Surname	Centre Number	Candidate Number
Other Names		2

GCE A Level – LEGACY

1214/01

S18-1214-01

GEOLOGY – GL4
Interpreting the Geological Record

TUESDAY, 5 JUNE 2018 – AFTERNOON

2 hours

	For Examiner's use only		
	Question	Maximum Mark	Mark Awarded
Section A	1.	15	
	2.	15	
	3.	15	
	4.	15	
Section B	5.	7	
	6.	17	
	7.	8	
	8.	8	
	Total	100	

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ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page 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.

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

This section should take approximately 1 hour to complete.

1. **Figure 1a** shows the effect of chemical weathering on the rock-forming minerals of an exposure of coarse-grained igneous rock.

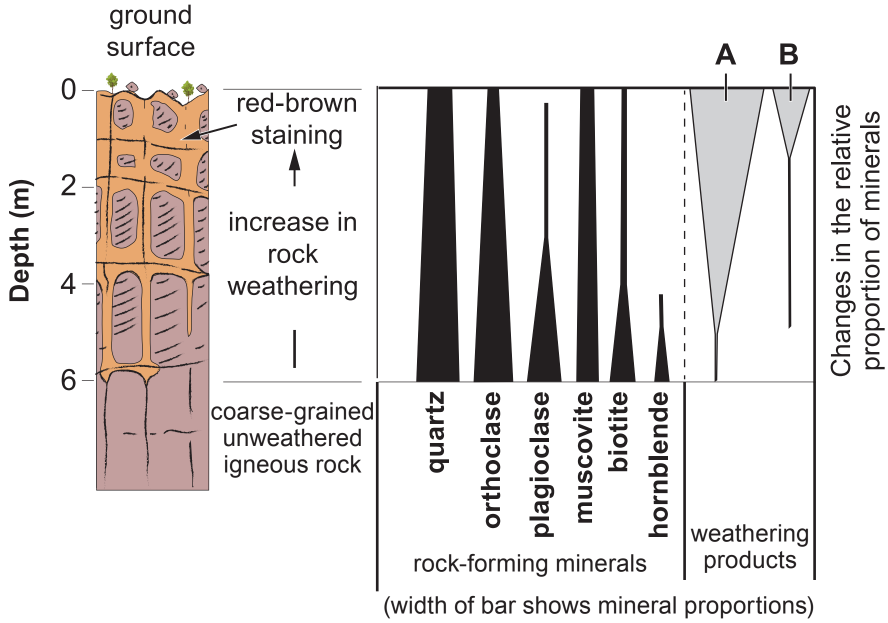

Figure 1a

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

(i) State the name of the unweathered igneous rock. [1]

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(ii) Name the **two** weathering products (**A** and **B**) formed by the chemical weathering of this exposure. [2]

A ....

B ....

(iii) Describe the chemical processes and minerals involved in the formation of these weathering products. [3]

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(iv) Explain why quartz is more resistant to chemical weathering than plagioclase feldspar. You may refer to Bowen's reaction series. [3]

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(b) **Figure 1b** is a photograph of an exposure of a mafic igneous rock.

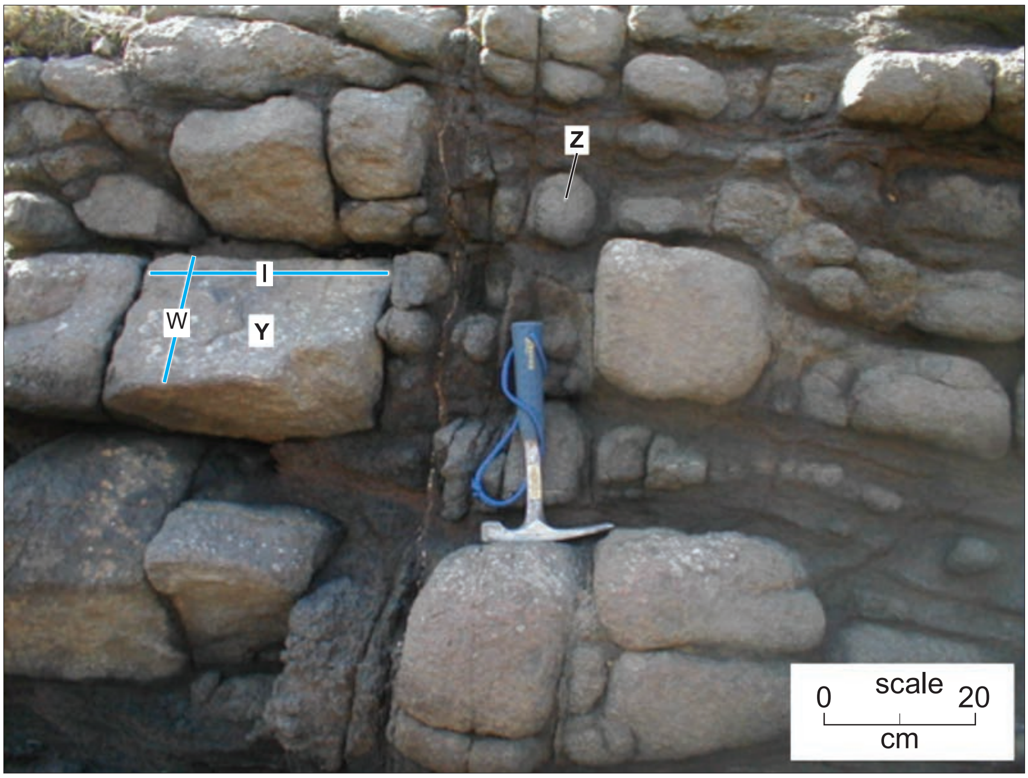

Figure 1b

Refer to **Figure 1b**.

(i) Complete **Table 1** below recording the size and shape of the two blocks labelled **Y** and **Z**. [3]

Block	width (w) (cm)	length (l) (cm)	shape
Y	•	•	•
Z	10	9	•

Table 1

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(ii) Explain the differences in the size and shape of these blocks. [3]

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2. **Figure 2a** shows two pressure-temperature pathways within the stability fields of three silicate minerals found in metamorphic rocks.

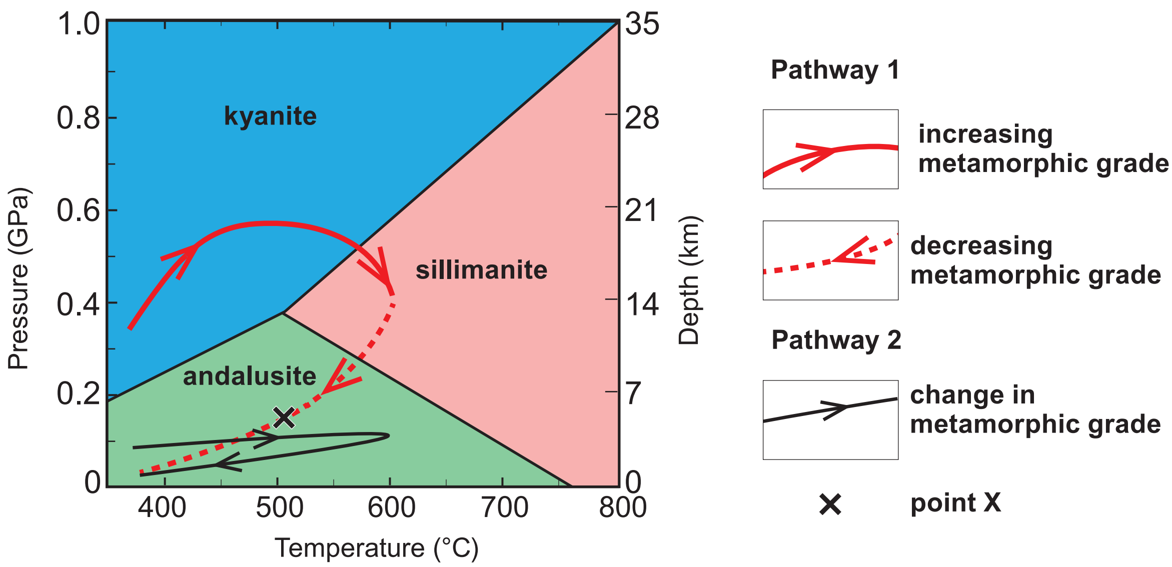

Figure 2a

Refer to **Figure 2a**.

(a) (i) State the pressure at which andalusite and sillimanite are both in equilibrium at a temperature of 600 °C. [1]

.... GPa

(ii) Complete **Table 2** by stating;
- the maximum temperature and pressure to which the metamorphic rocks along **pathway 1** were subjected
- the silicate minerals most stable at these maximum temperatures/pressures along **pathway 1**. [4]

pathway 1	maximum conditions reached on pathway 1	mineral most stable at this maximum
maximum temperature (°C)	•	•
maximum pressure (GPa)	•	•

Table 2

(b) (i) State the type of metamorphism shown by the pressure/temperature conditions associated with **pathway 1** in **Figure 2a**. [1]

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(ii) Describe the rock cycle processes and plate tectonic setting responsible for the following conditions during metamorphism along **pathway 1**. [4]

1. increasing metamorphic grade

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2. decreasing metamorphic grade.

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(c) **Figure 2b** shows a photomicrograph of a metamorphic rock that formed under the conditions at point **X** on **Figure 2a** having followed **pathway 1**.

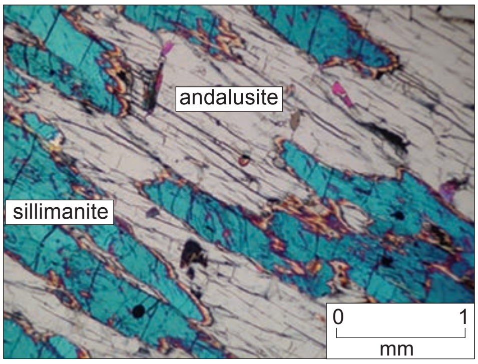

Figure 2b

Refer to **Figure 2b**.

(i) Describe how the mineralogy and texture of a rock formed by following **pathway 2** might differ from the photomicrograph (**Figure 2b**). Explain your answer. [3]

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(ii) In each of the stability fields on **Figure 2a** only the silicate mineral indicated is considered stable in that field.
Explain why the rock in **Figure 2b** contains **both** sillimanite and andalusite. [2]

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3. **Figure 3a** is a partly completed block diagram of folded strata, cut by a dip-slip fault and intruded by a dyke.

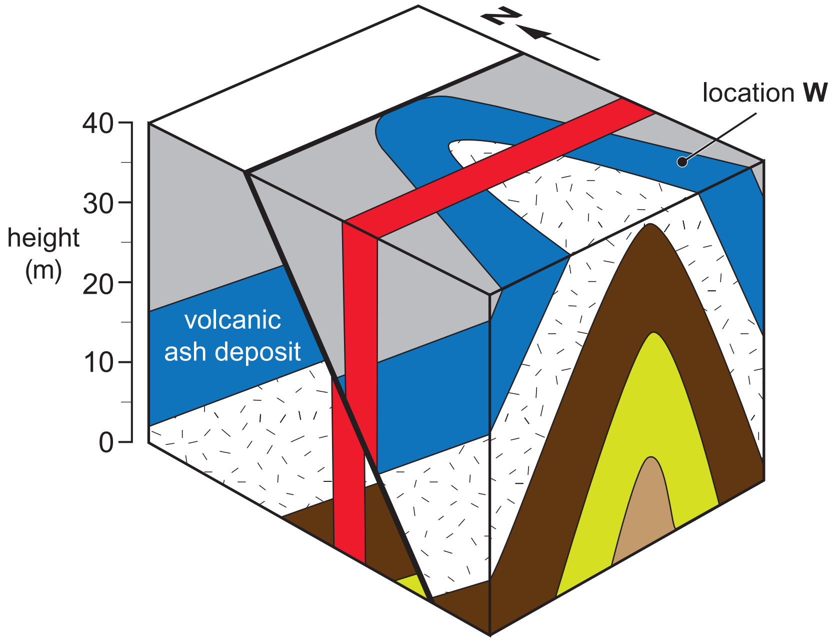

Figure 3a

Refer to **Figure 3a**.

(a) (i) On **Figure 3a** mark in **and label** the following features of the fold:
- the axis (label **A**)
- axial plane trace (label **APT**) [2]

(ii) Complete **Figure 3a** to show the probable outcrop of the **volcanic ash deposit** on the top surface, to the north of the dip-slip fault. [2]

(b) (i) Complete **Table 3** to describe the fault characteristics. [3]

Throw of volcanic ash deposit (m)	•
The principal stress **vertical** component (σ max, σ int, σ min)	•
Type of fault	•

Table 3

(ii) A student concluded that *"the fault has been reactivated"*. Evaluate the evidence from **Figure 3a** for this statement. [2]

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(c) **Figure 3b** is a photograph of a **horizontal** surface at location **W** on **Figure 3a** which is representative of the boundaries within layers of the volcanic ash deposit.

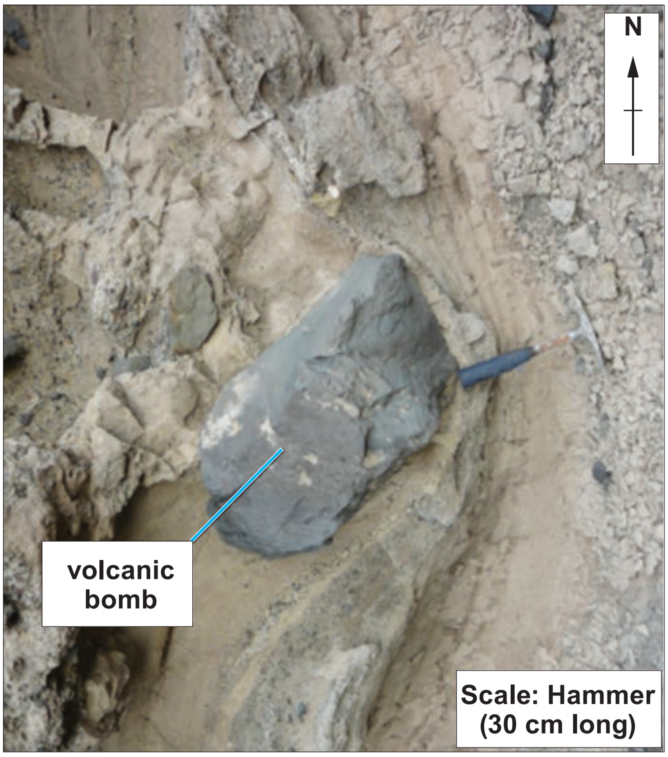

Figure 3b

Explain the evidence from **Figure 3b** that shows the volcanic ash deposit gets ***younger*** towards the west. [2]

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(d) A student described the fold in **Figure 3a** as
"…a symmetrical anticline with a plunge to north."
Evaluate this statement with reference to the data in **Figure 3a** and **Figure 3b**. [4]

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4. **Figure 4a** is a map of the Réunion hotspot track from the Deccan Traps (India) to Réunion Island, which is offset by the Central Indian Ridge. **Figure 4b** shows a model of the development of a typical mantle plume considered to be the cause of hot spots.

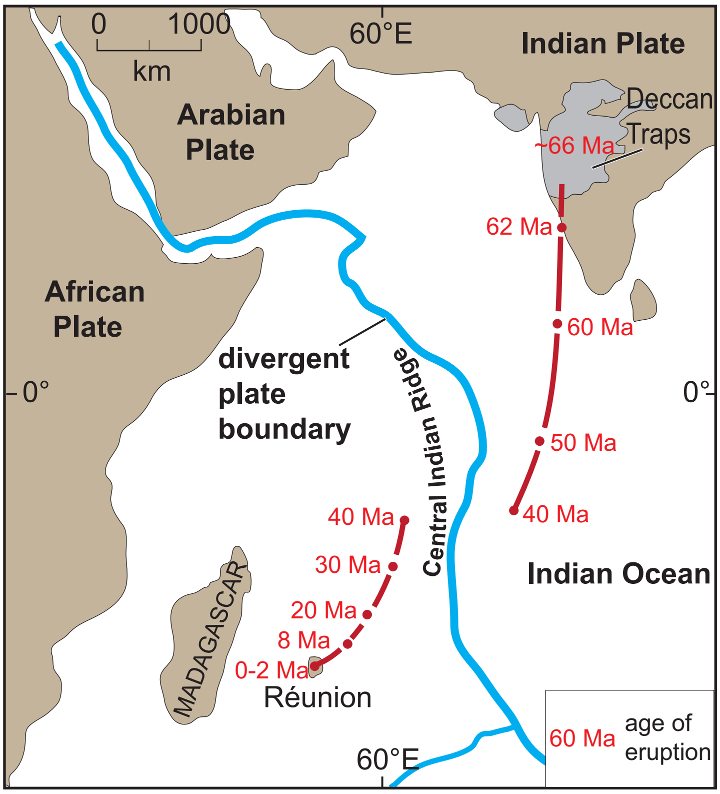

Figure 4a

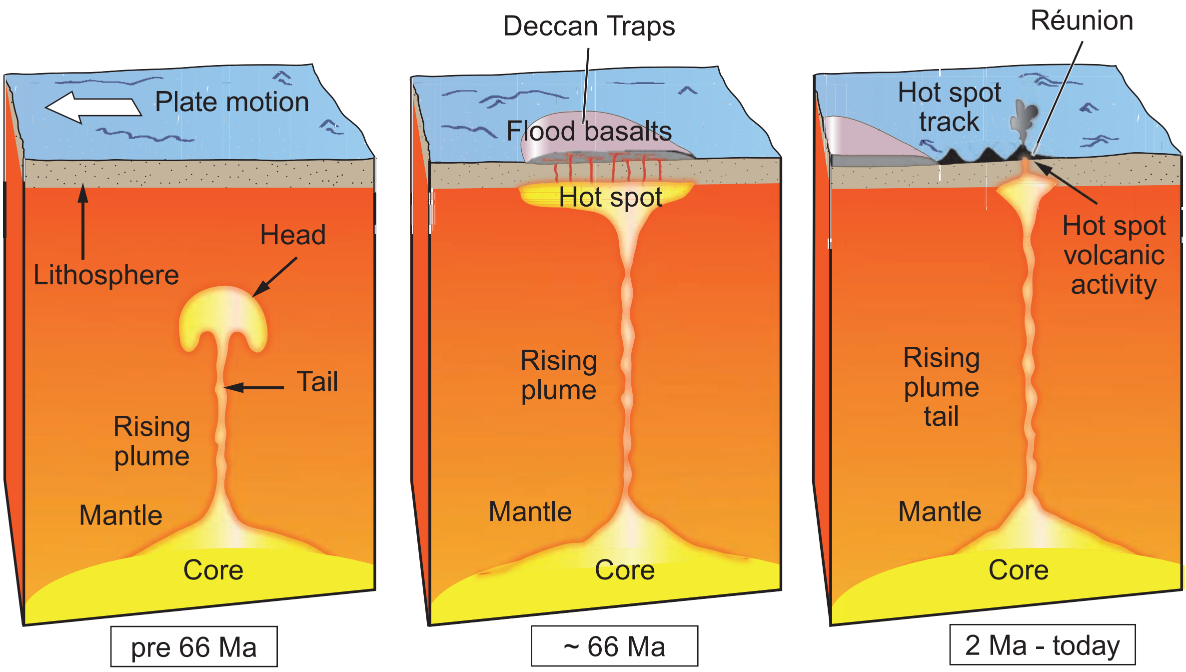

Figure 4b

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Refer to **Figure 4a** and **Figure 4b**.

(a) (i) Name the plate beneath which the mantle plume is thought to be situated today. [1]

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(ii) State the evidence from **Figure 4a** that supports the theory that the Indian and African plate both moved over a fixed mantle plume. [2]

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(iii) Explain how a mantle plume might produce basaltic magma. [3]

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(b) **Table 4** shows data of calculated eruption rates for the Deccan Traps and Réunion.

	Age of eruption (Ma)	Duration of volcanism (Ma)	Volume of basalt erupted (km^3)	Rate of eruption ($km^3\ yr^{-1}$)
Deccan Traps	66	1	1,500,000	1.5
Réunion	2 to present	2	•	0.04

Table 4

(i) Complete **Table 4** by calculating the volume of basalt erupted from Réunion. Show your working below. [2]

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(ii) With reference to **Figure 4b** and **Table 4**, account for the large extent of the Deccan traps compared with the Réunion hot spot. [3]

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(c) From your knowledge, explain why volcanism associated with the Deccan Traps has been suggested as a factor responsible for a major mass extinction event. [4]

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SECTION B

*Questions **5 - 8** relate to the **British Geological Survey Telford (S&D) 1: 25 000 Classical Areas geological map** extract.*

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

This section should take approximately 1 hour to complete.

5. The Wrekin is a steep-sided ridge composed mainly of Precambrian rocks that runs NE-SW across the **geological map**. Springs come to the surface at the base of the ridge which is cut by a number of dykes.

(a) Refer to **grid squares 6308** and **6309** and the **generalised geological column**. Complete **Table 5** by inserting the following in order of their relative ages – oldest at the base:

*Dolerite (**D**), Tuff (**Z**), Wrekin Quartzite (**WQ**) and the Wrekin Fault.* [3]

Relative age	Geological units
Youngest	Boulder Clay
	•
	•
	•
Oldest	•

Table 5

(b) (i) Explain why there is a steep ridge running NE–SW across the map. [2]

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(ii) Suggest **two geological** reasons for the location of the reservoir (shaded white) in **grid square 6309**. [2]

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6. *(a)* **Figure 6a** shows a **sketch** representing a simplified cross section within **box A** on the **geological map** along the line **B – C**.

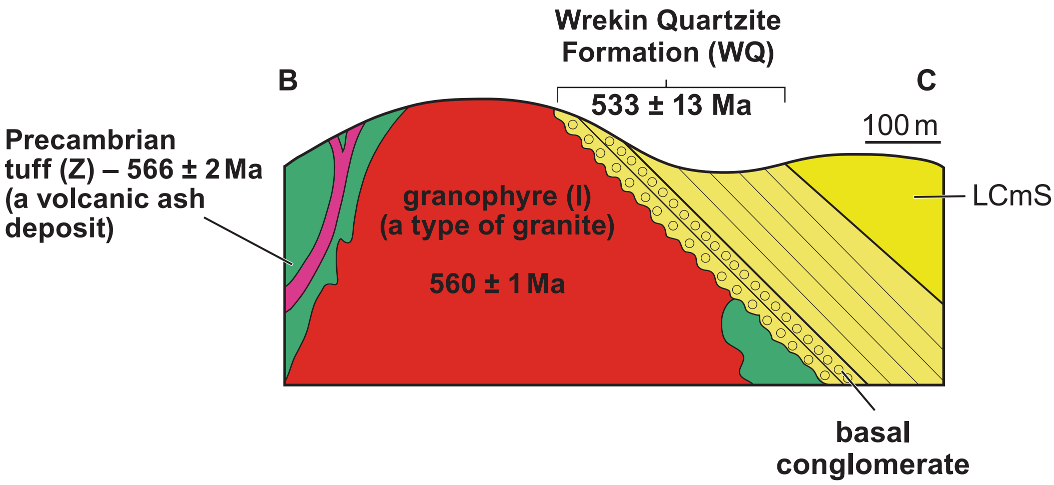

Figure 6a

Refer to **Figure 6a** and **box A** (an enlargement of **box A** is below the generalised geological column).

*"The granophyre (**I**) intruded the Precambrian tuff (**Z**) ".*
Describe the evidence that supports this statement. [2]

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(b) **Figure 6b** shows detail of the boundary between the Precambrian granophyre (**I**) and the Wrekin Conglomerate – the basal layer of the Wrekin Quartzite Formation (**WQ**) – within **box A** on the **geological map**.

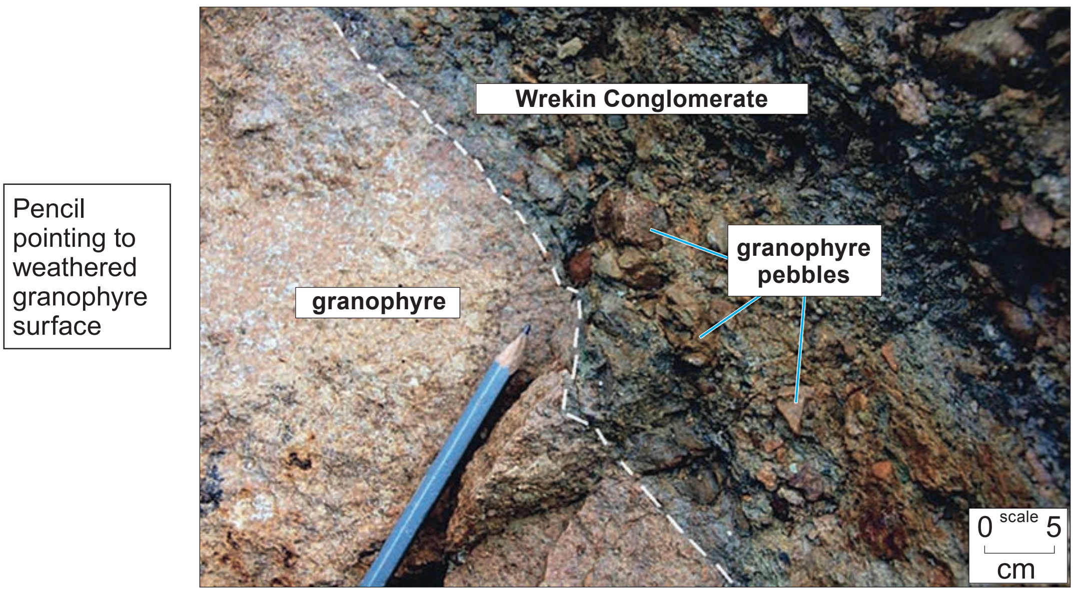

Figure 6b

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Refer to **Figure 6b**, the **geological map** and the **generalised geological column.**

(i) Complete **Table 6** to identify the characteristics of the Wrekin Quartzite Formation (**WQ**) compared to the granophyre (**I**). [3]

characteristics	granophyre (**I**) - a type of granite	Wrekin Quartzite Formation (**WQ**)
rock type	igneous	sedimentary
dip angle (degrees)	not applicable	•
dip direction	not applicable	•
age	Precambrian	•
date	560 Ma (± 1 Ma)	533 Ma (± 13 Ma)
fossil content	not applicable	unfossiliferous

Table 6

(ii) A student incorrectly suggested that the granophyre (**I**) intruded the Wrekin Quartzite Formation (**WQ**). Using evidence from **Figure 6b** and **Table 6** give **three** reasons why this suggestion is **incorrect**. [3]

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(iii) State the type of boundary between the granophyre (**I**) and the Wrekin Quartzite Formation (**WQ**). [1]

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(c) The Wrekin Quartzite Formation (**WQ**) consists of unfossiliferous orthoquartzite with a conglomerate/breccia at the base. **Figure 6c** is an exposed upper bedding surface within the Wrekin Quartzite Formation (**WQ**), showing symmetrical sedimentary structures.

Figure 6c

(i) State the name of the symmetrical sedimentary structures in **Figure 6c**. [1]

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(ii) Suggest a possible sedimentary environment in which the Wrekin Quartzite Formation (**WQ**) was deposited. Give reasons for your answer. [3]

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(iii) Suggest reasons why the Wrekin Quartzite Formation (**WQ**) might lack fossils. [4]

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7. **Figure 7** shows a partly completed gravity profile (corrected for topography) along a simplified geological cross-section between **X** and **Y** on the **geological map**. **Table 7** shows the mean density values for the rocks that crop out along the cross-section.

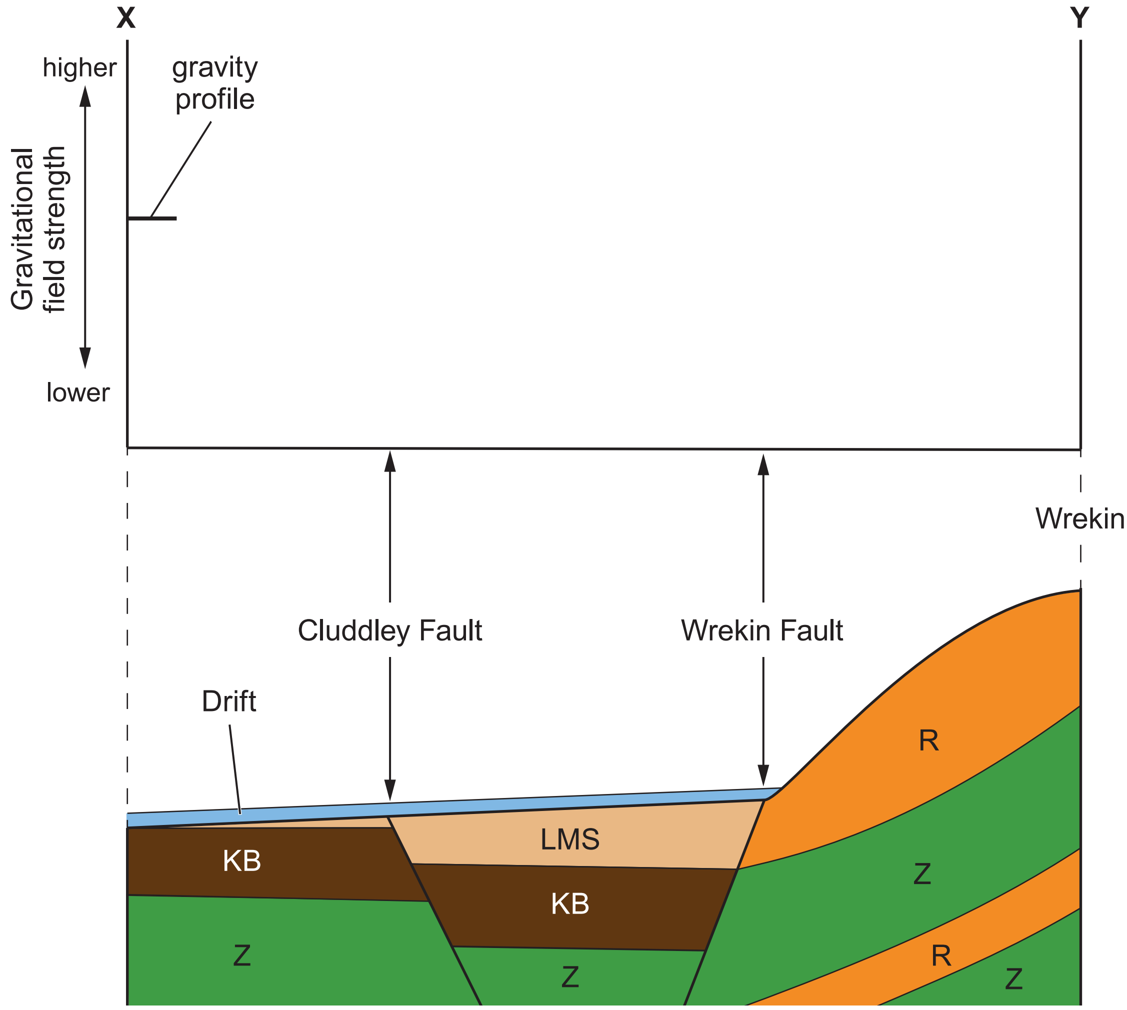

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Figure 7

Rock type		Individual bed density (g cm^{-3})	Mean density value (g cm^{-3})
Bridgnorth Sandstone (**LMS**)			2.13
Keele Beds (**KB**)	(60% sandstone)	2.41	•
	(40% mudstone)	2.46	
Precambrian (**R** and **Z**)			2.58

Table 7

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(i) The Keele Beds have an overall composition of 60% sandstone: 40% mudstone. Complete **Table 7** by calculating the overall mean density of the Keele Beds. Show your working below. [2]

(ii) With reference to **Table 7**, **sketch** the remainder of the gravity profile relative to location **X** along the line **X-Y**. [3]

(iii) Explain the gravity profile in terms of:
- density contrasts
- geological structure. [3]

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8. **Figure 8** is a photograph of part of the Huntington Lane open cast mine **(grid square 6508)** looking North. The site, mined early last century, was reopened to remove the remaining coal between 2010 – 2013 but recovery was 7% less than originally estimated.

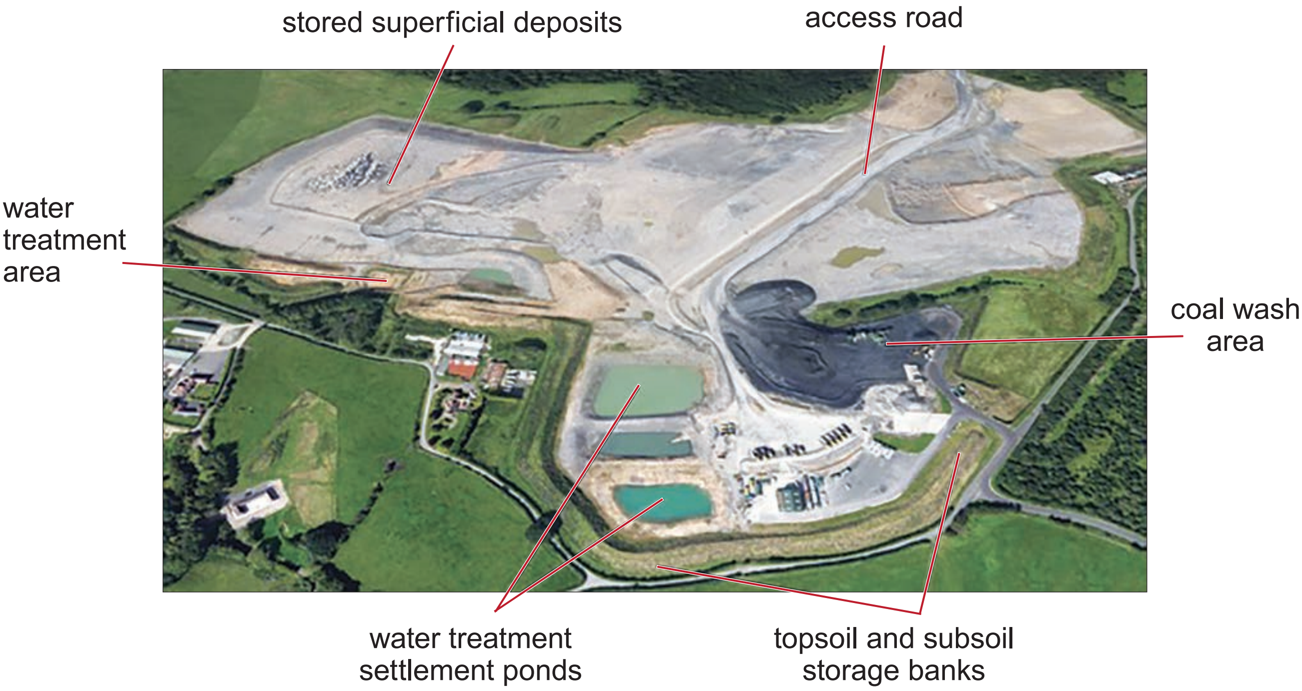

Figure 8

(a) Refer to the **generalised geological column** and the **geological map**.

(i) Coals from Clunch Coal (**CL**) down to Little Flint Coal (**LF**) of the Lower Coal Measures (**LCM**) were extracted from this site.

Using the **generalised geological column**, calculate the minimum thickness of rock, including the coals, that was removed to obtain these coals. Show your working. (Scale of the **generalised geological column** is 1:1000). [2]

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(ii) Suggest **two geological** reasons why coal recovery might have been 7% less than originally estimated during planning. [2]

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(b) With reference to **Figure 8** and **your knowledge**, describe the potential environmental issues posed by the most recent extraction of coal that have been partly managed at this site. [4]

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END OF PAPER

Acknowledgements

Figure 1b P Loader
Figure 2b https://www.esci.umn.edu/orgs/whitney/andalusite_4L.jpg
Figure 3b P Loader
Figure 4a adapted from P. Francis; *Volcanoes, A planetary perspective*.
Figure 4b Tasa Graphic Arts, Inc, 2010
Figure 6a *Ercall Quarries, The Wrekin, Shropshire*; J.Pringle & I. Stimpson
Figure 6b http://www.geo-village.eu/wp-content/uploads/2014/10/Ercall_FieldTrip_Sat18Oct.pdf
Figure 6c https://geogeek1726.wordpress.com/2014/03/20/the-ercall/
Figure 8 Google Earth

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