



GCE A LEVEL

A480U20-1



MONDAY, 9 JUNE 2025 – AFTERNOON

GEOLOGY - A LEVEL COMPONENT 2

GEOLOGICAL PRINCIPLES AND PROCESSES

1 hour 45 minutes plus your additional time allowance

Surname

First Name(s)

Centre Number

Candidate Number

2

ADDITIONAL MATERIALS

In addition to this examination paper you will need:

- **a calculator**
- **a ruler.**

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball-point pen or your usual method.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces on the previous page.

Answer ALL questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in questions 2 and 5.

(Turn over)

Answer ALL questions in the spaces provided.

- 1 FIGURE 1a opposite is a photograph of stony meteorite P. TABLE 1 shows the percentages of the main elements in the Earth's crust, meteorite P and another meteorite (meteorite Q).

TABLE 1

Element	Abundance in the Earth's crust (%)	Abundance in meteorite P (%)	Abundance in meteorite Q (%)
•	46	32	
silicon	27	14	
aluminium	8.1	•	
iron	6.3	30	88
calcium	5.0	1.1	
•	2.9	12	
sodium	2.3	0.55	
potassium	1.5	•	
others	0.9	9.35	12

(Turn over)

1 (a) Refer to TABLE 1 and FIGURE 1a.

- (i) Using your knowledge, complete the 'Element' column of TABLE 1 by stating the name of the TWO missing elements. [2 marks]**
- (ii) Use the information in FIGURE 1a to complete TABLE 1 by calculating the abundance of aluminium and potassium in meteorite P. [1 mark]**
- (iii) Using the data in TABLE 1, state the type of meteorite represented by meteorite Q. [1 mark]**
-

- (iv) State which category of the Goldschmidt Classification system the main element of meteorite Q belongs to. Tick (✓) ONE box only.**

[1 mark]

☐

Atmophile

☐

Lithophile

☐

Siderophile

☐

Chalcophile

(Turn over)

1 (b) FIGURE 1b opposite shows how density varies with depth in the Earth. The mean density of the Earth's core is labelled on the graph.

(i) Meteorite P has a density of 3.3 g cm^{-3} . Using FIGURE 1b:

- State the depth at which the Earth has a density of 3.3 g cm^{-3} .
- Suggest which layer of the Earth is most likely to be represented by meteorite P. [2 marks]

Depth _____ km

Layer _____

(ii) Suggest why the density of the Earth increases rapidly at a depth of 5155 km. [2 marks]

(Turn over)

1 (b)(iii) Using FIGURE 1b, state the mean density of the Earth's core. [1 mark]

_____ g cm⁻³

(Turn over)

- 1 (b)(iv) Using your answer to part b(iii), and the information below, calculate the volume of the Earth's core (in cm^3). Show your working. Give your answer in standard form. [3 marks]

Density:

$$\rho = \frac{m}{V}$$

ρ = mean density of the Earth's core (g cm^{-3})

m = mass of the Earth's core ($1.85 \times 10^{27} \text{ g}$)

V = volume of the Earth's core (cm^3)

_____ cm^3

2 FIGURE 2a opposite is a photograph of a rock outcrop taken facing south.

Refer to FIGURE 2a.

(a)(i) Measure the throw of Fault F on FIGURE 2a.

[1 mark]

_____ m

(ii) State the type of fault represented by Fault F (normal, reverse, thrust). Give a reason for your answer.

[2 marks]

Fault type: _____

Reason: _____

(Turn over)

2 (a)(iii) A student stated,

‘The faults in FIGURE 2a were formed by east-west tensional stresses.’ Evaluate this statement.

[2 marks]

(Turn over)

2 (a)(iv) At one time the throw of Fault F was greater than it is now. With reference to changing principal stress directions, explain how this reduction in throw occurred. [2 marks]

(Turn over)

2 (b) FIGURE 2b opposite shows photographs taken close to the location in FIGURE 2a. In each, a rock type has been outlined with a box (ROCK G and ROCK H).

FIGURE 2c opposite shows photomicrographs of the texture and composition of ROCK G and ROCK H.

Refer to FIGURE 2b and FIGURE 2c. Explain how the texture, composition and structure of ROCK G and ROCK H are related to their modes of formation.

[6 QER marks]

(Turn over)

[illegible]

13

(Turn over)

3 FIGURE 3a opposite is a map of part of the Hawaiian chain of basaltic volcanoes across the Pacific Plate. Labels show the centre of several important volcanoes.

FIGURE 3b opposite shows the estimated rate of eruption along the Hawaiian chain.

Refer to FIGURE 3a and FIGURE 3b.

(a) One theory for the origin of the Hawaiian chain is that these volcanoes formed above a fixed mantle plume, currently located beneath Kīlauea, over which the Pacific Plate has steadily moved.

(i) Using FIGURE 3a, state the distance the Pūhāhonu volcano has travelled from the fixed mantle plume.

[1 mark]

_____ km

(Turn over)

- 3 (a)(ii) Using your answer to question 3(a)(i) and FIGURE 3b, calculate the mean rate of movement of the Pacific Plate (in cm yr^{-1}) since the formation of the Pūhāhonu volcano. Show your working. [2 marks]

_____ cm yr^{-1}

3 (a)(iii) Describe the relationship between the rate of eruption and age of volcanism in FIGURE 3b.

[3 marks]

(Turn over)

3 (a)(iv) Name and describe ONE volcanic hazard that could be associated with the present-day volcanism at Kīlauea. [2 marks]

(Turn over)

3 (b) An alternative theory for the formation of the Hawaiian chain of volcanoes, without involving a mantle plume, involves stretching and thinning of the Pacific Plate lithosphere.

(i) Outline the evidence in FIGURE 3a that supports the more widely accepted plume theory. [3 marks]

(Turn over)

3 (b)(ii) Suggest how the alternative (non-plume) theory might have generated basaltic magma.

[2 marks]

(Turn over)

3 (c) FIGURE 3c opposite is a phase diagram for the olivine solid solution series. Crystals of olivine were obtained from the basalt rock erupted from Pūhāhonu.

Refer to FIGURE 3c.

(i) State the temperature at which pure forsterite crystallises.

[1 mark]

_____ °C

(ii) Olivine crystals from the extinct Pūhāhonu volcano have a composition of 25% iron (Fe). Complete TABLE 2 below to show the characteristics of the Pūhāhonu melt as it cooled. Assume that the melt remained in equilibrium with the crystals as they formed. [3 marks]

TABLE 2

	Temperature of melt (°C)	Composition of crystals (%Fe)	Composition of melt (%Fe)
Initial crystallisation	1780	•	25
Crystallisation at 1700 °C	1700	16	•
Final crystallisation	•	25	

(Turn over)

3 (c)(iii) Suggest how the compositional data in TABLE 2 supports the conclusion that the Pūhāhonu volcano erupted very high temperature lava. [1 mark]

18

4 FIGURE 4a opposite shows a graphic log produced from a borehole of marine sedimentary rocks.

Refer to FIGURE 4a.

(a)(i) Using the description of the three sedimentary rocks in TABLE 3, complete the graphic log shown in FIGURE 4a. [3 marks]

TABLE 3

Description of beds
“Measuring up the sequence from POINT X to POINT Y, there is 8m of medium-grained sandstone, followed by 5m of coarse-grained sandstone containing brachiopod fossils, and finally another 12m of medium-grained sandstone with symmetrical ripple marks.”

(ii) The finest sediments in FIGURE 4a were deposited in seawater no deeper than 50m. Sketch a line in COLUMN Z of FIGURE 4a to show the changes in the depth of seawater represented by this graphic log.

[2 marks]

(Turn over)

4 (b) FIGURE 4b opposite is a regional model showing the distribution of marine sedimentary rocks where the sequence in FIGURE 4a was deposited.

(i) Refer to FIGURE 4a and FIGURE 4b.

The graphic log in FIGURE 4a is a record of the sedimentary rocks from a borehole at one of three locations in FIGURE 4b. State at which location (K, L, M) the graphic log was recorded. Tick (✓) ONE box and give TWO reasons for your answer. [3 marks]

☐**K**☐**L**☐**M**

Reason 1: _____

Reason 2: _____

(Turn over)

4 (b)(ii) State whether arrow C on FIGURE 4b demonstrates an episode of:

- marine transgression
- marine regression
- constant sea level.

Give a reason for your answer. [2 marks]

Arrow C demonstrates an episode of

Reason: _____

(iii) State what is meant by 'Walther's Law'. [1 mark]

(Turn over)

4 (b)(iv) A student stated:

- 'Walther's Law can be applied when interpreting the lithofacies in FIGURE 4b,
- and overall, FIGURE 4b represents an environment of decreasing energy conditions.'

Evaluate the student's statement. [3 marks]

(Turn over)

4 (c) FIGURE 4c opposite is a photograph of a sedimentary structure observed in beds of sandstone shown in FIGURE 4a but not shown in the key.

(i) Name the sedimentary structure shown in FIGURE 4c.

[1 mark]

(Turn over)

4 (c)(ii) For one sedimentary structure that can be used to show the previous direction of the movement of air or water, other than that shown in FIGURE 4c,

- **describe its appearance and**
- **explain how it can be used to indicate the direction of movement of air or water.**

You may wish to illustrate your answer with a labelled diagram(s). [5 marks]

20

5 FIGURE 5a opposite shows changes in atmospheric carbon dioxide levels since the year 1000.

FIGURE 5b opposite shows these changes in greater detail since the year 1880. Each figure shows a different proposed boundary for defining the onset of the Anthropocene Epoch.

(a)(i) State ONE natural source of carbon dioxide.

[1 mark]

(ii) Describe the change in atmospheric carbon dioxide concentration since the year 1500, shown in FIGURE 5a.

[3 marks]

(Turn over)

5 (b) A student stated:

‘The beginning of the Anthropocene Epoch should be defined by the appearance and increased abundance of anthropogenic (human-made) deposits.’

Explain and evaluate the statement using FIGURE 5a, FIGURE 5b and/or your own knowledge of possible anthropogenic markers in the geological record.

[6 QER marks]

(Turn over)

6 FIGURE 6a opposite is a photograph of a plant fossil (J).

FIGURE 6b opposite is a photograph of a present-day plant (K) with similar morphological characteristics.

- (a)(i) Plant fossil J appeared in the fossil record after the Devonian period and was extinct by the end of the Permian period. Tick (✓) the most likely age of plant fossil J. [1 mark]**

☐

Silurian

☐

Carboniferous

☐

Triassic

- (ii) State the principle that allows geologists to infer the most likely mode of life of extinct species based on the study of present-day species. [1 mark]**

(Turn over)

6 (a)(iii) Give ONE similarity and ONE difference between the morphology of plant fossil J and present-day plant K. Refer to features A and B shown in FIGURE 6a and FIGURE 6b. [2 marks]

Similarity: _____

Difference: _____

(Turn over)

6 (a)(iv) Suggest the limitations in comparing the morphology of the plants shown in FIGURE 6a and FIGURE 6b. [2 marks]

(Turn over)

6 (a)(v) Name and describe the fossilisation process that led to the preservation of plant fossil J.

[3 marks]

Fossilisation process: _____

Description: _____

(Turn over)

6 (b) FIGURE 6c opposite shows leaf surface area data collected from several different types of plant.

FIGURE 6d opposite shows how typical leaf surface area varies with latitude.

Refer to FIGURE 6c.

(i) State the range in leaf surface area of fern leaves in FIGURE 6c. [2 marks]

_____ to _____ cm^2

(ii) A median surface area of 4 cm^2 was calculated for shrub leaves. Draw a line on FIGURE 6c to show this.

[1 mark]

(Turn over)

6 (c) Refer to FIGURE 6d.

(i) Describe the relationship between typical leaf surface area and latitude. [2 marks]

(Turn over)

6 (c)(ii) With reference to global climates, suggest why this relationship may exist. [2 marks]

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END OF PAPER

(Turn over)

Acknowledgements

FIGURE 2a

<https://www.flickr.com/photos/jsjgeology/8471260787/in/set-72157632763455730>. Photograph James St John

FIGURE 2b

<https://www.flickr.com/photos/jsjgeology/48863311216>.
Photograph James St John

<https://www.flickr.com/photos/jsjgeology/21426722099>.
Photograph James St John

FIGURE 2c

<http://suvratk.blogspot.com/2016/10/photomicrograph>.
Photograph Suvrat Kher

Plate 20-B, U.S. Geological Survey Professional paper 194.
1940. – ID. Johnston, W.D.,
Jr. 303 – jwdj0303 – U.S. Geological Survey

FIGURE 6a

<https://www.science.org/doi/full/10.1126/science.aal4760>.
Acknowledgement not found

(Turn over)

QUESTION NUMBER	ADDITIONAL PAGE, IF REQUIRED. WRITE THE QUESTION NUMBER(S) IN THE LEFT-HAND MARGIN.

(Turn over)

[illegible]

(Turn over)

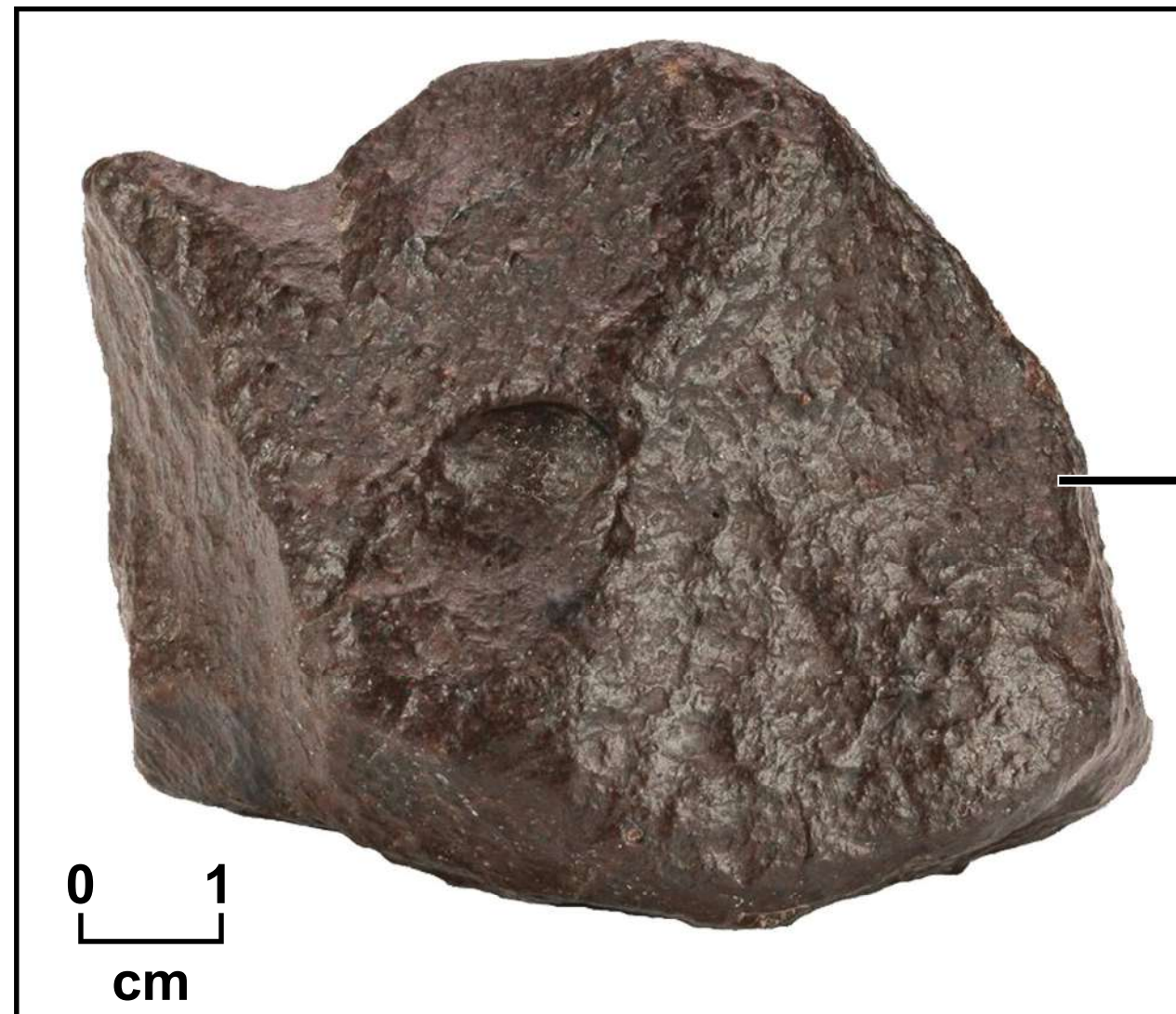
QUESTION NUMBER	ADDITIONAL PAGE, IF REQUIRED. WRITE THE QUESTION NUMBER(S) IN THE LEFT-HAND MARGIN.

(Turn over)

QUESTION NUMBER	ADDITIONAL PAGE, IF REQUIRED. WRITE THE QUESTION NUMBER(S) IN THE LEFT-HAND MARGIN.

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1	13	
2	13	
3	18	
4	20	
5	10	
6	16	
Total	90	

FIGURE 1a



**Meteorite P – a meteorite
containing 9 times as much
aluminium as potassium**

FIGURE 1b

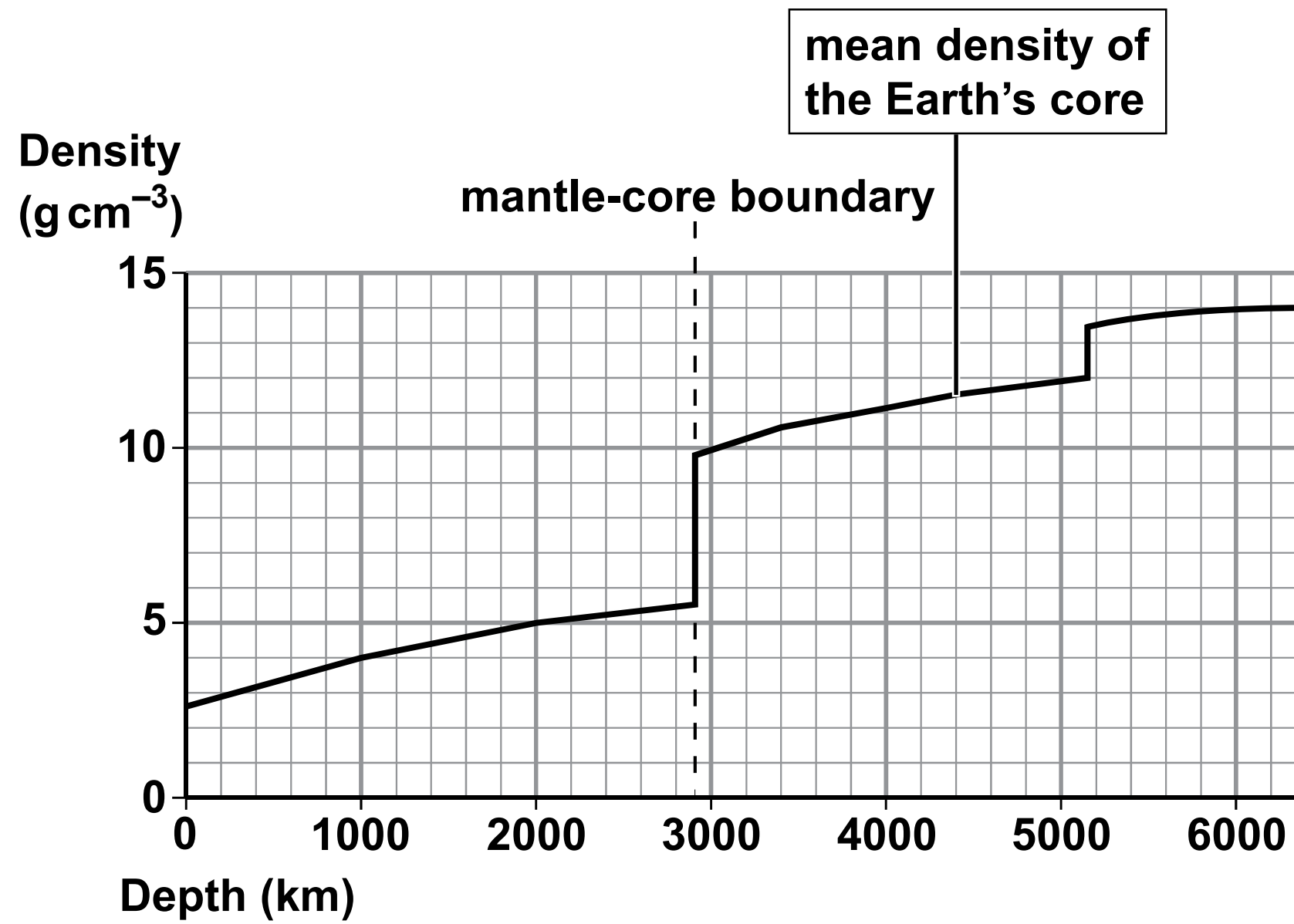
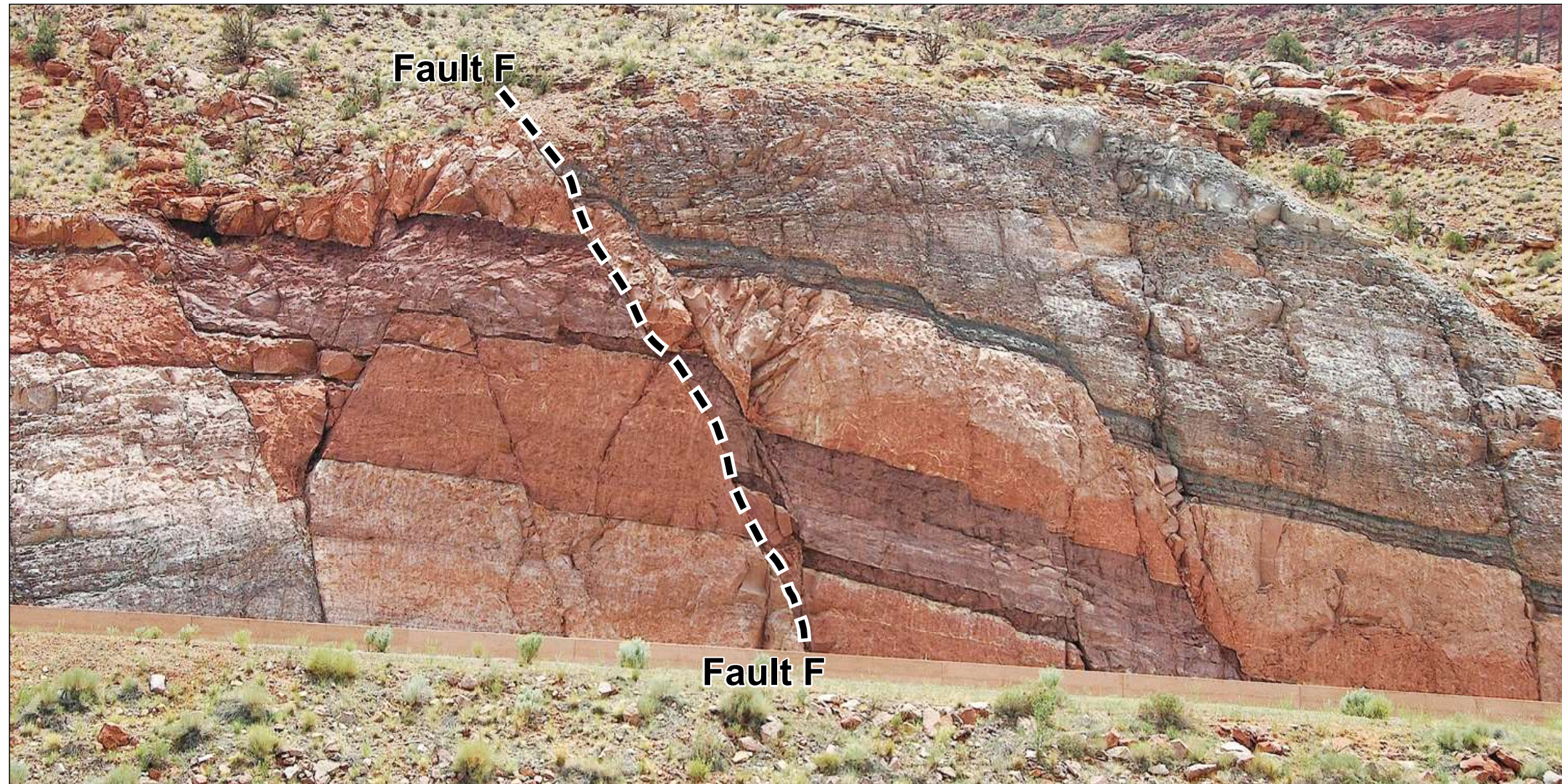


FIGURE 2a



0 5
m

FIGURE 2b

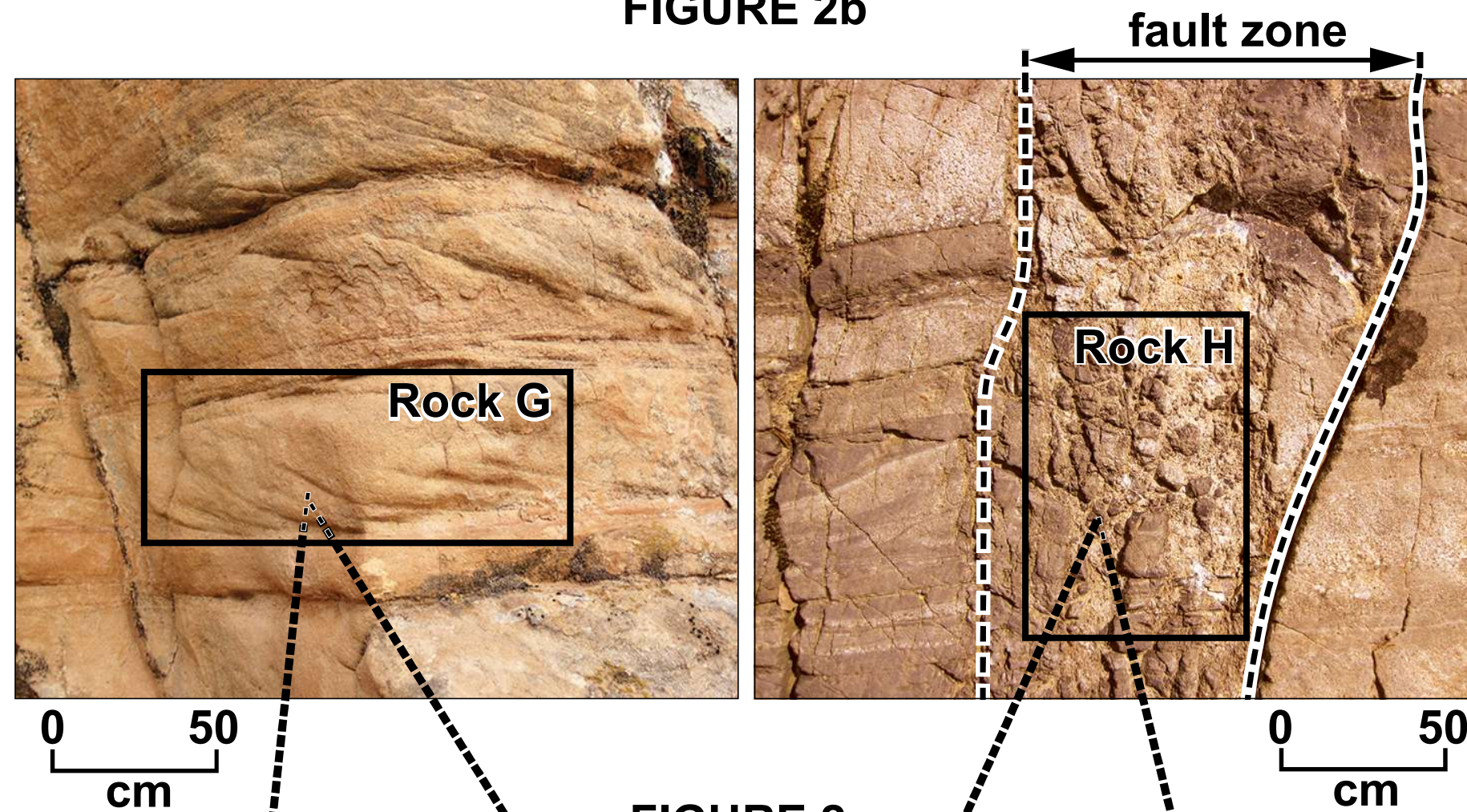


FIGURE 2c

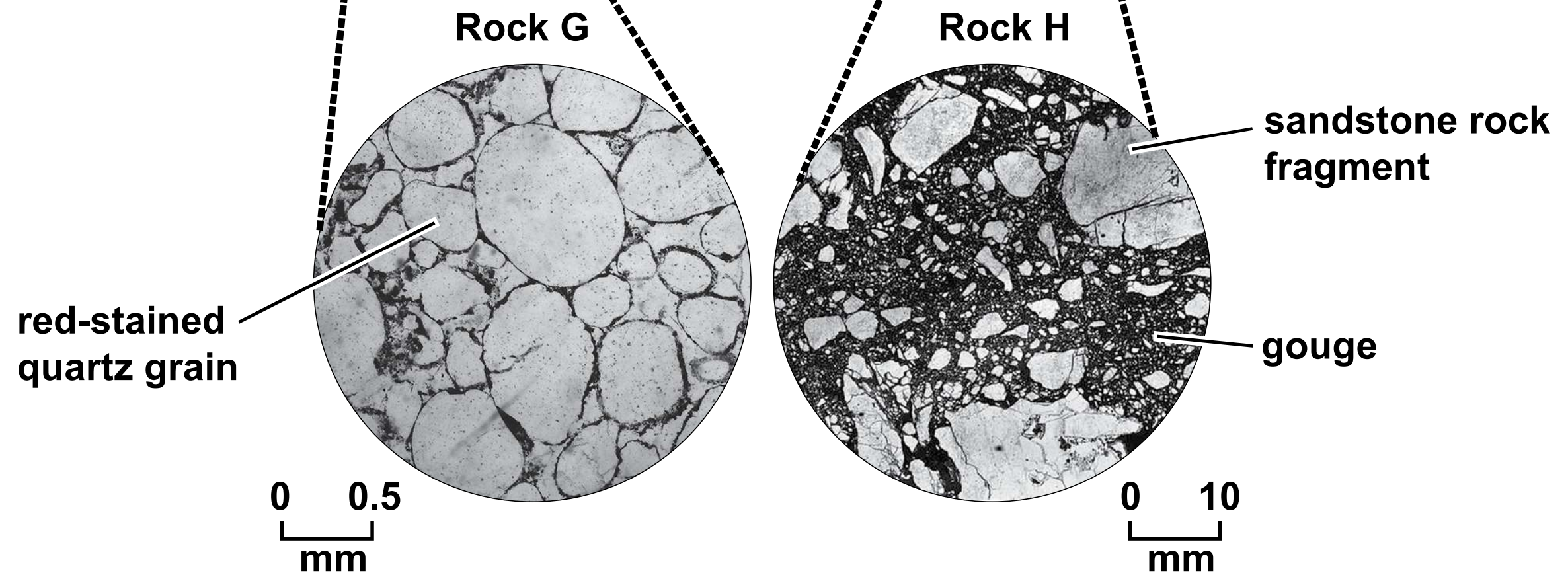


FIGURE 3a

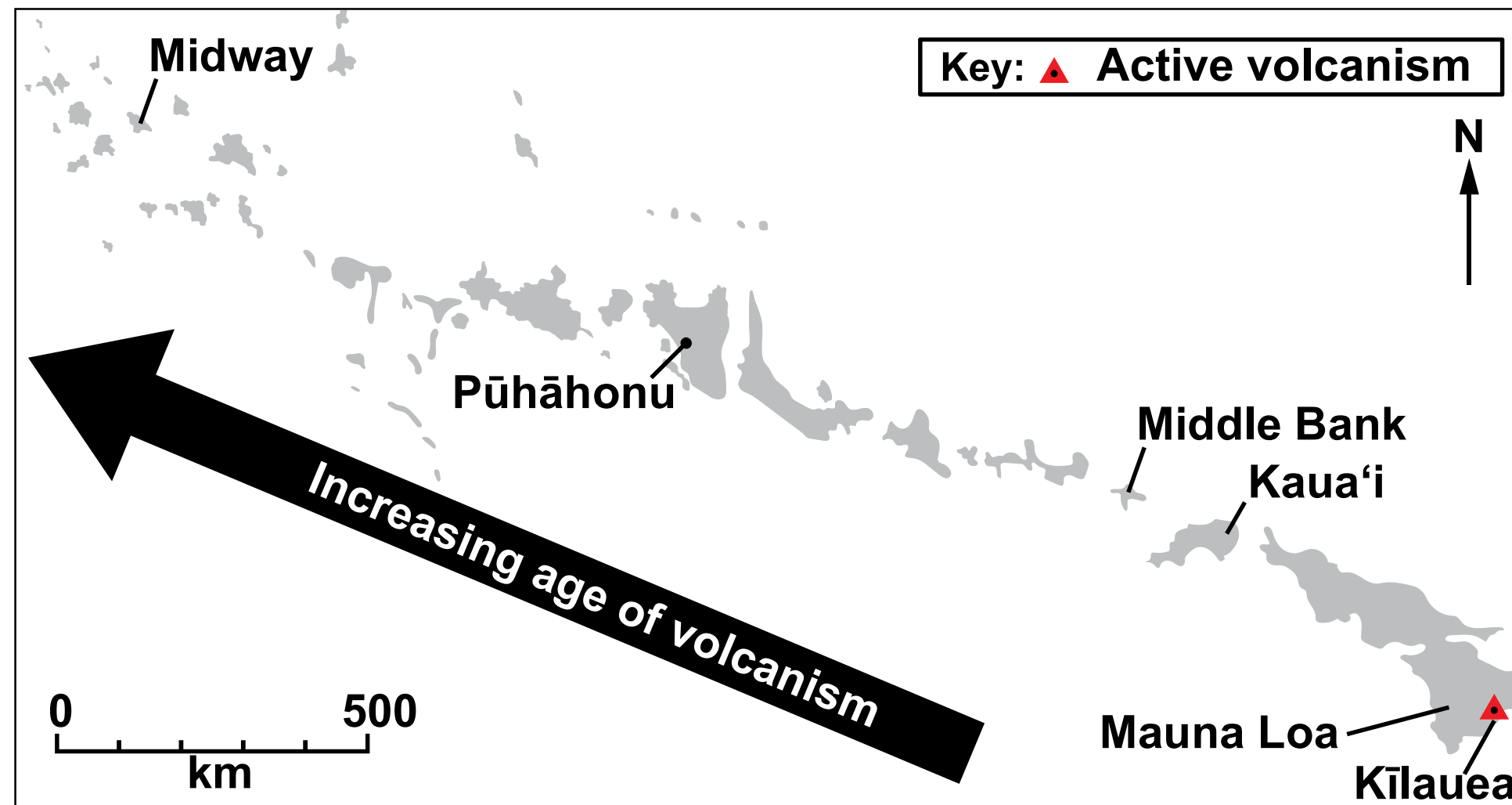


FIGURE 3b

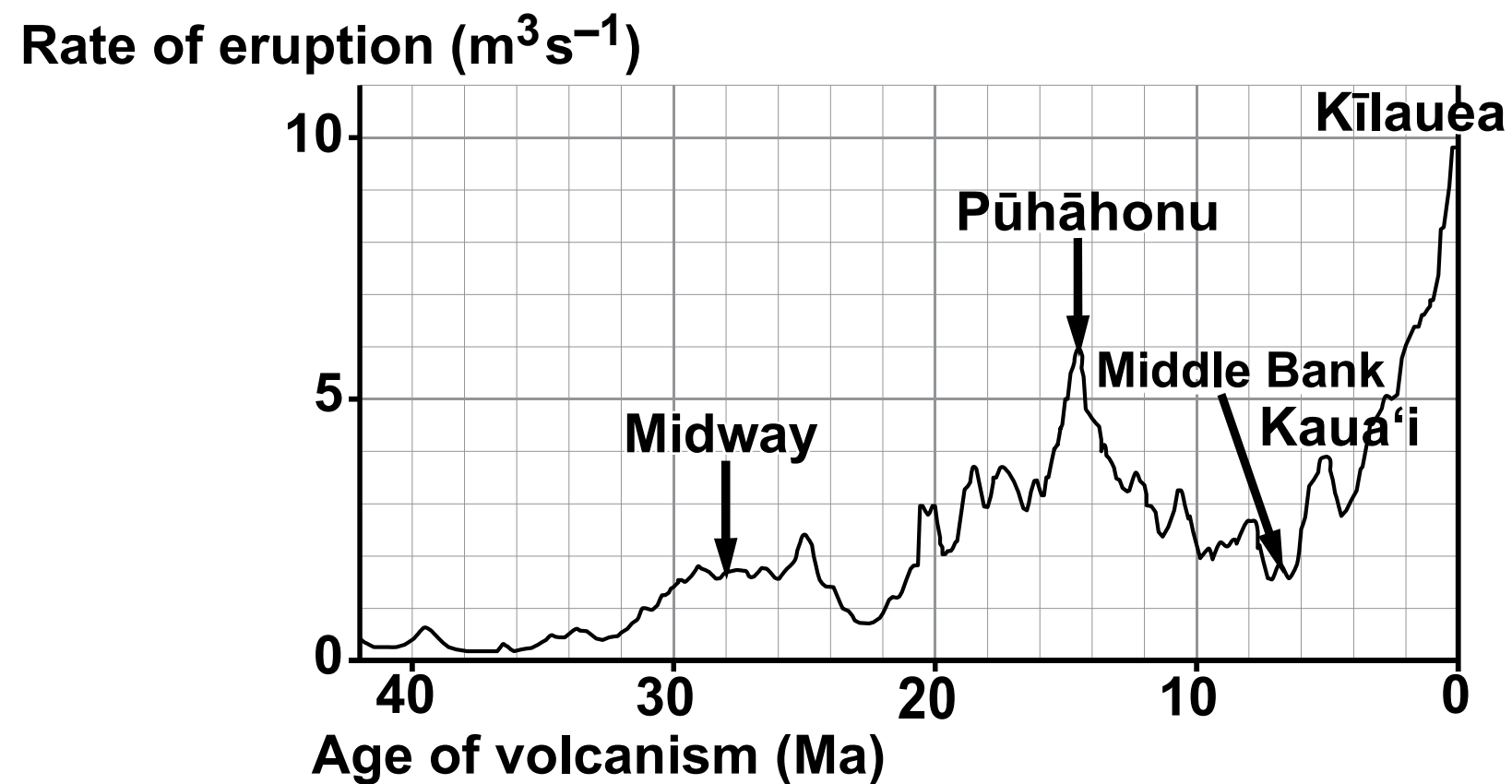
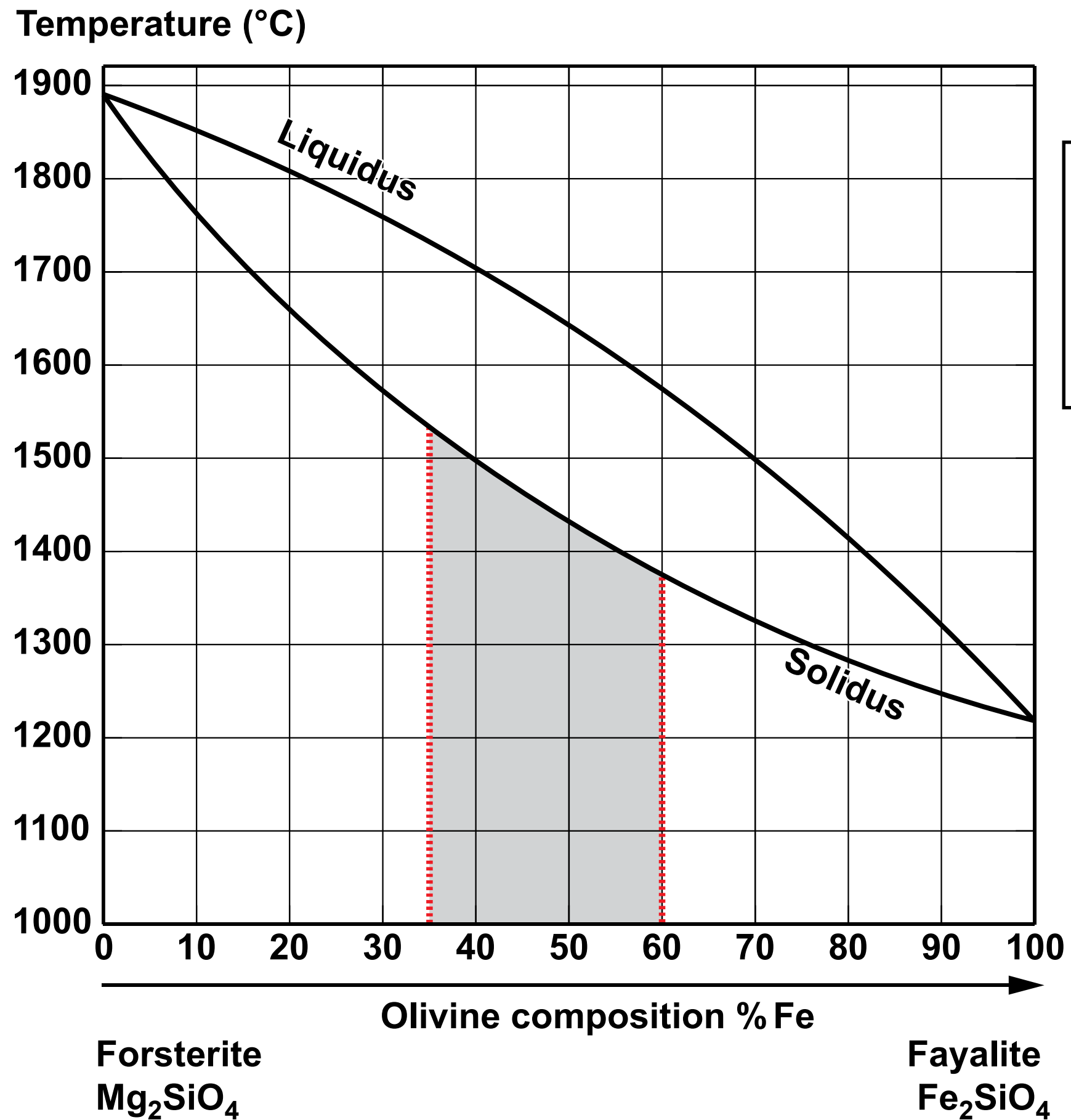
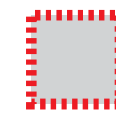


FIGURE 3c



Key:



Typical olivine
composition
in basalt rock

FIGURE 4a

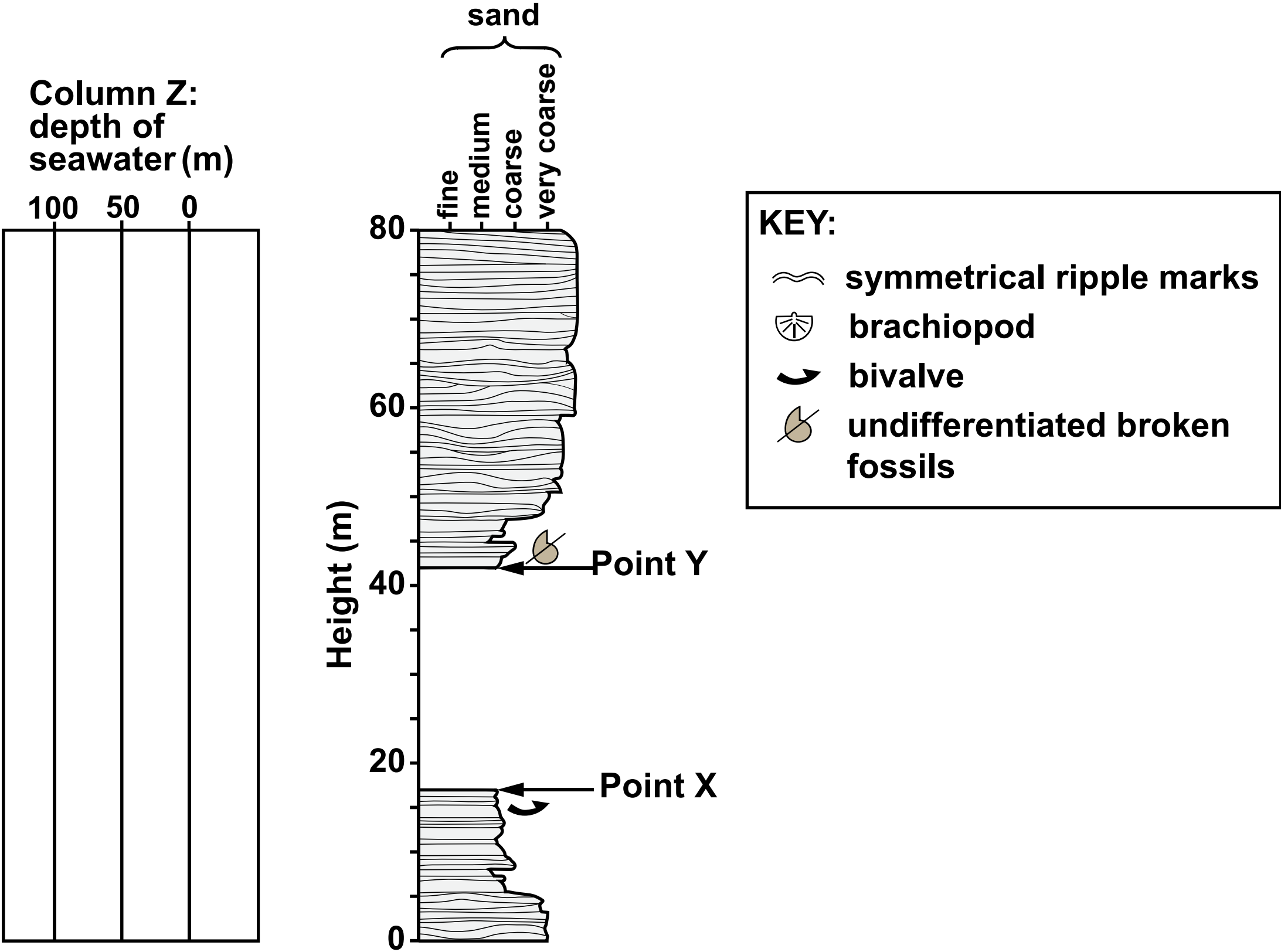


FIGURE 4b

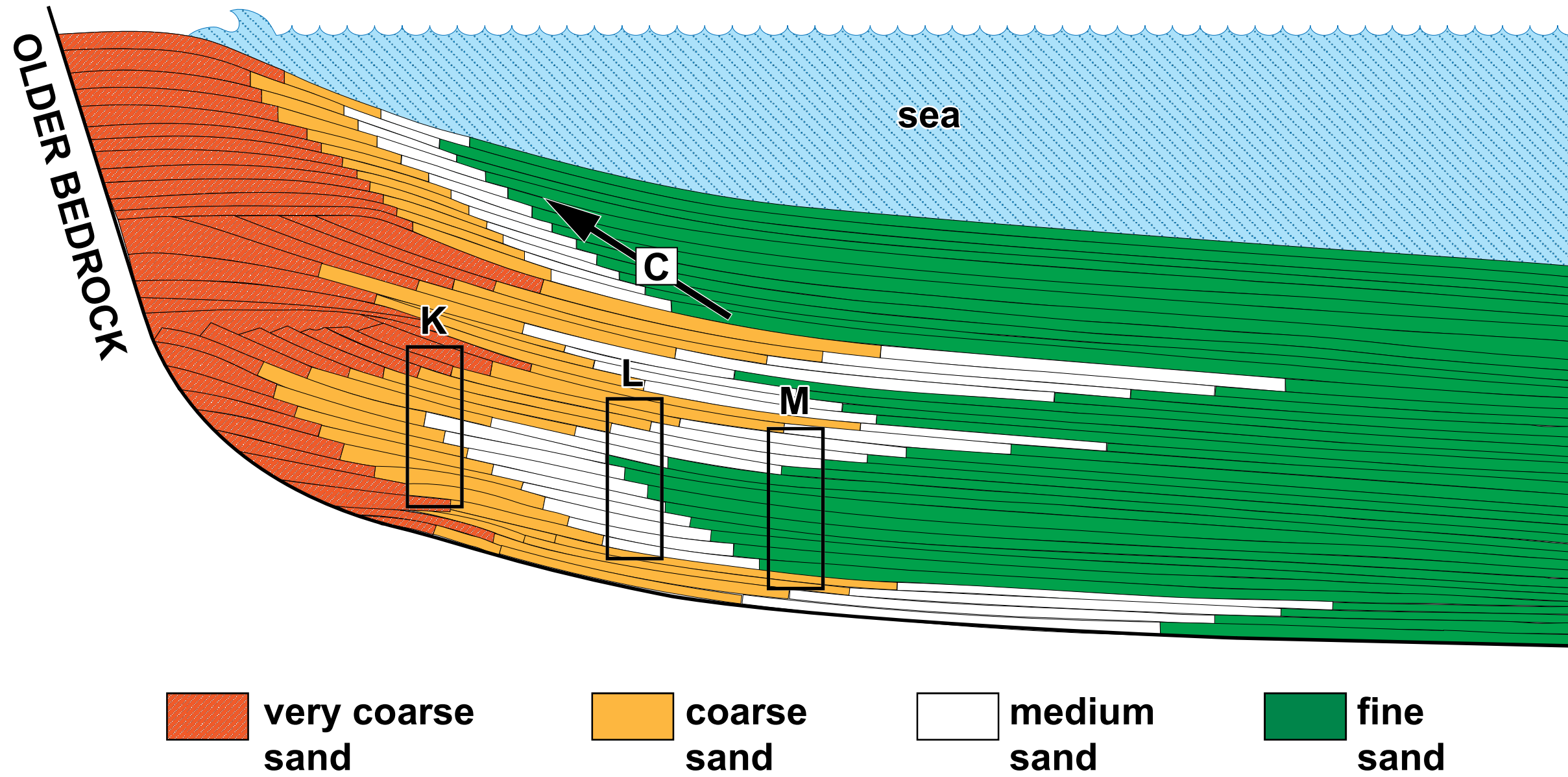


FIGURE 4c



0 20
cm

FIGURE 5a

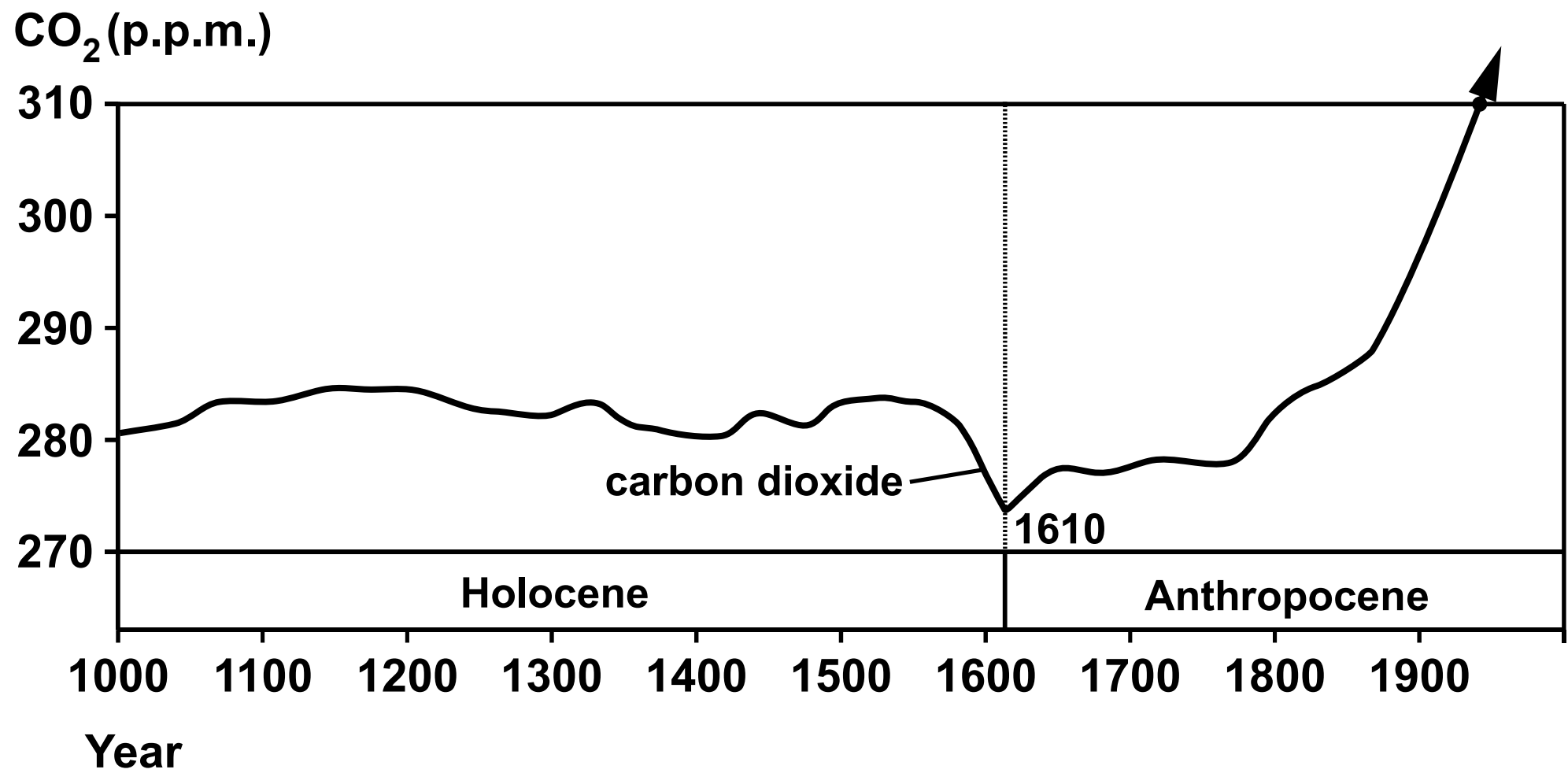


FIGURE 5b

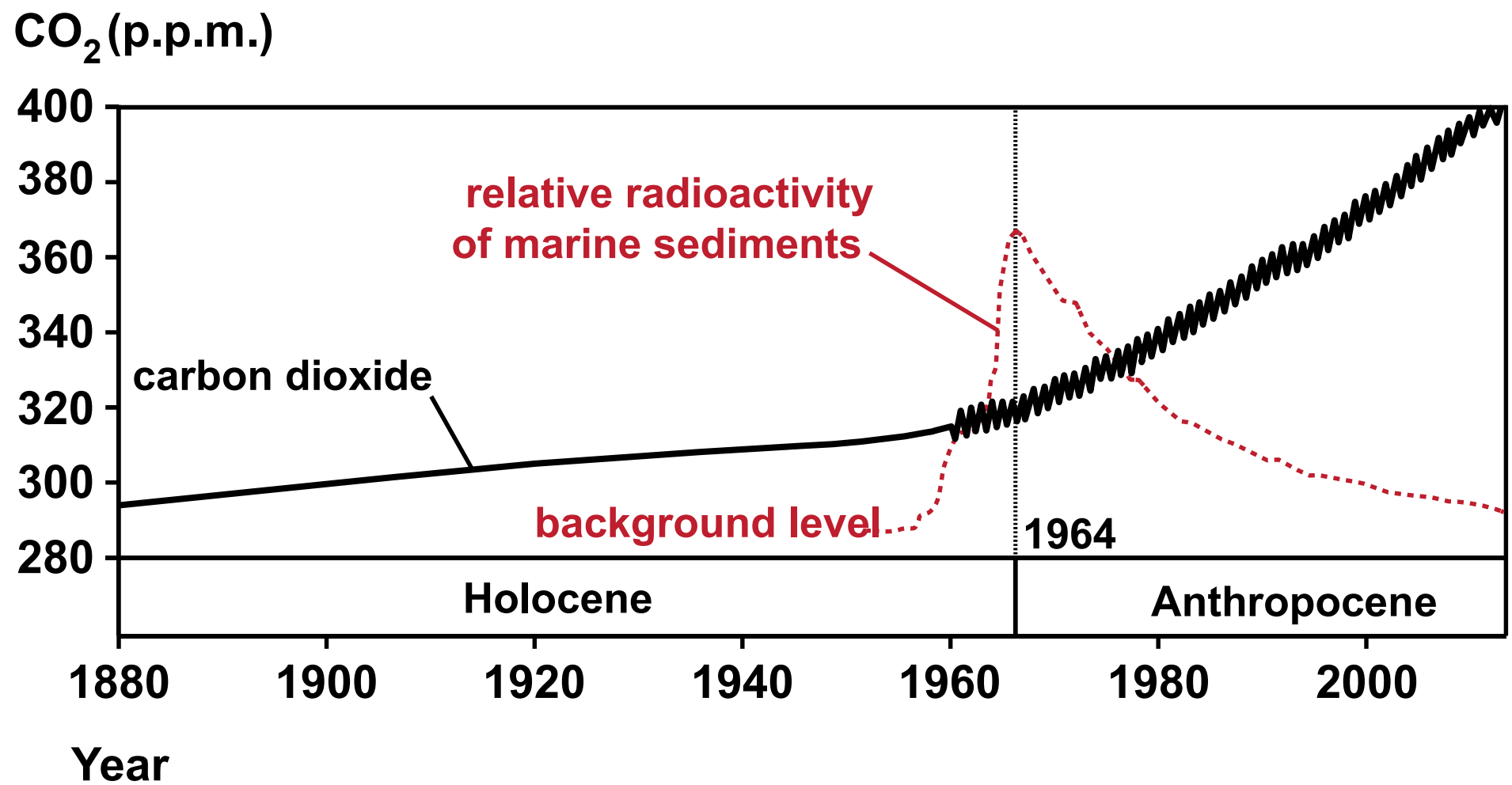


FIGURE 6a

PLANT FOSSIL J

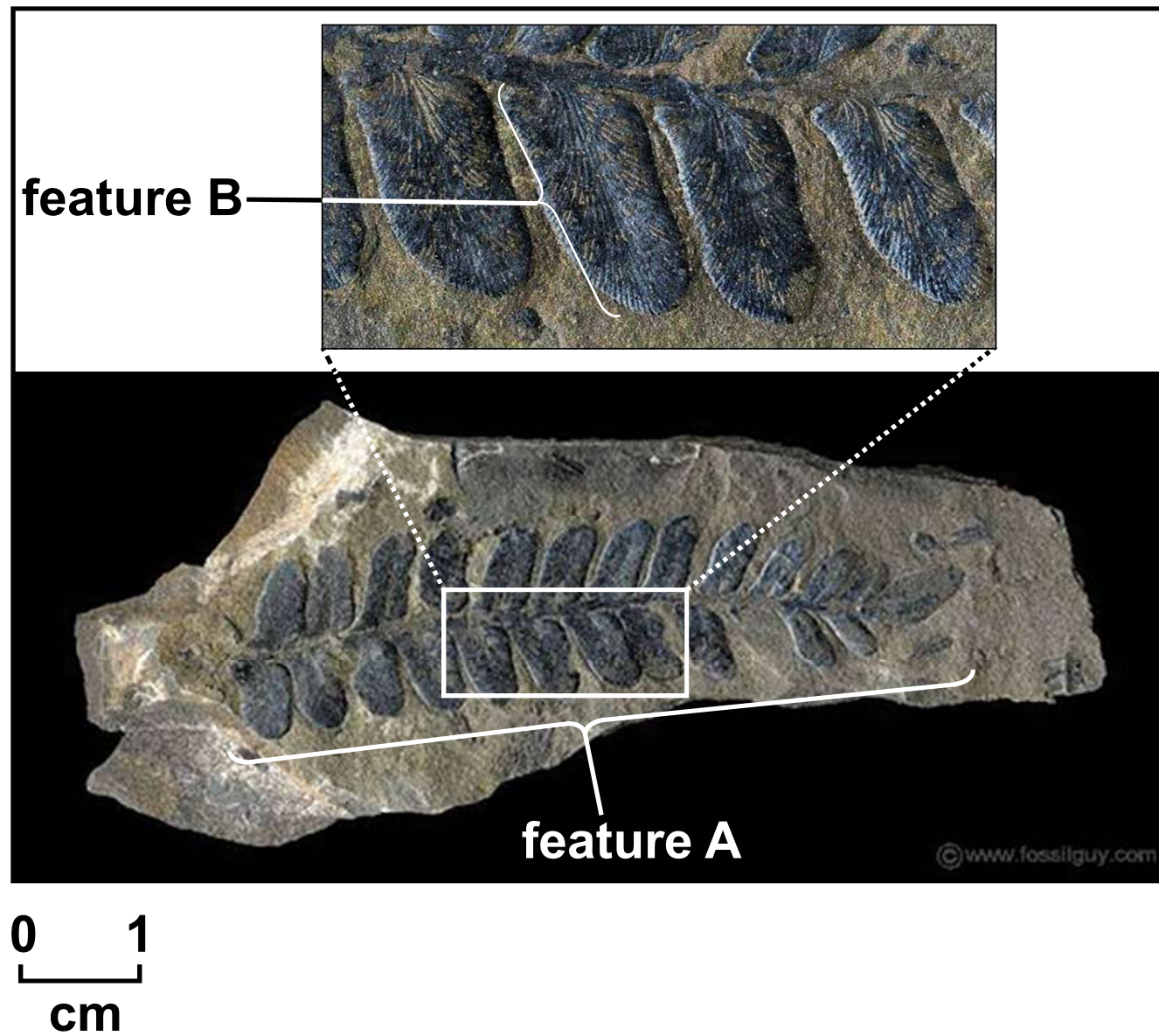


FIGURE 6b

PRESENT-DAY PLANT K

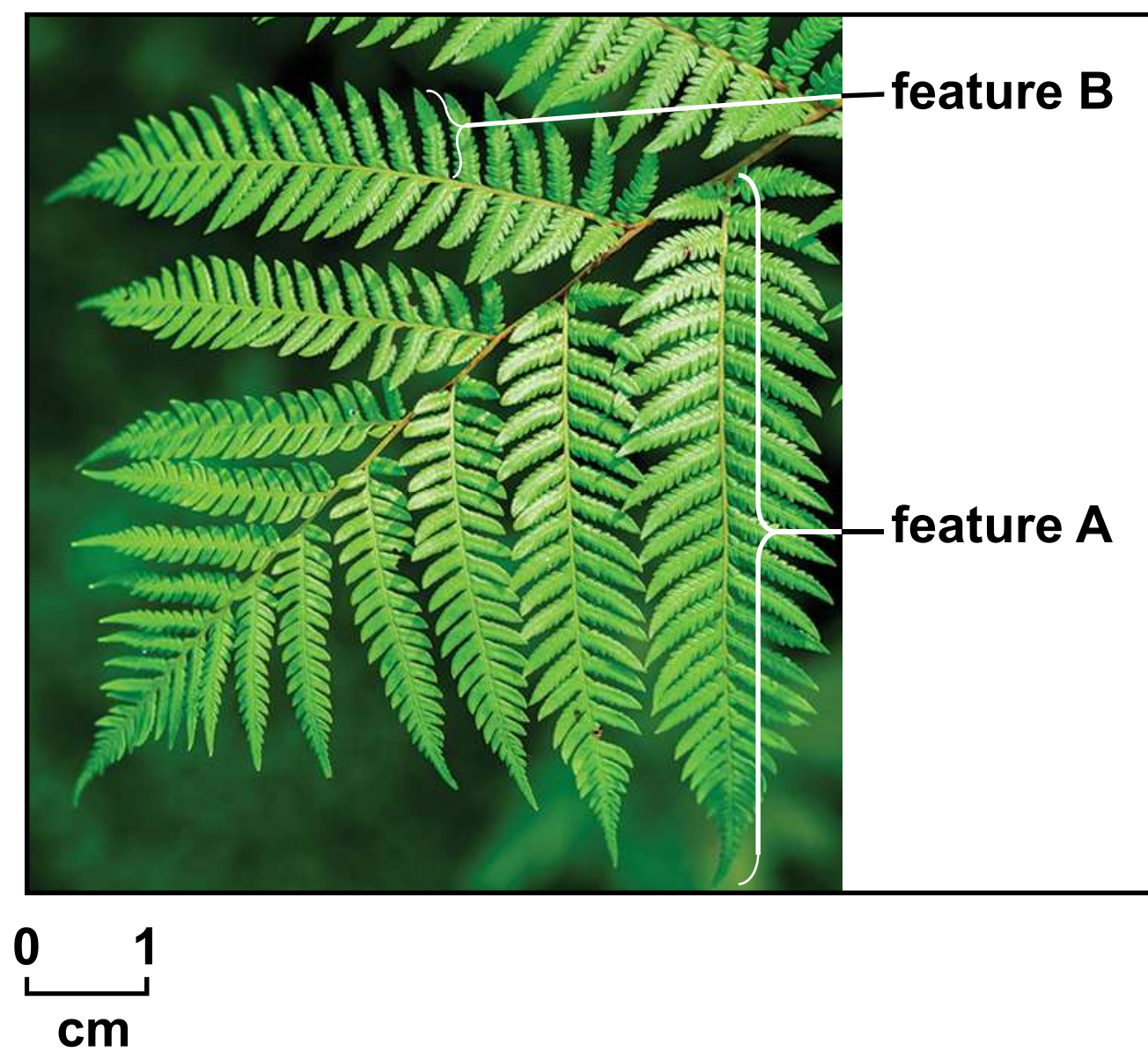
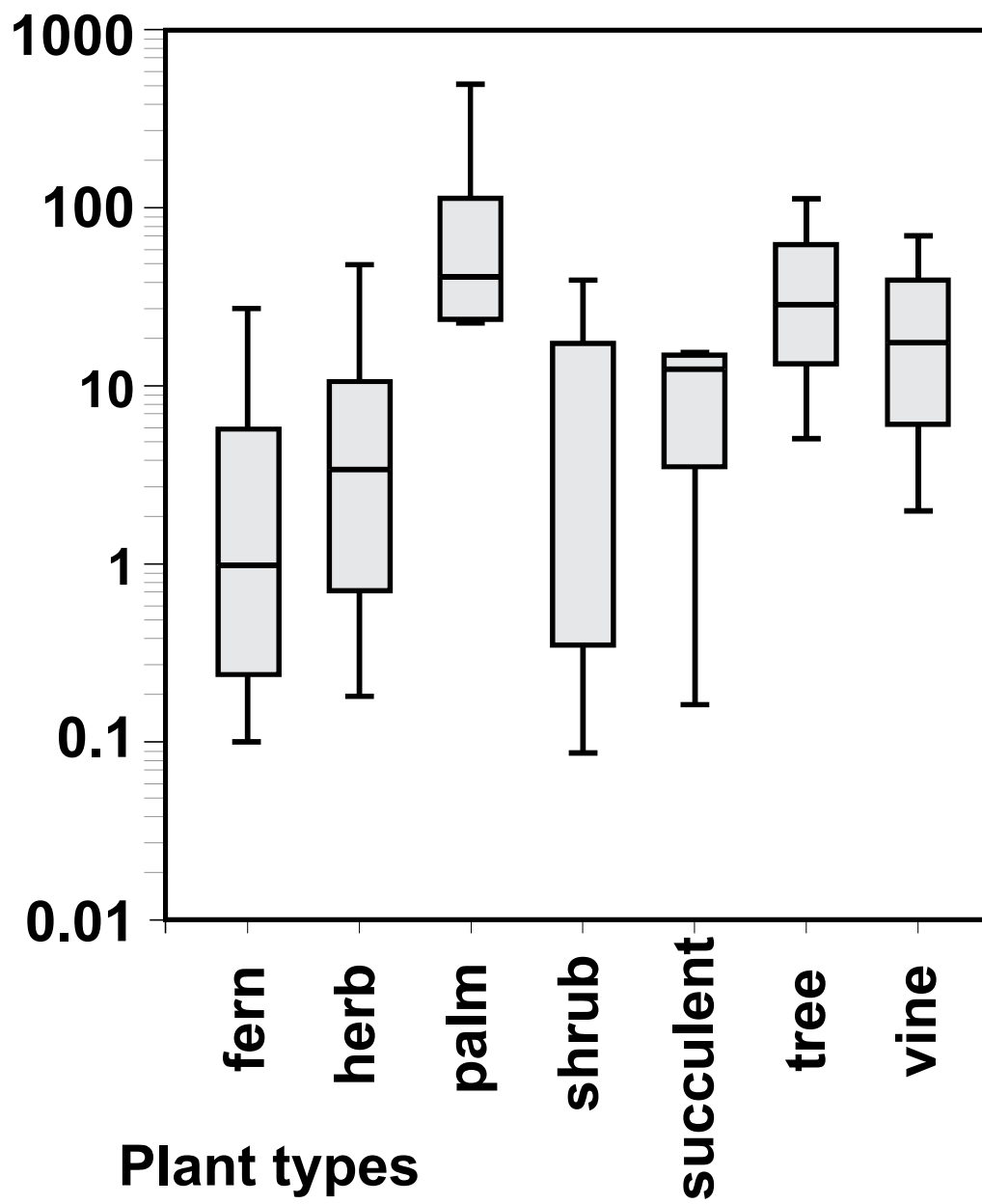


FIGURE 6c

Leaf surface area (cm²)



KEY:

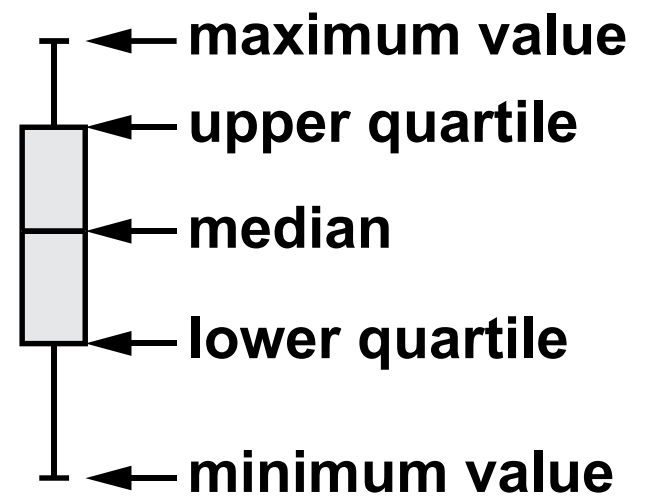


FIGURE 6d

Leaf surface area (cm²)

