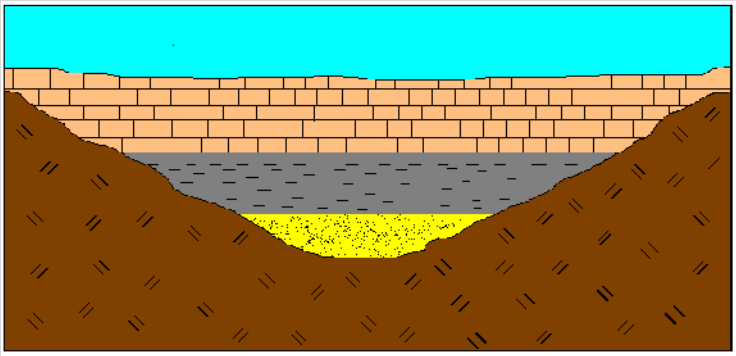
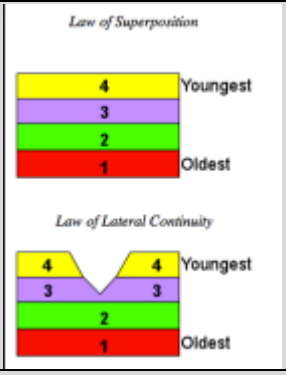
RELATIVE DATING

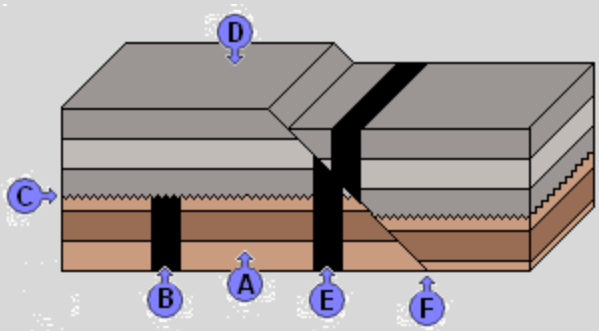
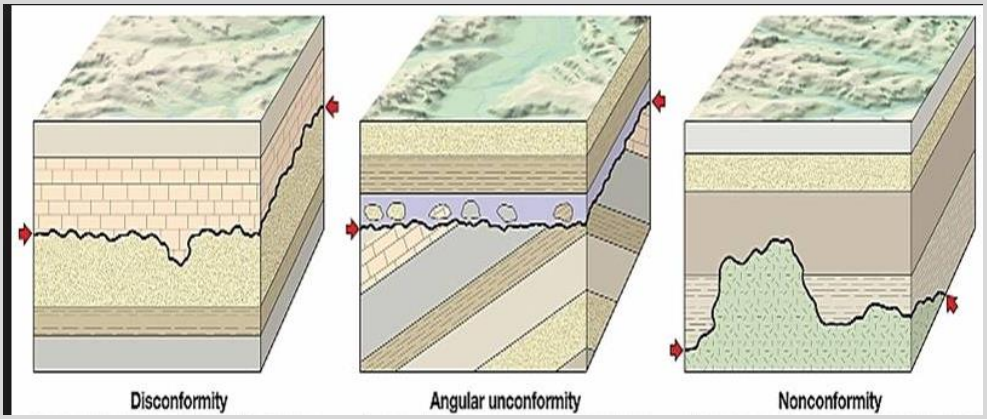
STRATIGRAPHIC METHODS

- **Fossil assemblage** is a collection of fossils found together in the same rock (environment). These may be a life or death assemblage.
- **Zone fossil** is a fossil that can be used to date rocks as they are restricted to a specific time zone. These organisms evolved quickly.
- **Stratigraphy** is the study of strata/layers of rock with respect to their order, relative position and their relationship to the geological timescale.

There are five main types of relative dating which are sometimes referred to as laws:

Law number	Law name	Principle
1	**Original horizontality**	Layers of sediment were **originally deposited horizontally** under the action of **gravity** (commonly in **shallow seas**). Moreover, clasts carried by a river are commonly deposited on the river bed with breaks in deposition represented as bedding planes. It is therefore assumed that **if layers of rock are tilted**, **they have moved** from this original horizontal position. *There are some exceptions to the rules such as fault breccia and uranium precipitates that occur in role/lobe shapes.*  Original Horizontal Strata
2	**Principle of superposition**	In any **undisturbed sequence** of rocks the **youngest layer is found** at the **top** and was the most recent to be deposited and the **oldest at the bottom**. Each layer is younger than the layer it is deposited on below but older than any above. This assumes rock sequences have **not been titled** upside down. 
3	**Way-up criteria**	Some structures can only form one way up and so represent the palaeo-orientation of the strata. Such examples include: 1. **Desiccation cracks** – which dry up with cracks tapering towards the older strata and a wider top surface. 2. **Graded bedding** – provided it is upward fining, large particles will sink to the bottom first, followed by lighter sediment above. Pyroclastic material can also be deposited in grades with blocks and bombs forming agglomerates before the fine ash is deposited last to form tuff.

		3. **Rootlets**, always grow downward and protrude out into the soil. They are commonly below a coal seam in the topsets of a deltaic deposit. 4. **Cross bedding**, these can be truncated at their upper (younger) surface and asymptotic on their lower (older) surface. They are concave upwards with an angle of repose @ ~ 37^0 5. Ripple marks have crests which point upwards. 6. **Flute casts,** is a depression found on the bottom of a bed caused by a turbulent flow that erodes downward. The cavity is infilled with sediment from above. 7. Pillow lavas – these expand upwards forming a bulbous head but they sink with a saggy bottom end that tapers downward. Vesicles may also be present on their upper surface. 8. Baked and chilled margins. Baked margins form on country rocks which are older than the intrusion. A sedimentary layer above an intrusion showing no baked margin must be younger and deposited after the intrusion cooled. 9. A laver flow may be weathered and oxidised on its upper surface and have a higher proportion of vesicles near the surface. Indicating which way is up and so is younger. 10. Intrusions that show magmatic differentiation will have a dense, ultramafic cumulate layer rich in metals and darker ferromagnesian minerals on the lower base. This formed due to gravity settling, indicating the lower side. 11. **Fossils** can sometimes be found **in life position** and so indicate the way up. 
4	**Included fragments**	Fragments eroded from a younger rock can be included within a younger rock. The fragments have to be older than the rock they are matrixed in: 1. Xenoliths found in igneous rocks have to be older than the intrusion as they are fragments of the country rock that fell into the magma during stopping (but assimilation did not melt these). 2. Derived fossils are older than the beds they are found in since they have been eroded from a previous rock matrix and redeposited in a younger sedimentary rock. 3. Pebbles found in a conglomerate are older rocks that have been eroded and then redeposited. 

5	**Cross-cutting relationships**	Any feature that cuts through another feature or rock must be the younger than what they cut. An example could be a fault that cuts through a fold or unconformity. The layers and features that it cuts across and displaces must be older as they had to already be present for it to cut through. Similarly, a dyke intrudes into features and rock layers already present/older than it. 
Extra	**Unconformities**	Unconformities represent a break in deposition and erosion of the succession. They are a gap in the geological record during which there may be time to fold and erode older rocks before the deposition of new layers begins again. There is often a dip in the oldest beds, meaning that rocks of various ages are in contact with the younger beds above. When there is no change in dip across the unconformity, the plane of unconformity may be recognised by the erosion, rootlets or missing parts of the fossil record. Basal conglomerate may also form in the plane of unconformity. 

FOSSILS AND RELATIVE DATING

For fossils to be a reliable tool in identifying relative ages, it is important that they **evolved rapidly**, showing **obvious preserved changes** (they are called **zone fossils**).

Ideally, they should be **widespread, numerous and in a variety of rock types** or environments to allow us a chance of finding them.

The process of identifying fossil species allowed us to divide the geological record up into divisions, based on their fossil content and so unknown rocks could be placed in their correct order by identifying their fossil species.

In **desert environments** and other such depositional environments, there is **little evidence of life** to be preserved.

In **the Precambrian, before** the evolution of life with **hard parts**, few organisms could be preserved.

Boreholes are drilled to release **chippings** to the surface containing samples from **all depths** of the well. These samples are analysed for their **microfossil assemblage** and their relative age established. It is important to **identify the oldest** microfossils in any borehole sample.

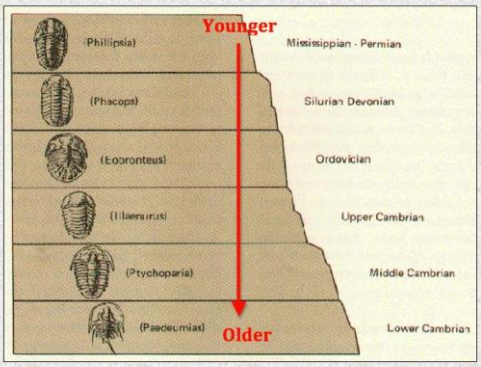
Derived fossils are a problem as they are older than the rock they are found in and can be considered included fragments. This can occur if a fossil is made from **silica that has been precipitated** into a rock of a different sediment. Silica is much **harder and more resistant** to erosion so if the rock is eroded, the fossil survives and is **transported**. It may be **deposited** again into a new sediment and so forms a derived fossil.

The **recognition of fossils** in rock strata and the use of the **laws of stratigraphy** have allowed frocks all across the globe to be classified by relative ages. They have been put into the appropriate **era, period and epoch**. These divisions of the geological timescale were **later given absolute ages** using radiometric dating. This makes the geological timescale a mixture of evidence using **zone fossils, fossil assemblages** and **radiometric dates.**

Rules of Relative Dating

4. Law of Faunal Succession:

- helps correlate rocks across large distances by comparing fossils. The idea is that rocks of similar ages contain fossils of similar types, some of which do not appear in any other layer. The older fossils appear in the bottom while younger ones appear in the top



EON	ERA	Date*	PERIOD
PHANEROZOIC	CENOZOIC	2.6	QUATERNARY
			NEOGENE
		23	PALAEOGENE
	MESOZOIC	66	CRETACEOUS
		145	JURASSIC
		201	TRIASSIC
	PALAEOZOIC LATE	252	PERMIAN
		299	CARBONIFEROUS
		359	DEVONIAN
	PALAEOZOIC EARLY	419	SILURIAN
		444	ORDOVICIAN
		485	CAMBRIAN
		541	
PROTEROZOIC (part)	NEOPROTEROZOIC (part)		