THE HISTORY OF EARTH

It is interesting to note how little of Earth's history has been characterised by life. Bacterial life was the only life that existed for millions of years, and it was also through cyanobacteria (photosynthesising silica algae) that the atmosphere started to oxygenate – a prerequisite for life on land. Only in the past hundreds of millions of years have animals started to develop, and you can clearly see the different cycles of mass extinctions (often due to climate change) that are followed by life explosions (when many ecological niches open up to new organisms).

The Rainforest collapse stands out (the black box/black line on the clock) – it depicts a period in which it rapidly turned cold and enormous amounts of rainforest disappeared faster than it could be broken down. This led to a lot of carbon being buried and fossilised, and it is this fossilised carbon that is our primary source for fossil fuels such as charcoal and oil.

The history of the Earth in 12 hours

00.00 (4,6 billion years)
The Earth forms as a burning globe
The Earth is formed by particles that collide in space and are held together by gravitational forces. In the planet's earliest stage, it is a burning globe with oceans of lava and no protective atmosphere.

00.14 (4,51 billion years)
The Moon is formed
Earth collides with a smaller planet (Theia). The debris from Theia is enclosed by the debris from Earth and it remains in the Earth's orbit as its moon.

00.31 (4,4 billion years)
Flowing water and early crust
The Earth's surface starts to harden, and the Earth's crust is formed. In conjunction with this, the first oceans of flowing water also begin to take shape.

01.18 (4,1 - 3,8 billion years)
The Earth is bombarded by large meteorites
During this time, the Earth is bombarded by large meteorites. Researchers believe they may have brought organic material, water, or possibly even single-cell organisms to Earth, but nobody knows for sure.

01.30 (4,1 - 3,5 billion years)
Life begins – singe-cell organisms
There are different theories about how life first began on Earth, but at approximately this time in Earth's history we begin to see signs of single-cell organisms starting to flourish in the oceans.

02.52 (3,5 billion years)
Oxygen starts to be formed by photosynthesising bacteria

Cyanobacteria develop the ability to photosynthesise, and in this way release large quantities of oxygen into the water and air. Organisms that lacked the ability to survive at high oxygen levels were severely affected, and some refer to this time as ‘the first mass extinction’.

03.00 (3,5 - 3 billion years)
The continental plates are formed
At this stage, the majority of the Earth’s crust has hardened and started to form continents and ocean floors. Beneath the hard crust, viscous masses of magma move, just as they do today, in a process called plate tectonics. This process is fundamental for the formation of new rock, the dissolving of old crust, and the reason for the formation and separation of continents over millions of years.

Approx. 05.29
The Oxygen Catastrophe
Bacteria that require oxygen-free conditions die. They make way for oxygen-loving organisms.

10.00 (750 - 580 million years)
Snowball earth – Earth is entirely frozen
It is believed that Earth was entirely covered by glaciers at this point in time – even at the equator. That is why it is said that Earth looked like a snowball.

10.21 (635 - 542 million years)
Multicellular animals – many strange species
Multicellular life is experimenting, and a series of strange organisms emerge, including Dickinsonia and Charnia. Most species from this fauna only survived during this period and have no living relatives today.

10.26 (600 million years)
The Ozone layer is formed – protects against harmful radiation from the sun
At this point in time there is so much oxygen in the atmosphere that it starts to form ozone, O_3, which spreads itself like a protective layer around Earth, limiting the insolation of harmful radiation from the sun. The development of an ozone layer made life possible, not just in the oceans but also on land.

* 10.35 (541 million years; temperatur 14)
Cambrian explosion – trilobites and squid
At this point in time a major development in life on Earth takes place, and the oceans are colonised by trilobites and squid, among other animals. A number of strange animal groups also emerge, such as Opabinia, a free-swimming animal with five eyes and a long trunk with a claw at the end.
As there was only ice and nothing that absorbed CO_2, the CO_2 and methane levels increased through volcanic eruptions etc. Microbes converted organic carbon into CO_2 under the ice. Ultimately, it became warm enough for the ice (the snowball) to melt at the equator. Higher sea levels. High levels of CO_2 and 45 degrees in the water.

* **10.46 (470 million years)**
Fungi and plants move onto land
Life begins to move onto land. Plants are helped by fungi to collect nutrients, enabling them to colonise more and more of the barre rocky landscape over time.

** 10.50 (450 - 440 million years; temperature 4)
It gets very cold – most animals die out
At this point in time large glaciers form at the South Pole where the landmasses we now call Africa and South America lay at the time. The cold climate led to many of the animals that developed in the hot climates of the Cambrian and Ordovician periods meeting a cold death.

* 10.59 (390 - 340 million years)
Frogs and reptiles develop on land
Vertebrates crawl up on land which paves the way for the development of amphibians and reptiles.

** 11.01(375 - 360 million years)
Mass extinction of marine species

* 11.05 (350 - 300 million years; temperature 12)
Giant insects develop
In the newly formed ecosystem on land, the first insects also develop and some become gigantic (e.g. dragonflies with 68cm wingspans).
In the Silurian period, the glaciers disappeared and at the end of the Silurian period, we find the first plant fossils from land. Gondwana separates, the continents move toward the equator. Several continents provide more coastlines with shallow water. In the Devonian period, we see lots of marine life and the first corals, as well as the first fossils of animals adapted to life on land.

11.08 (335 million years; temperature 11)
Pangea, our most recent super continent is formed
At this point, all landmasses are gathered together in a single giant continent called Pangea.
The super continent Pangea is formed, continental climate – dry and less glacier formation. No landmasses at the poles. Massive volcanic eruptions in Siberia at the end of the Permian Period. 2 million square kilometres of volcanos! Methane release from ocean floors.

11.12 (305 million years; temperature -2)
*** **The Rainforest collapse – major carbon deposits are formed**
Large rainforests grow in the warm climates of the Devonian and Silurian Periods, which we can see remnants of in the major carbon deposits as these forests died due to lower temperatures.
Low CO_2 due to large forests that absorb CO_2 – lower temperature – forests die – the ice grows – lower sea levels.

** 11.21 (252 million years)
90% of Earths species die out

11.22 (240 million years)
The first flowers
The first flowers see the light of day when plants develop the ability to reproduce by forming seeds. The first flowers are believed to have looked like the magnolias of today.

* 11.22 (240 - 225 million years; temperature 2-4)
The first dinosaurs
Varying temperate climate similar to today.
Life on land is taken over by dinosaurs that, thanks to high levels of oxygen in the air, grow to become huge in size.

11.25 (225 million years)
The first mammals
The first mammals develop and establish themselves on land where they live in the shadow of the dinosaurs, adapted to a nocturnal and underground life.

** 11.28 (201,3 million years)
Most land animals die out, except for the dinosaurs.

* 11.37
The first birds.

11.44 (100 million years)
The first grass
Before and during the majority of the age of the dinosaurs, there was no grass on Earth. Instead, ferns and bush-like trees dominate the vegetation. However, the first grass came toward the end of the Cretaceous Period.

** 11.50 (66 million years)
All large land animals die out, including the dinosaurs.

* 11.51 (från 66 million years; temperature 8)
The age of mammals and fungi begins
In the wake of the devastating asteroid, fungi, which can survive on all dead organisms and mammals, which have managed to survive by living underground and can avoid fungal diseases due to their warm body temperatures, are flourishing. In the meantime, most dinosaurs die out. The meteorite impact creates debris in the atmosphere, inhibiting photosynthesis; it is warmer due to this and other reasons.

11.52 (50 million years)
The Himalayas are formed
The Indian plate has broken away from the African continent and collides with Asia, which initiates the formation of the Himalayan mountain range. On the way, as a detached continent, an enormous volcanic area forms that is active for several million years.

11.52 (50 million years; temperature 14)
Climate crisis – average temperature rises by 6 degrees.
At this point in time, the carbon dioxide levels in the air increased significantly and the average temperature on Earth rose by 5-8 degrees in a short time. When such dramatic changes occur some processes can set off others and lead to an even faster temperature rise, and this time period is often used as a warning for how the climate could change if we continue to have an impact on it.

11.55 (Ca. 35 million years)
The Alps are formed

11.59.36 (since 2,48 million years)
Ice Ages

11.59.40 (2,1 million years)
The first humans

11.59.57 (300 - 200 thousand years)
Humans (Homo sapiens) begin to populate the Earth.

* Bursts of diversification
** The Big 5 - mass extinctions
*** **The Rainforest collapse – major carbon deposits are formed**

Massextinctions

The five major mass extinctions that have affected the planet are often referred to as 'The Big 5'. They have occurred every 50-150 million years. The most recent, which wiped out the dinosaurs, took place approximately 66 million years ago.

Text in picture by Budjarn Lambeth, information from brittanica.com and bbc.co.uk.:

Ordovician
Time: 445 million years ago
Death rate: 85 %
Likely causes: Rapid global cooling | Falling sea levels
Results: Coastal areas destroyed | Chemical reactions affected by cold.

Devonian
Time: 340 million years ago
Death rate: 70 %
Likely causes: Asteroid impact (s) | Rapid global cooling
Results: Local destruction from debris | Ocean life affected by temperature.

Permian
Time: 250 million years ago
Death rate: 95 %
Likely causes: Volcanic activity | Increase in Methane and CO_2 | Rapid global warming
Results: Oxygen removed from oceans | Desertification of land.

Triassic
Time: 200 million years ago
Death rate: 76 %
Likely causes: Increase in Methane and CO_2 | Rapid global warming
Results: Desertification of land | Frequent heat waves.

K-T
Time: 65 million years ago
Death rate: 80 %
Likely causes: Asteroid impact | Volcanic acitivity | Falling sea levels
Results: Widespread fires | Plants disrupted by global ash cloud | "Nuclear winter".

Causes of mass extinctions

Climate
Rapid changes (hundreds of years) to the climate can lead to organisms not having enough time to adapt to the new conditions and dying out.

Short and long cycles
Global/Regional effect
We can have an impact

Meteorite impacts
Unusual events that can have major consequences, such as the mass extinction at the end of the Cretaceous Period.

Short time
Global/Regional/Local effect
We cannot have an impact

Atmospheric circulation
Large air masses are moved around the Earth, primarily driven by the heat of the sun. These are large-scale cycles, but if the composition of the air changes – for example through higher levels of carbon dioxide – the circulation pattern can change and thereby also affect life globally.

Long cycles
Global effect
We can have partial impact

Volcanism
Volcanos are a natural part of Earth's geology and the formation of mountains. At a local and regional level however, a volcanic eruption can have major consequences, as ash and gases block the sun's insolation, and in the long term, can contribute to an increased amount of greenhouse gases.

Brief (usually)
Regional/Local effect
We cannot have an impact

Sea level changes
If the sea level changes, many organisms are forced to relocate – both those that live near beaches on the ground and those in shallow waters. If the organisms do not have time to adapt to the new environments, they are at risk of extinction.

Long and short cycles
Global/Regional/Local effect
We can have an impact

Air temperature
Changes to air temperature such as those we can measure from the greenhouse effect, is a very complex system. The global warming we are seeing today does not make it warmer everywhere; instead, some places are dryer or wetter. However, the temperature is increasing on a global scale, and this can affect the living environment for many species. In addition, the changes in

temperature also affect the air circulation patterns, which can lead to changes in the atmospheric circulation as well.

Short and long cycles
Global/Regional effect
We can have an impact

Ocean oxygen levels

With small changes to ocean oxygen levels it can already be difficult for many animals to survive. Particularly microorganisms, but also many fish and other animals are very sensitive to changes in oxygen levels.

Long cycles
Global effect
We can have a partial impact

Acidification

The release of carbon dioxide into the atmosphere, e.g. through the burning of fossil fuels, also leads to oceans absorbing carbon dioxide. Carbonic acid then forms in the water, making the water sourer. This can be devastating for many organisms that build up calcium-based skeletons, which are broken down in the sour water.

Short and long cycles
Regional/Local effect
We can have an impact