A Level Geology Induction Tasks

Topic: Geological Principles

Resources:

- How to Take Notes Using the Cornell Method
- How to Read for Understanding
- Geological Principles Notes
- A Brief History of Geological Time
- Geological Principles Cornell Notes Booklet
- Blank Summary Sheet on Geological Principles
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Strongly advised optional extension task

- Men of Rock - Deep Time Worksheet

Complete the following tasks ready for the start of term.

Read the short article on how to read for understanding (see links above).

1. Read the notes on Geological Principles.
2. Read the short article on how to take notes using the Cornell method.
3. Take notes in the Geological Principles booklet.
4. Complete the three review questions at the end of the booklet.

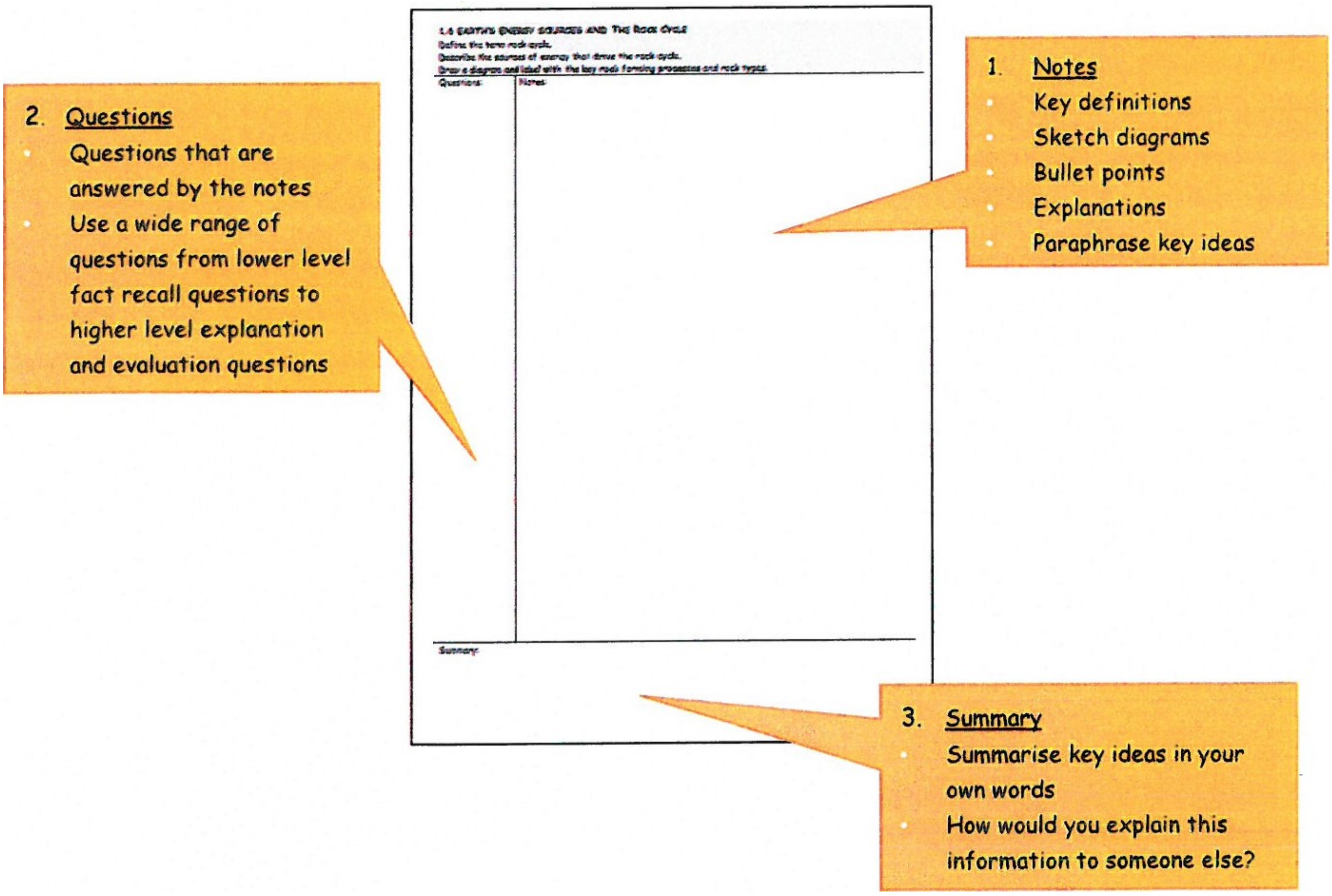
Learning: Review the material, especially the summary sheet at the end of the booklet, periodically over the summer holidays to fix the information in your long-term memory. A good way of doing this is to print off copies of the blank summary sheet and try to fill it out from memory. Check your answers using your completed booklet and the printed notes.

Assessment: There will be a short initial assessment in the first week of term to see if you have understood this topic, and to assess your academic study skills.

Note Taking Using the Cornell Method

The Cornell system of note taking can help organise your notes, actively involve you in the creation of knowledge, improve your study skills, and leod to academic success at A-level. As you can see from the example below, the note paper has been split up into three separate sections. The large space to the right of the wide margin and above the summary area is the record column where you write your notes. After reading a section of a textbook or an article, record the key information you have highlighted or underlined in the text in this section. Include definitions, sketches, lists and key explanations. The recall column and summary area should remain empty as you write your notes.

After you have recorded all the information for this section, use the recall column to write down the key questions that these notes answer. Use a variety of questions, including low level factual recall questions, as well as higher order questions that get you to explain or even evaluate. These questions will deepen your learning of the material. You can also use the topic/paragraph headings from your reading to make questions up. Later, when you come revise, you can test your retention of the topic by covering over the notes in the record column and try to answer the questions you have written in the recall column.



Lastly, the summary area should be used to -condense a section of notes down to one or two sentences to summarise each topic. They should be written in your own words and not copied from the textbook or article! Each section should have its own summary and should be done after you have completed the other two columns.

Making notes in this way before the lesson will improve your understanding of the topic and mean the lesson can be used to dig deeper into the topic and apply your knowledge. Lessons should be a two way process: an opportunity to grill your teacher on their understanding of the subject by asking more probing questions that can only be done by reading; and time for your teacher to give you help and support to push your understanding to the next level.

Reading for Understanding

By reading for understanding we mean "serious" reading rather than "casual" reading for pleasure. To start at point A and go through to point Z is obviously the best way to read a good thriller or novel, but the reading you will have to do as part of your A level course is more intensive and more complex. It is material that you have to absorb deeply, and learn. Tn those circumstances, to rely solely on that "A to Z" method is rarely effective, chiefly because if a course textbook is worth reading it's worth reading at least twice, and probably a lot more. In fact, on any first reading, your chances of digesting more than 40% ore slim, regardless of the amount of time you spend on it.

Often when we read a difficult book or article, we all too easily lose concentration and end up reading the words without taking in any of the information - perhaps you are doing it right now! However, the good news is that it is the system of reading that is ot fault, and not the brain of the reader.

The three point system outlined below is o strategy tailor-made for actively mastering academic textbooks and articles incorporating the skills of skimming, active reading and questioning. Tt is a system which at its most successful enables you to read a section of text six times more efficiently and actually quicker than one A to Z reading.

1. Skimming

Skim read the section or topic area of the book or article using the following ideas.

Read the headings, subheadings and ony chapter titles.
Read the introduction, the conclusion, and any interim summaries there may be. Read and look at any graphs, illustrations, diagrams and tables.

This will take five minutes at most, and provide an immediate sense of the overall shape and focus of the material to be read. The text is no longer alien to you. Having spent five minutes doing this you ore now ready to dig deeper.

Read the first and lost sentences of each paragraph.

You con get a rough idea of what a piece is about, at considerable speed, by skimming quickly through the first and last sentences or so of every paragraph. If the writer of your textbook has any idea of what they are doing, you will see that a paragraph follows a logical, even predictable, pattern. A paragraph is an essay in miniature: it introduces a topic, explores it, and then draws a conclusion. So, one can assume that if one reads the beginning and end of such o paragraph, it should be possible to make at least an educated guess at the content and direction of the material in between. If you concentrate hard, and are not tempted to scan anything but those first and last sentences, your mind will automatically be drawing inferences and filling in the gaps for itself. So you can move from paragraph to paragraph at high speed, while your brain estimates the likely nature of what you ore missing out. Obviously at this stage in your reading, you are only getting to know the material, not mastering it.

2. Active reading

You should now have a strong sense of what you are about to read. This not only means that you will cover the ground much faster: it also means that the various points and ideas will register much more definitely. Furthermore, there is an important by-product: you will enjoy the "full read" much more. Your confidence will be higher because you know what the stuff is about, and you will also find it pleasant to have a dialogue with the text rather than have to plough submissively through it.

At this stage you are reading to learn, and in order to learn you need to follow exactly what the text is saying. So now you should slow right down, taking it bit by bit and read in a "normal" A to Z fashion. However, to really make sense of what you are reading, you need to read actively.

Underline or highlight the key points and terms.

One method that can help is to underline or highlight important words. Personally, underlining using a ruler and pencil is my preferred method as any mistakes can be rubbed out, unlike a highlighter pen which is definitely not mistake tolerant. Underlining is also more flexible than highlighting. You can accurately target specific words, double or treble underline, put an asterisk in the margin to emphasise an important point, put numbers against points, or write brief notes. Whichever way you chose try not to mark too many words; pick out just enough, so that you still get the main points if you read only the words underlined or highlighted. If you make too many markings, you defeat the purpose: nothing stands out. The trick is to underline or highlight sparingly. See how few words you can mark and still be able to find the markings helpful. Aim to pick out key words, not whole sentences; don't worry about capturing everything. You can always go back to the textbook again.

Write the topic area each paragraph covers in the margin of your textbook or article.

It is easy with underlining and highlighting to find that you have switched to autopilot without noticing. The process can become too passive. On reaching the end of a paragraph it is good practice to decide what the main point was and either double-underline those words or better still write a brief note in the margin of the book naming the topic that each paragraph covers. So, these methods of underling and highlighting words as you read are powerful study techniques. They focus your attention on the text, they force you to think about what the key points are, and it leaves a record on the page of the meaning you found in the words as you read them. When you go back to a marked text to write up your notes into a neat format, you can quickly tune in to those earlier thoughts - especially if you have written comments in the margin.

Sometimes as you read you will get stuck. When this happens, don't give up or sit staring at the page; find a way to tackle the problem.

Look up unfamiliar words in a dictionary.
Re-read a sentence a number of times, breaking it down into smaller chunks.
Draw a sketch diagram or concept map to work out what the text is trying to explain.
Visualise images in your head.
Look for examples in the text that help illustrate the meaning.

3. Review & Questioning

This stage is a kind of "mopping-up operation". The first two stages outlined above should ensure an impressive rate of absorption, but there will be gaps, especially if this is the first session you have had on the material. Now you should read it through again (A-Z style), actively looking for anything you've missed or remain unsure about. Questioning what you read is another way to keep your mind active while you are reading. Questions are what make reading interesting and challenging. They help you to engage with what you are reading about. You need to ask questions such as:

What is this telling me?
How does it fit with what I already know?
Could I now explain it to somebody else?
Can I now summarise the text in my own words?
Reading is the core study skill. The purpose of it is to enable you to learn. But learning is not a passive process; don't just let the words wash over you. You have to make sense of them as you read and then use them to think.

GEOLOGICAL PRINCIPLES NOTES

Geology is the study of the Earth ("geo" is the Greek word for Earth) and a geologist is a scientist who studies the Earth. Not only do geologists address practical problems such as how to keep pollution out of groundwater, how to find oil and minerals, and how to avoid landslides, but they also address academic questions such as the causes of earthquakes and volcanoes, the evolution of life, and the formation of the Earth. Perhaps one of the most important aspects of geology has been to determine the age of the Earth.

The Earth is very old. Geological data indicate that the Earth formed 4.6 billion years ago and the span of time since its formation is known as geological time. To define such vast intervals of time, in the order of billions of years, geologists developed the geological column. The geological column depicts the major subdivisions of geological time. The largest subdivisions break Earth history into two eons, the Phanerozoic (from Greek phaneros 'visible, evident' + zoic 'life') and the Cryptozoic (from Greek kruptos 'hidden' + zoic 'life'). The Phanerozoic Eon is further subdivided into eras. In order from oldest to youngest, they are the Palaeozoic (old life), Mesozoic (middle life), and the Cenozoic (recent life). These eras are further divided into periods. The names of the geological periods refer to the localities where rocks representing that time interval were first identified (for example, rocks representing the Devonian period are found in Devon, UK) or to a characteristic of the time (rocks from the Carboniferous period contain a lot of coal, which is pure carbon). This geological column (see below) was initially worked out correlating layers of rock from around the world and determining their relative ages (i.e. which layer was older or younger than another layer) using key geological principles.

Geological Column

Eon	Era	Period	
Phanerozoic (*visible life*)	Cenozoic (*new life*)	Quaternary	0 Ma
		Tertiary	
	Mesozoic (*middle life*)	Cretaceous	65 Ma
		Jurassic	
		Triassic	
	Palaeozoic (*old life*)	Permian	250 Ma
		Carboniferous	
		Devonian	
		Silurian	
		Ordovician	
		Cambrian	
Cryptozoic (*hidden life*)		Pre-Cambrian	542 Ma
			4.6 Ga

Note: Ka = thousand years Ma : million years Ga : billion years. (Table NOT to scale).

James Hutton, a Scottish gentleman farmer and doctor, often referred to as the "father of modern geology" was the first person to write about these geological principles. While wandering in the highlands of Scotland, he noted that many features (such as ripple marks) found in sedimentary rocks resembled features he could see forming today in modern depositional environments. Based on such observations, Hutton developed the idea of uniformitarianism, and published it in a 1785 book called The Theory of the Earth.

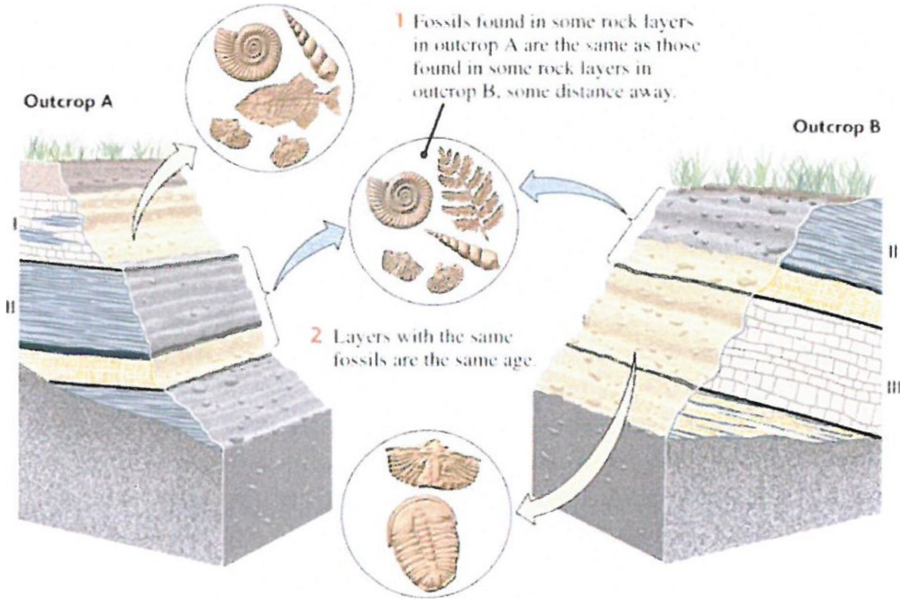
The principle of uniformitarianism states that physical processes we observe today also operated in the past at roughly the same rates, and that these processes were responsible for the formation of geological features that we now see today on the Earth's surface. More concisely, the principle can be stated as: the present is the key to the past. Hutton deduced that the development of individual geological features took a long time, and that not all features formed at the same time, so the Earth must have a history that includes a succession of slow events. Since no one in recorded history has seen the entire process of sediment first turning into rock and then later into mountains, Hutton also deduced that there must have been a long time before human history, and that the Earth was very old. This principle can also be applied to fossils as well. For example, corals only live in warm, shallow tropical seas today, so if we find fossil corals in ancient rocks we assume they also lived in these conditions.

Building from the work of Hutton and others, the British geologist Charles Lyell formally laid out a set of these geological principles in the first modern textbook of geology (Principles of Geology, published in 1830). These principles continue to provide the basic framework within which geologists determine the relative ages of rock layers and geological events.

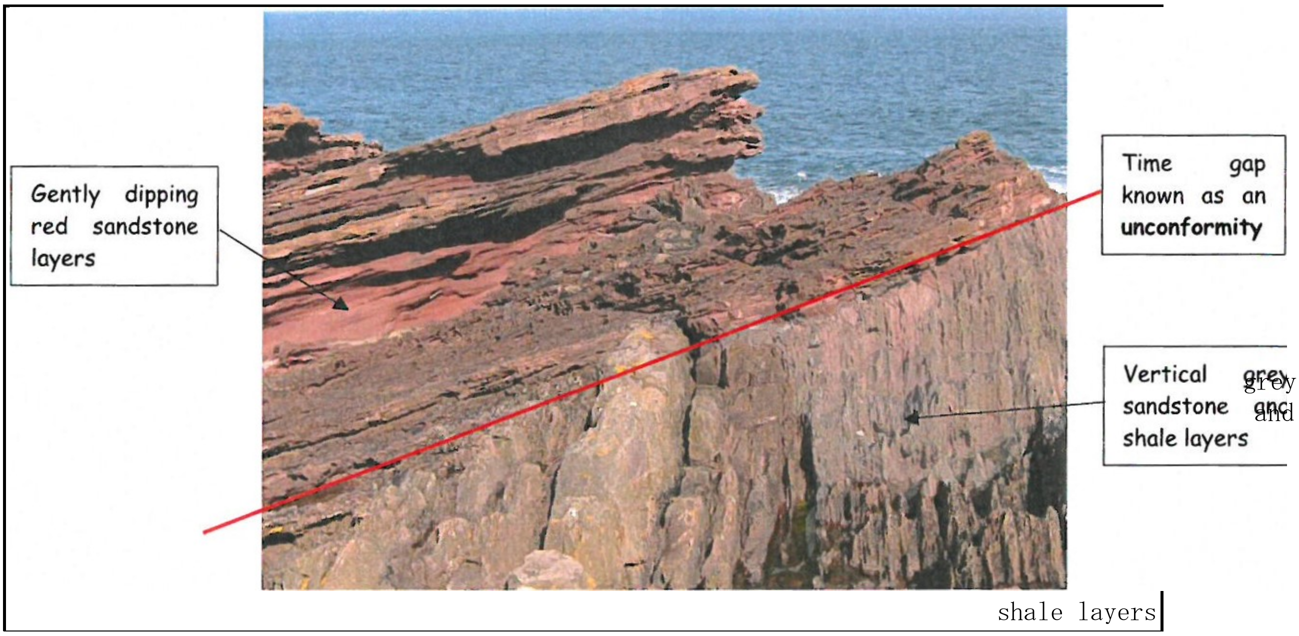
The principle of original horizontality states that sediments are nearly always deposited in horizontal beds and so if we find a sequence of sedimentary rock layers that is folded or tilted, we know that the rocks were deformed by tectonic stresses <u>after</u> the sediments were deposited. The principle of superposition states that each layer of sedimentary rock is <u>younger</u> than the one beneath it and older than the one above it. Geological common sense tells us that a younger layer cannot slip beneath a layer that has already been deposited. However, younger sediments can be found beneath older ones if the rocks have been overturned due to tectonic activity. The correct "way up" of sedimentary rocks is checked by using sedimentary structures such as cross bedding, graded bedding, sole structures, desiccation cracks and ripple marks. The law of cross-cutting relationships states that the rock or structure doing the cutting is always <u>younger</u> than the rock or structure it is cutting through. Obvious examples are dykes, faults and unconformities. The law of included fragments states that the fragments or rocks included inside another are always <u>older</u>. Two examples illustrate this: if a layer of sediment deposited on an igneous layer includes pebbles of the igneous rock, then the sedimentary layer must be younger; if an igneous rock (which was once liquid) contains fragments of another rock, the fragments must be older than the igneous rock. In both cases the included fragment must be older.

During Britain's industrial revolution (late 1780s) the government decided to build a network of canals to transport coal and iron, and hired an engineer named William Smith to survey the excavations. Smith, who had worked as a surveyor in a number of coal mines as well, noticed that the rocks were arranged in a predictable pattern and that the various layers of rock (which he termed strata) could always be found in the same relative positions. Additionally, each particular stratum (singular for strata) could be identified by the fossils it contained, and the same succession of fossil groups from older to younger rocks could be found in many parts of England. He also realised that a particular group of fossils could be found only in a limited interval of strata, and not above or below this interval. Thus, once a fossil species disappears at a particular layer, it never reappears higher in the sequence. All these observations led to the principle of faunal succession which uses fossils to date the relative ages of sedimentary rocks.

To see how this principle works, examine the diagram on the next page, which shows two outcrops of rock some distance away from each other. In the top two layers of Outcrop A some of the fossils can be found in both layers which shows they formed soon after each other. Outcrop B does not have the same top layer as Outcrop A, but because its top layer has the same fossils in it as the second layer at Outcrop A we can assume they were formed at the same time. And because the base layer at Outcrop B has similar, but not the same, fossils as the layer above we can assume this layer was formed just before the middle layer. Putting all this together enabled Smith to work out the relative ages of the rocks in many areas of Britain and led to the production of the first geological map of Great Britain in 1815. Interestingly, Smith's work provided the geological underpinning for the theory of evolution.



In 1788, at about the same time Smith was working on the canals in England, James Hutton was boating along the coast of Scotland and became puzzled by an outcrop along the shore at Siccar Point. Here he found gently dipping layers of red sandstone lying on top of vertical layers of grey sandstone and shale.



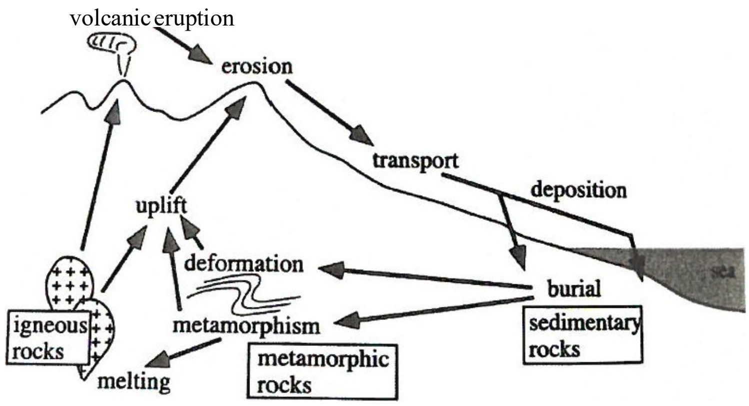
With the principle of uniformitarianism in mind, Hutton suddenly realised the significance of what he saw. The grey sandstone and shale layers had been originally deposited horizontally, turned into rock, tilted vertically, and eroded before the red sandstone layers had been deposited on top. Hutton deduced that the surface between the grey and red rock layers represented a time interval during which new strata had not been deposited at Siccar Point and the older strata had been eroded away. We now call such a surface, representing gaps in geological time, an unconformity, because the top layers do not conform to the bottom layers. Unconformities help geologists order sequences of rocks, but like other relative dating principles, they do not give an absolute or numerical age. To do this we had to wait for the discovery of radioactivity.

Simply put, radioactive elements decay at a constant rate that can be measured in the lab and can be specified in years. In 1911, the geologist Arthur Holmes first developed a technique for using measurements of radioactive elements to calculate the ages of rocks. This is known as radiometric dating. Certain elements, such as uranium and potassium (both found in minerals in igneous rocks) and carbon (found in organic material), have different versions of the element known as isotopes. Some of these isotopes are unstable and as soon as they form undergo a change called radioactive decay, which converts them into a different, more stable element. The time it takes for half the original unstable (parent) atoms to decay into a new stable (daughter) atom has been investigated in the laboratory, and because this is a constant, geologists can calculate the age of a mineral by measuring the ratio of parent to daughter isotopes in the mineral. Although from the 1950s onwards, geologists have searched the world for localities to date igneous rocks so that numerical ages could be put onto the geological column and date the key events in Earth history, the geological processes that formed them were still not understood.

In the 1960s, a scientific revolution in geology yielded a grand unifying theory, known as plate tectonic theory, which is the foundation for understanding most geological processes on Earth. The outer layer of the Earth (the lithosphere) consists of separate pieces (lithospheric plates), that move with respect to each other. Plate movement occurs at rates of about 1 to 15cm per year. As a plate moves, its internal area remains mostly rigid and intact. But rock along plate boundaries undergoes intense deformation (cracking, sliding, bending, stretching and squashing) as the plate grinds or scrapes its neighbours or pulls away from its neighbours. There are three types of plate boundary, constructive boundaries (where two plates move away from each other), destructive plate boundaries (where two or more plates move towards each other), and conservative boundaries (where two plates move side by side of each other). However, in order for plate tectonics to function it requires a major source of energy in which to power it.

The geological processes that shape the Earth's surface are powered by two major sources of energy; geothermal heat from the Earth's interior and external energy from the sun. The Earth's internal heat is the ultimate source of energy for virtually all tectonic and mantle processes. It is these processes that form igneous and metamorphic rocks. Igneous rocks are those that were once molten; they usually contain crystals that grew within this molten material as it cooled. Metamorphic rocks form when heat or pressure (or both) causes preexisting rock to recrystallize, but without melting. The sun's energy drives the water cycle, and controls weathering, erosion, transportation and deposition, forming sedimentary rocks. Igneous, sedimentary and metamorphic rocks are linked together through the rock cycle.

The rock cycle, depicted in the diagram below, is the progressive transformation of Earth materials from one rock type to another by key rock forming processes such as weathering, erosion, transportation, deposition, lithification, metamorphism, partial melting and crystallisation. Rocks on high ground are broken down into smaller pieces by weathering, and are then transported downhill by rivers and glaciers to a place where they get deposited and buried. This is the erosional and depositional part of the rock cycle. If these processes were the sole agents of change, the ultimate fate of the Earth's surface would be for hills and mountains to be worn away, until eventually everywhere was flat and buried mud. However, the Earth is a dynamic planet and there are forces of deformation and uplift at work that continually bring igneous and metamorphic rocks, and hardened sediment, to the surface. This provides an unending supply of material to be worked on by the forces of erosion, and so the rock cycle continues.



The Rock Cycle

Men of Rock – Deep Time Worksheet: Strongly Advised Optional Extension Task

Watch the video https://www.youtube.com/watch?v=FYfuI2uZLmg and answer the questions below

1. Scottish geologist known as the 'Founding Father of Geology'

2. Age of the Earth given in the bible in the 18th century

3. Evidence Hutton found to show that his farmland was being eroded away

4. Why was Hutton worried about the constant loss of topsoil from his fields?

5. Evidence Hutton found to indicate the Earth could renew or recycle material to form new land

6. How did James Watt help Hutton develop his 'Theory of the Earth'?

7. How did Hutton prove that some rocks originated from a molten state?

8. Two ways Hutton suggested that land could be created.

9. Why did Hutton's 'Theory of the Earth' bomb when he presented it in 1785?

10. Why did the origin of granite create such controversy in the late 18th century?

11. Evidence Hutton used to prove a molten origin for granite at Glen Tilt

12. Describe the evidence Hutton found at Siccar Point to prove the Earth was millions rather than just thousands of years old.

13. Draw a simple sketch to show the relationship between the two rock types at Siccar Point. Label the unconformity.

14. How old are the two rocks at Siccar Point and what is the time gap or unconformity that separates them?

15. Complete the famous phrase coined by Hutton to summarise his views on the age of the Earth.

No ………………… of a beginning, no ……………………… of an end.

16. Hutton's discovery of the concept of 'Deep Time' is considered just as important as which two other scientific discoveries at this time?

17. How did Lord Kelvin try to calculate an actual age for the Earth?

18. What age did Lord Kelvin give for the formation of the Earth?

19. Why was Kelvin's age for the Earth too young? What later discovery would allow an accurate age for the Earth to be determined?

20. Name the oldest rocks in the UK, giving their age and the radiometric dating method used to date them.

21. Name the mineral that is used to date the rocks in Scotland and describe its properties-you'll need to look this last bit up on the internet

22. What is the significance of this mineral and the remote settlement of Jack Hills, 800km from Perth in Australia – internet needed again!

A Brief History of Geological Time

Watch the video https://www.youtube.com/watch?v=rWp5ZpJAIAE and answer the questions below.

1) Which method did William Smith devise in 1819 in order to date rocks?
2) Are trilobites generally found in rocks which are older or younger than the rocks in which ammonites are found?
3) What are the 5 divisions of the geological timescale? (clue – E, E, P, E, A)
4) What are the largest units of Geological time? How long can they last?
5) Why is the oldest geological Era called the Hadean?
6) When was the Archaen and what does the name mean?
7) What are stromatolites?
8) What does Proterozoic mean?
9) What are eukaryotes and why was their evolution significant?
10) Which eon began 541 million years ago and what does its name mean?

11) When was the Palaeozoic era?

12) What was the Cambrian explosion?

13) Which significant index fossils evolved during the Cambrian and were incredibly widespread?

14) Which organisms evolved first, fish or amphibians?

15) When did Pangaea form?

16) What happened 252 million years ago? Why was it significant?

17) What are the potential causes of this event?

18) Which era is sometimes known as the “Age of Reptiles”?

19) When did K-T or K-Pg mass extinction event and what was its likely cause?

20) Which element provides evidence for this cause in the rock record?

21) What is the name given to the current era in which we live?

22) What happened approximately 34 million years ago?

23) What happened 2.6 million years ago?

24) Around 15,000 years ago the planet began to warm again – give 3 examples of ice age megafauna (large animals) which became extinct.