

GCE A level

1214/01

GEOLOGY – GL4

Interpreting the Geological Record

P.M. MONDAY, 6 June 2016

2 hours plus your additional time allowance

Surname _____

Other Names _____

Centre Number _____

Candidate Number 2 _____

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
Section A		
1.	15	
2.	15	
3.	15	
4.	15	
Section B		
5.	11	
6.	17	
7.	12	
Total	100	

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

- the Geological Map Extract (Kirkcaldy);
- a hand-lens or magnifier to study the map (optional);
- a calculator;
- a protractor.

INSTRUCTIONS TO CANDIDATES

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

Write your name, centre number and candidate number in the spaces provided on the front cover.

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.

Candidates are reminded that marking will take into account the quality of communication used in their answers.

SECTION A

Answer ALL questions in the spaces provided.

This section should take approximately 1 hour to complete.

1. FIGURE 1a opposite is a geological section showing two igneous bodies (A and B) which occur within a sedimentary rock sequence. FIGURE 1b opposite shows a vertical section of structures within igneous body A. FIGURE 1c opposite shows details of the composition and texture at four selected depths between P-Q across igneous body B in FIGURE 1a.

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

(i) Identify the structures within igneous body A (FIGURE 1b) and explain their origin. [2]

Structures _____

Origin _____

1(a) (ii) Using evidence from FIGURE 1b alone, draw an arrow labelled Y (\leftarrow Y) on FIGURE 1a to show the YOUNGEST SEDIMENTARY rock unit in the sequence. Explain your answer. [3]

1(b) (i) With reference to FIGURE 1a and FIGURE 1c, describe the distribution of olivine within igneous body B. [3]

1(c) Igneous body A has a radiometric age of 76 Ma. Draw an arrow labelled X (\leftarrow X) on FIGURE 1a where a specimen of IGNEOUS rock might be OLDER than 76 Ma. Explain your answer. [3]

15

2. **FIGURE 2a** opposite shows photomicrographs of two sedimentary rocks (rocks A and B). **FIGURE 2b** opposite is a triangular graph on which the composition of rock A has been plotted.

(a) **State TWO differences in TEXTURE between rocks A and B in FIGURE 2a.**

Explain why the textures differ. [4]

Difference _____

Difference _____

Explanation _____

- 2(b) (i) The composition of rock B before lithification was 95 % quartz, 5 % feldspar. Plot this composition on FIGURE 2b and label with the letter B. [1]**
- (ii) Draw an arrow from point A on FIGURE 2b to show how the COMPOSITION of rock A might change over time if it were subjected to intense chemical weathering in a tropical climate. [2]**
- (iii) Explain the changes in composition you have identified in (b) (ii). [3]**

2(c) State in which of the following environments of deposition you would most likely find sediments similar to those of rocks A and B being deposited today.

Choose ONE environment ONLY from the list below for rock A and ONE for rock B, indicating with the appropriate rock letter (A or B). [2]

Environment of deposition	Rock A or B (Choose ONE environment for each rock)
beach (marine)	
coral lagoon	
semi-arid river (alluvial fan)	
tidal mudflats	

2(d) Describe the likely POST-DEPOSITIONAL history of rock B stating the evidence for your conclusions. [3]

15

- 3. **FIGURE 3** opposite shows deformed fossil brachiopods of the **SAME** species preserved on a bedding surface within cleaved shale. **TABLE 3** opposite shows data collected from the specimens.

Refer to FIGURE 3.

- (a) (i) **Describe, with reasons, the possible environment in which the shale was deposited. [2]**

3(a) (ii) The evidence suggesting that the fossil brachiopods on this bedding plane represent a life or death assemblage is conflicting.

Critically evaluate the statement that suggests “the brachiopods represent a LIFE assemblage”. [3]

3(b) Complete TABLE 3 opposite page 13.

(i) Measure the long (hinge) axis of brachiopod X and express this as a ratio with the short axis. [2]

(ii) Measure the angular shear (ψ) of brachiopod X. [1]

(c) Refer to FIGURE 3 and TABLE 3.

(i) State the letter of ONE fossil brachiopod that shows bilateral symmetry. [1]

Brachiopod _____

(ii) Describe the differences in the way in which brachiopods A and G have been deformed. [2]

4. **FIGURE 4 opposite shows the changes in diversity of marine fauna (Sepkoski's curves) during the Phanerozoic along with the arrangement of continents over the same time.**

Refer to FIGURE 4.

- (a) (i) **Name the most abundant Phanerozoic fauna (Cambrian, Palaeozoic OR Modern) that existed during the Mesozoic era. [1]**
-

4(a) (ii) Complete TABLE 4 opposite with the following.

- 1. The percentage of marine families that became extinct during the end Cretaceous (K-T) extinction. Show your working in the space provided.**

- 2. The name of the mass extinction at which approximately 51 % of marine families became extinct. [3]**

Extinction events	Percentage of marine families extinct
<p>end Cretaceous (K-T)</p>	<p>Working</p> <p>•</p> <p>Answer = _____ %</p>
<p>•</p>	<p>51 %</p>

TABLE 4

4(b) Explain why the small number of families recorded in the late Precambrian may not necessarily reflect the abundance of life at that time. [3]

4(c) (i) Describe the relative change in the area of continental shelf seas in FIGURE 4 between the Precambrian and the end of the Carboniferous. [2]

(ii) DESCRIBE the correlation between changes in the diversity of marine organisms and the breakup of the continents following the end Permian (P-T) mass extinction. [2]

SECTION B

Questions 5 - 7 relate to the BRITISH GEOLOGICAL SURVEY 1:50 000 GEOLOGICAL MAP extract of KIRKCALDY (SHEET 40E)

Answer ALL questions in the spaces provided.

This section should take approximately 1 hour to complete.

5(a) With reference to the CROSS-SECTION, state the

- **maximum thickness**
- **maximum depth**

of the quartz dolerite (qD) beneath sea-level (OD) on the axis of the Leven Syncline. [2]

Maximum thickness on the Leven Syncline	• m
Maximum depth on the Leven Syncline	• m

5(b) The quartz dolerite (qD) that crops out in BOX A on the GEOLOGICAL MAP is interpreted as the surface outcrop of a sill.

- (i) Complete FIGURE 5 by stating the TWO rock types you might predict to find IN THE FIELD at the upper boundary of the sill in BOX A. [2]

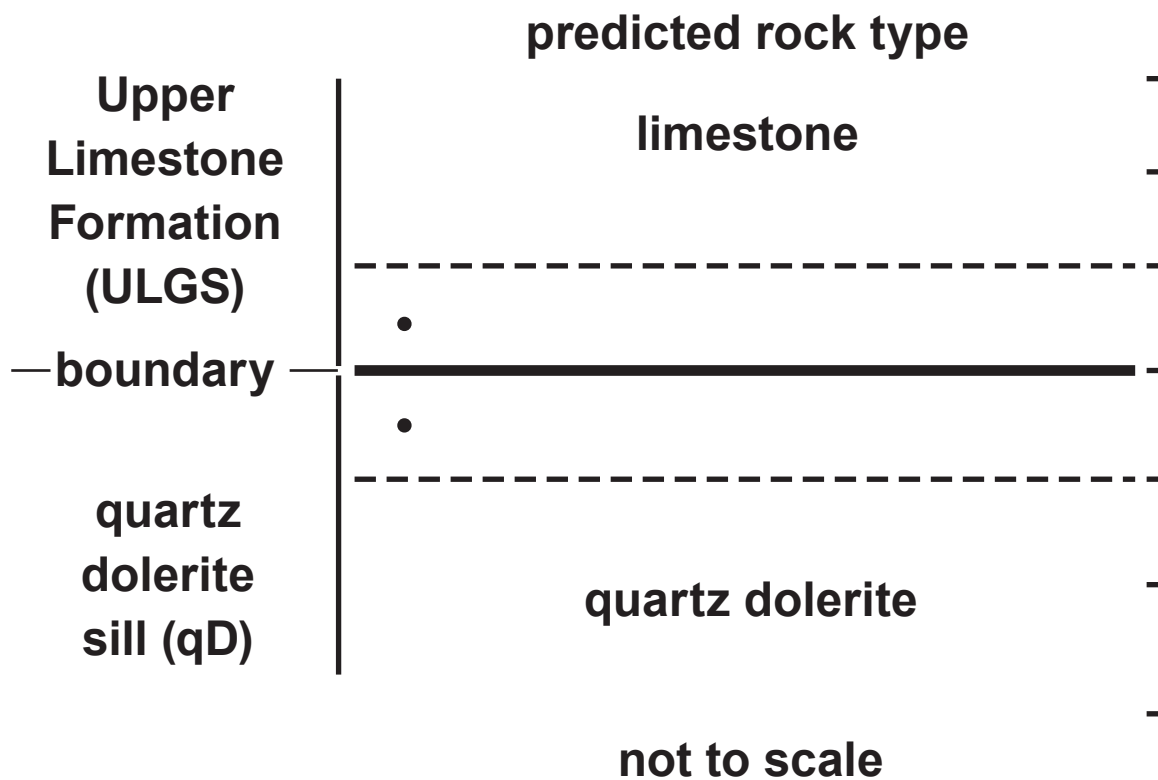


FIGURE 5

5(b) (ii) From your KNOWLEDGE, explain why an igneous body made of quartz dolerite (qD) is more likely to be associated with an intrusion than a lava flow. [2]

5(b) (iii) Critically evaluate the evidence from the GEOLOGICAL MAP and CROSS-SECTION that suggests the quartz dolerite (qD) forms a sill rather than a dyke. [3]

5(c) “The quartz dolerite (qD) sill was partly intruded along faults.”

Critically evaluate the EVIDENCE from the CROSS-SECTION for this statement. [2]

6. **FIGURE 6 opposite is a copy of the GEOLOGICAL MAP.**

Refer to the GEOLOGICAL MAP, GENERALISED GEOLOGICAL COLUMN and FIGURE 6.

(a) (i) **On FIGURE 6, draw in the axial plane trace of a PLUNGING ANTICLINE. Use the symbol in the key to indicate the direction of plunge of this fold. [2]**

(ii) **Describe the EVIDENCE that enables identification of the following fold characteristics. [2]**

1. **Anticline** _____

2. **Direction of plunge**

6(b) A student incorrectly concluded that the Durie Fault (GS 3602) showed strike slip movement to the right (dextral). Give TWO pieces of map evidence that show this interpretation to be INCORRECT. [2]

1. _____

2. _____

- 6(c) Using the **GEOLOGICAL MAP** and **CROSS-SECTION**, describe the general characteristics of the Buckhaven Fault that crops out in **GRID SQUARE 3698** by completing **TABLE 6** below. [4]

Buckhaven Fault characteristics	
Dip angle	varies with depth
Strike direction	•
Downthrow side	•
Hanging wall	•
Fault type	•

TABLE 6

6(d) The **CROSS-SECTION** shows the base of the Upper Coal Measures (UCMS) to the east of the Buckhaven Fault is approximately aligned with the Chemiss coal (CHE) of the Middle Coal Measures (MCMS) to the west.

- (i) Using the **GENERALISED GEOLOGICAL COLUMN ONLY**, calculate the throw (vertical displacement) of the Buckhaven Fault. Show your working. [2]

Throw = _____ m

- (ii) Describe how displacement on the Buckhaven Fault varies with depth. [2]

6(e) Coal mining of the Middle and Lower Coal Measures (MCMS and LCMS) occurred within the Leven Syncline on land and beneath the Firth of Forth Estuary. Using the CROSS-SECTION and GENERALISED GEOLOGICAL COLUMN suggest the GEOLOGICAL problems that might have been encountered during mining. [3]

7. **FIGURE 7a** opposite is a model showing coal-bearing strata on the limb of a plunging fold. **TABLE 7** gives details of the conditions needed to dispose of carbon dioxide (sequestration) in coal-bearing strata.

CO₂ SEQUESTRATION

The long-term disposal of carbon dioxide (CO₂) by pumping liquefied gas into deeply buried coal seams (over 1200 m deep) is an option for reducing atmospheric CO₂ levels. CO₂ binds strongly to the surfaces within coal where it is stored.

TABLE 7

- (a) **Shade and label the TOP SURFACE** of **FIGURE 7a** to show the area below which there is potential for CO₂ sequestration. [2]

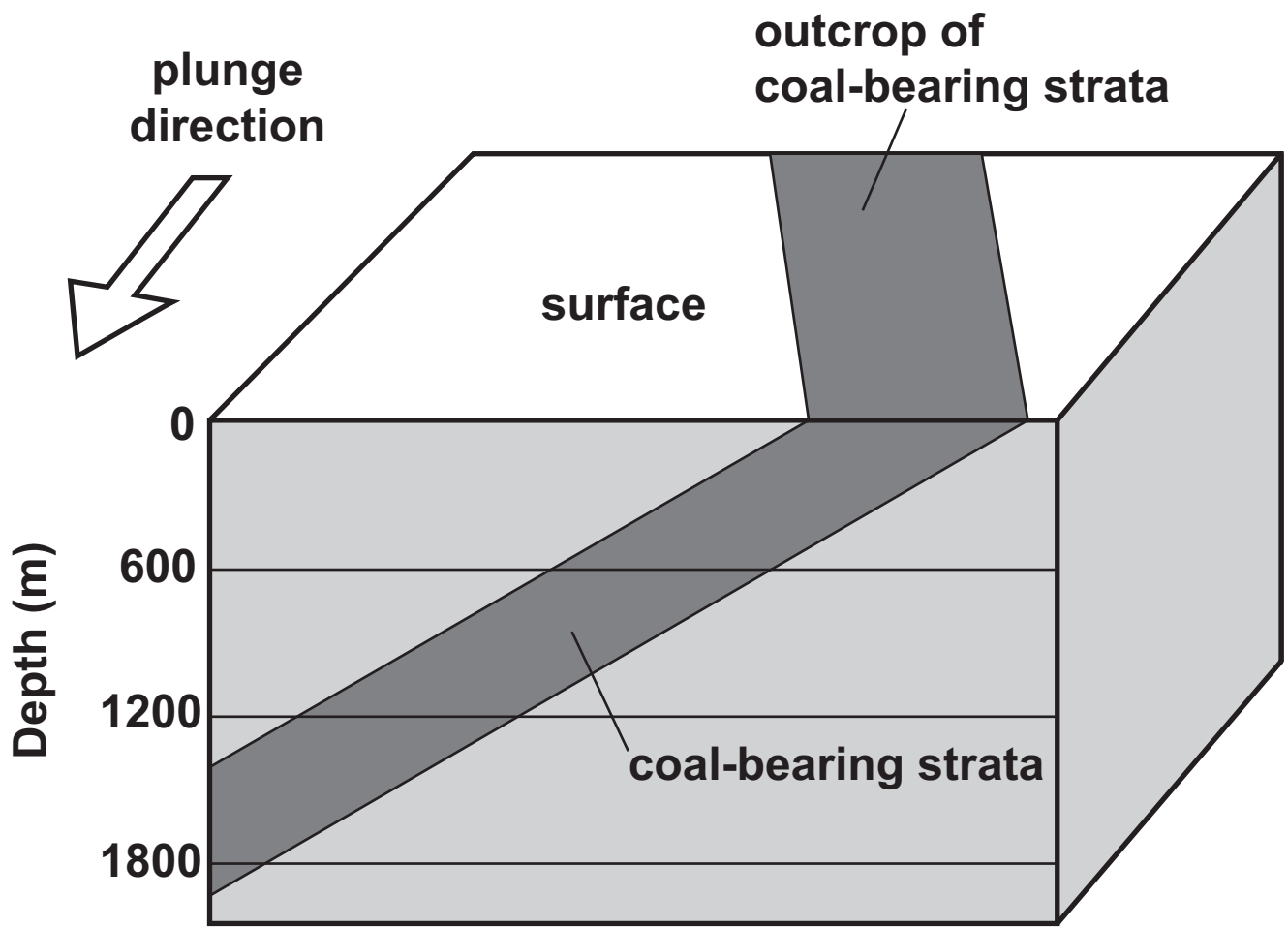


FIGURE 7a

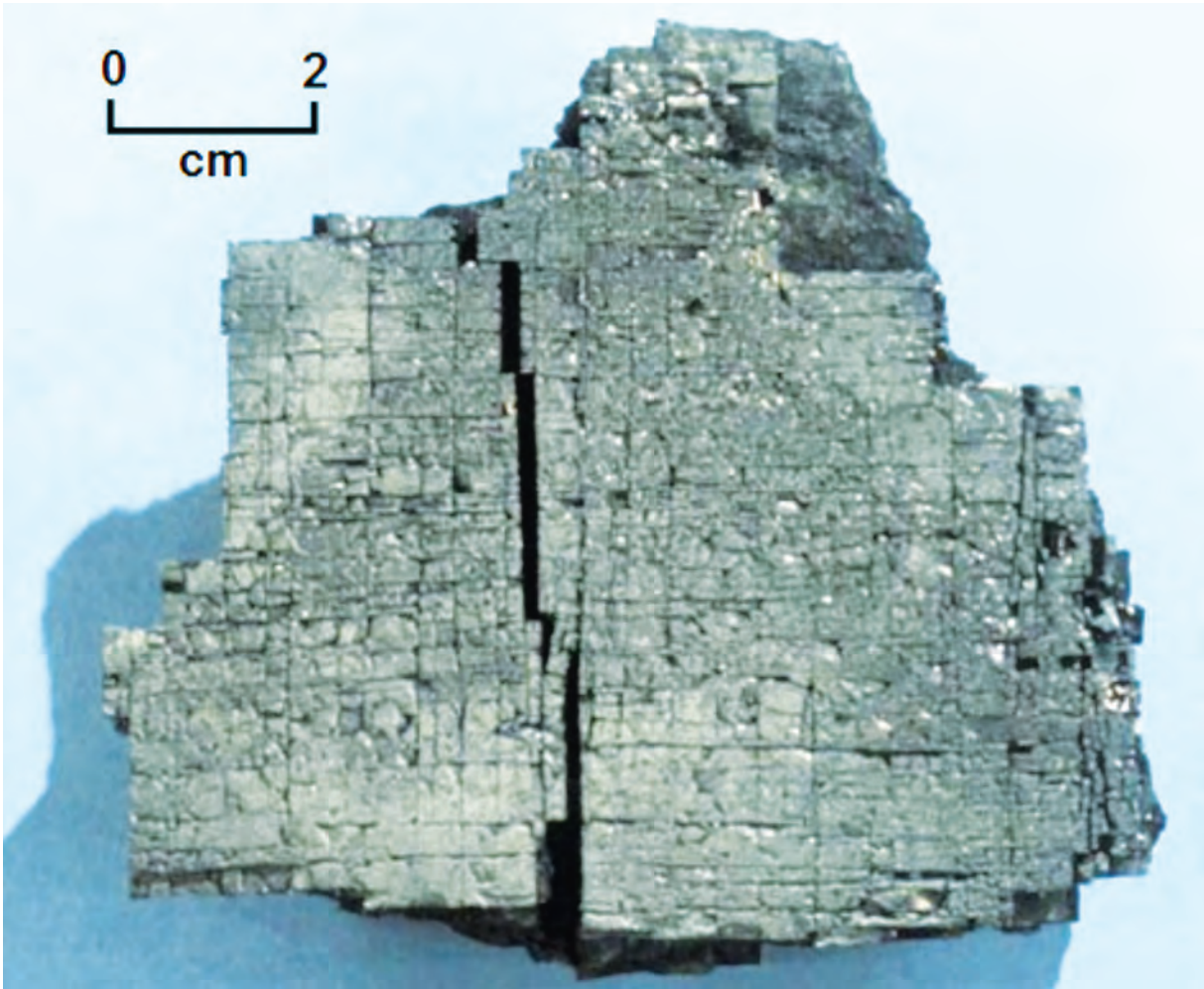


FIGURE 7b

7(b) FIGURE 7b opposite is a photo of a typical specimen of Carboniferous coal.

(i) Describe the structures within the specimen of coal. [2]

(ii) Explain why the structure of coal might be suitable as a host rock for CO₂ sequestration. [2]

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END OF PAPER

ACKNOWLEDGEMENTS

FIGURE 1b

<http://www.cneas.tohoku.ac.jp/labs/geo/ishiwata/SendaiSympo3.htm>

FIGURE 2a

Rock A: <https://cdn-assets.answersingenesis.org/img/articles/arj/v3/uluru-fig5.jpg>

Rock B: <http://wserv3.esc.cam.ac.uk/1acollections/items/show/176>

FIGURE 3

adapted from Structural Geology – Twiss & Moores – W.H. Freeman 1992

FIGURE 4

Benton & Harper; Introduction to Paleobiology and the Fossil Record

FIGURE 7b

BGS: UK Coal Resource for New Exploitation Technologies, Final Report

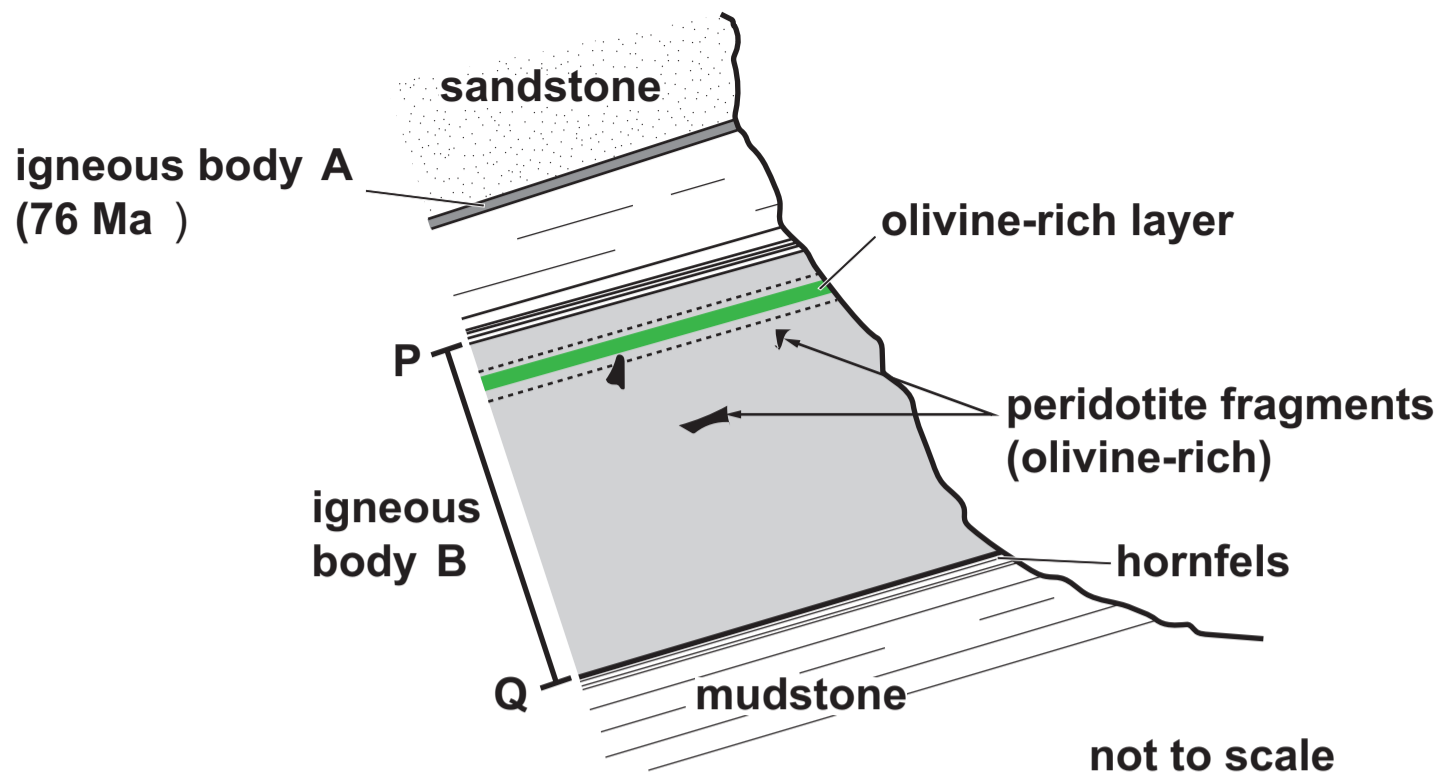


FIGURE 1a

hammer 30 cm



FIGURE 1b

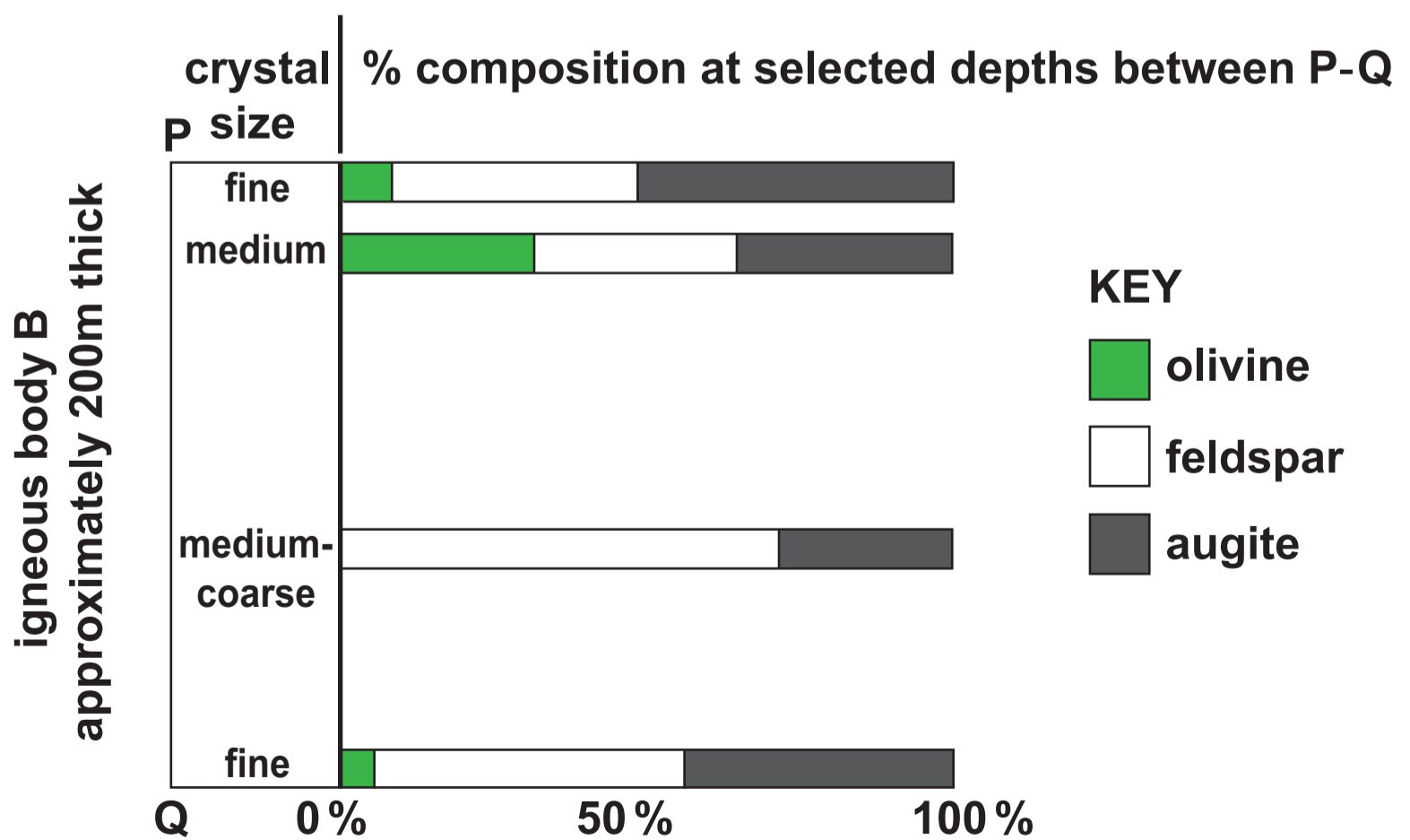


FIGURE 1c

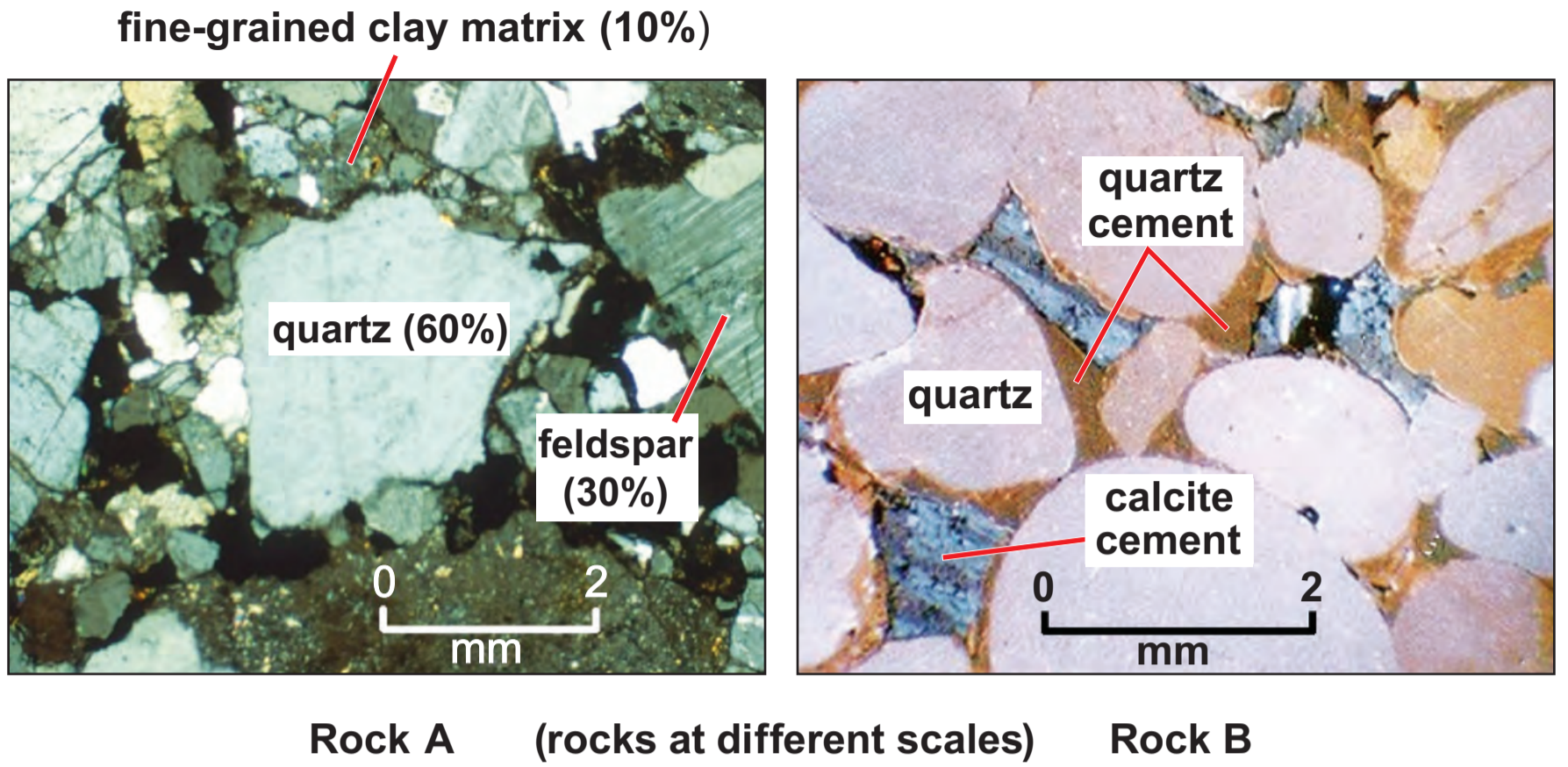


FIGURE 2a

Rock A Composition (%)	
Quartz	60
Feldspar	30
Clay	10

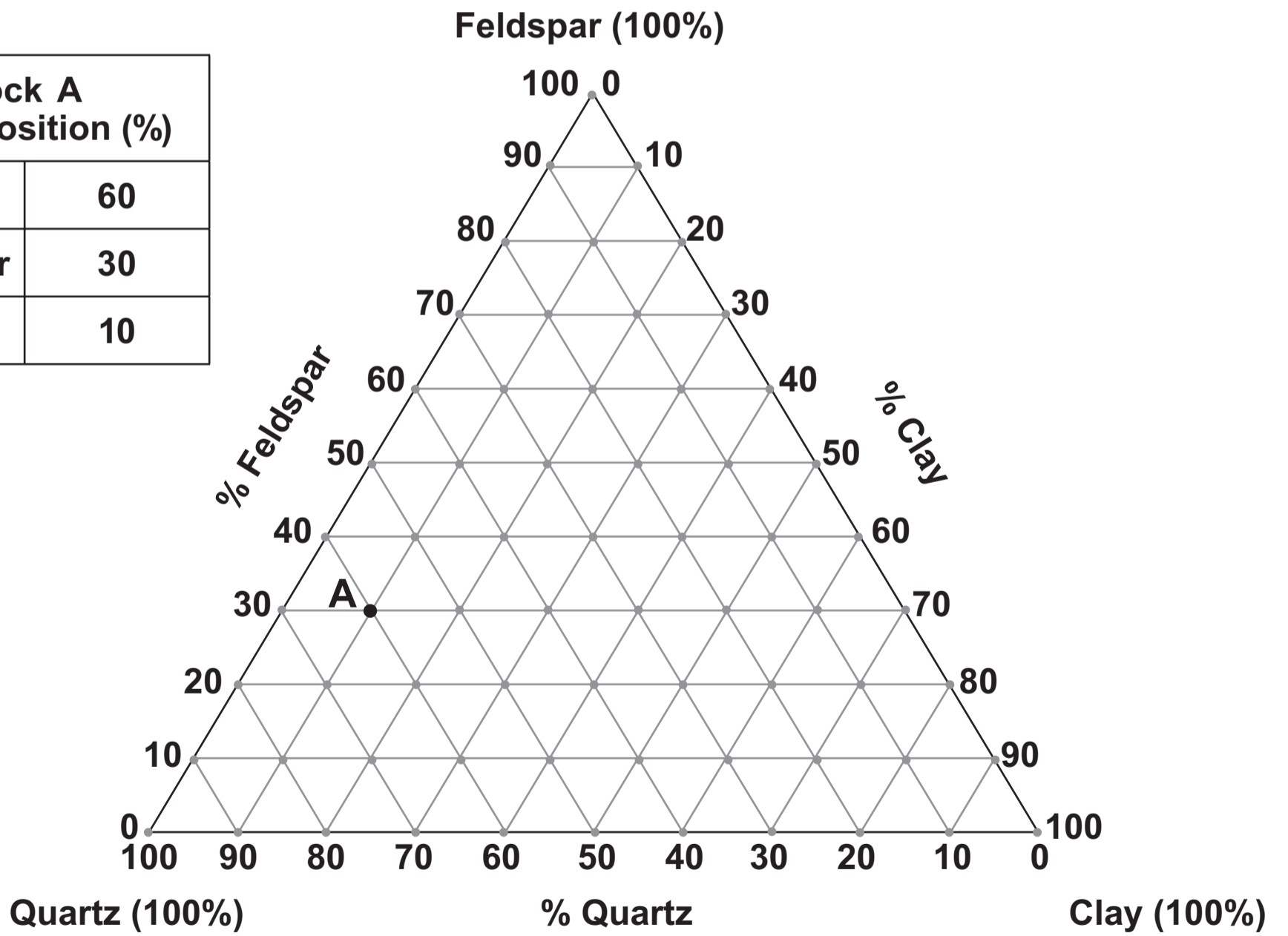


FIGURE 2b

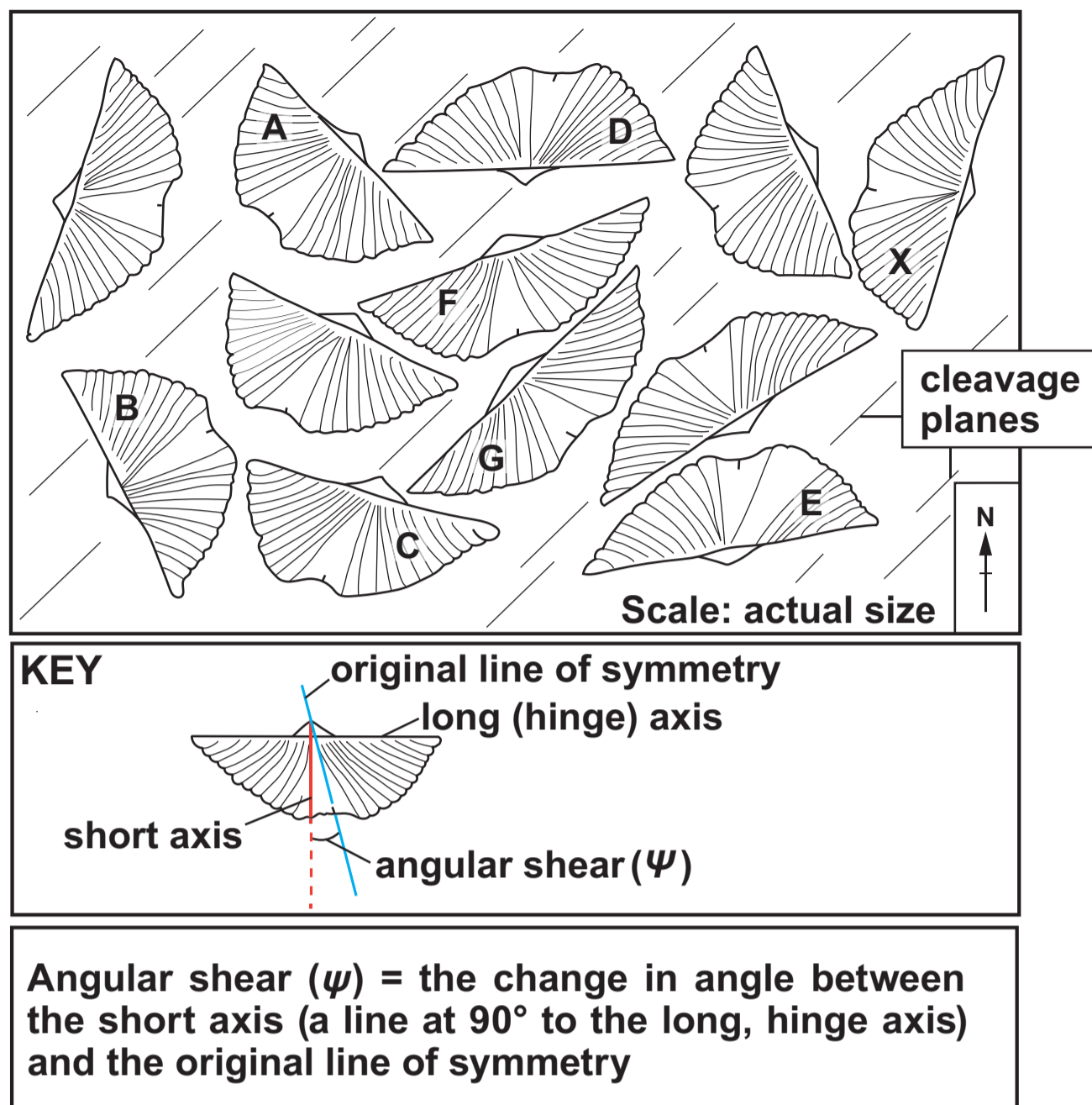


FIGURE 3

Brachiopod letter	Long (hinge) axis (mm)	Short axis (mm) (at 90° to long axis)	Long : short axis ratio	Angular shear (ψ)
A	38	19	2.0	0°
B	40	19	2.1	6°
C	41	19	2.2	15°
D	46	18	2.6	17°
E	47	16	2.9	17°
F	48	16	3.0	12°
G	51	15	3.3	0°
X		17		

TABLE 3

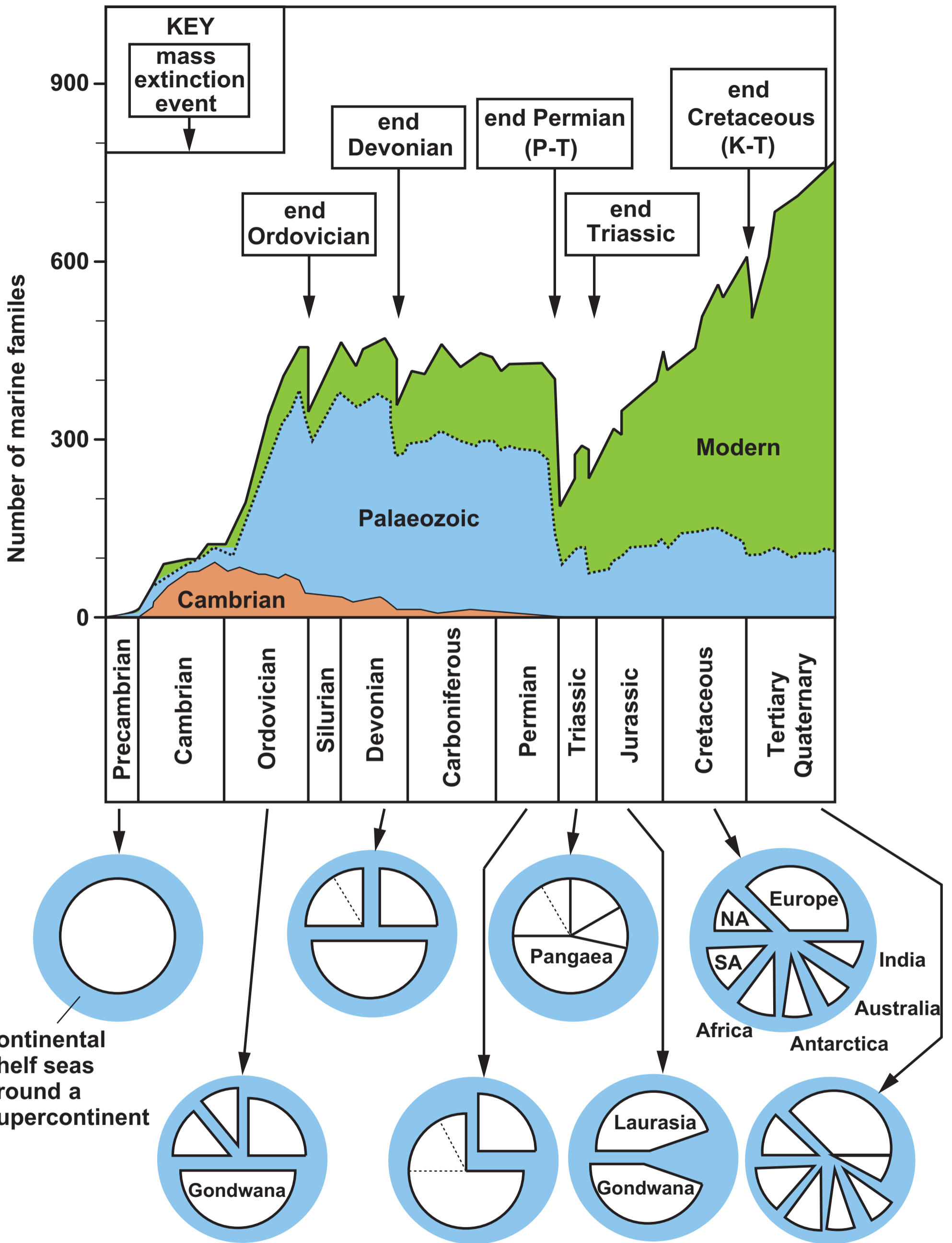
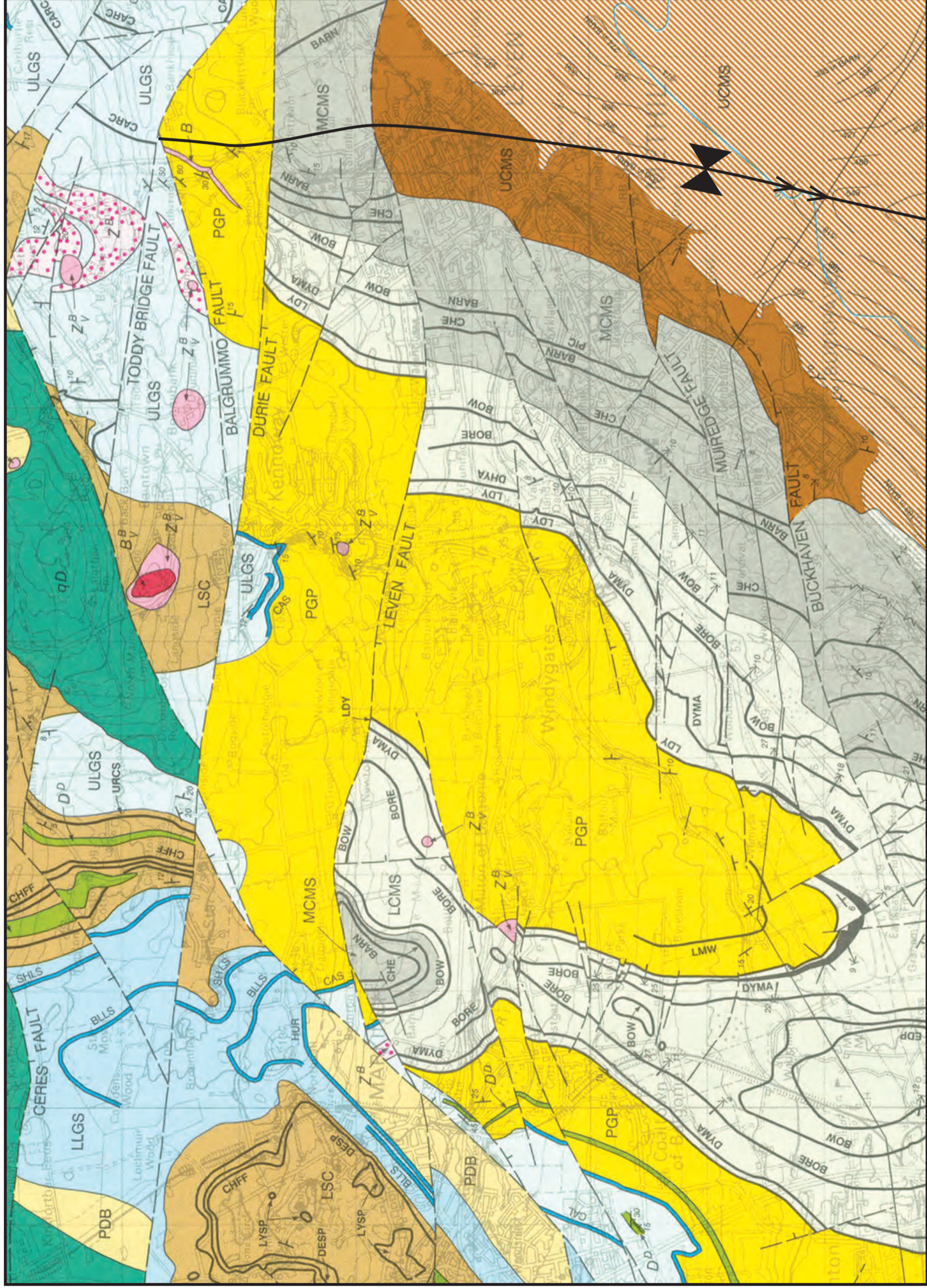


FIGURE 4



KEY



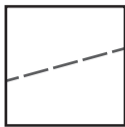

- 
axis of anticline
- 
axis of syncline
- 
fault
- 
plunge direction

FIGURE 6