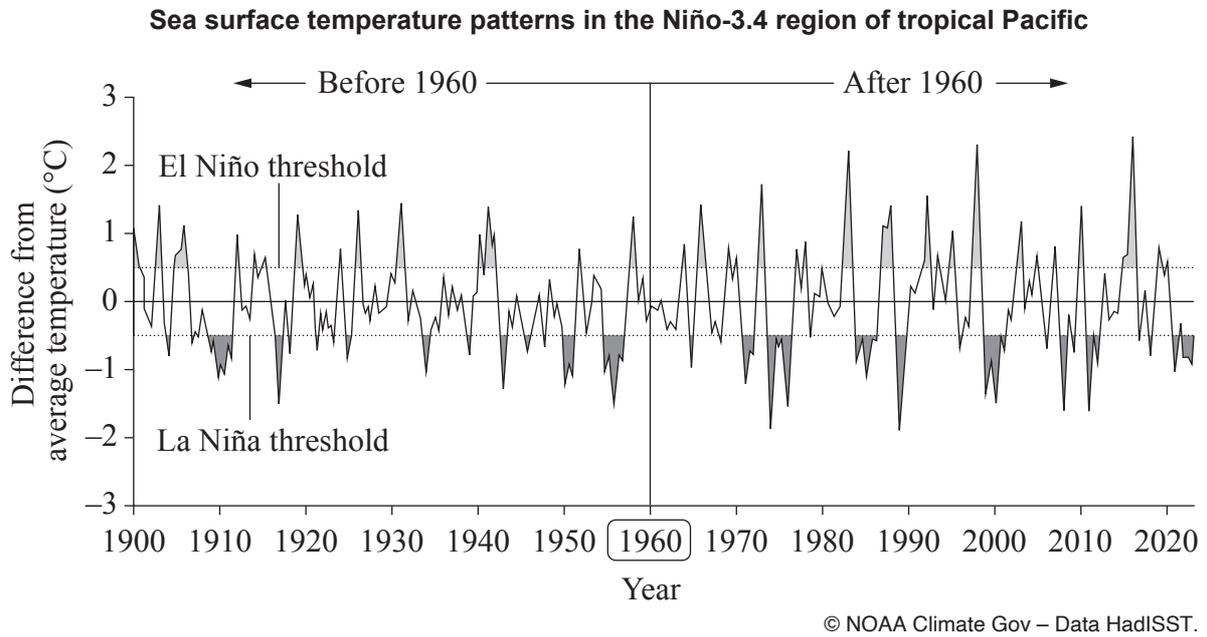
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Question 32 (10 marks)

El Niño and La Niña are climate-related patterns that occur in the Pacific Ocean. Sea surface temperature patterns over time are shown in the graph.



- (a) Compare the frequency and intensity of El Niño and La Niña events identified on the graph, before and after 1960. **3**

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Question 32 continues on page 29

Question 33 (8 marks)

Earth's spheres include the atmosphere, biosphere, cryosphere, geosphere and hydrosphere.

8

Using TWO examples from the list below, analyse relationships between Earth's interacting spheres and humans.

Possible examples include:

- Plate tectonic supercycle
- Development of photosynthetic life
- Natural disasters
- Industrial revolution
- Natural resources
- Other relevant examples from the Earth and Environmental Science course.

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Question 33 continues on page 31

Question 34 (4 marks)

Australia and Antarctica were once connected as part of the Gondwana supercontinent. Australia has drifted northward, away from Antarctica.

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Using examples, explain the effects of Australia's movement on both climate and evolution.

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Question 35 (4 marks)

NASA's *Perseverance* rover is one of several missions searching for evidence of ancient life on Mars.

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Analyse the ways in which new evidence provided by missions such as *Perseverance* might complement existing evidence for the meteorites/panspermia hypothesis for the origin of organic molecules on Earth.

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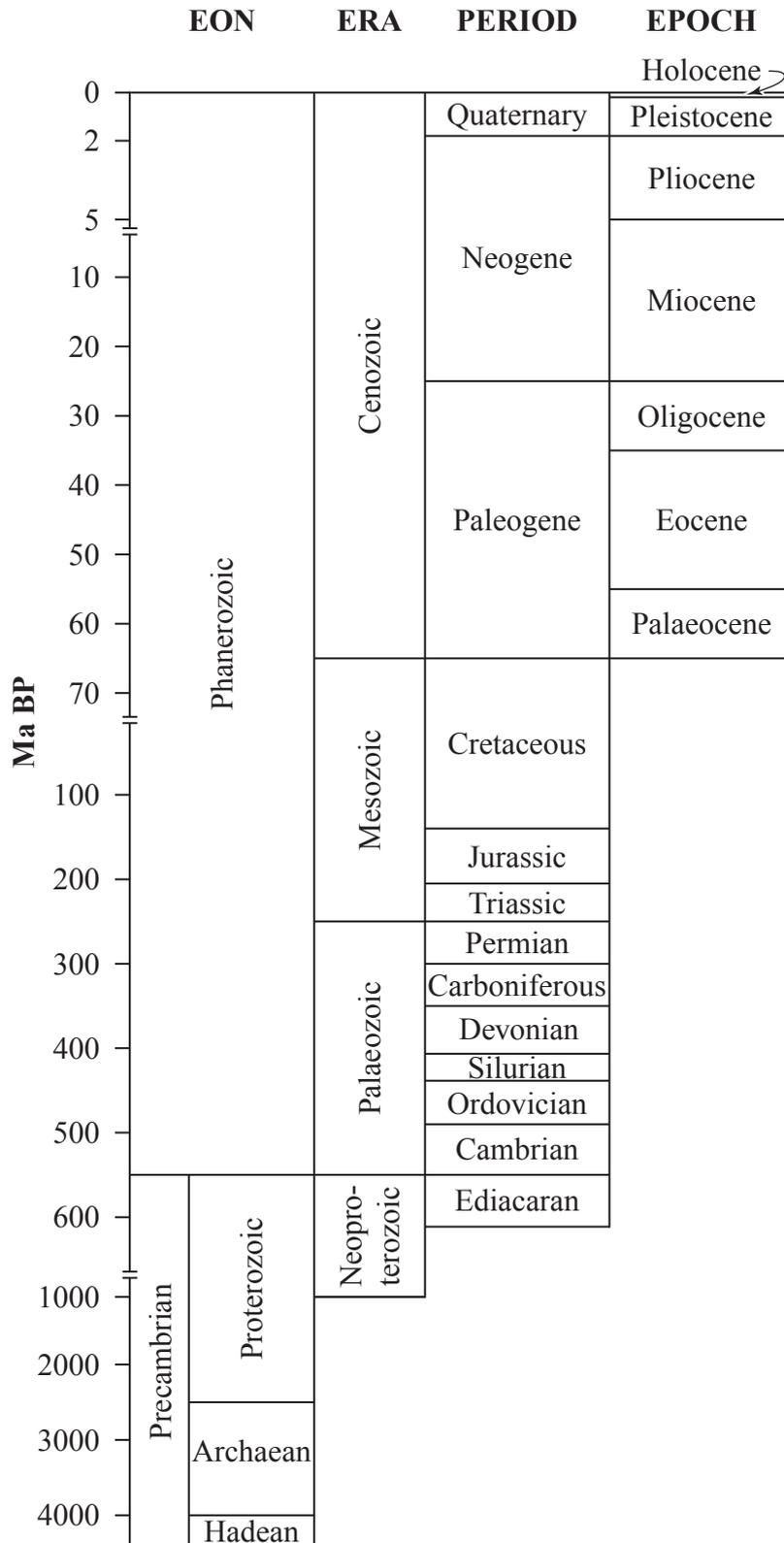
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Earth and Environmental Science

Geological Time Scale



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