



**GCE A LEVEL  
A480U20-1**

**WEDNESDAY, 12 JUNE 2024 – AFTERNOON**

**GEOLOGY - A LEVEL COMPONENT 2  
GEOLOGICAL PRINCIPLES AND PROCESSES  
1 hour 45 minutes plus your additional time allowance**

**Surname**

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**First Name(s)**

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**Centre Number**

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**Candidate Number**

**2**

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## **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 1 and 5.**

**(Turn over)**

**Answer ALL questions in the spaces provided.**

**1 FIGURE 1a opposite shows a cliff section together with sketches of three fossils (A, B and C) collected from the Jurassic limestone.**

**(a) Refer to FIGURE 1a.**

**(i) State the fossil groups to which fossils A, B and C belong. [2 marks]**

**Fossil A:** \_\_\_\_\_

\_\_\_\_\_

**Fossil B:** \_\_\_\_\_

\_\_\_\_\_

**Fossil C:** \_\_\_\_\_

\_\_\_\_\_

**(Turn over)**

- 1 (a)(ii) A student concluded that the fossils preserved in the Jurassic limestone may not give an accurate record of marine life during the Jurassic. Evaluate the student's conclusion. [3 marks]**

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- 1 (a)(iii) Trilobites became extinct at the end of the Permian. Explain the presence of the trilobite fossils in the Jurassic breccia. [3 marks]**

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**1 (b) FIGURE 1b opposite shows the processes that may preserve organisms such as FOSSIL B in FIGURE 1a.**

**Describe the fossilisation processes shown on FIGURE 1b. [6 marks QER]**

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**(Turn over)**



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- 2** **FIGURE 2a** opposite is a cross-section across a convergent plate boundary with isotherms showing the variation in temperature with depth.

**FIGURE 2b** opposite the following page shows melting point curves for dry and wet peridotite and a partly completed graph of depth against temperature along the line X–Y beneath the volcano on **FIGURE 2a**.

- (a)** Describe the melting point curve for wet peridotite between depths of 0 km and 100 km in **FIGURE 2b**.

**[2 marks]**

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**(Turn over)**

**2 (b) Refer to FIGURE 2a and FIGURE 2b.**

- (i) Plot the points to complete LINE V on FIGURE 2b using the isotherms beneath the volcano on FIGURE 2a. The first three points have been plotted for you. Join the points to show the variation in temperature with depth beneath the volcano between 0 km and 100 km. A vertical line (X–Y) has been drawn on FIGURE 2a to assist you. [3 marks]**
- (ii) Explain why the magma beneath the volcano on FIGURE 2a must originate from wet rather than dry peridotite. [2 marks]**

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**(Turn over)**

**2 (c) FIGURE 2c opposite shows two photographs of granites (Photograph C and Photograph D) both of which formed at a convergent plate boundary. The granites contain either xenoliths or enclaves.**

**(i) State which photograph on FIGURE 2c (PHOTOGRAPH C or PHOTOGRAPH D) shows an enclave. Explain your answer. [3 Marks]**

**Photograph \_\_\_\_\_**

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**(ii) The volcano shown on FIGURE 2a erupts lavas with a range of compositions from mafic to silicic. Use FIGURE 2a and FIGURE 2c to suggest reasons for this variation in composition. [4 marks]**

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- 3** **FIGURE 3a** opposite is a field sketch showing minor folding of Carboniferous limestones in a road cutting at Ecton, Staffordshire.

**FIGURE 3b** opposite is a polar equal area 'stereonet' of dip measurements recorded by a student on FOLD F on **FIGURE 3a**.

**TABLE 1** below contains one additional dip measurement on FOLD F recorded by the student.

- (a)** Refer to **FIGURE 3a**, **FIGURE 3b** and **TABLE 1**.
- (i)** Mark on **FIGURE 3b**, with a cross (+), the dip angle and dip direction of the limestone bedding plane represented by the data in **TABLE 1**. [1 mark]

**TABLE 1**

| dip angle of the limestone bedding plane | dip direction of the limestone bedding plane |
|------------------------------------------|----------------------------------------------|
| 45°                                      | 280°                                         |

**(Turn over)**

- 3 (a)(ii) The length of folded surface P to Q is 125m. Using the formula below, calculate the percentage of crustal shortening of the folded surface between L and M on FIGURE 3a. Show your working.  
[2 marks]

Percentage of crustal shortening =

$$\frac{(\text{length of the folded surface P to Q} - \text{length of the horizontal surface L to M})}{\text{length of the folded surface P to Q}} \times 100$$

Percentage of crustal shortening = \_\_\_\_\_ %

(Turn over)

**3 (a)(iii) Explain the presence of the ‘intensely jointed zones with possible reverse faults’ labelled on FIGURE 3a. [3 marks]**

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**(b)(i) Mark on the ‘stereonet’, FIGURE 3b, a line to show the approximate trend of the fold axial plane trace of FOLD F. [1 mark]**

**(Turn over)**

**3 (b)(ii) In analysing the data on FIGURE 3a and FIGURE 3b the student concluded that FOLD F is:**

- **an anticline**
- **that is plunging**
- **and tight**
- **with an axial plane that dips to the ENE.**

**Evaluate the student's conclusion. [4 marks]**

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**(Turn over)**

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**3 (c) FIGURE 3c opposite shows a geological map of the area surrounding the road cutting shown in FIGURE 3a.**

**Refer to FIGURE 3c.**

- (i) Mark on the map on FIGURE 3c, a line to show the axial plane trace of FOLD F. [1 mark]**

**(Turn over)**

- 3 (c)(ii) The mineral veins on FIGURE 3c are believed to have been formed by ‘precipitation from acidic hydrothermal fluids derived from deeply buried sedimentary rocks’. Evaluate the extent to which the distribution of the mineral veins on FIGURE 3c is controlled by lithology and structure.**

**[4 marks]**

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**4 FIGURE 4a opposite shows the plate tectonic development of the southern hemisphere between 65 and 20 Ma.**

**(a) Refer to FIGURE 4a.**

**(i) Describe the change in latitude of Australia and Antarctica between 65 and 20 Ma. [2 marks]**

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**(Turn over)**

- 4 (a)(ii) **TABLE 2** shows four stages of the Wilson Cycle of ocean development. Identify the **TWO** stages of the Wilson Cycle that correspond to the Tasmanian Passage at 65 Ma and 20 Ma. Explain your answers. [4 marks]

**TABLE 2**

|                                                                                                                 |                                                                                                        |
|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| <b>MATURE STAGE:</b> widening of the narrow sea into a wider ocean by seafloor spreading.                       | <b>YOUNG STAGE:</b> formation of new spreading centres with narrow seas between the rifted continents. |
| <b>END STAGE:</b> all oceanic lithosphere has been subducted and an active continental orogenic belt is formed. | <b>EMBRYONIC STAGE:</b> extension of continental areas and formation of continental rift valleys.      |

Stage of Wilson Cycle at 65 Ma \_\_\_\_\_

Explanation: \_\_\_\_\_

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(Turn over)

**Stage of Wilson Cycle at 20 Ma** \_\_\_\_\_

**Explanation:** \_\_\_\_\_

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**4 (b) FIGURE 4b opposite shows the change in Antarctic sea water temperature and global atmospheric CO<sub>2</sub> concentration between 65 and 20 Ma.**

**Refer to FIGURE 4b.**

- (i) One hypothesis for the onset and growth of the Antarctic Ice Sheet is that it was caused by changes in global atmospheric CO<sub>2</sub> concentrations and Antarctic sea water temperatures. Evaluate this hypothesis using the data on FIGURE 4b. [3 marks]**

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**(Turn over)**

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- 4 (b)(ii) An alternative hypothesis for the onset and growth of the Antarctic Ice Sheet is that it was caused by the opening of the Drake and Tasmanian Passages. Explain the reasoning behind this hypothesis using the data on FIGURE 4a only. [3 marks]**

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**4 (c) Using FIGURE 4a, suggest why the growth of the Antarctic Ice Sheet is thought to have resulted in further cooling of the Earth's climate. [3 marks]**

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**(Turn over)**

- 5 FIGURE 5a opposite shows a cumulative frequency grain size graph for an orthoquartzite and information on how to determine the coefficient of sorting.**

**FIGURE 5b opposite the following page shows the possible locations in a desert environment where this orthoquartzite may have been deposited.**

- (a) Refer to FIGURE 5a and FIGURE 5b.**
- (i) The median is the 50th percentile on a cumulative frequency graph. Use all the information on FIGURE 5a to determine the median grain size of the orthoquartzite in the following units:  $\phi$  units and mm.**
- [2 marks]**

**Median grain size \_\_\_\_\_  $\phi$**

**Median grain size \_\_\_\_\_ mm**

**(Turn over)**

- 5 (a)(ii) Use the formula on FIGURE 5a to calculate the coefficient of sorting of the orthoquartzite. Show your working. [2 marks]**

**Coefficient of sorting = \_\_\_\_\_**

- (iii) Use your answer to (a)(ii) and FIGURE 5a to state the sorting of the orthoquartzite. [1 mark]**

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**5 (a)(iv) State the most likely environment (A, B, or C) on FIGURE 5b in which the orthoquartzite was deposited. Explain your answer. [3 marks]**

**Location:** \_\_\_\_\_

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**(Turn over)**

- 5 (b) FIGURE 5c opposite is a photograph of another sedimentary rock which was also deposited in a desert environment. Its composition is shown.**

**TABLE 3 opposite the following page shows grain size data for this sedimentary rock.**

**FIGURE 5d opposite the following page is a simplified version of FIGURE 5a.**

- (i) Use the data in TABLE 3 to complete the cumulative frequency curve for this sedimentary rock on FIGURE 5d. The first three points have been plotted for you. [2 marks]**
- (ii) A student correctly concluded that this sedimentary rock was deposited in environment D on FIGURE 5b. Using FIGURE 5c and FIGURE 5d, explain the evidence for this conclusion. [6 marks QER]**

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**(Turn over)**





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**6 FIGURE 6a opposite shows some of the forces acting on tectonic plates which drive or oppose their motion.**

**(a) Refer to FIGURE 6a.**

- (i) Draw an arrow (  ) in each of the two blank boxes on FIGURE 6a to show the relative direction of motion of the tectonic plate at that location. [1 mark]**
- (ii) State ONE example of a force from FIGURE 6a which opposes the motion of tectonic plates. Explain your answer. [2 marks]**

**Name:** \_\_\_\_\_

**Explanation:** \_\_\_\_\_

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**(Turn over)**

- 6 (b)(i) In 1931 Arthur Holmes suggested a process to explain the continental drift hypothesis of Alfred Wegener. Explain how this process, shown by the dashed arrows on FIGURE 6a, has been used to explain the motion of tectonic plates. [3 marks]**

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- (ii) In 1975 geophysicists Donald Forsyth and Seiya Uyeda suggested that the slab pull force ( $F_{sp}$ ) is the main driver of tectonic plate motion. Use FIGURE 6a and your knowledge to explain how the slab pull force drives the motion of tectonic plates. [2 marks]**

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**(Turn over)**

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**6 (c) GPS data shows that a location on a continental tectonic plate is moving towards the north-east with a bearing of  $055^\circ$  from north. This motion is measured in a northward and in an eastward direction as shown on FIGURE 6b. FIGURE 6c opposite is a displacement-time graph showing the northward component of this motion.**

- (i) Use FIGURE 6c to show, in the space below, that the northward component of the continental tectonic plate's velocity at this location is approximately  $29 \text{ mm yr}^{-1}$ .  
[1 mark]**

- 6 (c)(ii) Refer to FIGURE 6b. The continental tectonic plate is moving towards the north-east with a bearing of  $055^\circ$  from north. Use trigonometry to calculate the resultant velocity (in  $\text{mm yr}^{-1}$ ) of the continental tectonic plate at this location. Show your working. [2 marks]

resultant velocity of the continental tectonic plate =

\_\_\_\_\_  $\text{mm yr}^{-1}$

(Turn over)

**6 (c)(iii) Explain what the resultant velocity of this continental plate at this location suggests about the forces that drive and oppose its motion.**

**[2 marks]**

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**6 (d) Using your knowledge, explain how palaeomagnetic data can be used to show the motion of continental plates. [2 marks]**

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**END OF PAPER**

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## **ACKNOWLEDGEMENTS**

### **FIGURE 2c**

#### **PHOTOGRAPH C**

[https://www.researchgate.net/publication/275938342\\_Granites\\_Really\\_Are\\_Magmatic\\_Using\\_Microstructural\\_Evidence\\_to\\_Refute\\_Some\\_Obstinate\\_Hypotheses](https://www.researchgate.net/publication/275938342_Granites_Really_Are_Magmatic_Using_Microstructural_Evidence_to_Refute_Some_Obstinate_Hypotheses)

Acknowledgement not found

#### **PHOTOGRAPH D**

[https://southwestcoastphotos.com/photo\\_13716275.html](https://southwestcoastphotos.com/photo_13716275.html)

Photograph David Evans

### **FIGURE 5c**

<https://twitter.com/ajmartin1991/status/1250463834218860544>

Photograph Andrew J Martin

| <b>QUESTION<br/>NUMBER</b> | <b>ADDITIONAL PAGE, IF REQUIRED.<br/>WRITE THE QUESTION NUMBER(S) IN THE<br/>LEFT-HAND MARGIN.</b> |
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| For Examiner's use only |              |              |
|-------------------------|--------------|--------------|
| Question                | Maximum Mark | Mark Awarded |
| 1                       | 14           |              |
| 2                       | 14           |              |
| 3                       | 16           |              |
| 4                       | 15           |              |
| 5                       | 16           |              |
| 6                       | 15           |              |
| Total                   | 90           |              |

**FIGURE 1a**

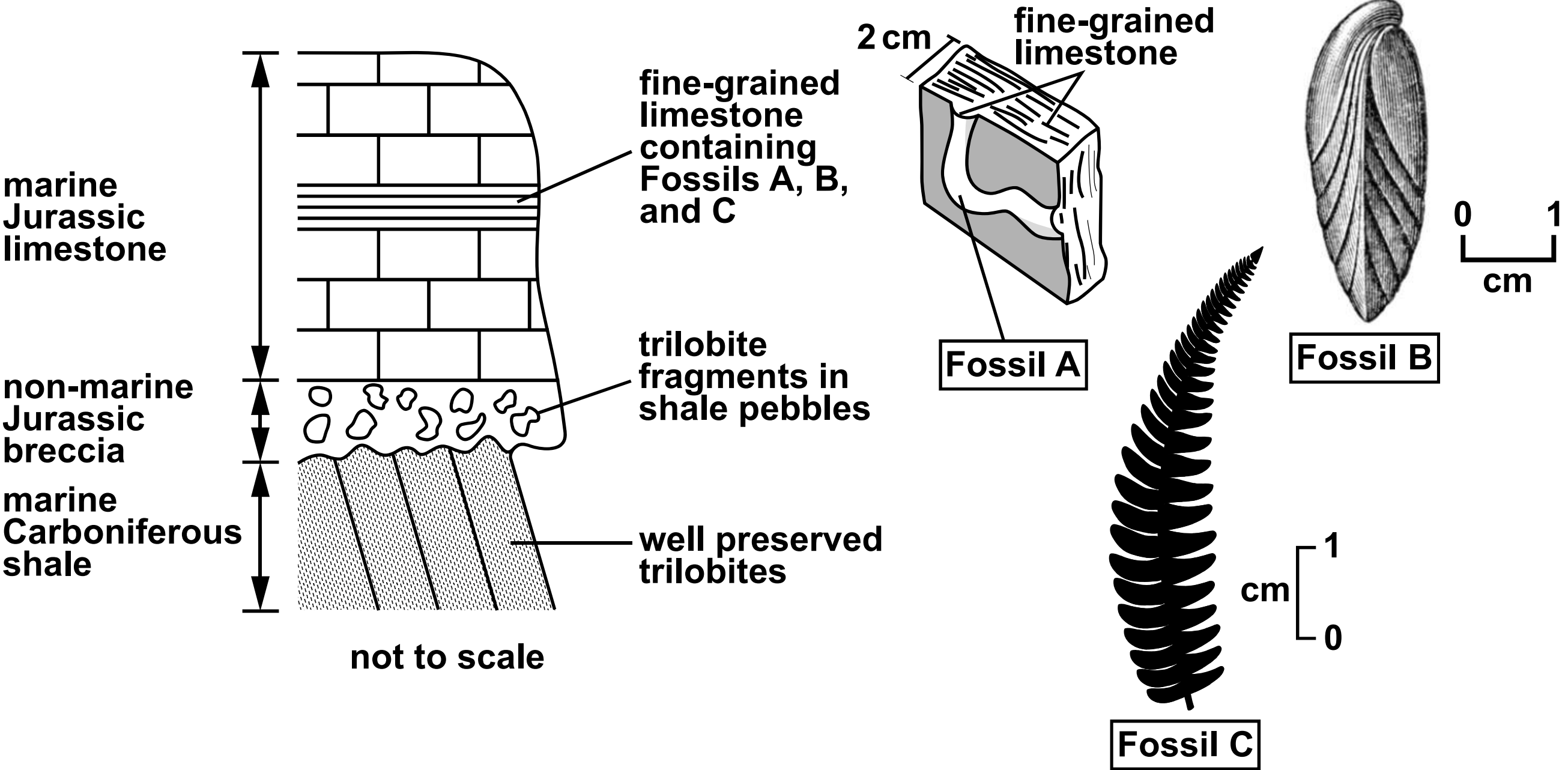
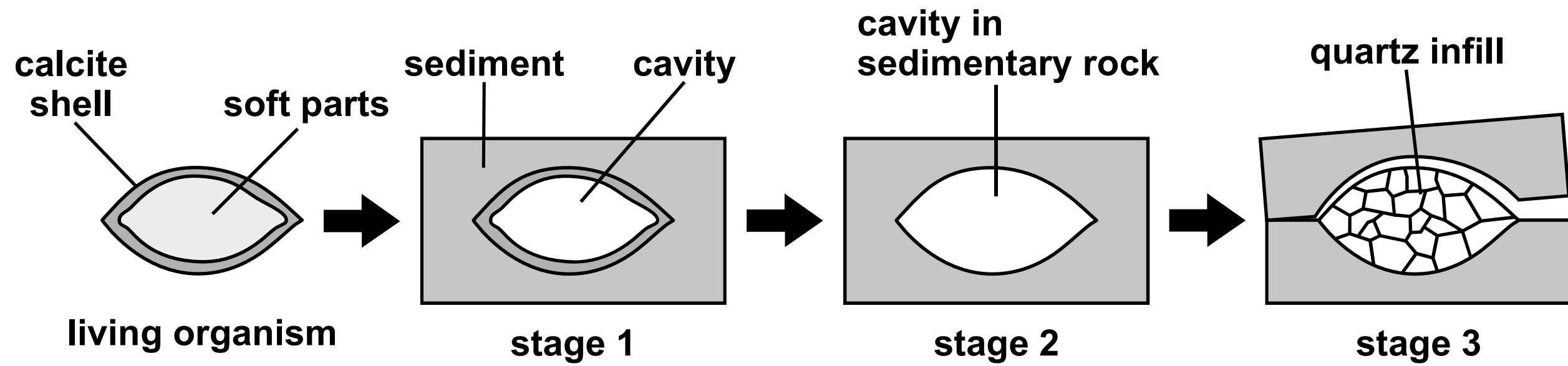


**FIGURE 1b**



Depth below sea level (km)

volcano erupting lavas ranging from mafic to silicic in composition

sea

200°C

400°C

600°C

800°C

1000°C

1200°C

no vertical exaggeration

Diagram illustrating a cross-section of a mid-ocean ridge. The vertical axis represents depth below sea level in kilometers, ranging from 0 to 100 km. The horizontal axis represents distance along the ridge. A volcano is shown erupting at the surface, with lavas ranging from mafic to silicic in composition. The ridge axis is marked with a red 'X' at the surface and a red 'Y' at the base. The magma chamber is shown as a series of red ovals along the ridge axis. The temperature profile is indicated by dashed lines and labels: 200°C, 400°C, 600°C, 800°C, 1000°C, and 1200°C. The ridge axis is labeled 'no vertical exaggeration'. The ridge is flanked by the sea on both sides.

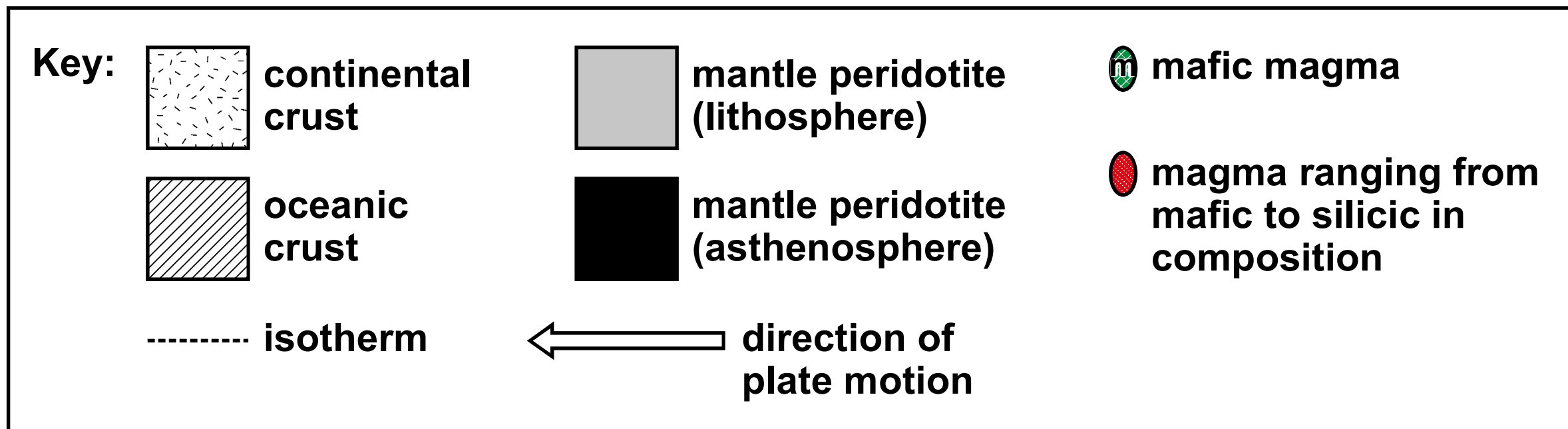


FIGURE 2b

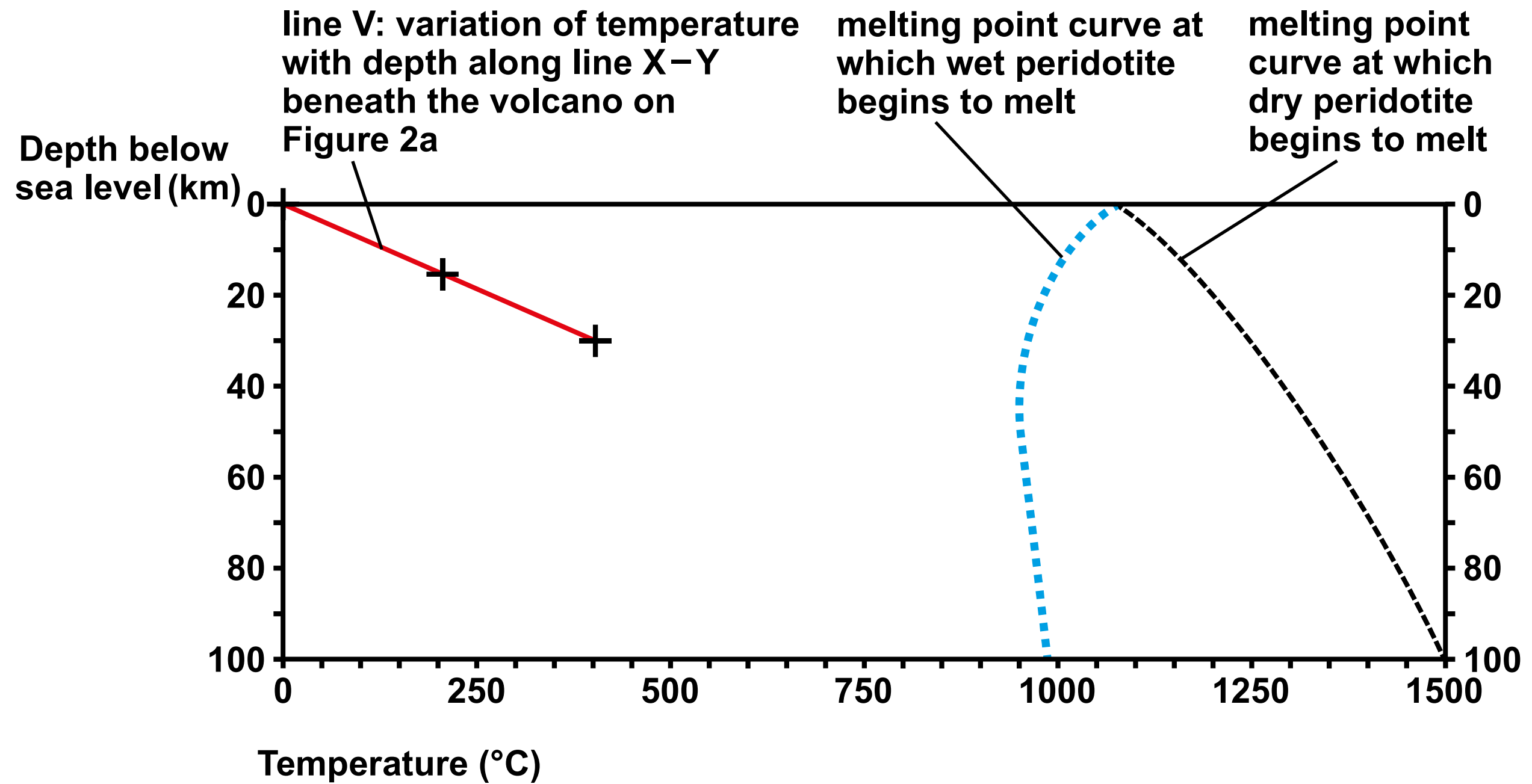


**FIGURE 2c**

**Photograph C**

**andesitic igneous rock**



0 10  
cm

**Photograph D**

**hornfels**



0 50  
cm

FIGURE 3a

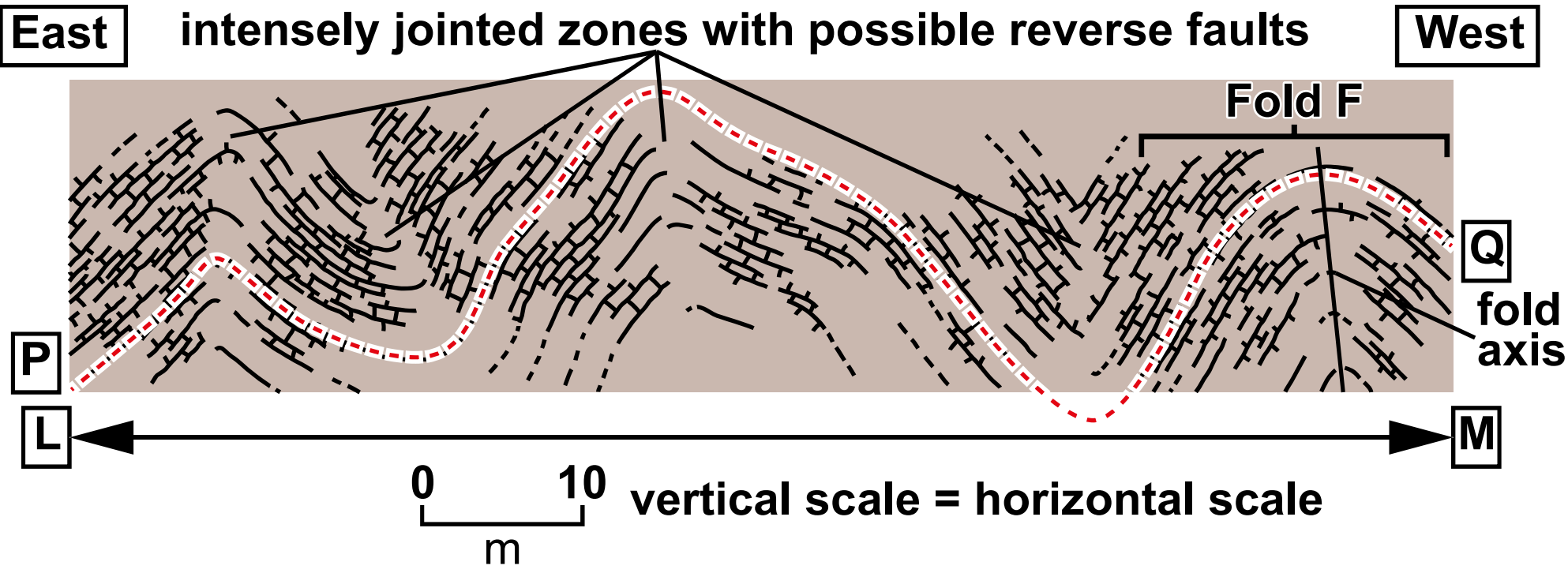


FIGURE 3b

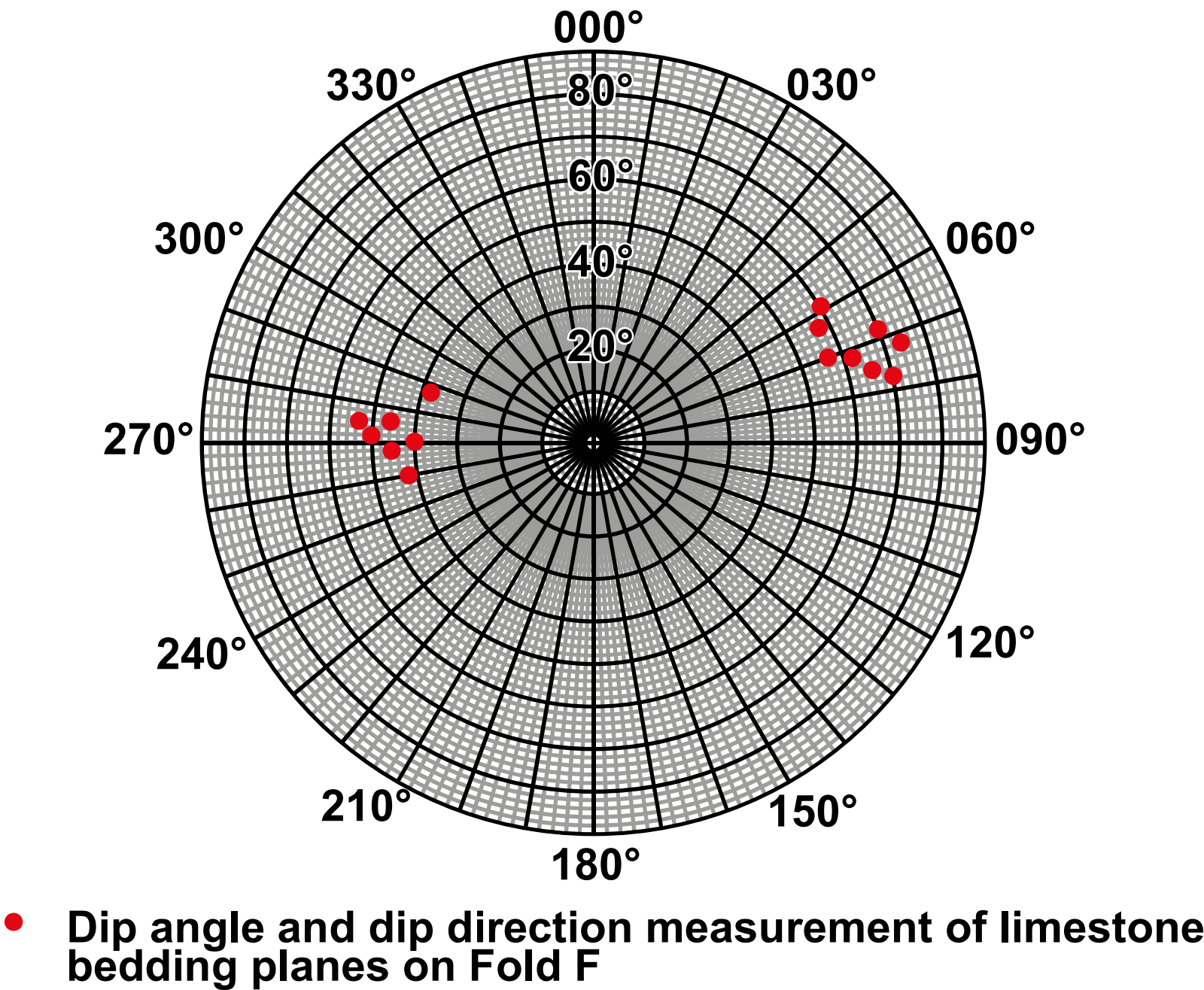


FIGURE 3c

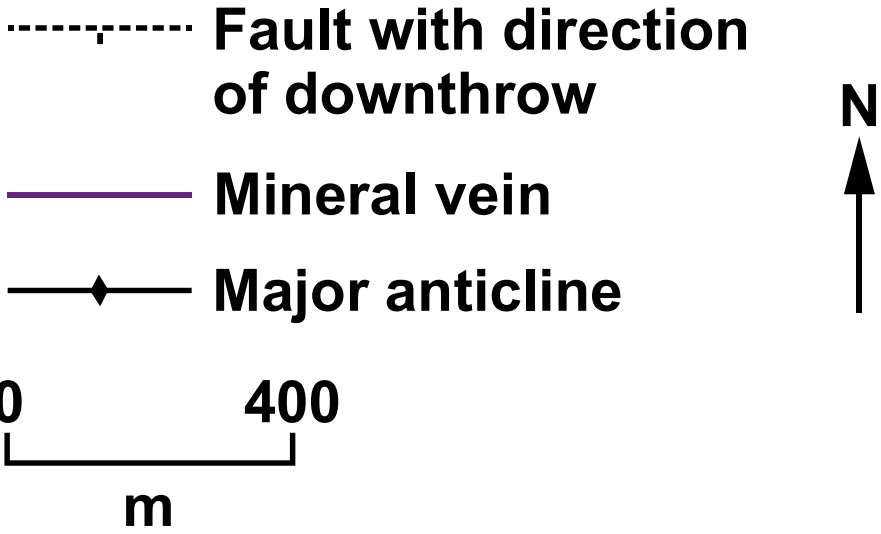
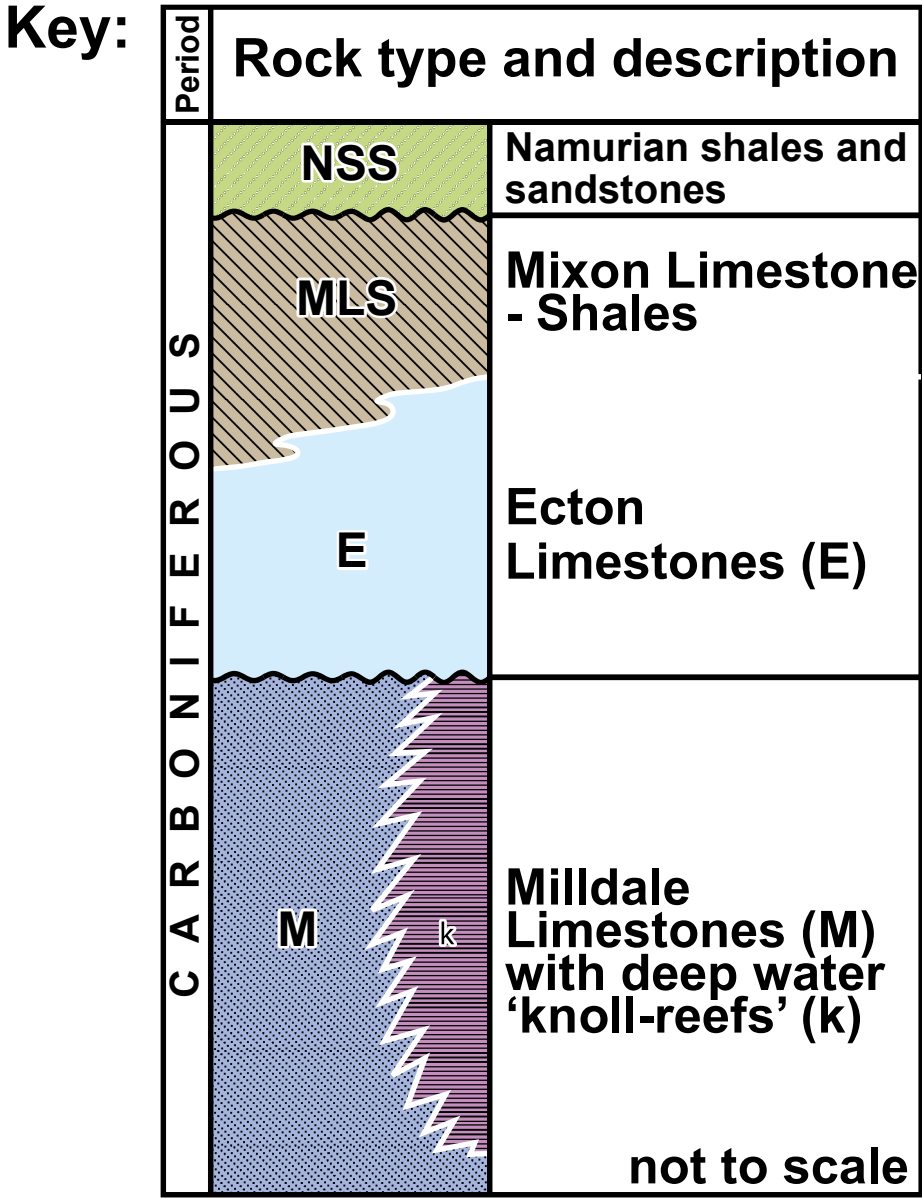
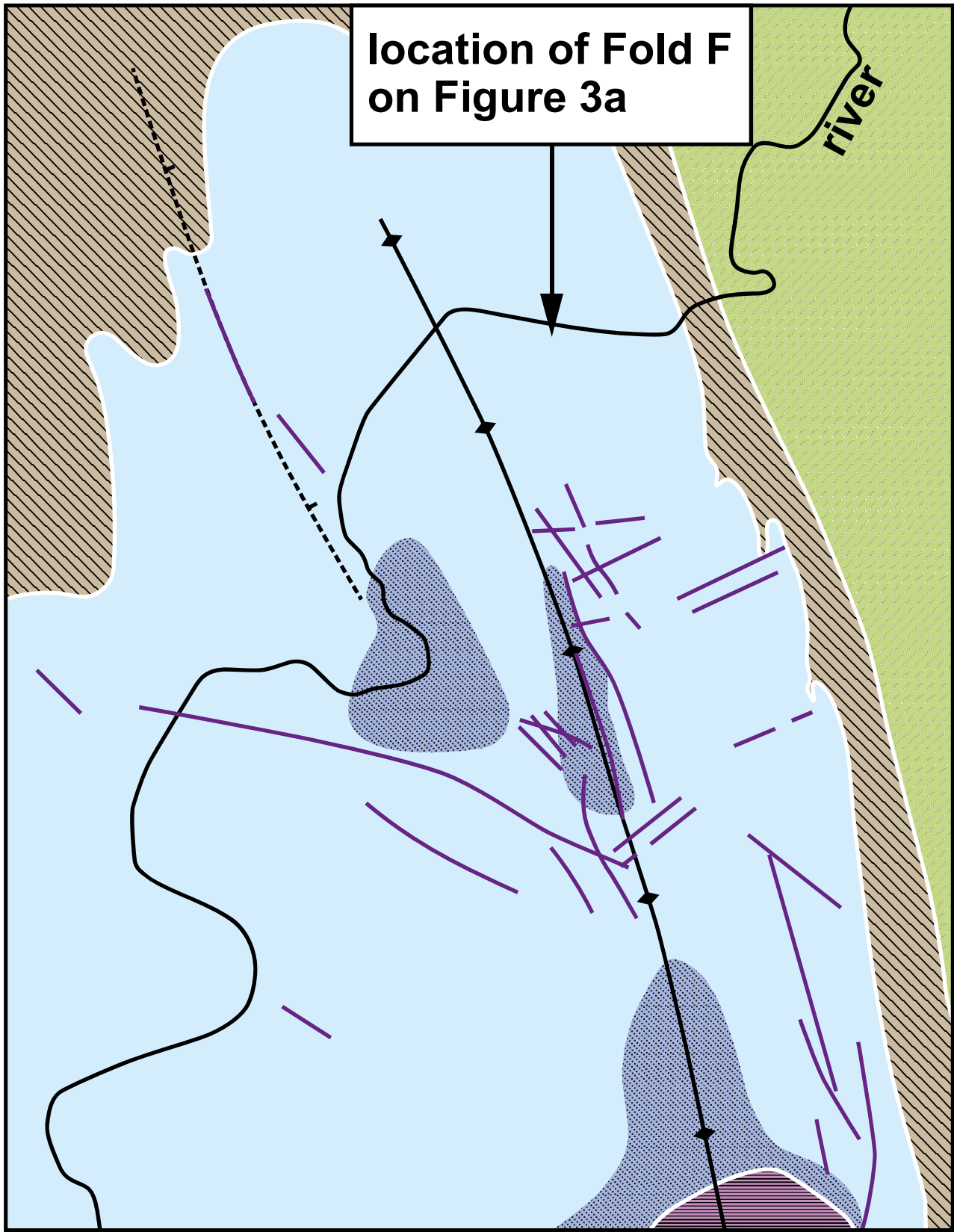
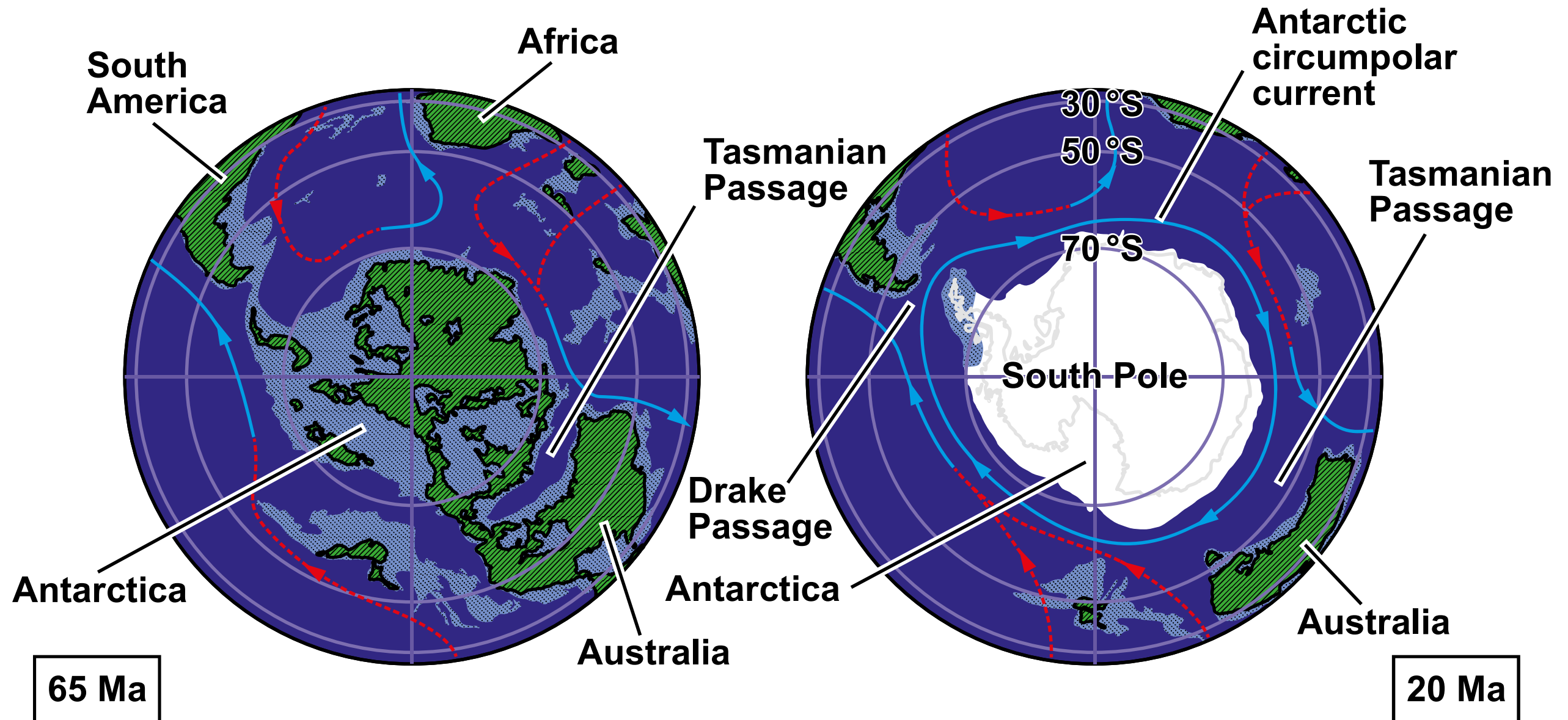
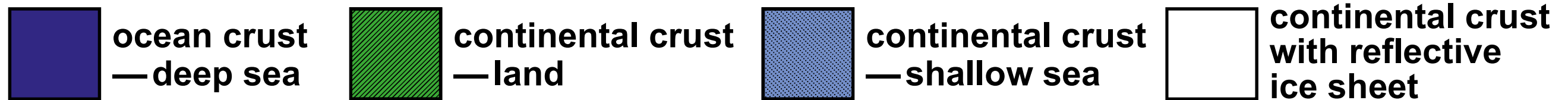


FIGURE 4a



Key:



50°S = 50°S line of latitude

 warm surface ocean current

 cold deep ocean current

**FIGURE 4b**

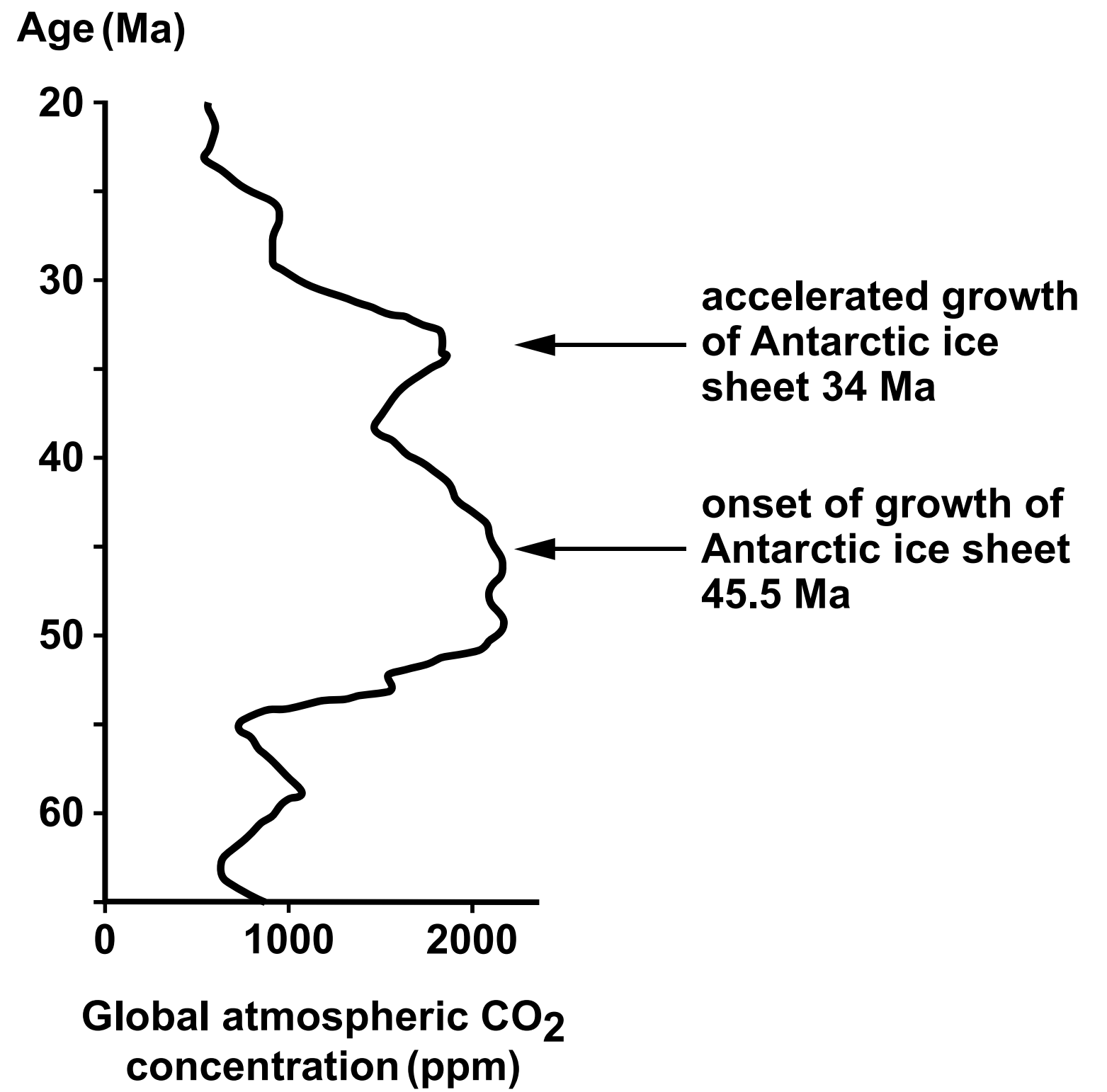
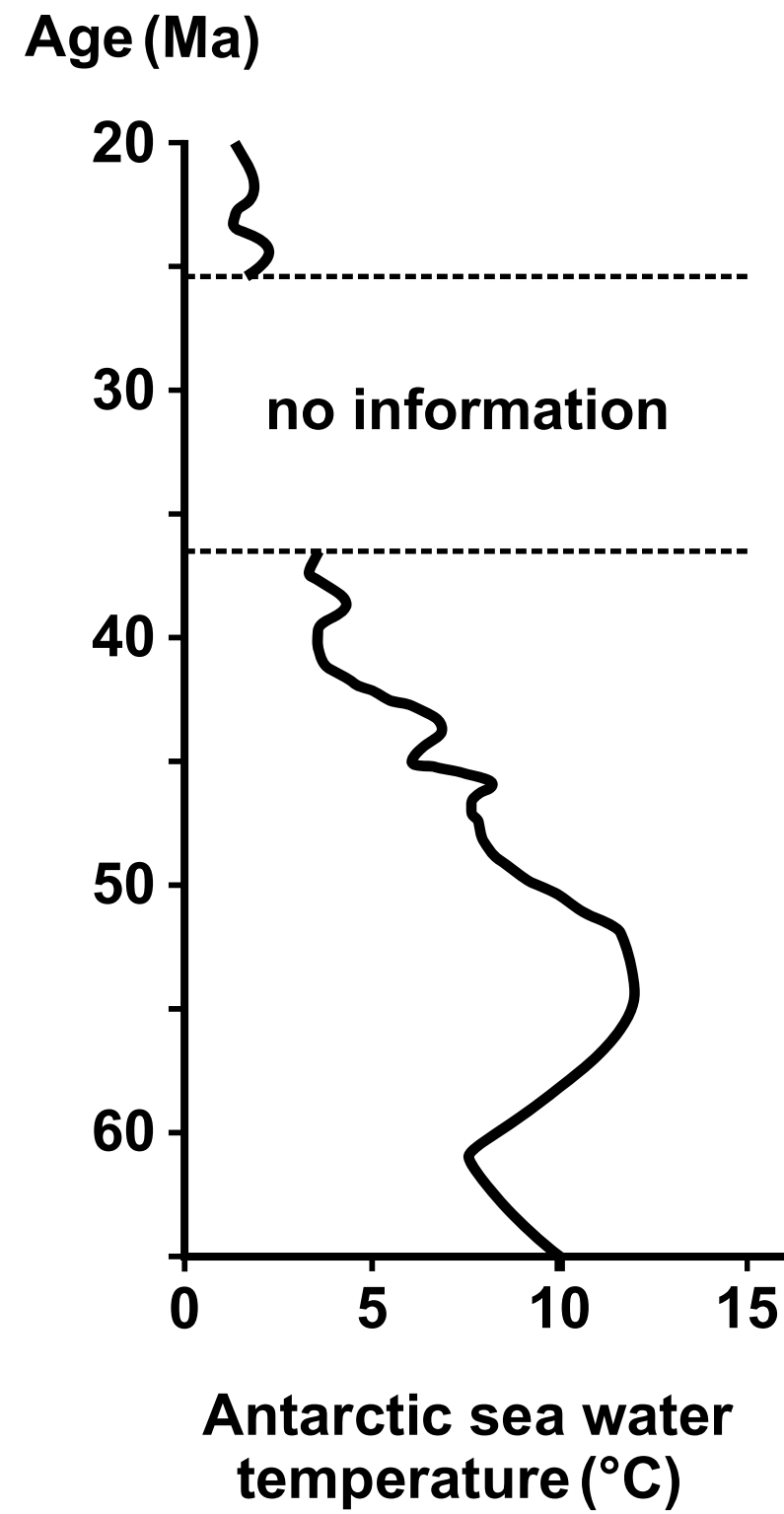
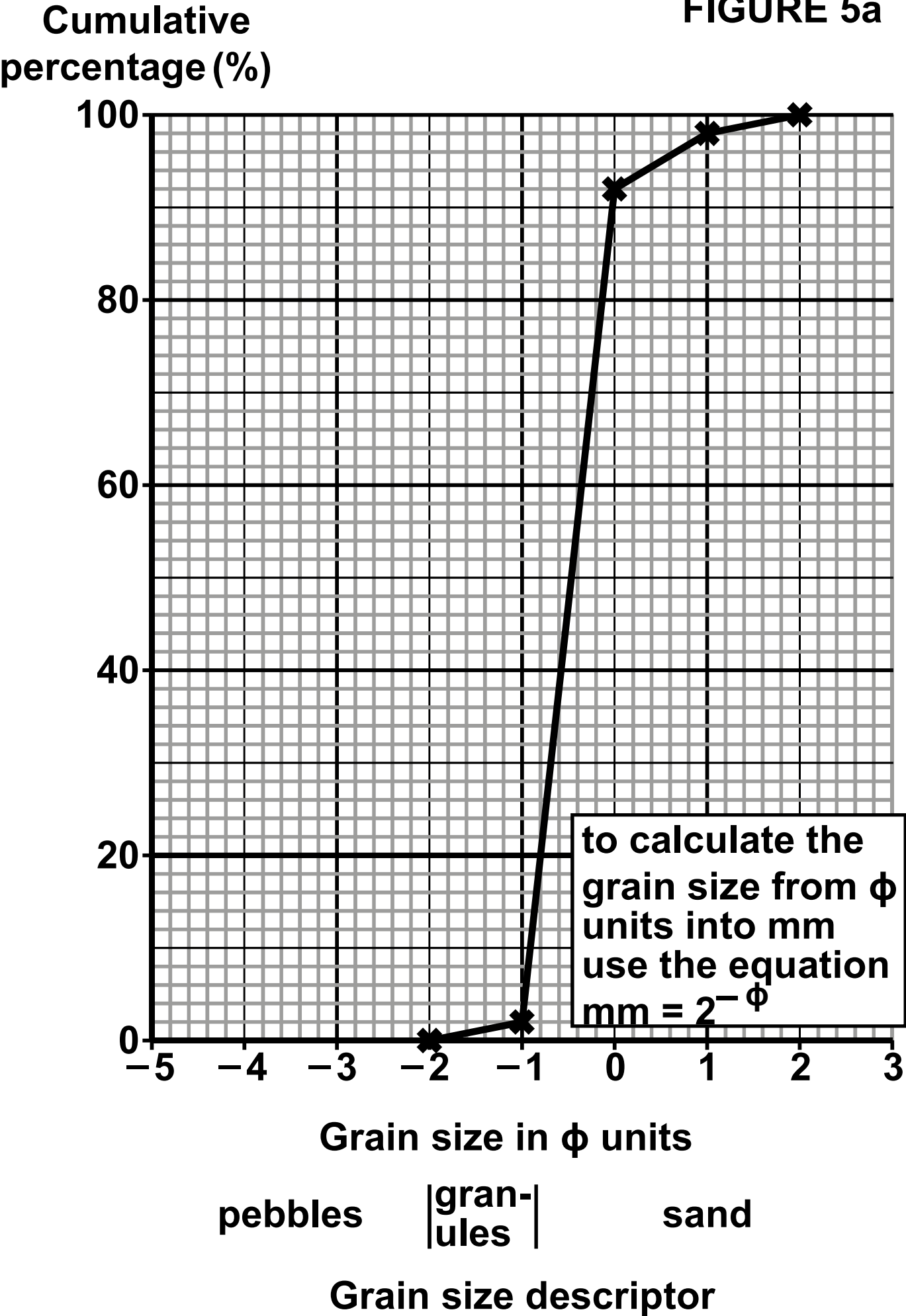


FIGURE 5a



Coefficient of sorting =  $\frac{\phi_{84} - \phi_{16}}{2}$

( $\phi_{84}$  is the  $\phi$  grain size value at 84% cumulative percent)

| Sorting descriptor      | Coefficient of sorting |
|-------------------------|------------------------|
| very well sorted        | <0.35                  |
| well sorted             | ≥0.35 and <0.50        |
| moderately well sorted  | ≥0.50 and <0.70        |
| moderately sorted       | ≥0.70 and <1.00        |
| poorly sorted           | ≥1.00 and <2.00        |
| very poorly sorted      | ≥2.00 and <4.00        |
| extremely poorly sorted | ≥4.00                  |

**FIGURE 5b**

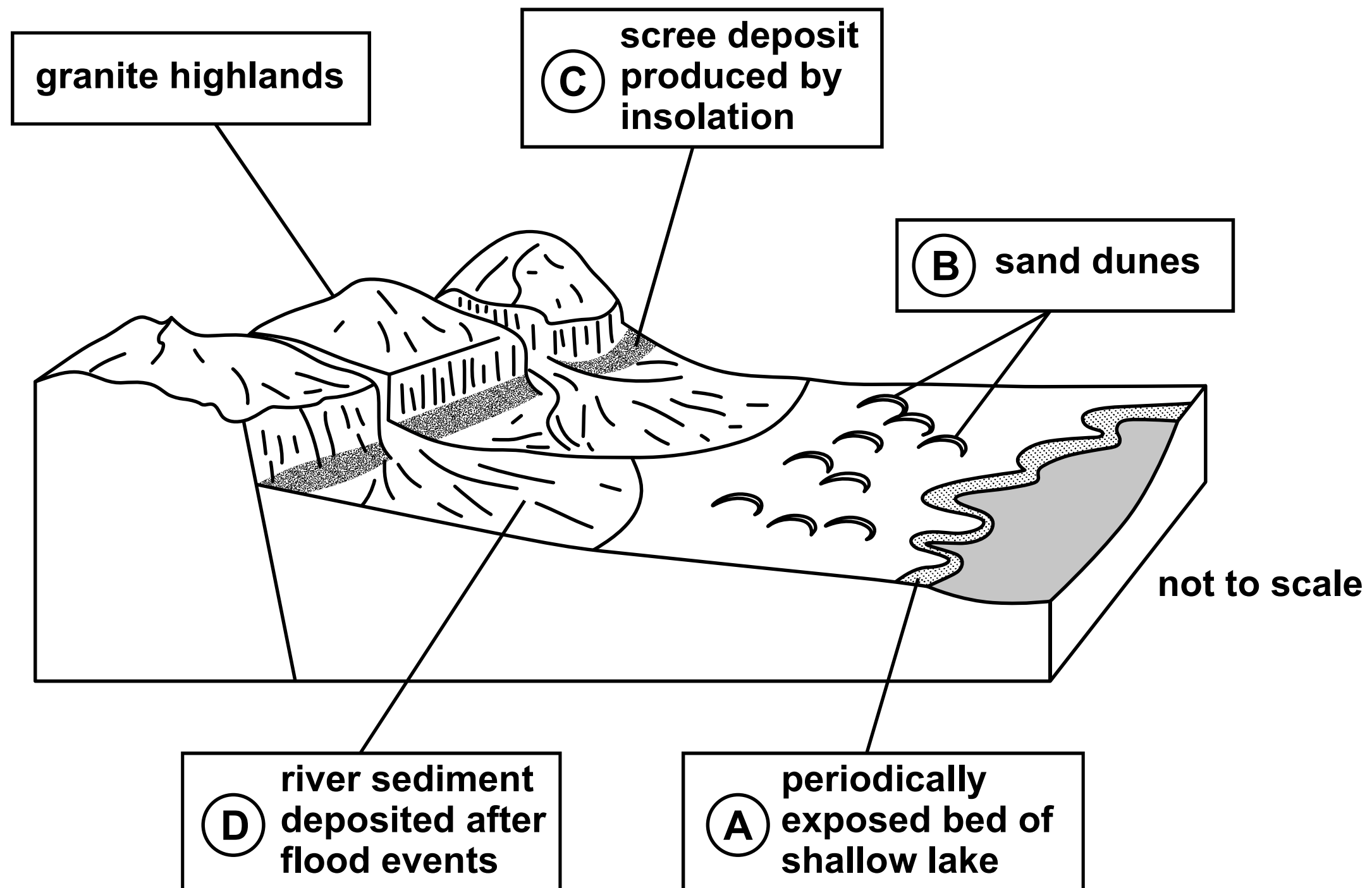


**FIGURE 5c**



**Mineralology:**  
quartz 62%  
feldspar 31%  
rock fragments 5%  
clay 1%  
others 1%

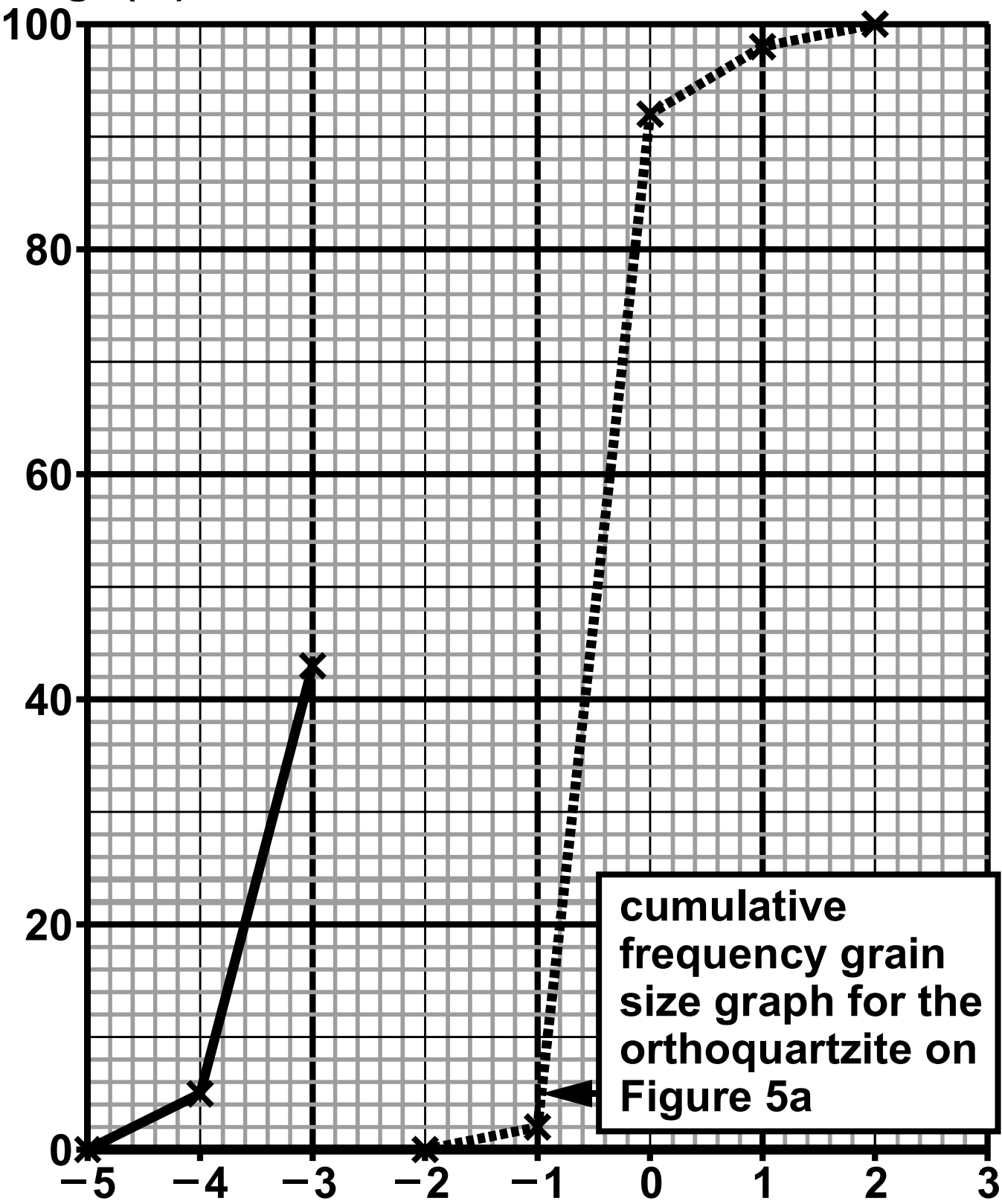
0 6  
cm

TABLE 3

| Grain size $\phi$   | Percentage mass of sediment (%) |
|---------------------|---------------------------------|
| $-5 \geq \phi > -6$ | 0                               |
| $-4 \geq \phi > -5$ | 5                               |
| $-3 \geq \phi > -4$ | 38                              |
| $-2 \geq \phi > -3$ | 27                              |
| $-1 \geq \phi > -2$ | 19                              |
| $0 \geq \phi > -1$  | 8                               |
| $1 \geq \phi > 0$   | 3                               |
| $2 \geq \phi > 1$   | 0                               |

Cumulative  
percentage (%)

FIGURE 5d

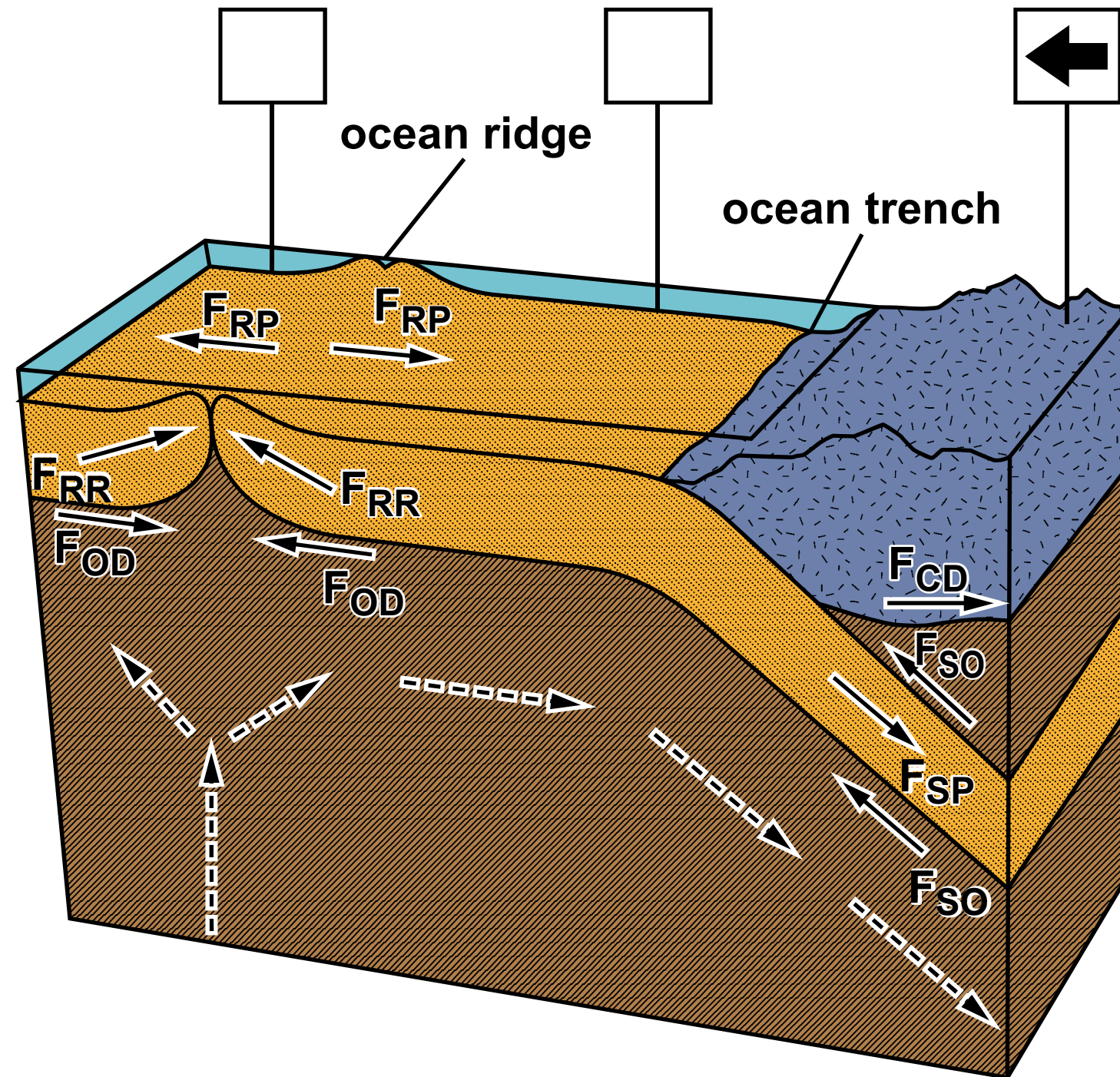


Grain size in  $\phi$  units

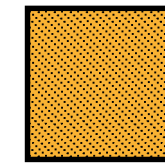
pebbles | gran-  
ules | sand

Grain size descriptor

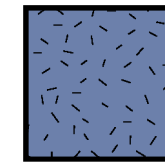
FIGURE 6a



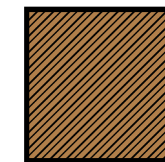
Key:



oceanic  
lithosphere



continental  
lithosphere



asthenosphere



Direction of force acting on  
lithospheric plate.

$F_{CD}$ : continental drag

$F_{RP}$ : ridge push

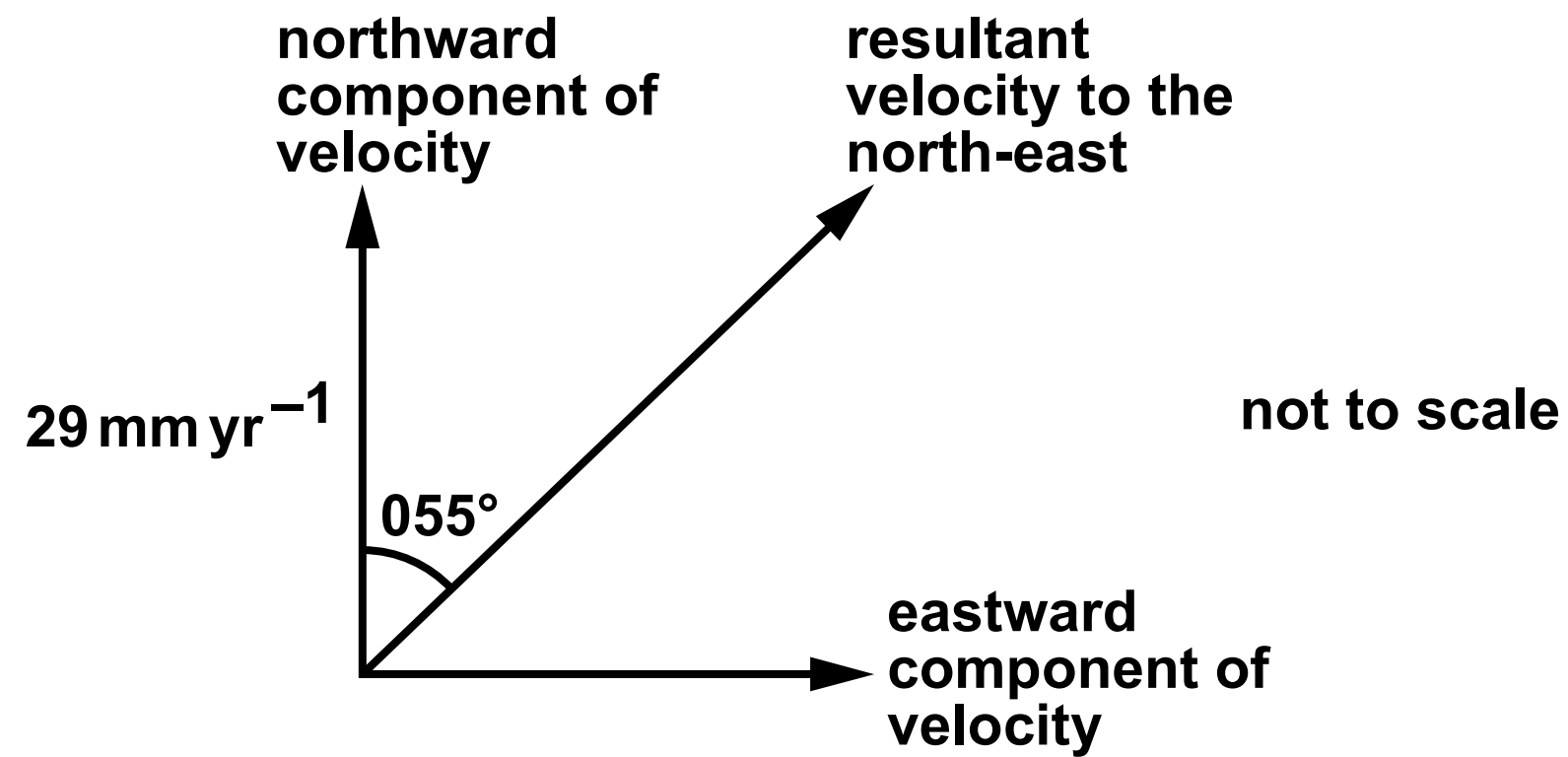
$F_{OD}$ : ocean drag

$F_{RR}$ : ridge resistance

$F_{SP}$ : slab pull

$F_{SO}$ : slab and overriding  
plate drag

FIGURE 6b



Displacement  
of the GPS  
station in a  
northward  
direction (mm)

FIGURE 6c

