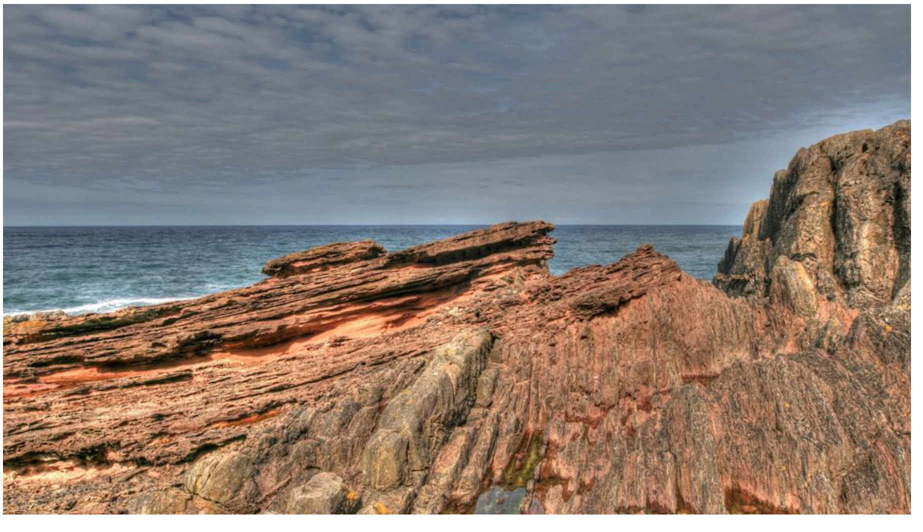
Torquay Girls' Grammar School

2024-2026
Geology Student Transition Handbook & Workbook



Name	
Teacher	
Form	

WHAT GEOLOGICAL QUESTIONS CAN WE ASK? *(All Themes)*

d) Think of some geological questions you would like to ask.

e) Pick a geological question to answer. Write the question and the answer you find on a sticky note to be fixed to the middle of this page.

INTRODUCTION

Congratulations on choosing **Geology** as one of your subjects. You have chosen to study an *exciting*, *dynamic science* that explores the planet on which we live. It will give you an appreciation of how the Earth developed into its present state, how it affects each and every one of us, and how we may be affecting it. This handbook is designed to prepare you for your first year of study and hopefully answer any questions you may have at this stage.

The first section is a 'handbook' which gives you vital information about the study of Geology, the details of your course, and gives you the opportunity to keep track of your progress. It must be kept in the front of your Geology file, as you will be using it throughout your course. At the end of the booklet you will find an Appendix of useful documents.

Your teacher is **Mr Gordon Neighbour**. Lessons will take place in S1 (The Mary Anning Room), you'll usually find me there or in the Careers office. Contact me by emailing gneighbour@tggsacademy.org. Please don't hesitate to email me over the summer if you have any questions ☺

AIMS OF THE COURSE

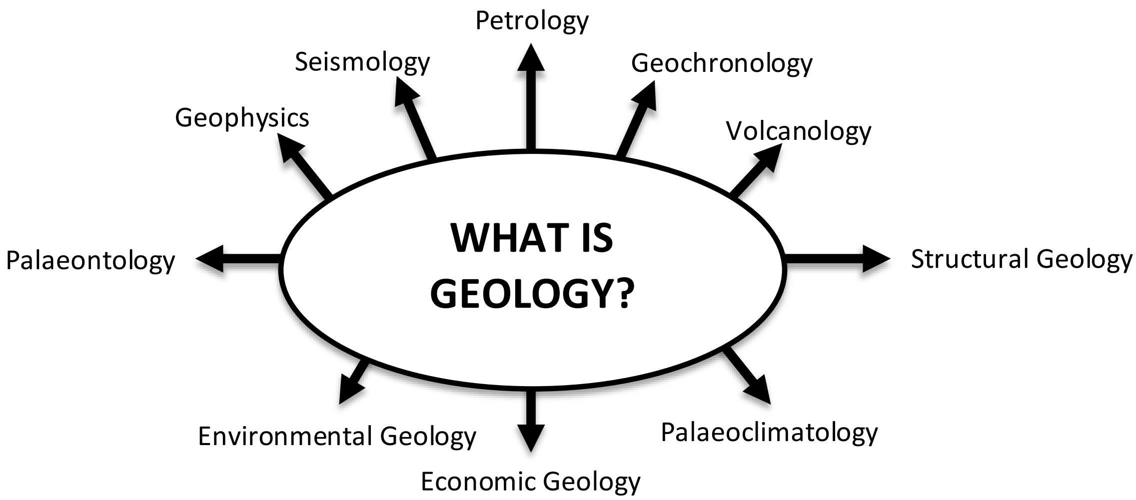
In Y12 and Y13 Geology you will:

- Develop an understanding of Geology, the branch of science concerned with the structure, evolution, and dynamics of the Earth and with the exploitation of the mineral and energy resources that it contains in a sustainable way.
- Gain a thorough understanding of the relevance of science today through your geological study.
- Apply physical, chemical, and biological principles to the investigation of the Earth, developing a distinctive scientific methodology, invoking internal and external Earth processes to explain the evolution of the planet through geological time.
- Apply geology to human activities and how we interact with the world around us.

A level Geology - What do you know?

WHAT IS GEOLOGY?

1. **a) What are these disciplines within Geology?**
   b) Can you add any more to this mind map?



c) Write a definition of the word "Geology".

____

____

THE COURSE

You are studying the **Eduqas** A level course in Geology. There are 11 modules that make up the course: Four at AS level (Year 12) known as the '**Fundamentals of Geology**', another seven at A2 level known as the '**Interpreting the Geological Record**' and '**Geological Themes**'.

An outline of the topics is given below as well as a link to the full detailed specification. Relevant excerpts from the specification will be included in each of the workbooks as we work through the course.

Fundamentals of Geology	**Interpreting the Geological record**	**Geological themes**
F1: Elements, Minerals & Rocks	G1: Rock forming processes	T1: Geohazards
F2: Surface & internal processes	G2: Rock deformation	T2: Geological Map Applications
F3: Time & change	G3: Past life & past climates	T4: The Geological Evolution of Britain
F4: Earth structure & global tectonics	G4: Earth materials & natural resources	

NB: Topics won't necessarily be studied in this order.

The complete specification for the course can be found online at:
https://www.eduqas.co.uk/qualifications/geology-as-a-level/#tab_overview
…and here is a link to a PDF of the specification:
https://www.eduqas.co.uk/media/rckbdnax/eduqas-a-level-geology-spec-from-2017-e-24-01-2020.pdf

ASSESSMENT

At the end of the course you will sit three exams and be awarded a grade A*-E:

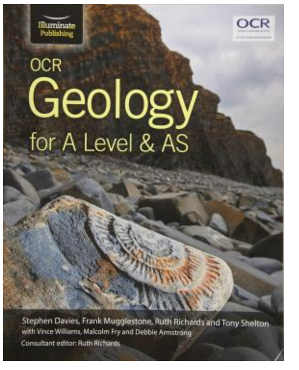
- Component 1 Geological Investigations, 2.25 hour exam, 35% of qualification. Involves two short answer questions, and the interpretation of a geological map with associated specimens/ photographs.
- Component 2 Geological Principals and Processes, 1.75 hour exam, 30% of qualification. Involves six stimulus response questions.
- Component 3 Geological Applications, 2 hour exam, 35% of qualification. Involves two short stimulus response questions, questions associated with the interpretation of a Geological Survey map extract, and short questions based on the chosen theme: The Geological Evolution of Britain.

There is no coursework for Geology, but there are 20 **Specified Practicals** (SPs) which must be completed to meet the practical aspect of your qualification. This is similar to practicals you completed as part of your GCSE Science course, however while a few take place in the classroom, several practicals are completed in the field on our field-trips. You must provide evidence that you have completed all SPs and therefore you will be allocated an A4 Laboratory book to store this evidence in room S1. These will always remain in S1.

BOOKS

Reading (including research on the web) is essential for success at A Level. The more you read, whether it is a textbook or further reading, the better the geologist you will become. You should be prepared to broaden your knowledge and understanding of the subject of your own accord through extensive further reading. In S1 there is a range of books that can be used during lesson time and if the classroom is free. But in the meantime there are a number of textbooks that can help you.

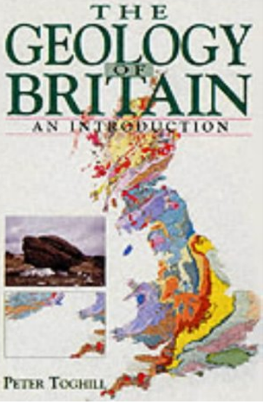
OCR GEOLOGY for A Level and AS
When you arrive at the school you will be given a copy of this book to borrow for the two year course.

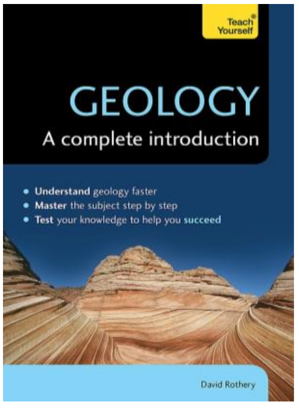


However, you may wish to purchase your own copy to get a head start over the summer.

We use this textbook as it provides a good, comprehensive introduction to help you with the basics. It has some useful diagrams but is essentially an introduction book for another exam board so you need another reference to stretch you further.

We also use this book which gives an excellent overview of the Geology of the British Isles.



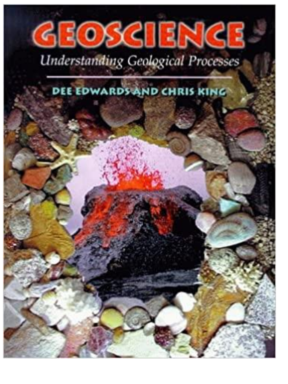


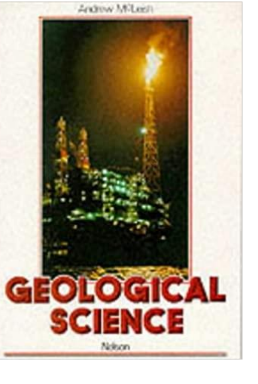
If you want to purchase a book to read over the summer, I would recommend this one. It is a reasonably priced and particularly useful introductory book called **Geology: A Complete Introduction: Teach Yourself** by David Rothery.

Other textbooks you will have the opportunity to borrow once at College include:

GEOSCIENCE by Dee Edwards & Chris King
GEOLOGICAL SCIENCE by Andrew McLeish

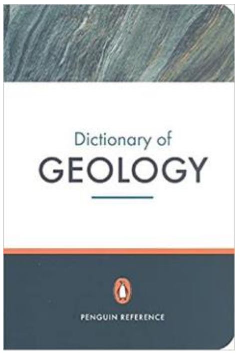
You may wish to purchase your own copy for reading over the summer, although these are aimed more at Y13 content beyond the basics.

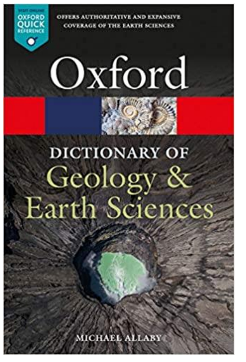


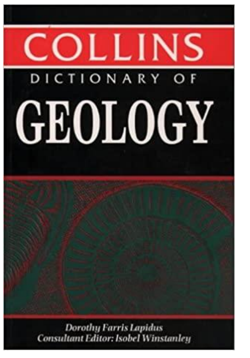


Geology has a language of its own, therefore, in addition to the course textbook I very strongly recommend that you buy a Dictionary of Geology. A Geologist's "DoG" is their best friend; you are expected to become familiar with the very wide range of technical geological terms if you are to communicate as a Geologist. There are several inexpensive versions available, you may even find a different version online which appeals to you:

- **Penguin Dictionary of Geology** by Philip Kearey
- **A Dictionary of Geology and Earth Sciences** by Michael Allaby
- **Collins Dictionary of Geology** by Dorothy Lapidus







As Geology is such a fascinating subject there are of course several TV shows which may appeal to you, many of which are available through online viewing platforms such as BBC iPlayer and All 4; although the whole series may not be available any longer sometimes shorter clips still are, which are worth watching too. I would recommend signing up for a free month's trial of Netflix or Amazon Prime Video over the summer and watching some of these:

Netflix recommendations:	Amazon Prime recommendations:	Other documentaries worth finding online:
• Into the Inferno (1 episode) • Chasing Coral (1 episode) • The Universe (series) • Walking with Dinosaurs (series) • Planet Earth (series) • Our Planet (series) • Blue Planet (series) • Blue Planet II (series)	• Voyage of the Continents (series) • Earth the Inside Story (1 episode) • Wonders of the National Parks (series) • The World's Greatest Geological Wonders (series) • Treasures of the Earth (series)	• Earth: the Power of the Planet • How Earth Made Us • Men of Rock • Journeys from the centre of the Earth • The Essential Guide to Rocks • How the Universe Works • The Rise of the Continents • Earth Story • Saving Planet Earth: fixing a hole (All 4) • Japan's Tsunami: Caught on Camera (All 4) • Episodes of Horizon

There is also an excellent Open University online Geology course through Open Learn. You can access Open Learn from this link - www.open.edu/openlearn/subject-information

CAREERS AND HIGHER EDUCATION

Where possible we will invite lecturers from universities to come and speak to you or we will arrange sessions remotely via **MS Teams** or **ZOOM,** and if practical we will try to attend study days offered by universities. If you are interested in a career in geology and would like more information or ideas for suitable work experience, please ask. Further info can be found at:

https://www.geolsoc.org.uk/geologycareerpathways

READING BEYOND THE SPECIFICATION

Why do you need to look at what the universities call "wider-reading"? It is really important to extend yourself beyond the confines of the syllabus - It can help you to improve your grades. You might not be able to use your reading to answer specific exam questions, but it can deepen your understanding of the syllabus. With a deeper understanding of your subject comes confidence in tackling exams, and this should lead to better grades. Beyond school, it will help you once you start your course. The ability to read around a topic and form strong, balanced arguments based on that reading is essential for excelling in most university courses, so it’s good to start practicing now.

Suggested Wider Reading (reading beyond the Syllabus)

Colliding Continents: A geological exploration of the Himalaya, Karakoram, and Tibet by Mike Searle. Mike Searle, a geologist at the University of Oxford and one of the most experienced field geologists of our time, presents a rich account of the geological forces that were involved in creating these mountain ranges. Using his personal accounts of extreme mountaineering and research in the region, he pieces together the geological processes that formed such impressive peaks.

Earth Story by Simon Lamb and David Sington. This book invites readers to follow the journey our planet has undergone over the last four billion years - starting at a time when there was no dry land.

T. Rex and the Crater of Doom by Walter Alvarez. This is a saga of high adventure in remote locations, of arduous data collection and intellectual struggle, of long periods of frustration ended by sudden breakthroughs, of friendships made and lost, and of the exhilaration of discovery that forever altered our understanding of Earth's geological history.

Supercontinent: Ten Billion Years in the Life of our Planet by Ted Nield. Ted Nield's book tells the astounding story of how that science emerged (often in the face of fierce opposition), and how scientists today are using the most modern techniques to draw information out of the oldest rocks on Earth.

The Goldilocks Planet: The 4 billion year story of Earth’s climate by Jan Zalasiewicz and Mark Williams. In this remarkable new work, the authors demonstrate how the Earth's climate has continuously altered over its 4.5 billion-year history.

How to Build a Habitable Planet: The Story of Earth from the Big Bang to Humankind by Wally Broecker and Charles Langmuir. An accessible yet scientifically impeccable introduction to the origin and evolution of Earth, from the Big Bang through the rise of human civilization.

The Two Mile Time Machine: Ice Cores, Abrupt Climate Change, and Our Future by Richard Alley. The fascinating history of global climate changes as revealed by reading the annual rings of ice from cores drilled in Greenland.

The Fossil Woman: A Life of Mary Anning by Tom Sharpe. A fascinating biography of one of the greatest fossil hunters of all time.

The Earth: A Very Short Introduction by Martin Redfern. This book brings an up to date with the latest understanding of the processes that govern our planet.

Lucky Planet: Why Earth is Exceptional – and What that Means for Life in the Universe by David Waltham. In this pop-science masterpiece Waltham, a Fellow of the Royal Astronomical Society, argues that life on Earth is, amazingly, a cosmic fluke.

Otherlands: A World in the Making by Thomas Halliday. "The best book on the history of life on Earth I have ever read" Tom Holland

The Worst of Times: How Life on Earth Survived Eighty Million Years of Extinctions by Paul B. Wignall. This book unravels one of the great enigmas of ancient Earth and shows how this ushered in a new age of vibrant and more resilient life on our planet.

When Life Nearly Died: The Greatest Mass Extinction of All Time by Michael J. Benton. Some 250 million years ago, 90% of life on earth was wiped out. It was the greatest mass extinction ever. This book assesses the competing claims for a meteorite impact or a volcanic eruption in Siberia and brings the story thoroughly up to date.

Beasts Before Us: The Untold Story of Mammal Origins and Evolution by Elsa Panciroli. This book charts the emergence of the mammal lineage, Synapsida, beginning at their murky split from the reptiles in the Carboniferous period, over three-hundred million years ago and how they made the world theirs long before the rise of dinosaurs!

The Greywacke: How a Priest, a Soldier and a Schoolteacher Uncovered 300 Million Years of History by Nick Davidson. Travelling through some of the most spectacular scenery in Britain, this book is a celebration of the sheer visceral pleasure generations of geologists have found, and continue to find, in noticing the earth beneath our feet.

The Planet in a Pebble: A journey into Earth's deep history (Oxford Landmark Science) by Jan Zalasiewicz. This is a narrative of the Earth's long and dramatic history, as gleaned from a single pebble.

The Chronologers' Quest: The Search for the Age of the Earth by Patrick Wyse Jackson. This is a thoroughly readable account of the measurement of geological time. It will be of great interest to a wide range of readers, from those with little scientific background to students and scientists in a wide range of the Earth sciences.

The Dating Game: One Man's Search for the Age of the Earth by Cherry Lewis. This engaging book brings Arthur Holmes back to life and skilfully weaves his adventures, loves and losses, around the early history and science of dating the Earth, and the discovery of radioactivity - the clock that tells geological time.

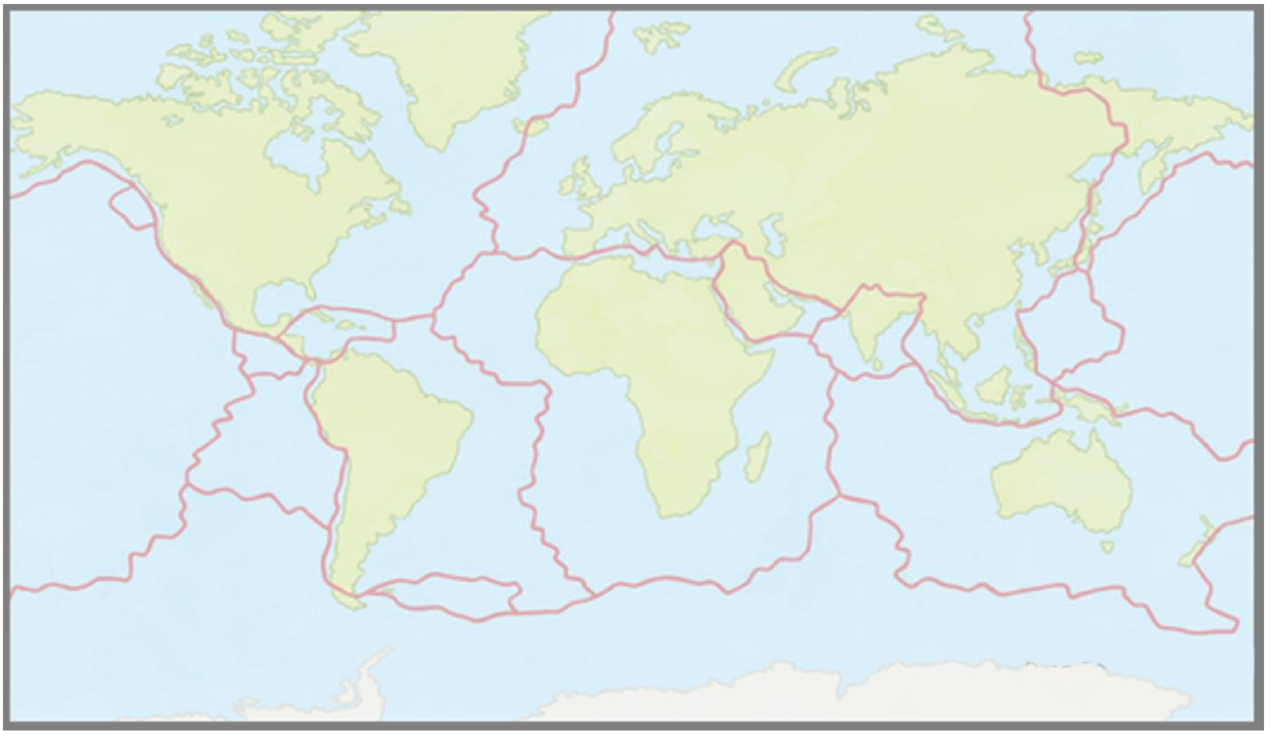
ACTIVITIES TO COMPLETE

On the following pages you will find some transition activities for you to attempt over the summer. You may wish to print out this booklet and complete them by hand, or you may wish to add text-boxes and complete the tasks digitally. Once you have completed the booklet bring a copy to your first Geology lesson in September. Completing the tasks will cover and enhance your critical thinking skills, as well as some basic geological skills and knowledge giving you a head-start with the A Level course.
I have designed some introductory activityies for a handful of the following Topics:

Fundamentals of Geology	Interpreting the Geological record	Geological themes
F1: Elements, Minerals & Rocks	G1: Rock forming processes	T1: Geohazards
F2: Surface & internal processes	G2: Rock deformation	T2: Geological map applications
F3: Time & change	G3: Past life & past climates	T4: The Geological Evolution of Britain
F4: Earth structure & global tectonics	G4: Earth materials & natural resources	

For the first task, use the letter key to label the tectonic plates of Earth's crust on the map below. Then go over the plate boundaries using three different coloured pens.

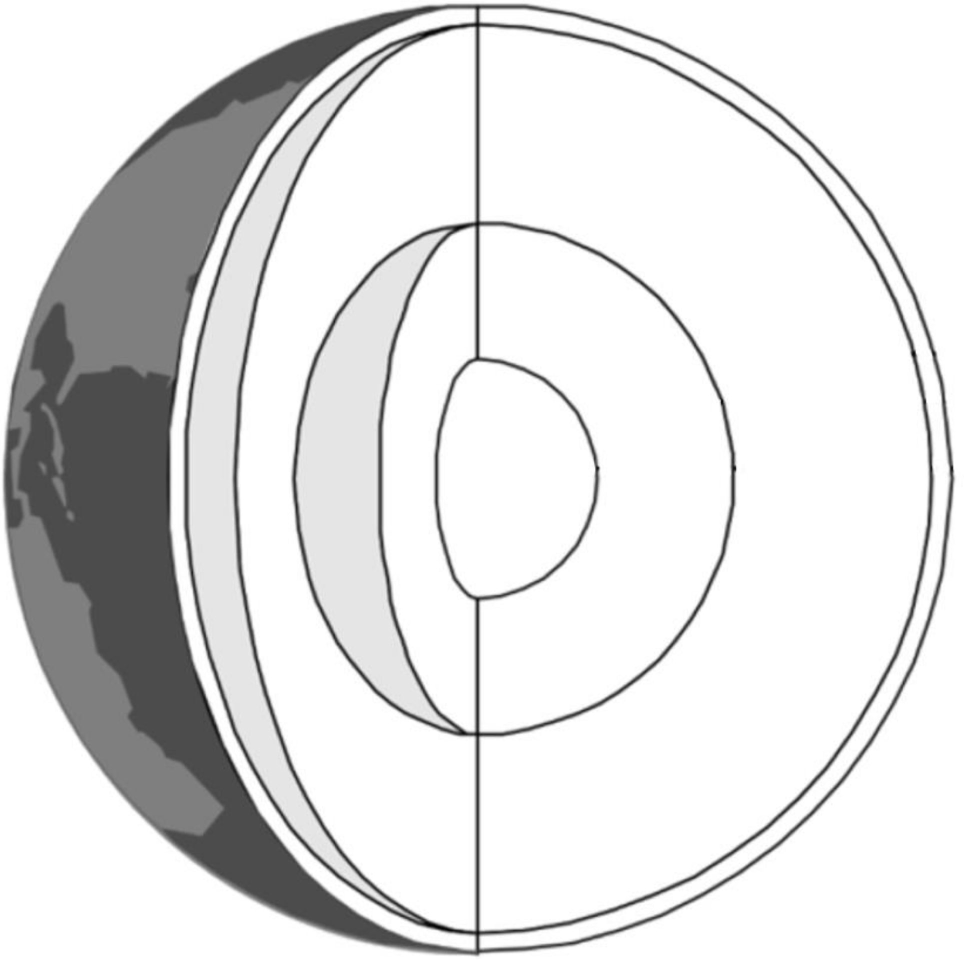
One colour should represent **divergent** plate boundaries where two plates are pulling apart.
The second colour should represent **convergent** plate boundaries where the two plates are colliding.
The third colour for **conservative** boundaries where the two plates are moving past one another.



A. Pacific Plate
B. North American Plate
C. South American Plate
D. Eurasian Plate
E. African Plate
F. Antarctic Plate
G. Australian Plate
H. Indian Plate
I. Arabian Plate
J. Juan de Fuca Plate
K. Nazca Plate
L. Cocoas Plate
M. Caribbean Plate
N. Philippine Plate
O. Scotia Plate

Understanding the internal structure of the Earth is essential for any Geologist. Research the following terms and annotate the diagram with as much information as you can find about each layer. For example, how thick is the layer, what is it made of, which types of earthquake wave can pass through it.

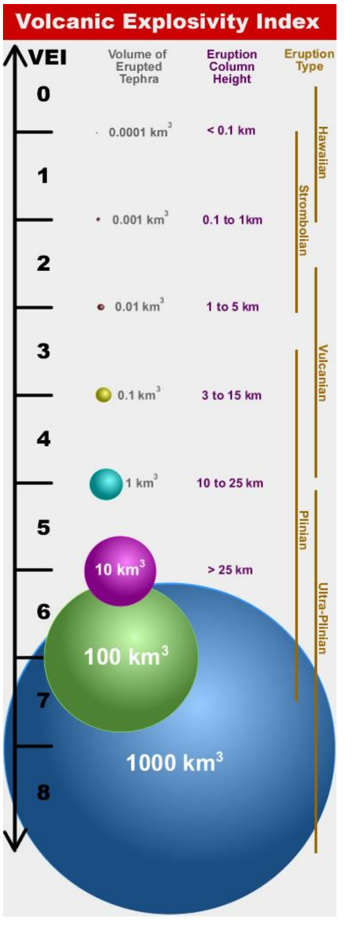
- **Crust**
- **Mantle** (you can divide this into upper and lower by adding a boundary)
- **Outer Core**
- **Inner Core**



Studying **natural hazards** is an essential part of Geology. The magnitude of earthquakes is recorded on a scale. The table lists 10 significant earthquakes that have occurred in the last 100 years or so. The table records the location of each, it's magnitude, and the number of human fatalities (if any). Fill in the yellow gaps, then label all 10 earthquakes on the world map below using the letters as a key.

	Date	Epicentre	Magnitude	Fatalities (if any)
A.		Léogâne, Haiti	7.0	46,000-316,000
B.	March 25th 1998	Balleny Islands, Antarctica	8.1	0
C.	March 27th 1964	Prince William Sound, Alaska, USA	9.2	131
D.	December 28th 1908	Messina, Italy		123,000
E.	September 22nd 2002	Dudley, West Mids, England	4.7	0
F.		İzmit, Turkey	7.6	17,127
G.	December 26th 2004	Indian Ocean	9.1-9.3	
H.	December 13th 1982	Dhamar, Yemen	6.2	2,800
I.	September 1st 1923	Kantō region, Japan	7.9	
J.	September 19th 1985		8.0	10,000

Another natural hazard that Geologists study is **Volcanic eruptions**. They are recorded on the V**olcanic Explosivity Index** (VEI). The table lists 10 significant eruptions that have occurred in the last 100 years or so. The table records the name and location of each volcano, it's VEI number, and the number of human fatalities (if any). Fill in the yellow gaps, then label all 10 volcanoes on the world map below using the letters as a key.



	Name of volcano	Country	Year	V.E.I number	Human fatalities (if any)
A.	Mt. Pelée	Martinique		4	33,000
B.	Bezymianny	Russia	1955-57	5	0
C.	Taal	Philippines	2020	4	39
D.	Nevado Del Ruiz	Colombia	1985	3	
E.	Eyjafjallajökull	Iceland		4	0
F.	Cerro Azul	Chile	1932	5	0
G.	Mount Pinatubo	Philippines	1991	6	
H.	Volcán de Fuego		2018	3	190
I.	Mount Nyiragongo	DR Congo	2002	1	147
J.	Mount St Helens	USA	1980		57

HOW LIKELY IS AN ERUPTION? *(Theme 8)*

We can work out the chances of a volcano erupting by looking at the history of volcanic eruptions and organising them by size. We measure the size of eruptions using the Volcanic Explosivity Index (VEI).

Volcanic Explosivity Index
VEI is a relative measure of the explosiveness of volcanic eruptions. It is measured by the volume of material erupted. Each VEI above 2 is 10 times larger than the one below.

VEI	Description	Volume of erupted material (km^3)	Volume of erupted material (km^3) (standard form)
8		>	
7		>	
6		>	
5	Paroxysmic	>	
4		>	
3		>	
2		>0.001	
1		>0.000001	
0	Effusive	<0.000001	

7. a) Each VEI also has an adjective to describe it. The list of terms is given below in alphabetical order. Match the correct adjective with its VEI.

cataclysmic	catastrophic	colossal
~~effusive~~	explosive	gentle
mega colossal	~~paroxysmic~~	super colossal

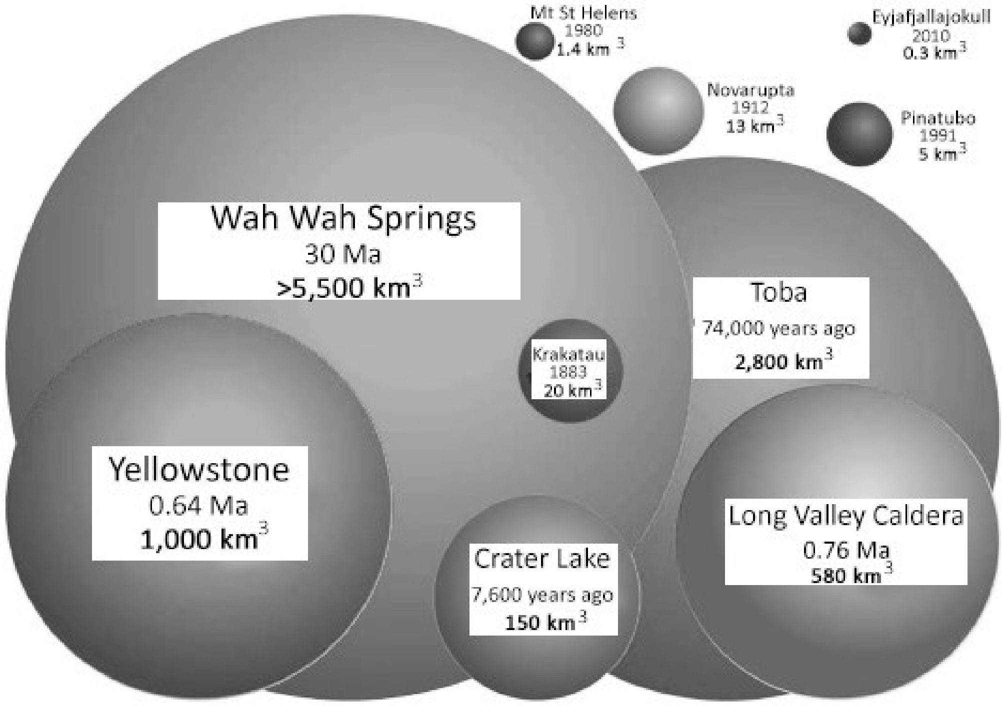
b) i) Complete the VEI table by calculating the volume of erupted material for each VEI.

ii) Convert each of these volumes into standard form.

c) i) The diagram on page 9 shows the relative size of some significant volcanic eruptions. Determine the VEI for each of these eruptions and label the diagram with the VEI of each eruption.

DIGGING DEEPER

ii) What do you think the limitations of using VEI to measure the explosiveness of an eruption might be?



Using the data sheet of 20th Century Volcanic Eruptions.

d) i) Work out how many eruptions of each VEI there were during the 20th Century.

ii) Calculate the chance of eruption for each VEI. Complete the table below.

VEI	Number of eruptions	Chance of eruption occurring
8	0	
7	0	
6		
5		
4		
3	231	
2	≈ 1,174	
1	≈ 4,827	
Total		

iii) Can you identify a pattern?

____

____

e) Why are there no VEI 7 or VEI 8 eruptions?

____

____

____

____

____

DIGGING DEEPER

f) How concerned should we be about an eruption of Yellowstone's supervolcano?

____

____

____

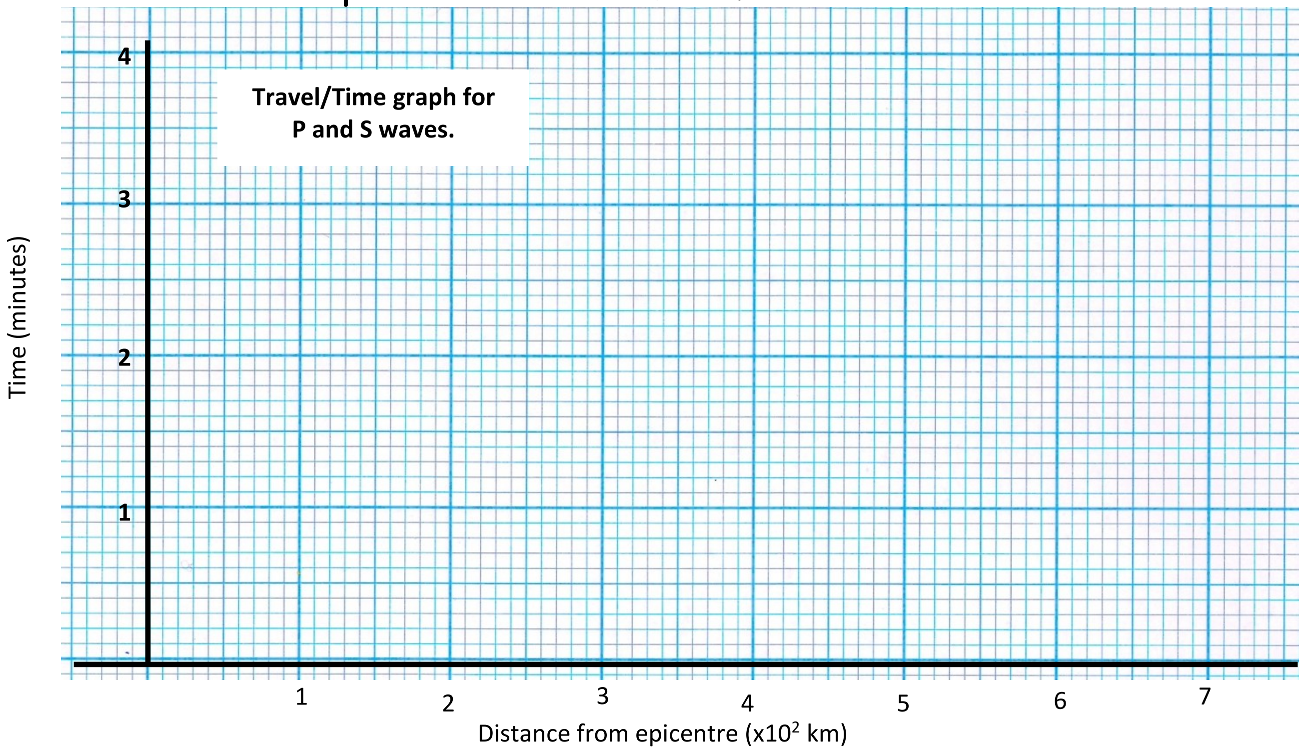
____

WHERE DID THE EARTHQUAKE HAPPEN? *(Theme 8)*

Earthquakes are constantly being detected across the world. In America, the United States Geological Survey (USGS) operate the *'Advanced National Seismic Stations'* network to monitor seismic activity across the country.
An earthquake has been detected by ANSS. The data from 3 monitoring stations is shown below.

8. a) On the graph below plot time/travel lines for 2 types of earthquake waves:

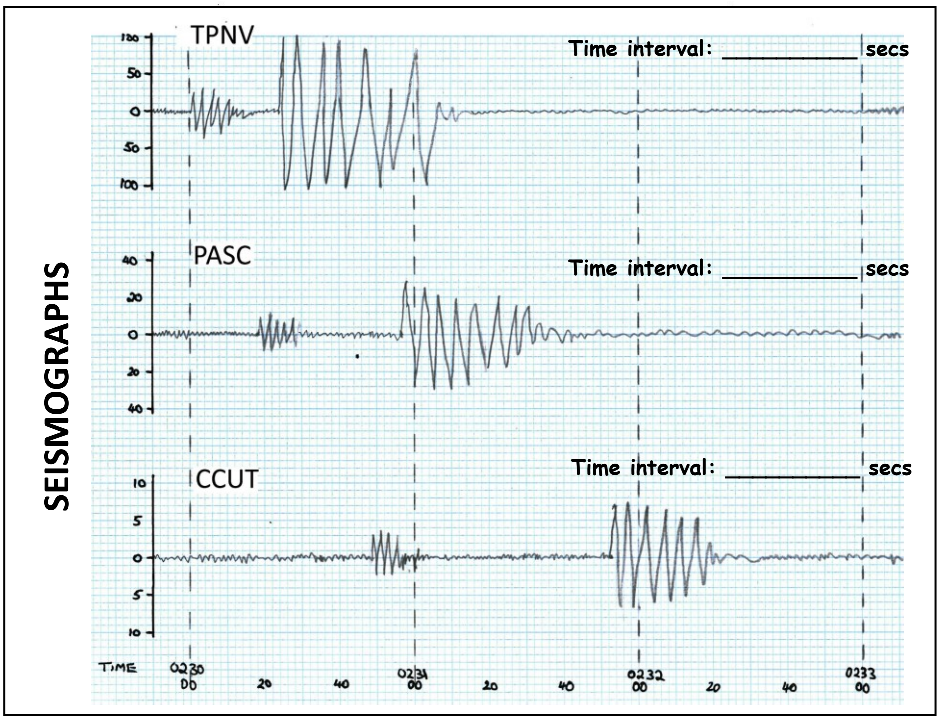
- **P waves - speed in the crust = 5.6 km s^{-1}**
- **S waves - speed in the crust = 3.25 km s^{-1}**



b) Plot the location of the seismic monitoring stations listed below on the map of the western U.S. Use an atlas to help you to find these places.

- **Cedar City, Utah (CCUT)**
- **Los Angeles (Pasadena), California (PASC)**
- **Tonopah, Nevada (TPNV)**

Scale:
1mm = 2 secs

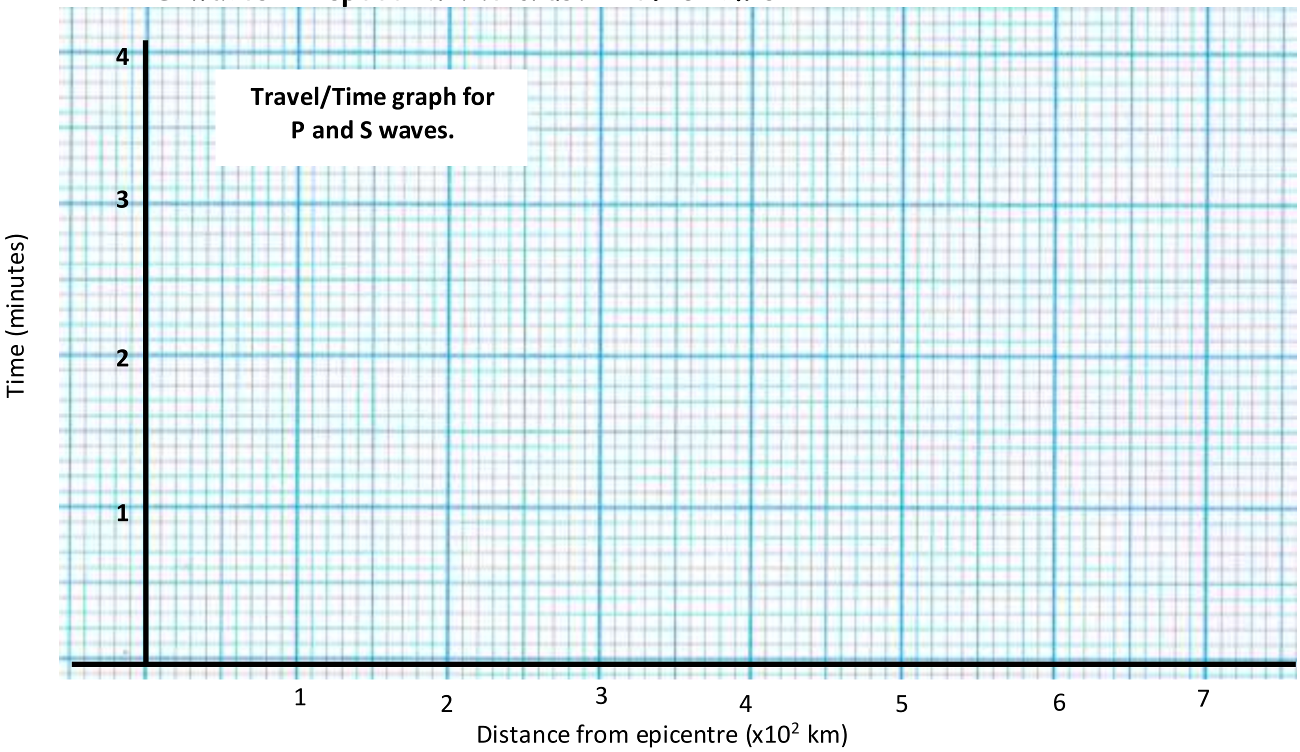


WHERE DID THE EARTHQUAKE HAPPEN?

Earthquakes are constantly being detected across the world. In America, the United States Geological Survey (USGS) operate the *'Advanced National Seismic Stations'* network to monitor seismic activity across the country.
An earthquake has been detected by ANSS. The data from 3 monitoring stations is shown below.

8. a) On the graph below plot time/travel lines for 2 types of earthquake waves:

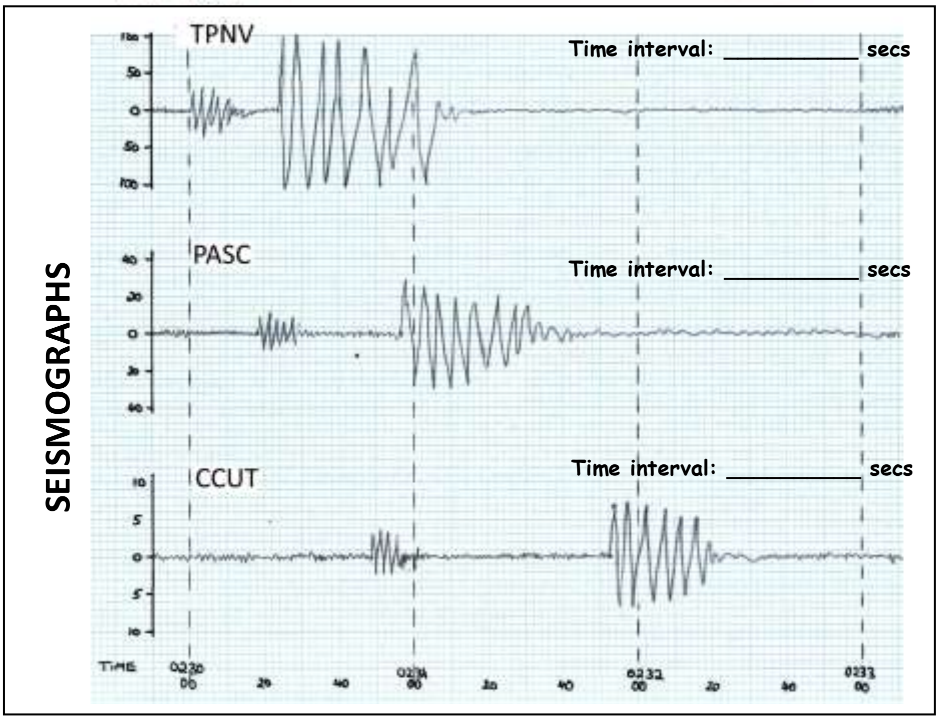
- **P waves - speed in the crust = 5.6 km s^{-1}**
- **S waves - speed in the crust = 3.25 km s^{-1}**



b) Plot the location of the seismic monitoring stations listed below on the map of the western U.S. Use an atlas to help you to find these places.

- **Cedar City, Utah (CCUT)**
- **Los Angeles (Pasadena), California (PASC)**
- **Tonopah, Nevada (TPNV)**

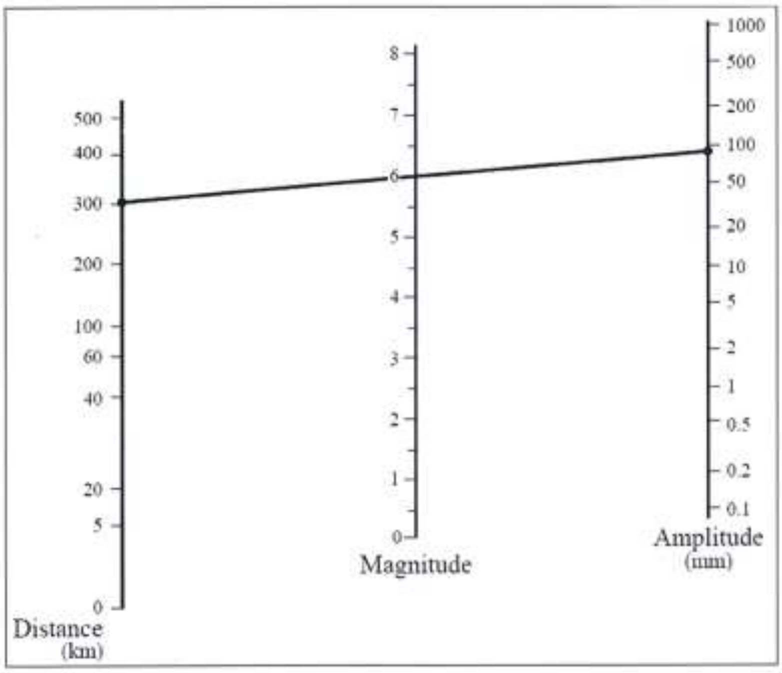
Scale:
1mm = 2 secs



c) i) Mark on the seismographs the point where the P waves and S waves arrive at each monitoring station. Measure the time interval between their arrival.
ii) Use the time/travel graph and the seismographs to work out the distance from the epicentre of the earthquake to each monitoring station.

iii) Mark these distances onto the map to locate the epicentre of the earthquake.

d) Annotate the map to show some of the problems an earthquake in this location may cause.



DIGGING DEEPER

e) Using all the data, work out the Richter magnitude of the Earthquake. What is the significance of this?
(An example of a magnitude 6 earthquake that had an amplitude of 90mm, 300km away from the epicentre has been drawn already).

f) Annotate all the graphs to show what we can work out about earthquakes from them.

HOW HIGH IS THE EARTH'S SURFACE?

We can measure the height of the Earth's surface relative to sea level. The percentages of the surface of different heights is shown in the table below.

Height/depth (km)	Percentage of total surface area of the Earth	Cumulative percentage area
> +5	0.1	0.1
+4 to +5	0.4	0.5
+3 to +4	1.1	
+2 to +3	2.2	
+1 to +2	4.5	
0 to +1	20.8	
sea level		
0 to -1	8.4	
-1 to -2	3.1	
-2 to -3	6.1	
-3 to -4	14.7	
-4 to -5	22.6	
-5 to -6	15.0	
-6 to -7	0.9	
-7 to -12	0.1	

9. a) Complete the table by calculating the cumulative percentage area starting from the highest point.

b) Plot a cumulative frequency graph to show the height of the land (use 1cm = 1km along the short edge of the graph paper) against cumulative percentage (use 1 cm = 5% along the long edge of the graph paper. Plot the lower height/depth value.

c) What percentage of the Earth's surface is:

i) ocean? **iii) mountains?**

ii) continent? **iv) ocean trenches?**

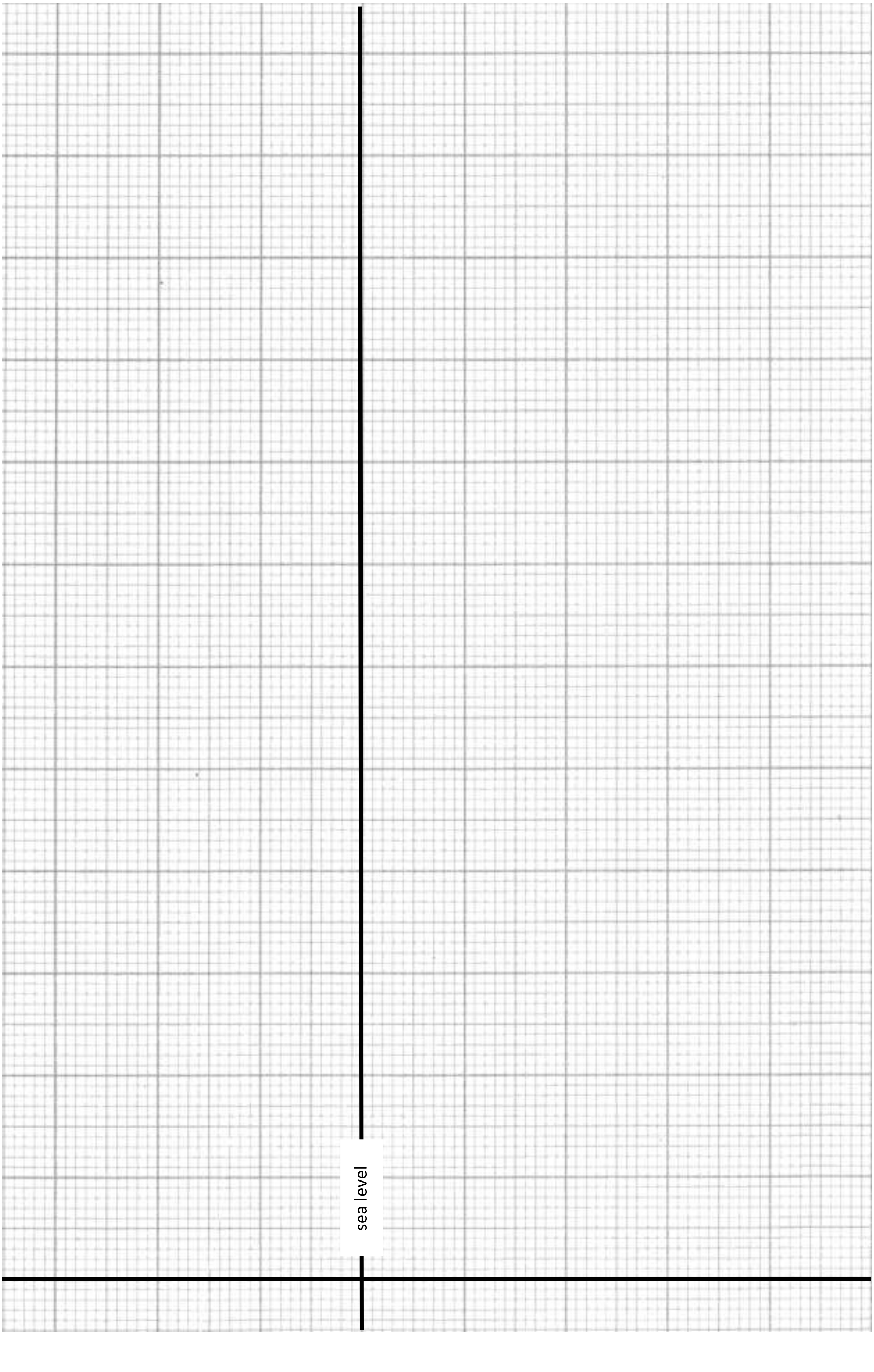
Show these areas on your graph.

d) What is the median and mode average height of the Earth's surface? Show this on your graph.

DIGGING DEEPER

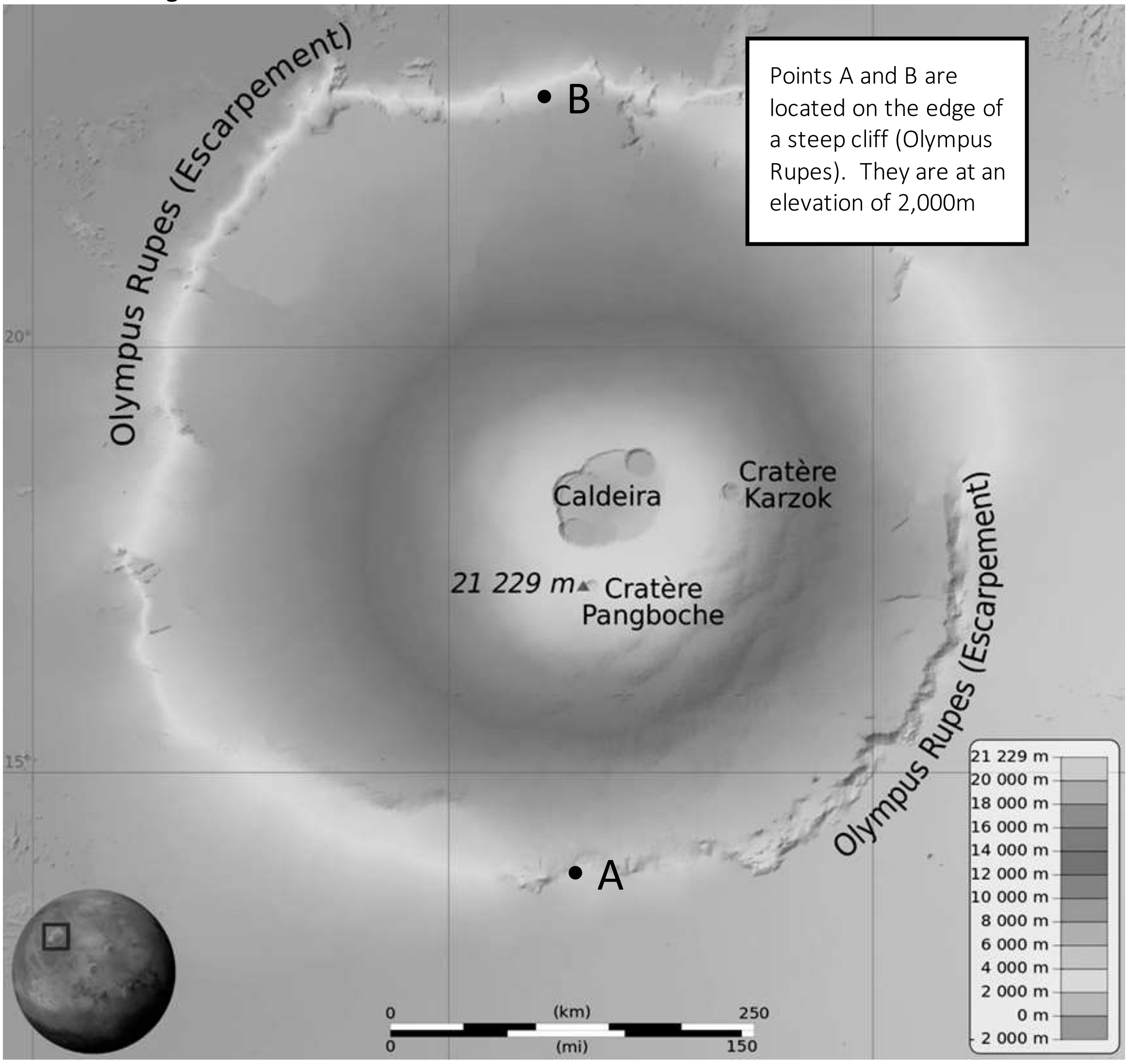
e) Work out the average height of the continents.

f) Is the Earth smoother than a snooker ball? Prove your answer.


sea level

HOW BIG IS IT?

The biggest volcano we know of is called "Olympus Mons" and is found in the western hemisphere of Mars. Just how big is it?



A map of Olympus Mons

11. a) Measure the distance between points A and B in kilometres to 2 significant figures. Complete the table on page 17.

b) Olympus Rupes is approximately circular in shape with points A and B defining its diameter. Calculate the circumference of Olympus Rupes in km to 2 s.f.

______________ km

c) NASA's Mars Rover "*Curiosity*" has a maximum speed of 0.14kmh^{-1}. Calculate how many days it would take for *Curiosity* to drive around Olympus Rupes.

________________ days

DIGGING DEEPER

d) Curiosity is programmed to move for 20 seconds, then spend 40 seconds assessing its position and route. Calculate how long it would actually take for it to drive around Olympus Mons.

d) We can compare the size of Olympus Mons with some volcanoes on Earth.

i) Plot a cross section of each volcano using a horizontal scale of 1mm = 2km and a vertical scale of 1mm = 0.5km.

ii) Colour each volcano in a different colour. Start with the smallest one.

DIGGING DEEPER

iii) Work out the slope gradient of each volcano.

iv) Work out the volume of each volcanic cone.

e) We can work out the area covered by each volcano by using:

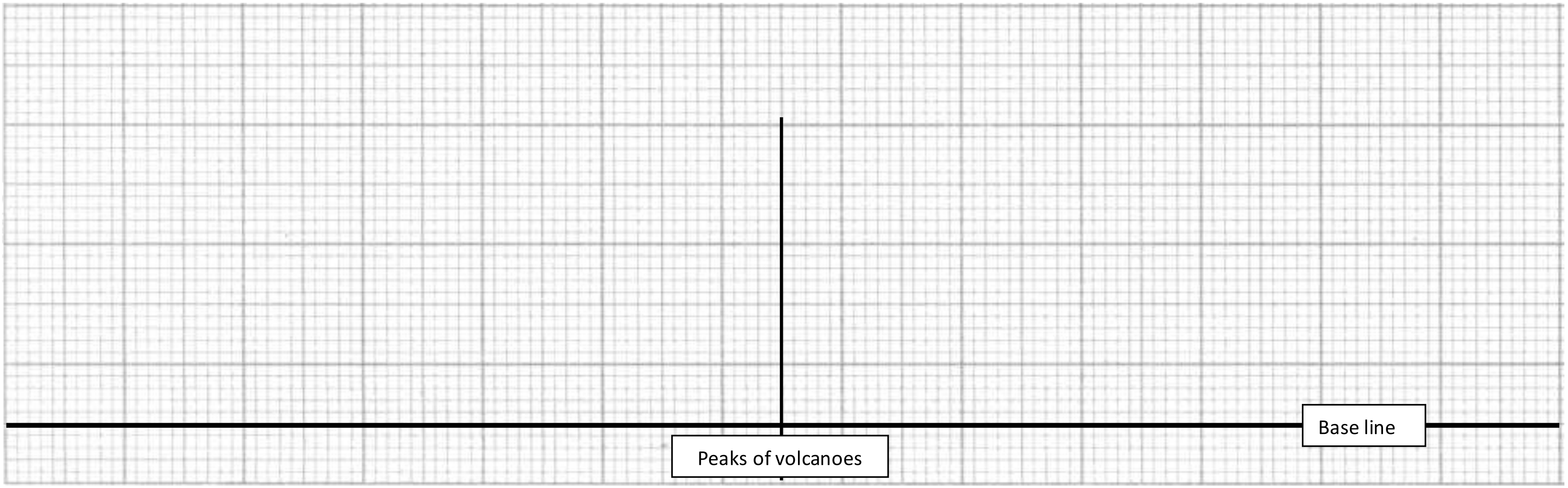
$$\pi r^2$$

i) Complete the table below with the area of each volcano.

DIGGING DEEPER

ii) What percentage of the area of Olympus Mons is the area of Earth's biggest volcano?

Volcano	Height	Diameter	Area
Mauna Loa (U.S.A.)	4,169 m	120 km	11,310 km^2
Mt. Etna (Italy)	3,350 m	44 km	•
Mt St. Helens (U.S.A)	2,549 m	10 km	•
Olympus Mons (Mars)	•	•	•



HOW MUCH TIME? *(Theme 9)*

HOW MANY IN A MILLION?

Geologists often talk about time in basic units of a million years. **This is shown as the units Ma** (*mega anni*). It is important for us to try to get an idea of how much time that represents.

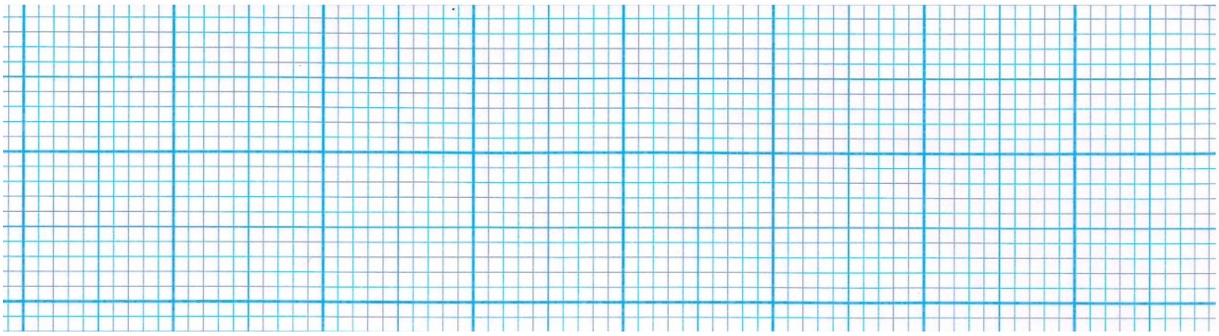
2. a) On the graph paper below, using a scale of 1 square = 1 year colour in squares to represent:

Your age ☐

The average age of your parents ☐

The age of TGGS (founded in 1915) ☐

Use a different colour for each age. Remember that these ages overlap so each age needs to include the previous one.



Each sheet of A4 graph paper has 90 squares across and 140 squares down the page. The size of the paper is 21 cm wide and 29 cm long.

b) At the same scale:
calculate how many sheets of A4 graph paper would be needed to colour to represent 1 million years.

c) i) The Earth is 4,550 million years old. How big an area would be needed to lay out all the A4 sheets of graph paper coloured to represent the age of the Earth?

DIGGING DEEPER
ii) How many football pitches would you need to spread these out? A pitch is 90 x 45 m.

Now use a scale of 1 square = 1 million years (Ma)

d) On the graph paper below colour in square to represent age of the following geological events:

- Origin of humans (5 Ma) ☐
- Extinction of Dinosaurs (66 Ma) ☐
- Break up of Pangaea (200 Ma) ☐
- Pangaea forms (300 Ma) ☐
- First life on land (395 Ma) ☐
- Animals with shells evolve (540 Ma) ☐
- Formation of the Earth (4,550 Ma) ☐

e) Use a different colour for each age. Remember that these ages overlap so each age needs to include the previous one.

DIGGING DEEPER

f) How else might this timescale be represented?

HOW LONG IS A DAY? *(Theme 2)*

We learn that the Earth's day is 24 hours long (more precisely it is 23 hours, 56 minutes and 4 seconds long). However this has not always been the case as the length of the day has changed through geological time. We know that the length of the year has stayed the same because of rocks called tidallites that are deposited in layers that follow the lunar month. By counting the number of bands geologists can work out the number of days in a year. The table below shows the result of these studies.

6.

Period	**Age (Ma)**	**Days per year**	**Hours per day**
Present	0	365	24
Upper Cretaceous	70	370	
Upper Triassic	220	372	
Upper Carboniferous	290	383	
Lower Carboniferous	340	398	
Upper Devonian	380	399	
Middle Devonian	395	405	
Lower Devonian	410	410	
Upper Silurian	420	400	
Middle Silurian	430	413	
Lower Silurian	440	421	
Upper Ordovician	450	414	
Middle Cambrian	510	424	
Ediacarin	600	417	
Cryogenian	900	486	
MEAN AVERAGE			

a) i) Calculate the total number of hours in a year. _______________ hours

ii) Calculate the number of hours in a day for each of the points of time given. Complete the table above.

b) i) Plot a graph of millions of years before present along the long edge of the graph paper against hours in the day along the short edge of the graph paper.

ii) Calculate the mean average age and mean average hours per day. This is the DOUBLE AVERAGE POINT; plot this point on the graph in a different colour. Draw a line of best fit for the graph through this double average point.

c) Describe the correlation shown by the graph. Label the graph to show this.

DIGGING DEEPER

d) Calculate the gradient of the graph to work out the increase in length of the day in seconds per century. Show your working and answer on the graph.

e) Suggest the causes for this change in the length of the day.

HOW MUCH WATER? *(Theme 11)*

One of the predicted effects of climate change is the melting of the world's glaciers and ice sheets. The water cycle shows us that the Earth's water is almost entirely stored in either the sea or in ice on the continents. We can work out the possible rise in sea level by looking at the area and volume of the water.

	Area (km^2)
Oceans	
Pacific	166,241,700
Atlantic	82,522,600
Indian	73,426,500
Arctic	14,056,000
Seas	
Caribbean	2,512,300
Mediterranean	2,509,700
Bering	2,266,250
Gulf of Mexico	1,554,000
Sea of Okhotsk	1,528,100
East China Sea	1,248,400
Sea of Japan	1,007,500
Others	12,258,950

10. a) i) Calculate the total area of the Earth's oceans and seas.

____________________________ **km^2**

ii) Give the total area of the oceans and seas to <u>3 significant figures</u>.

____________________________ **km^2**

iii) Give the total area of the oceans and seas in <u>standard form to 2 decimal places</u>.

____________________________ **km^2**

The Earth's two biggest ice sheets contain most of the planet's ice.

b) i) Calculate the total volume of ice on Earth.

Ice sheet	Area (km^2)	Average depth (km)	Volume (km^3)
Antarctica	11,965,700	2.45	•
Greenland	1,736,095	1.5	•
Other			397,245
		Total	•

ii) Give the total volume of ice in <u>standard form to 2 decimal places</u>.

____________________________ **km^3**

Ice is less dense than water, ice has a density of about 900 kgm^{-3}, water has a density of 1000 kgm^{-3}. If $1km^3$ of glacier ice melts it makes $0.9km^3$ of water.

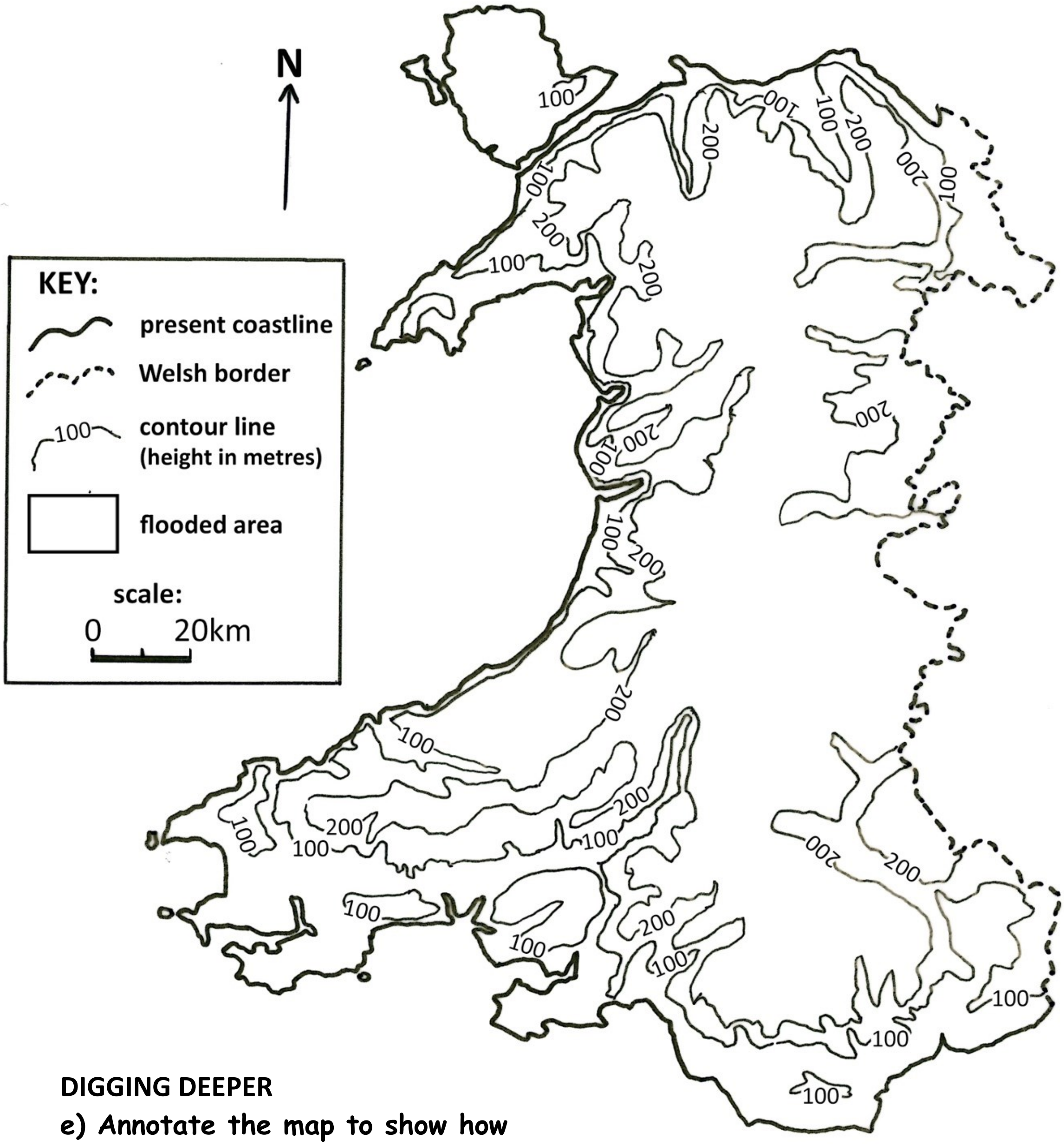
c) Calculate the volume of water that would be released if all the ice on Earth were to melt. Give your answer in <u>standard form to 2 decimal places</u>.

______________________________ **km^3**

d) i) Using your answers for a iii) and c) calculate the maximum rise in sea level if all the ice caps were to melt (as they did during the Cretaceous period (135-66 Ma). Show your working; give your answer in metres.

________________ **m**

d) ii) Draw on the map below the coastline of Wales if all the ice caps were to melt. Shade in the land that would be flooded by the sea as a result.

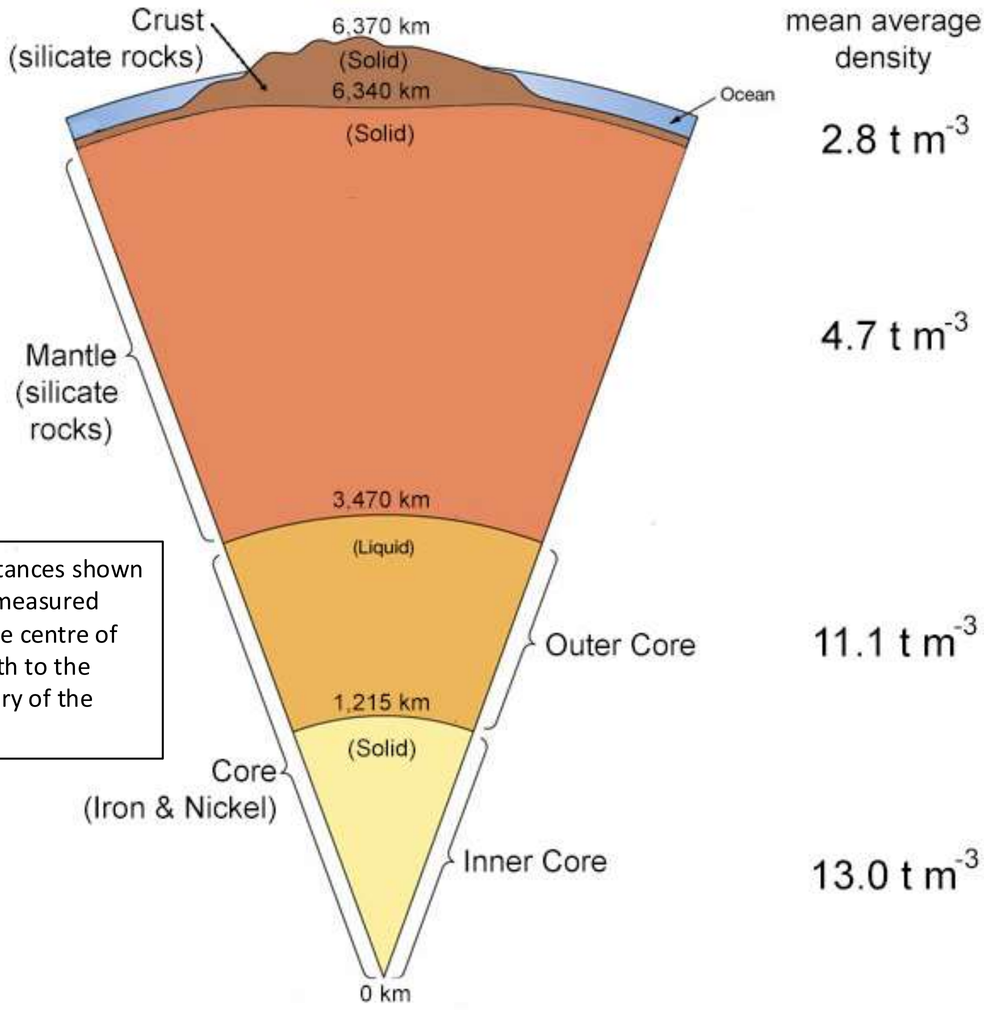


DIGGING DEEPER

e) Annotate the map to show how this sea level rise would affect the landscape of Wales.

HOW HEAVY IS THE EARTH?

We can work out the weight of the Earth if we know about the layers within the Earth and their densities. The four main layers of the Earth and some of their properties are shown below.



The distances shown are all measured from the centre of the Earth to the boundary of the layer.

EQUATION FOR THE VOLUME OF A SPHERE

$$V = \frac{4}{3}\pi r^3$$

EQUATION FOR DENSITY

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

$d = density$
$m = mass$
$r = radius$
$V = volume$

UNITS OF MASS

Tonnes			Grams			Equivalent units		
Multiple	**Name**	**Symbol**	**Multiple**	**Name**	**Symbol**	**Tonnes (t)**	**Kilogrammes (kg)**	**Grams (g)**
10^0	Tonne	t	10^6	Megagram	Mg	1 t	1,000 kg	1 million g
10^3	Kilotonne	kt	10^9	Gigagram	Gg	1,000 t	1 million kg	1 billion g
10^6	Megatonne	Mt	10^{12}	Teragram	Tg	1 million t	1 billion kg	1 trillion g
10^9	Gigatonne	Gt	10^{15}	Petagram	Pg	1 billion t	1 trillion kg	1 quadrillion g
10^{12}	Teratonne	Tt	10^{18}	Exagram	Eg	1 trillion t	1 quadrillion kg	1 quintillion g
10^{15}	Petatonne	Pt	10^{21}	Zettagram	Zg	1 quadrillion t	1 quintillion kg	1 sextillion g
10^{18}	Exatonne	Et	10^{24}	Yottagram	Yg	1 quintillion t	1 sextillion kg	1 septillion g
10^{21}	Zettatonne	Zt				1 sextillion t	1 septillion kg	1 octillion g

12. Using the data on page 18, calculate the total mass of the Earth by working out the volume of each layer, then its mass and then adding them together.

BE <u>VERY</u> CAREFUL WITH YOUR UNITS.

SHOW YOUR WORKING. GIVE ALL YOUR ANSWERS IN STANDARD FORM TO 1 D.P.

a) i) Volume of Inner Core:

____________ m^3

ii) Mass of Inner Core:

____________ t

b) i) Volume of Outer Core:

____________ m^3

ii) Mass of Outer Core:

____________ t

c) i) Volume of Mantle:

____________ m^3

ii) Mass of Mantle:

____________ t

d) i) Volume of Crust:

____________ m^3

ii) Mass of Crust:

____________ t

e) i) Total volume of Earth:

____________ m^3

ii) Total mass of Earth:

____________ t

f) What percentage of the Earth's mass is made up by the Crust?

DIGGING DEEPER

g) Express the mass of the Earth using some different units.

i) From the 'Units of Mass' table.

ii) In Imperial Units (stones seems a suitable one!)

iii) In another, non-traditional, unit of your choice.

Just like a Chemist uses a periodic table, a Geologist uses a **chronostratigraphic chart.** You'll find an up-to-date version of this at the end of the booklet.

You'll refer to a chart like this regularly. But it's still important to learn a little about each of the main Geological Periods. These are listed below in a table, followed by a mnemonic to help remember their order. Fill in as much information as you can about each period. Use internet research and the chart at the end of the booklet to help you. The interesting fact could be about the Geologist who first named the Period, or how the Period got its name. Perhaps the Period ended with a significant mass extinction. Use your imagination!

Name of Period	Dates	Typical organisms	Interesting fact
Quaternary		Sabre-toothed tiger (Smilodon) and Giant Sloths	
Neogene	23 to 2.5 Ma		
Palaeogene			The time after which Dinosaurs had become extinct allowing mammals to diversify
Cretaceous			
Jurassic	201 to 145 Ma		
Triassic			The Triassic was named after 3 distinct rock layers (*tri* meaning "three") found in Germany and NW Europe

Younger in age ↑

Permian			
Carboniferous		Plant life dominated. Also, giant dragonflies and millipedes.	
Devonian		First amphibians	
Silurian			
Ordovician			
Cambrian	541 to 485 Ma		Named after Cambria (Latin name for Wales) where Britain's Cambrian rocks are best exposed
Precambrian	Older than 541 million years ago (Ma)		

Younger in age

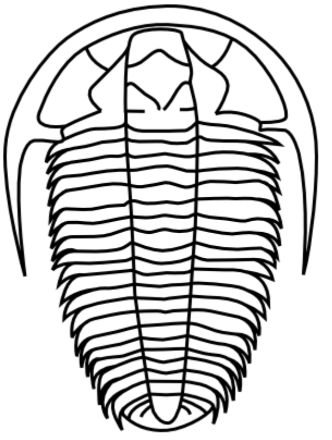
Can you think of a better way to remember the geological periods in order?

P – C – O – S – D – C – P – T – J – C – P – N – Q

As well as rocks and minerals, Geologists also study fossils. One example is the **Trilobite**. Research trilobites to answer the following questions.

How old (in millions of years) are the oldest trilobites?

____



When did trilobites become extinct?

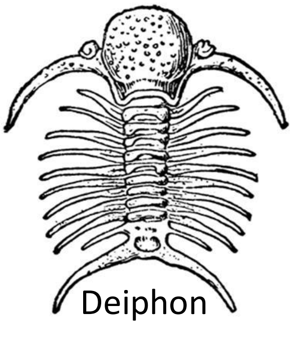
____

Label the following parts of a trilobite fossil:

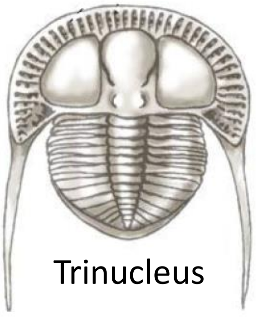
- Glabella
- Pygidium
- Genal spines

Can you find the names of any other parts?
If so, label them too.

Trilobites were marine organisms, they lived in the sea. Many different species of trilobite evolved to survive in different marine conditions. Research the following two trilobites. Why do they look so different? What were their various parts used for? Hint: think about how they moved (crawling, swimming) and how they fed.



Deiphon



Trinucleus

Some trilobites like this one had their eyes on stalks. What do you think would be the evolutionary advantage of this?

____

____

____

As you study Geology, you'll begin to appreciate that it's like conducting a **CSI** (crime scene investigation) of Earth's history using rocks and fossils.

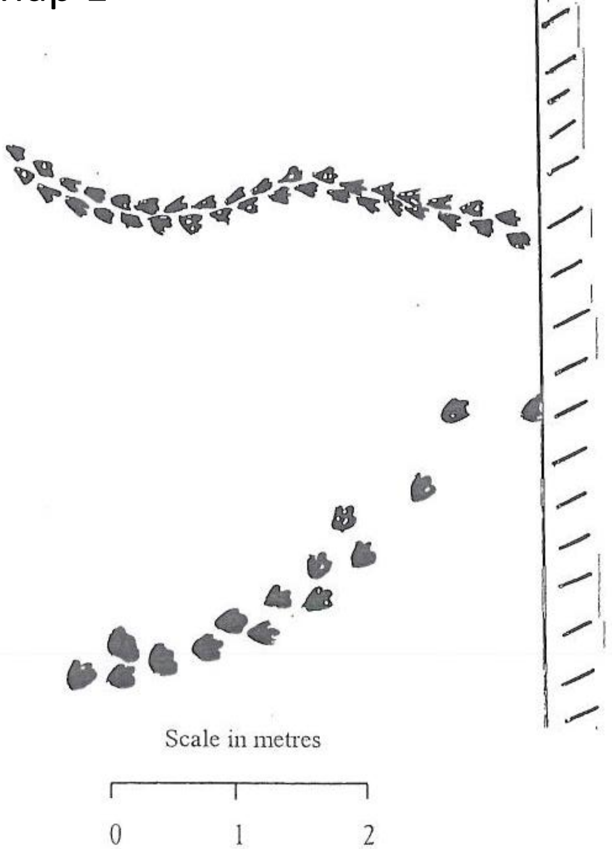
The Earth cannot speak to us and tell us what has happened, we need to figure it out. Let's practice your skills using **Dinosaurs** as an example.

Introduction

This is an exercise which involves you making deductions based on fossil evidence which has been uncovered in a quarry. There is no right or wrong answer.

200 million years ago where the quarry now stands was a lake. The lake was a popular haunt for all sorts of animals of the day such as Stegosaurus, Triceratops and the mighty Tyrannosaurus Rex. The lake was surrounded by fine-grained sands and muds which are excellent for preserving footprints. The hot, dry climate also helped in preservation by drying the prints out before the action of the water destroyed them. These footprints can tell us a great deal about the animals that made them.

Map 1



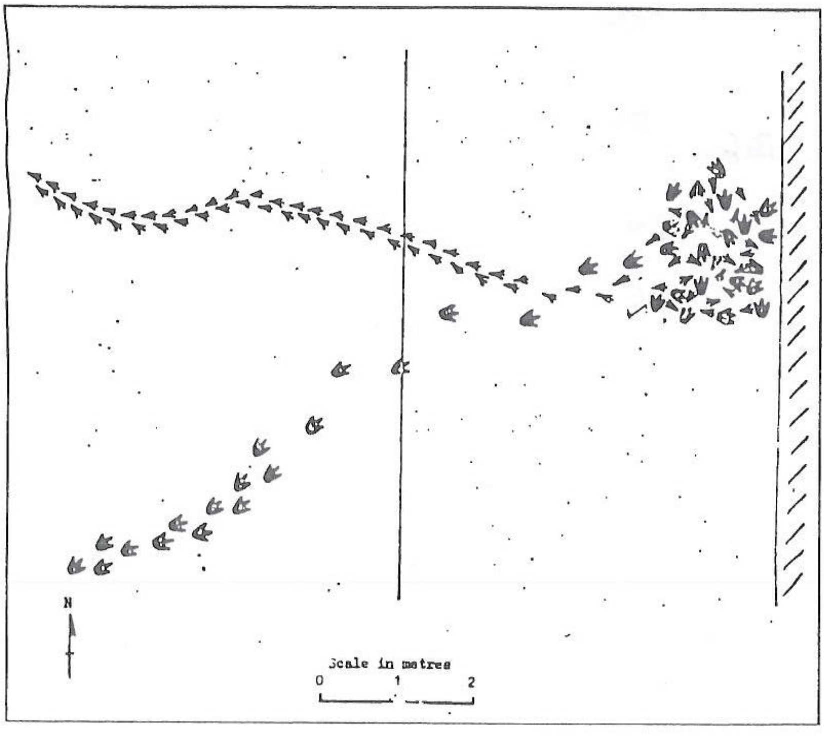
Study Map 1.

1. What could the footprints tell us about the dinosaurs themselves? E.g. type, number, size

2. Think of theories which could explain the pattern of footprints leading up to the quarry wall

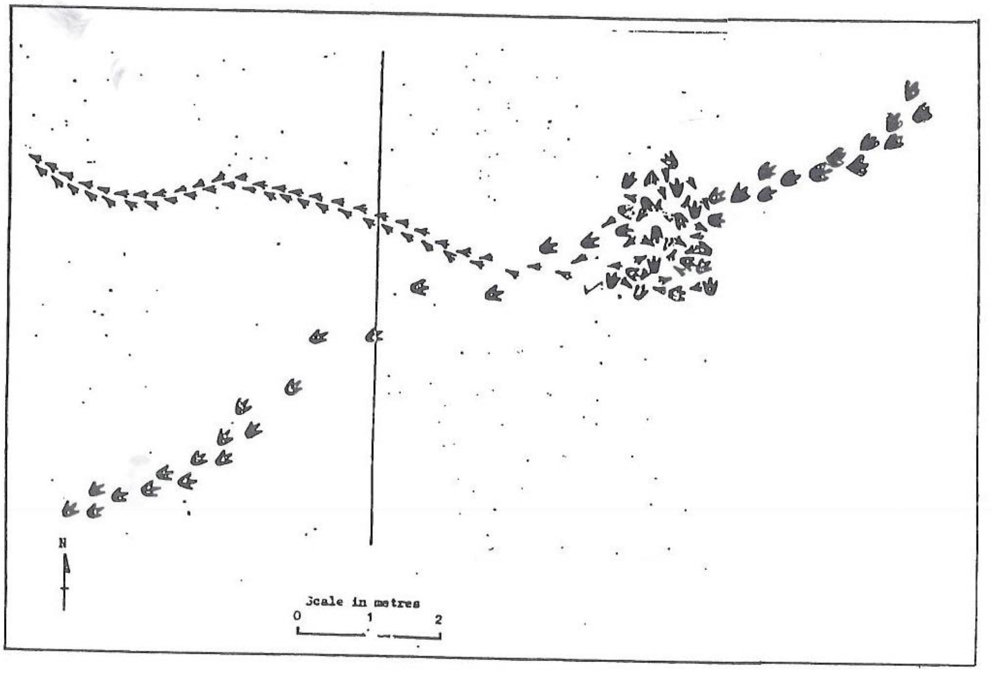
3. What evidence would you expect to find when the quarry wall moves back to support your theory?

Map 2



Now the quarry has moved back, have you changed your previous answers?

Map 3



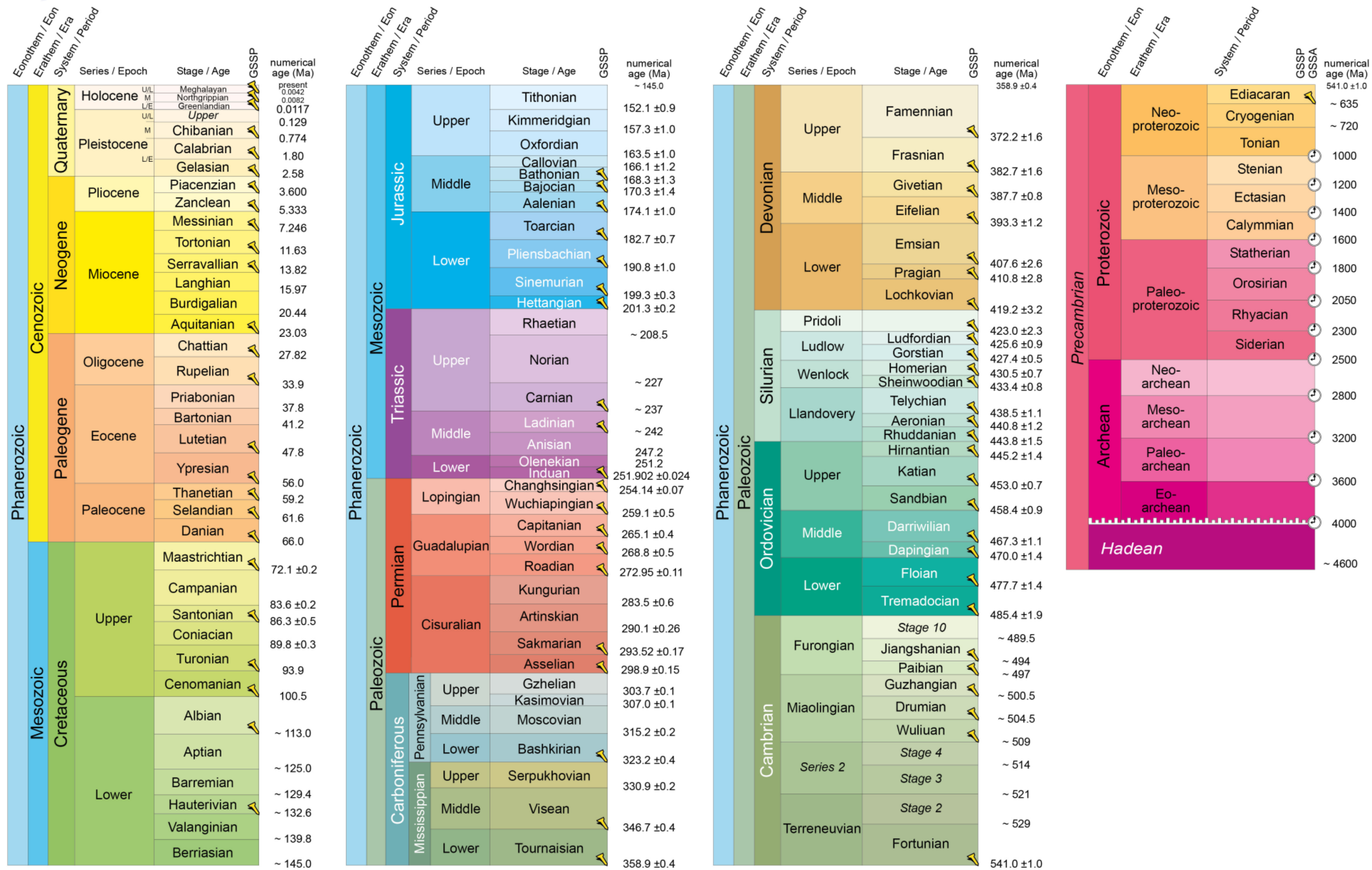
The quarry wall has been moved back by a further 5 metres exposing more of the fossil tracks.

Were you right? Say which of your theories best fits the latest evidence. Does this evidence change your ideas of why each dinosaur was on the mud flat? If so, how?

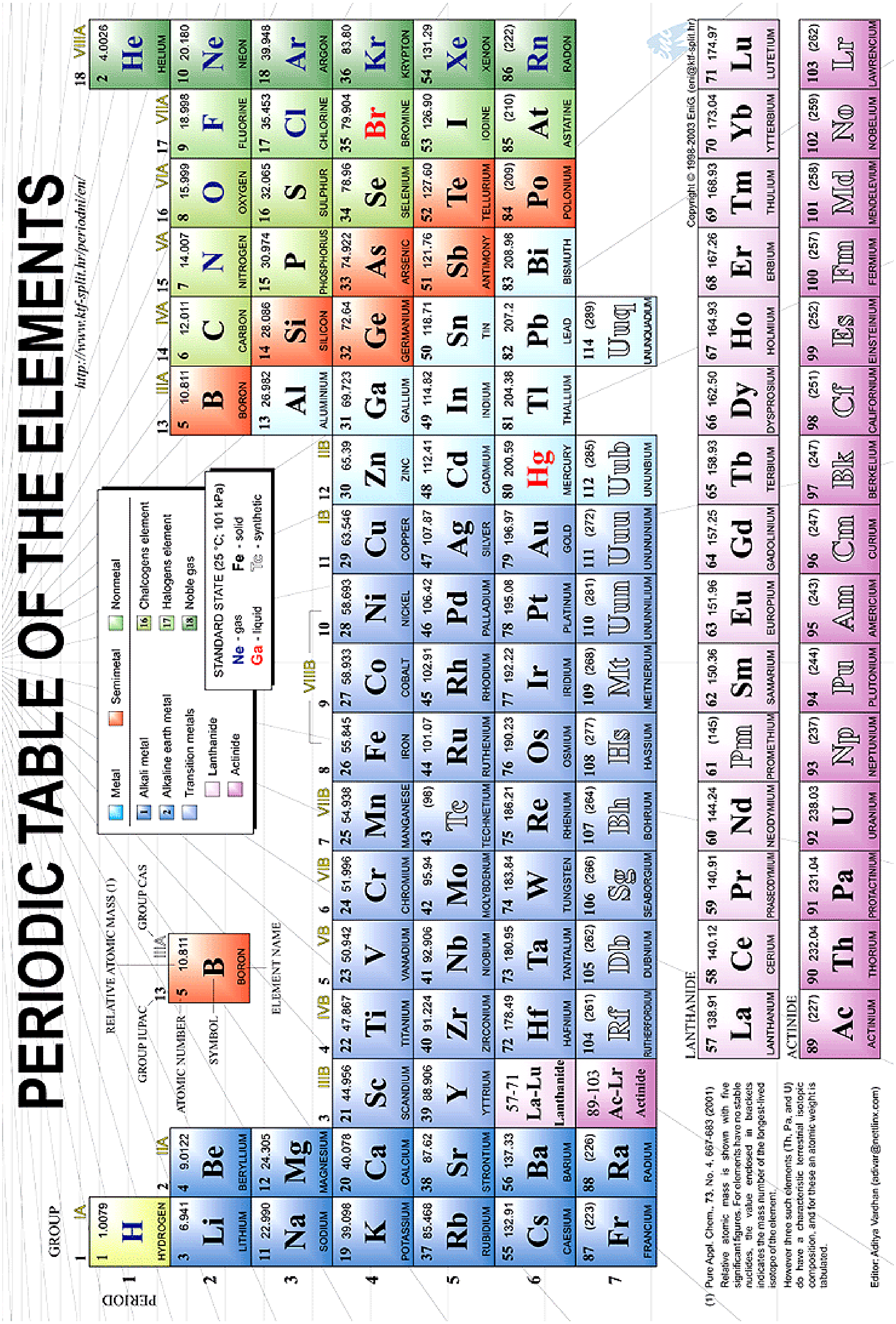
Appendix

INTERNATIONAL CHRONOSTRATIGRAPHIC CHART

www.stratigraphy.org International Commission on Stratigraphy v 2020/01



Appendix



PERIODIC TABLE OF THE ELEMENTS
http://www.ktf-split.hr/periodni/en/
GROUP
PERIOD
1 IA
2 IIA
3 IIIB
4 IVB
5 VB
6 VIB
7 VIIB
8
9
10
VIIIB
11 IB
12 IIB
13 IIIA
14 IVA
15 VA
16 VIA
17 VIIA
18 VIIIA
RELATIVE ATOMIC MASS (1)
GROUP IUPAC
GROUP CAS
ATOMIC NUMBER
SYMBOL
ELEMENT NAME
13 IIIA 5 10.811 B BORON
Metal
Semimetal
Nonmetal
1 Alkali metal
2 Alkaline earth metal
Transition metals
Lanthanide
Actinide
16 Chalcogens element
17 Halogens element
18 Noble gas
STANDARD STATE (25 °C; 101 kPa)
Ne - gas
Ga - liquid
Fe - solid
Tc - synthetic
1 1.0079 H HYDROGEN
2 4.0026 He HELIUM
3 6.941 Li LITHIUM
4 9.0122 Be BERYLLIUM
5 10.811 B BORON
6 12.011 C CARBON
7 14.007 N NITROGEN
8 15.999 O OXYGEN
9 18.998 F FLUORINE
10 20.180 Ne NEON
11 22.990 Na SODIUM
12 24.305 Mg MAGNESIUM
13 26.982 Al ALUMINIUM
14 28.086 Si SILICON
15 30.974 P PHOSPHORUS
16 32.065 S SULPHUR
17 35.453 Cl CHLORINE
18 39.948 Ar ARGON
19 39.098 K POTASSIUM
20 40.078 Ca CALCIUM
21 44.956 Sc SCANDIUM
22 47.867 Ti TITANIUM
23 50.942 V VANADIUM
24 51.996 Cr CHROMIUM
25 54.938 Mn MANGANESE
26 55.845 Fe IRON
27 58.933 Co COBALT
28 58.693 Ni NICKEL
29 63.546 Cu COPPER
30 65.39 Zn ZINC
31 69.723 Ga GALLIUM
32 72.64 Ge GERMANIUM
33 74.922 As ARSENIC
34 78.96 Se SELENIUM
35 79.904 Br BROMINE
36 83.80 Kr KRYPTON
37 85.468 Rb RUBIDIUM
38 87.62 Sr STRONTIUM
39 88.906 Y YTTRIUM
40 91.224 Zr ZIRCONIUM
41 92.906 Nb NIOBIUM
42 95.94 Mo MOLYBDENUM
43 (98) Tc TECHNETIUM
44 101.07 Ru RUTHENIUM
45 102.91 Rh RHODIUM
46 106.42 Pd PALLADIUM
47 107.87 Ag SILVER
48 112.41 Cd CADMIUM
49 114.82 In INDIUM
50 118.71 Sn TIN
51 121.76 Sb ANTIMONY
52 127.60 Te TELLURIUM
53 126.90 I IODINE
54 131.29 Xe XENON
55 132.91 Cs CAESIUM
56 137.33 Ba BARIUM
57-71 La-Lu Lanthanide
72 178.49 Hf HAFNIUM
73 180.95 Ta TANTALUM
74 183.84 W TUNGSTEN
75 186.21 Re RHENIUM
76 190.23 Os OSMIUM
77 192.22 Ir IRIDIUM
78 195.08 Pt PLATINUM
79 196.97 Au GOLD
80 200.59 Hg MERCURY
81 204.38 Tl THALLIUM
82 207.2 Pb LEAD
83 208.98 Bi BISMUTH
84 (209) Po POLONIUM
85 (210) At ASTATINE
86 (222) Rn RADON
87 (223) Fr FRANCIUM
88 (226) Ra RADIUM
89-103 Ac-Lr Actinide
104 (261) Rf RUTHERFORDIUM
105 (262) Db DUBNIUM
106 (266) Sg SEABORGIUM
107 (264) Bh BOHRIUM
108 (277) Hs HASSIUM
109 (268) Mt MEITNERIUM
110 (281) Uun UNUNNILIUM
111 (272) Uuu UNUNUNIUM
112 (285) Uub UNUNBIUM
114 (289) Uuq UNUNQUADIUM
LANTHANIDE
57 138.91 La LANTHANUM
58 140.12 Ce CERIUM
59 140.91 Pr PRASEODYMIUM
60 144.24 Nd NEODYMIUM
61 (145) Pm PROMETHIUM
62 150.36 Sm SAMARIUM
63 151.96 Eu EUROPIUM
64 157.25 Gd GADOLINIUM
65 158.93 Tb TERBIUM
66 162.50 Dy DYSPROSIUM
67 164.93 Ho HOLMIUM
68 167.26 Er ERBIUM
69 168.93 Tm THULIUM
70 173.04 Yb YTTERBIUM
71 174.97 Lu LUTETIUM
ACTINIDE
89 (227) Ac ACTINIUM
90 232.04 Th THORIUM
91 231.04 Pa PROTACTINIUM
92 238.03 U URANIUM
93 (237) Np NEPTUNIUM
94 (244) Pu PLUTONIUM
95 (243) Am AMERICIUM
96 (247) Cm CURIUM
97 (247) Bk BERKELIUM
98 (251) Cf CALIFORNIUM
99 (252) Es EINSTEINIUM
100 (257) Fm FERMIUM
101 (258) Md MENDELEVIUM
102 (259) No NOBELIUM
103 (262) Lr LAWRENCIUM
(1) Pure Appl. Chem., 73, No. 4, 667-683 (2001)
Relative atomic mass is shown with five significant figures. For elements have no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element.
However three such elements (Th, Pa, and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.
Editor: Aditya Vardhan (adivar@netlinx.com)
Copyright © 1998-2003 EniG. (eni@ktf-split.hr)