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GCE A LEVEL

A480U10-1

MONDAY, 5 JUNE 2023 – MORNING

GEOLOGY – A LEVEL COMPONENT 1
GEOLOGICAL INVESTIGATIONS

2 hours 15 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:

- **the Resource Sheet**
- **SPECIMENS B, C and K**
- **geological equipment for testing specimens**
- **the Mineral Data Sheet**
- **a calculator**
- **a ruler**
- **a protractor**

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

This paper is in 2 sections, A and B.

Section A: 30 marks. Answer BOTH questions. You are advised to spend about 35 minutes on this section.

Section B: 75 marks. Answer ALL questions. You are advised to spend about 1 hour 40 minutes on this section.

The geology is NOT designed to represent any particular area.

The Mineral Data Sheet and MAP 1 are provided on separate resource sheets.

Strips of plain paper may be obtained from the supervisor on request.

Three specimens, B, C and K, are provided for use.

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 6 and 9.

SECTION A

Answer ALL questions.

1 FIGURE 1a opposite is a map of Iceland (located on a divergent plate margin) showing selected volcanoes and rift zones.
FIGURE 1b opposite shows a cross-section of the Hekla volcano.
TABLE 1 contains information about two Icelandic volcanoes (Hekla and Katla).

TABLE 1

Volcano	Composition of lavas	Height (km)	Area (km^2)
Hekla	ranges from andesitic to basaltic	•	131
Katla	basaltic	1.51	☐ 260 ☐ 800 ☐ 2600 ☐ 8000

1 (a) (i) Add arrows in the TWO boxes on FIGURE 1a to show the relative direction of movement for the:

- **North American plate**
- **Eurasian plate. [2 marks]**

(ii) Complete TABLE 1 on the previous page by:

- **using FIGURE 1b to determine the height above sea level of the summit of Hekla.**
- **using FIGURE 1a and the information in TABLE 1 to ESTIMATE the area of Katla. Tick (✓) ONE box in TABLE 1. [2 marks]**

(iii) Refer to TABLE 1. HEKLA has a steeper slope angle than KATLA. Give a possible geological explanation for this difference. [4 marks]

1 (b) FIGURE 1c opposite shows a map of Heimaey, a volcanic island to the south of Iceland. It shows the impact of the 1973 eruption on the island.

(i) State TWO possible impacts of the ash fall. [2 marks]

1 _____

_____

_____

_____

2 _____

_____

_____

_____

(ii) Suggest ONE factor responsible for the distribution and thickness of the ash shown on FIGURE 1c. [1 mark]

_____

_____

_____

_____

1 (c) Explain why spraying the lava with seawater might have prevented the lava closing off the harbour entrance. [3 marks]

1 (d) Describe TWO methods that could be used to monitor potential future eruptions of Icelandic volcanoes. Explain how each method would indicate that an eruption was imminent. [4 marks]

Method 1 _____

_____

Explanation _____

_____

_____

_____

_____

_____

Method 2 _____

_____

Explanation _____

_____

_____

18

2 FIGURE 2a opposite shows the range of crystallisation temperatures of some silicate minerals. TABLE 2 provides data for ions often found in silicate minerals.

TABLE 2

Ion	Fe^{2+}	Mg^{2+}	Na^{+}
Ionic charge	+2	+2	+1
Ionic radius (nm)	0.74	0.66	0.97

(a) State which mineral on FIGURE 2a has the largest range of crystallisation temperatures. [1 mark]

2 (b) Refer to FIGURE 2a and TABLE 2. Olivine forms a solid solution series.

(i) Explain what is meant by the term 'solid solution series' [2 marks]

(ii) Explain why Mg^{2+} and Fe^{2+} can substitute for each other in olivine. [2 marks]

2 (c) **A student suggested that the data in FIGURE 2a explains why some silicate minerals are more resistant to chemical weathering than others. Evaluate this suggestion. [3 marks]**

2 (d) FIGURE 2b opposite shows an environment found at the Earth's surface.

Describe the products produced and the processes involved when an arkose sandstone undergoes weathering in the environment shown in FIGURE 2b. [4 marks]

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SECTION B

Answer ALL questions.

Study MAP 1 on the RESOURCE SHEET.

3 (a) SPECIMEN C was collected from within ROCK UNIT C on MAP 1. SPECIMEN C contains three main rock forming minerals, each identified by a characteristic colour.

(i) Complete TABLE 3 opposite by:

- **briefly describing how you would test or observe the named physical property**
- **recording the results of your tests/observations.**

[6 marks]

(ii) With reference to TABLE 3 and the Mineral Data Sheet, name the following rock forming minerals in SPECIMEN C. [2 marks]

White mineral _____

Black/brown mineral _____

3 (b) (i) Describe the texture of SPECIMEN C. [2 marks]

(ii) Suggest the probable cooling history of SPECIMEN C. [2 marks]

12

4 A student measured the orientation of the long axis of phenocrysts within ROCK UNIT C at LOCALITY 1 and LOCALITY 2 on MAP 1.

FIGURE 4a opposite shows phenocryst J identified on a horizontal surface at LOCALITY 2.
FIGURES 4b and 4c opposite are rose diagrams of phenocryst orientations at LOCALITIES 1 and 2.

(a) (i) Measure and record the orientation of the long axis of phenocryst J shown in FIGURE 4a.

[1 mark]

Orientation of phenocryst J _____ ° to _____ °

(ii) Describe the orientation of phenocrysts at LOCALITY 2 shown in FIGURE 4c. [2 marks]

4 (b) TABLE 4 is a partly completed chi-squared test at LOCALITY 2, used to test the null hypothesis (H_0) that 'there is no significant alignment of the phenocrysts'.

TABLE 4

Phenocryst alignment in degrees (class)	Observed frequency (O)	Expected frequency (E)	(O–E)	$(O–E)^2$	$\frac{(O–E)^2}{E}$
000-029	11	10	1	1	0.1
030-059	7	10	-3	9	0.9
060-089	5	10	-5	25	2.5
090-119	6	10	-4	16	1.6
120-149	15	10	5	25	2.5
150-179	•	10	•	•	•

Total	60	60	chi-squared value	11.2

(i) Using data from FIGURE 4c complete the blank cells for the 150°–179° class in Table 4. [2 marks]

4 (b) (ii) FIGURE 4d opposite is a chi-squared significance chart.

Using the significance chart (FIGURE 4d) explain the reason why the chi-squared value of these data means the null hypothesis (H_0) can be rejected at the 95% confidence level. [2 marks]

4 (c) At LOCALITY 1 on MAP 1 the chi-squared value was 1.14 and the null hypothesis was accepted.

With reference to the chi-squared data, suggest a geological explanation for orientation of the phenocrysts found at LOCALITY 1 and LOCALITY 2.

[3 marks]

10

5 Study SPECIMEN B which is representative of ROCK UNIT B and SPECIMEN K which shows a fossil found within ROCK UNIT B.

(a) Describe the texture and composition of SPECIMEN B. [3 marks]

5 (b) In the space below draw a diagram of SPECIMEN K. Add a scale to your drawing. [4 marks]

(c) Name the fossil group represented by SPECIMEN K. Give a reason for your answer. [2 marks]

Fossil group _____

Reason _____

_____

_____

_____

5 (d) A student suggested that, 'ROCK UNIT B was deposited in a shallow, tropical, marine environment'. Evaluate this statement with reference to SPECIMEN B and SPECIMEN K.

[4 marks]

5 (e) FIGURE 5 opposite shows a photomicrograph of a marine sandstone forming ROCK UNIT E.

State, giving a reason, the type of sandstone represented by ROCK UNIT E. [2 marks]

Type of sandstone _____

_____

Reason _____

_____

_____

_____

_____

_____

15

6 State and give reasons for the observations you would make in a FIELD INVESTIGATION to confirm the age relationships of the ROCK UNITS A, B, C and E within the area of BOX A on MAP 1.

You may wish to use an annotated diagram(s) in your answer. [9 QER]

9

7 MAP 2 opposite shows an area of MAP 1.

(a) Draw on MAP 2 the position of a fold axial plane trace to the north and south of FAULT F2. Using symbols in the key, label your fold axial plane trace to show:

- **the type of fold present**
- **the direction of plunge of the fold. [3 marks]**

(b) Label on MAP 2, using an arrow labelled U (U →), the position of an unconformity to the WEST of FAULT F1. [1 mark]

7 (c) **MAP 1 shows two faults, F1 and F2.**

(i) **Complete TABLE 5 opposite to compare FAULT F1 and FAULT F2. [4 marks]**

(ii) **State the evidence for your choice of the type of fault for FAULTS F1 and F2. [2 marks]**

FAULT F1

FAULT F2

10

8 **The topographic profile opposite was taken along the line X – Y on MAP 1.**
Complete the geological cross-section along this line using MAP 1.

- **Draw the rock units. Use similar ornament or letters for those as used on MAP 1.**
- **Draw and label any FOLD AXES.**
- **Project the rock units and structures above the ground surface to illustrate any cross-cutting relationships. [13 marks]**

13

9 A student concluded the following:
'The rocks on MAP 1:

- **have ALL been subjected to THREE episodes of deformation which**
- **occurred at different times**
- **with different types of stress**
- **acting in the same direction.'**

Evaluate this conclusion with reference to the evidence shown on MAP 1. [6 QER]

6

END OF PAPER

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

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ACKNOWLEDGEMENTS

FIGURE 2b Getty images

FIGURE 4a J. Speed

FIGURE 5 https://www.earth.ox.ac.uk. Acknowledgement not found

	For Examiner's use only		
	Question	Maximum Mark	Mark Awarded
Section A	1	18	
	2	12	
Section B	3	12	
	4	10	
	5	15	
	6	9	
	7	10	
	8	13	
	9	6	
	Total	105	

FIGURE 1a

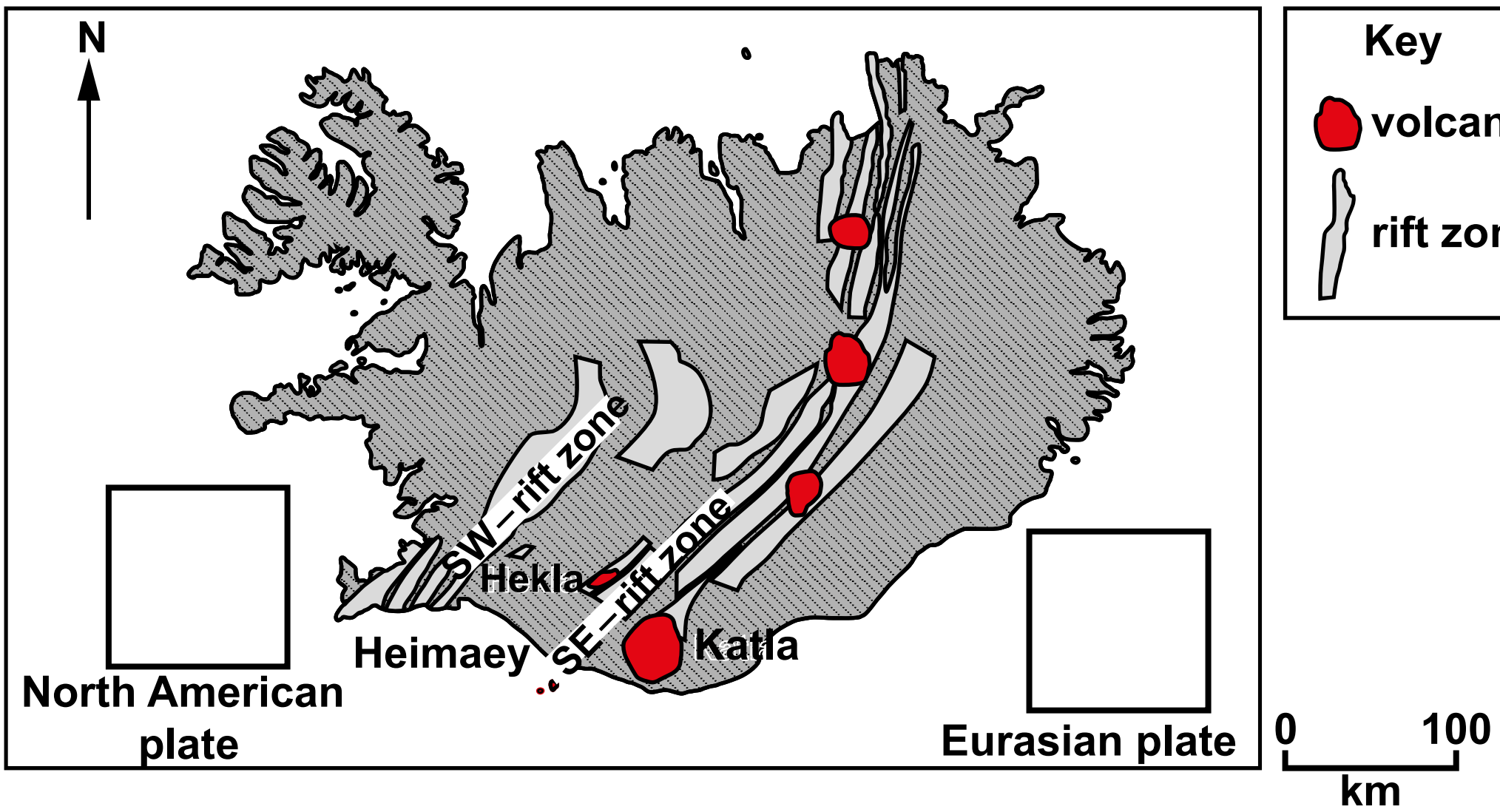


FIGURE 1b

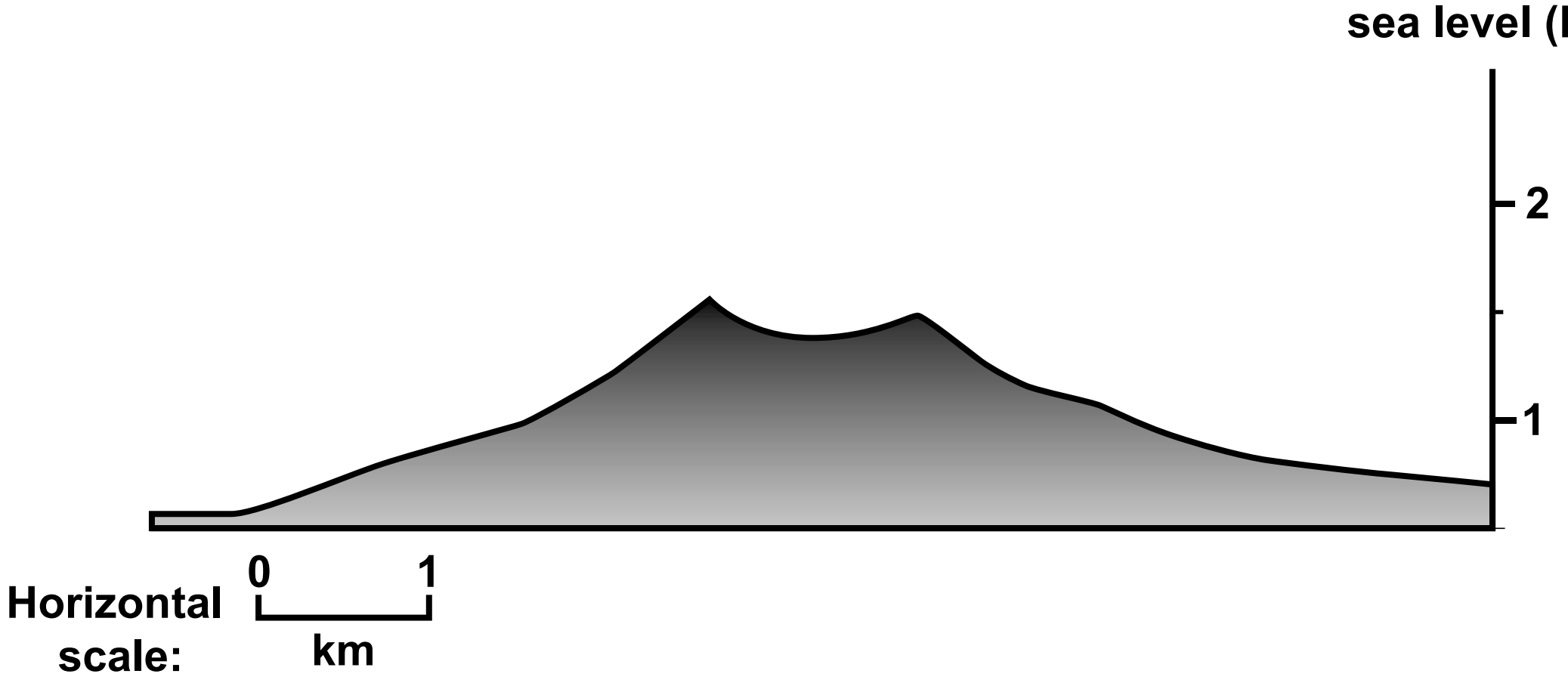


FIGURE 1c

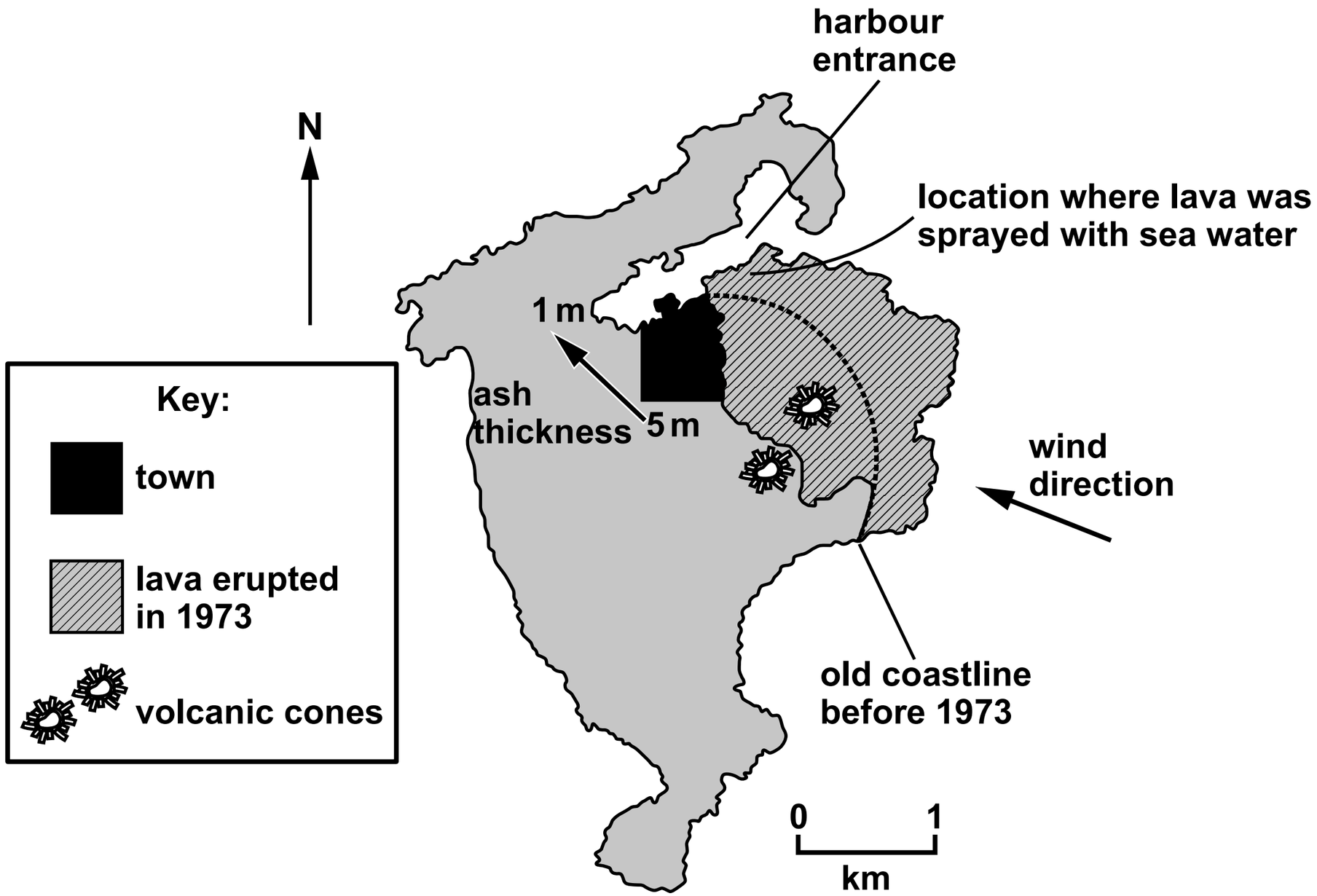

harbour entrance
N
location where lava was sprayed with sea water
1 m
ash thickness
5 m
wind direction
Key:
town
lava erupted in 1973
volcanic cones
old coastline before 1973
0
1
km

FIGURE 2a

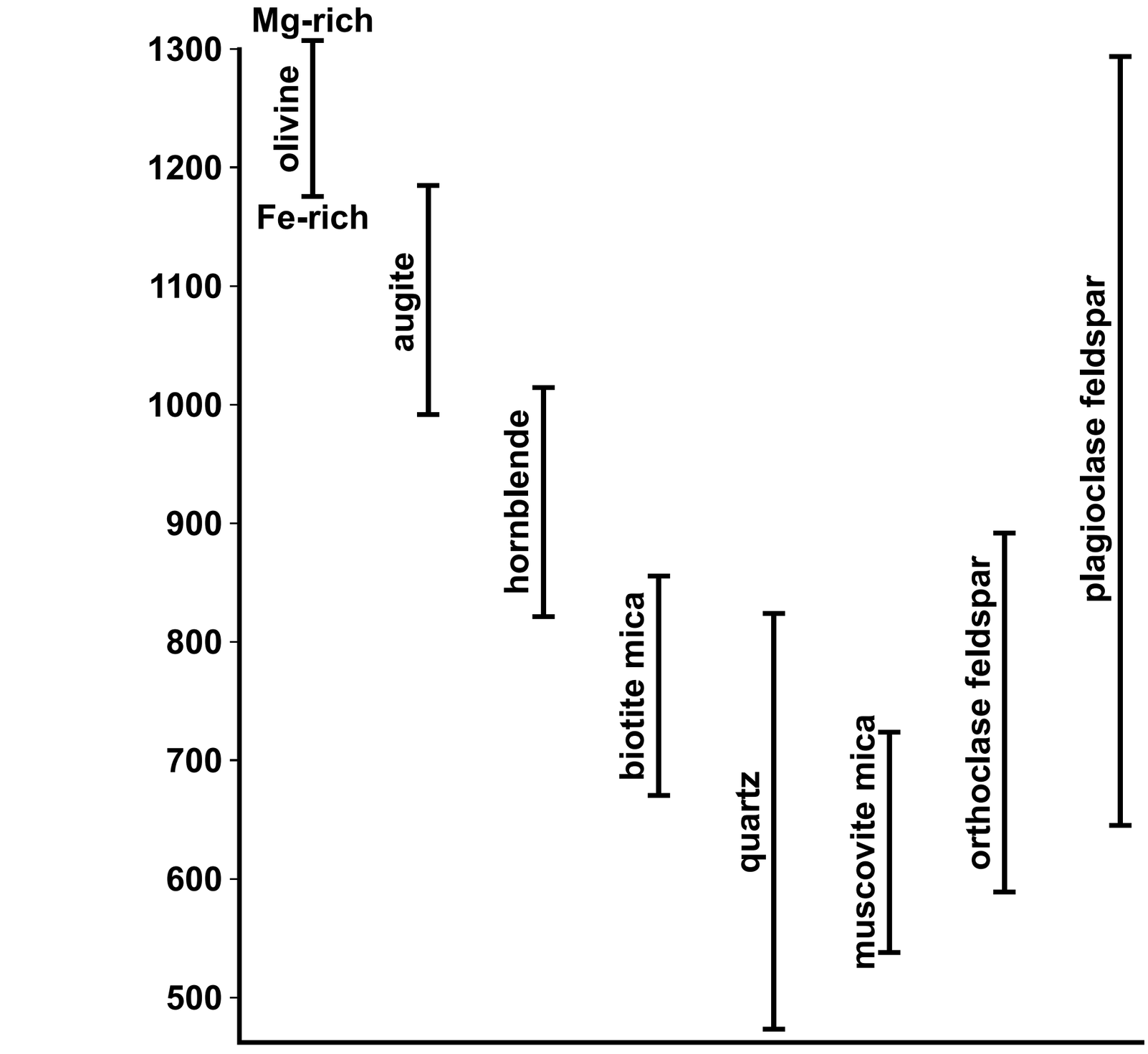

Approximate temperature of crystallisation (°C)
1300
1200
1100
1000
900
800
700
600
500
Mg-rich
olivine
Fe-rich
augite
hornblende
biotite mica
quartz
muscovite mica
orthoclase feldspar
plagioclase feldspar

FIGURE 2b

Annual temperature range = 22 °C to 34 °C

Mean annual rainfall = 5000 mm

TABLE 3

Characteristic colour of the mineral	Physical property	Description of test/observation	Results of test/observation
white	hardness	•	•
colourless	lustre	•	•
black/brown	cleavage	•	•

FIGURE 4a

FIGURE 4b

LOCALITY 1

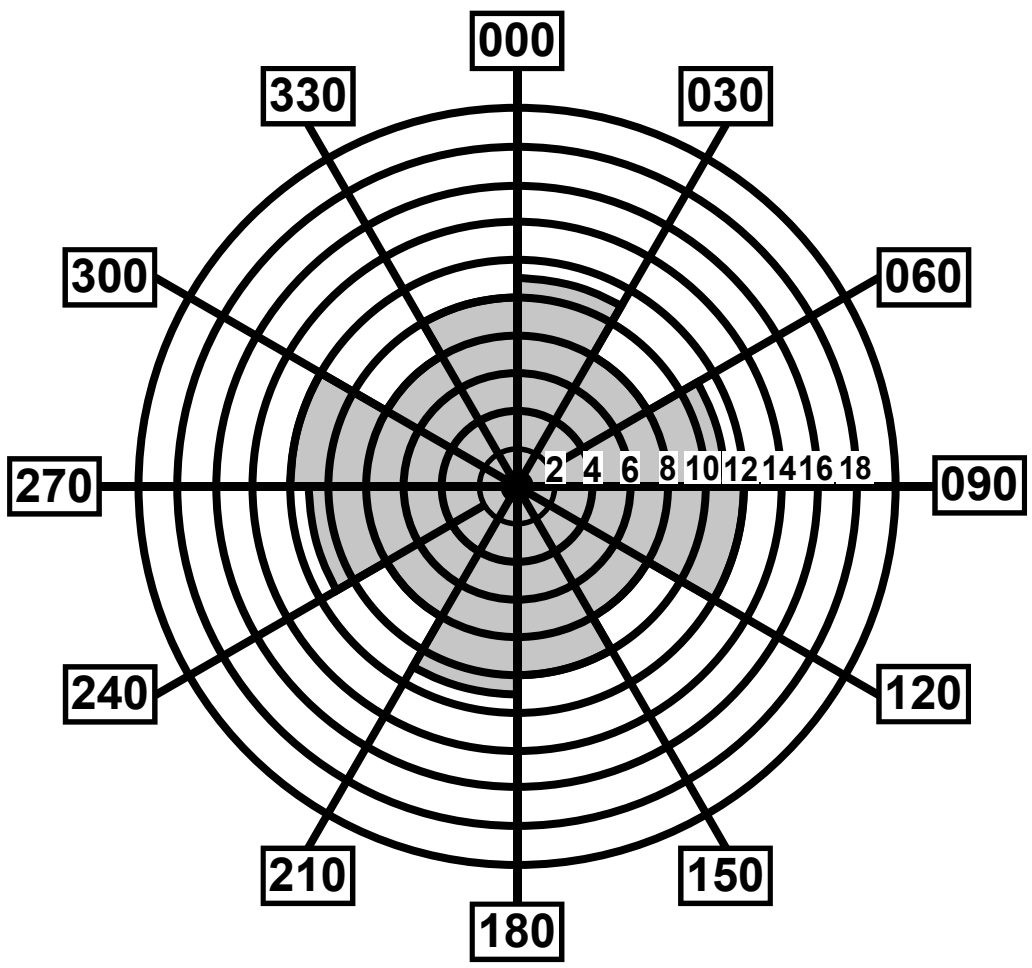


FIGURE 4c

LOCALITY 2

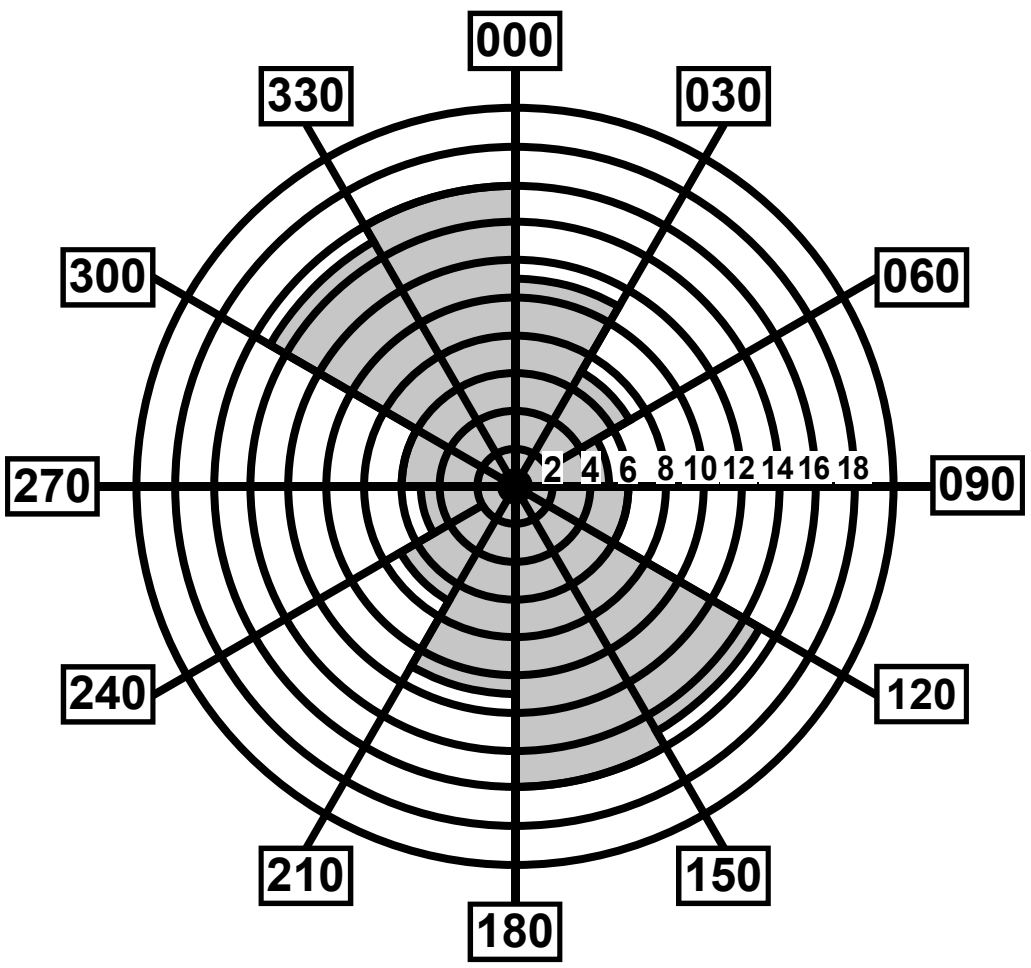
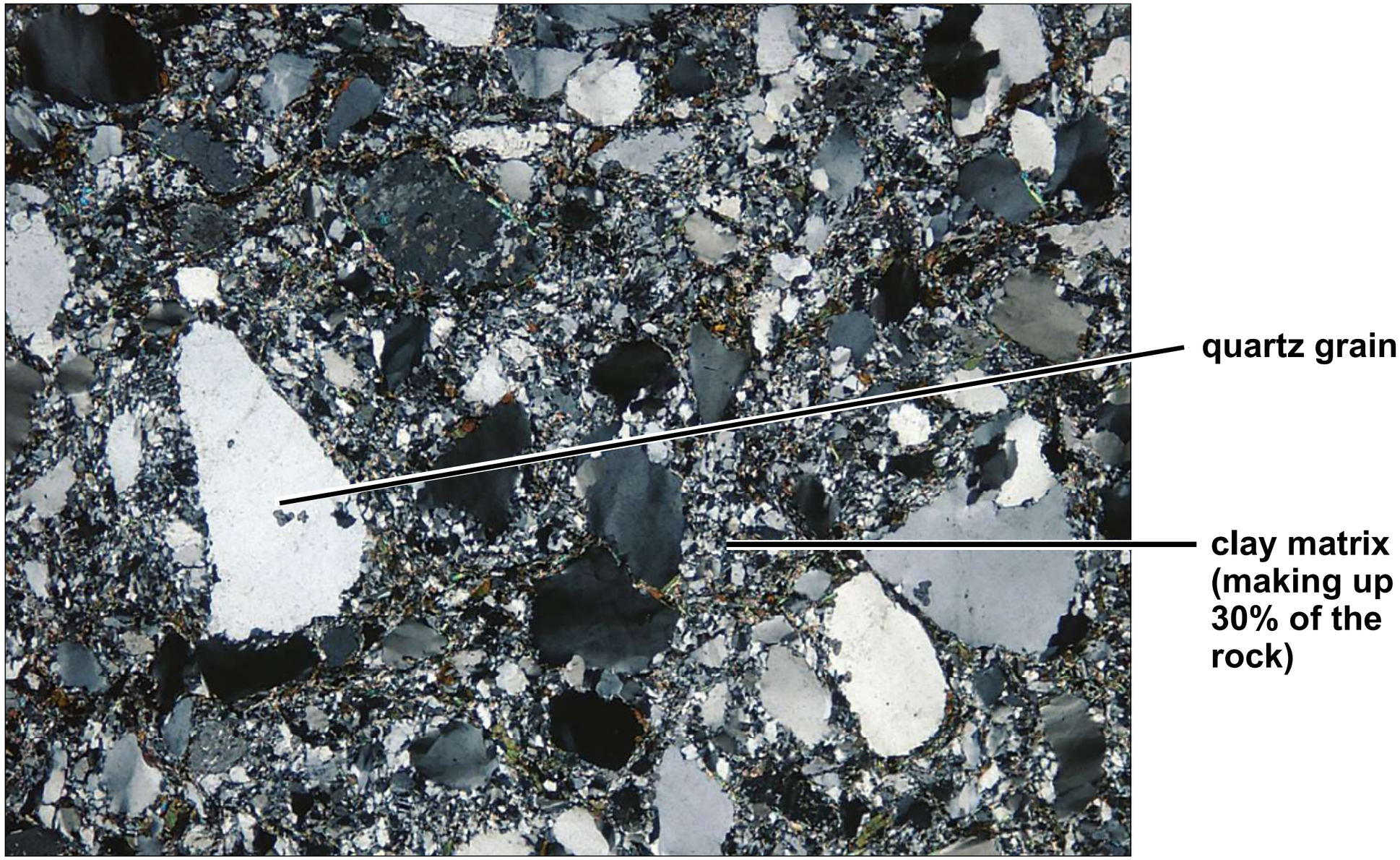


FIGURE 4d

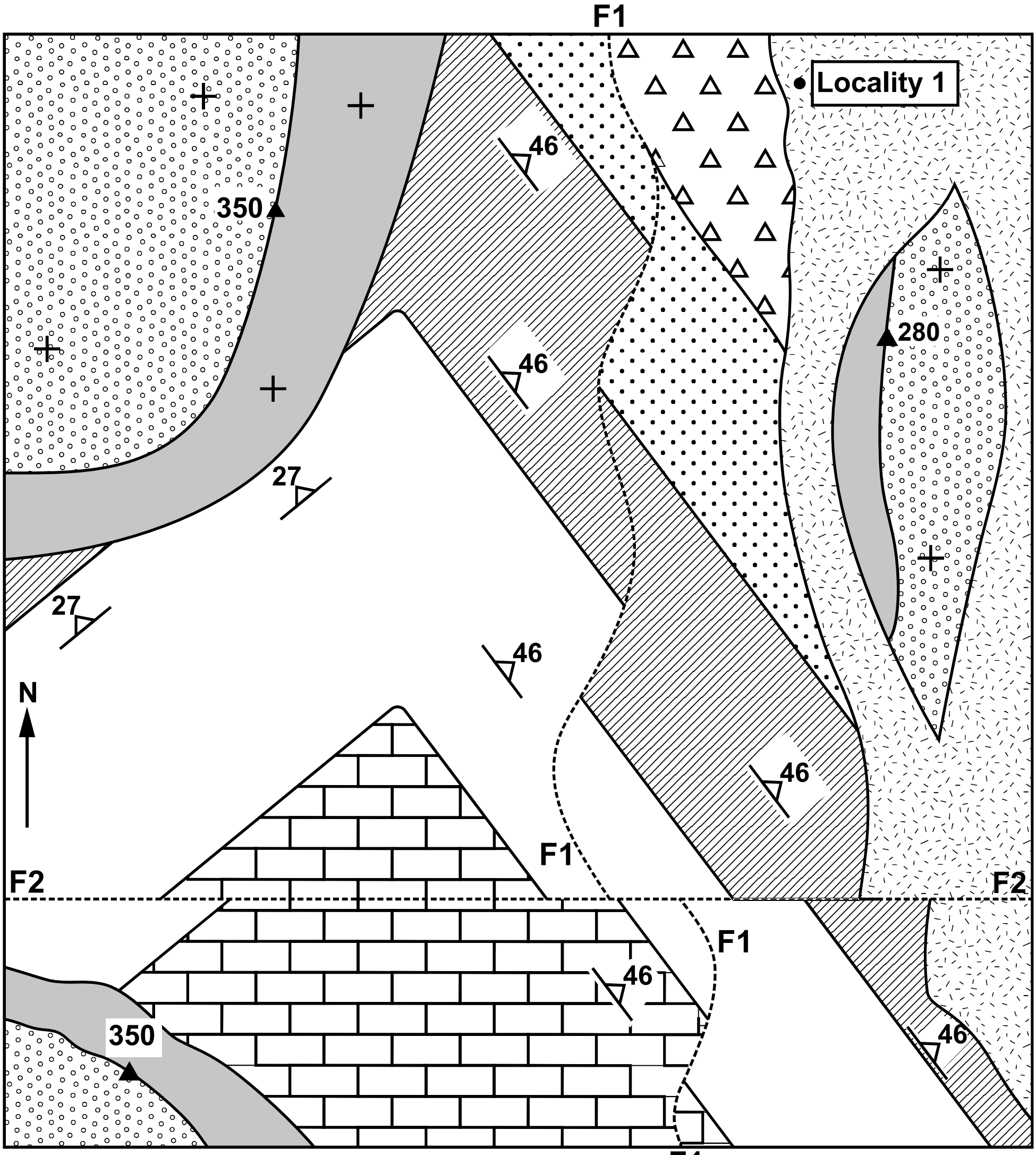
Degrees of Freedom	Probability										
	0.95	0.90	0.80	0.70	0.50	0.30	0.20	0.10	0.05	0.01	0.001
1	0.004	0.02	0.06	0.15	0.46	1.07	1.64	2.71	3.84	6.64	10.83
2	0.10	0.21	0.45	0.71	1.39	2.41	3.22	4.60	5.99	9.21	13.82
3	0.35	0.58	1.01	1.42	2.37	3.66	4.64	6.25	7.82	11.34	16.27
4	0.71	1.06	1.65	2.20	3.36	4.88	5.99	7.78	9.49	13.28	18.47
5	1.14	1.61	2.34	3.00	4.35	6.06	7.29	9.24	11.07	15.09	20.52
6	1.63	2.20	3.07	3.83	5.35	7.23	8.56	10.64	12.59	16.81	22.46
7	2.17	2.83	3.82	4.67	6.35	8.38	9.80	12.02	14.07	18.48	24.32
8	2.73	3.49	4.59	5.53	7.34	9.52	11.03	13.36	15.51	20.09	26.12
9	3.32	4.17	5.38	6.39	8.34	10.66	12.24	14.68	16.92	21.67	27.88
10	3.94	4.86	6.18	7.27	9.34	11.78	13.44	15.99	18.31	23.21	29.59
	Non-significant								Significant		

Degrees of freedom (df) = number of categories - 1

FIGURE 5



MAP 2



Key:

- Axial plane trace of anticline
- Axial plane trace of syncline
- Fault
- Plunge direction

TABLE 5

	FAULT F1	FAULT F2
Vertical displacement	•	0m
Dip amount and dip direction of the fault plane	75° towards the west	•
Type of fault	•	•


Metres relative to sea level
X
Y
600
500
400
300
200
100
0
–100
–200
–300
–400
–500
–600