Australian Government
Geoscience Australia

Geological Timescale

- for printing and display along a wall

Geological timescale background information

The geological timescale is one of the major achievements of geoscience over the last two centuries. The timescale subdivides the 4.6 billion years since the planet formed into a series of time units (e.g. Jurassic Period). Rocks, and particularly the fossils within them, have been compared across the world to work out their age relative to each other. This information has been calibrated against an absolute scale measured in years. The absolute ages of rocks are usually calculated by measuring the natural radioactive decay of minerals. This international standard timescale allows geoscientists to determine the ages of events in Earth history and so understand the evolution of the planet from its formation to the present day.

Instructions for making your ‘to scale’ timescale

Many depictions of the Geological Timescale are not drawn to the same scale over the history of the Earth. Often the pre-Cambrian sections appear smaller than the post-Cambrian sections even though they are not. This Geological Timescale uses the same scale for the entirety of geological time.

Each period is represented proportional to the length of elapsed time. When printed on A4 paper 100 Ma (million years) equals approximately 6 cm.

- Print the PDF document single-sided in colour on A4 paper (choose the ‘Fit’ option when printing) (11 pages, 3 metres).
- Trim the edges of the pages
- Optional: Laminate each page
- Stick horizontally along a wall.

The PDF file can also be printed on A3 paper. This would make a display that is 4 metres long with 100 Ma being equal to approximately 8 cm.

Using the Geological Timescale with students

Age of the Earth

A starting point for all discussions about the geological timescale is the age of the Earth (and big numbers). There are various ways that the age of the Earth can be represented:

- 4 600 million years which is shortened to 4600 Ma
- 4.6 billion years

Note that the age of the Universe is ~ 14 billion years

Place various markers on the timescale

To check on current understanding of events during the history of the Earth ask students to stand or point to the position along the timescale where they think that certain events related to the evolution of life took place (s*ee Appendix A for examples).* It can be interesting to see if students sequence the development of different lifeforms correctly even if not placed at the right point in time.

This activity could lead onto placing a larger selection of pictures/labels along the time scale to show the relative timing of significant events (*see suggestions in Appendix B*).

Discuss how the age of rocks and geological time is measured

RELATIVE DATING

The earliest geological time scales were developed using the order of rocks in sedimentary rock sequences with the oldest layers at the bottom and younger layers at the top (Law of Superposition). However, a more powerful tool for correlation across wider areas is the fossilised remains of ancient animals and plants within the rock layers. This relative dating process using fossils can be applied from the beginning of the Cambrian Period (541Ma), which contains the first evidence of hard-bodied macro-fossils, to the present day. This approach allowed William Smith (a coal mine engineer and canal surveyor who worked in England in the late 1700s) to order the fossils and rock layers he observed. He noted that different rock layers contained different fossils and he could recognise the similar layers over wide areas using the differences in the fossils. In 1815 Smith produced a geology map of England and Wales, the first large scale geological map in the world. Similar rocks and fossils were gradually mapped across the world. This helped geologists to work out the changes in environments that have taken place over time.

ABSOLUTE DATING

When radioactive isotope dating techniques were developed in the early 1900s stratigraphic correlations become less important as igneous and metamorphic rocks could be ‘absolutely dated’ for the first time. The absolute age of rocks, usually measured in millions of years before the present day, is the current basis for the Geological Timescale.

Numerical ages of rocks are often determined by a process called radiometric dating. Radiometric dating involves the study of radioactive isotopes of elements such as uranium and potassium which occur naturally in the Earth’s rocks. These radioactive isotopes are naturally unstable and undergo radioactive decay into more stable elements. For instance, uranium decays to lead and potassium decays to argon. The rate of this decay is constant for each radioactive isotope. By determining the amounts of both the radioactive isotope and the isotope into which it decays (daughter isotope), scientists may calculate the age of the mineral/rock.

RADIOACTIVE DECAY

Each radioactive atom has a particular rate of decay. The number of atoms (n) that decay during a set period of time is directly proportional to the number of radioactive atoms in the sample (N). For example, out of 10 million atoms (N = 10 000 000) of the radioactive element radium, 4273 will decay each year (n = 4273). The fraction $\frac{n}{N}$ is known as the decay constant (λ). In the case of radium:

$$\lambda = \frac{4273}{10000000} = 0.0004273 \text{ per year.}$$

It is easier to think in terms of the half-life (T) of the radioactive atom, which is the period of time it takes for half of the original atoms to decay to the daughter atoms. T is always equal to 0.693 ÷ λ. Therefore in the case of radium, T = 0.693 ÷ 0.0004273 or T = 1622 years.

Further information and activities are available from:

- **Geoscience Australia education webpages**

  http://www.ga.gov.au/education/classroom-resources/geological-time

  Here you can access Geoscience Australia's Timescale Bookmark, the Geological TimeWalk Booklet, instructions for creating your own Timewalk, two mobile apps about geological time and two posters that show the History of the Earth and Australia Through Time.

- **Earth Learning Idea**

  http://www.earthlearningidea.com/English/Geological_Time.html

  Fantastic teaching activities, lots of practical ideas supported with information for teachers.

- **Sahul Time**

  http://sahultime.monash.edu.au/

  Interactive created by Monash University. You can manipulate the age of the earth to show changes in sea level and the shape of Australia. Go further back in time and see the changes in the positions of the continents.

- **Australia: The Time Traveller's Guide (2012)**

  http://www.essential-media.com/node/179

  Four part ABC series with supporting website with short video clips.

- **OZ Fossils – ABC**

  www.abc.net.au/ozfossil/default.htm

  The Pitfall game is a virtual excavation of bones suitable for primary students.

- **Australian dinosaur story**
  http://www.environment.gov.au/heritage/places/national/dinosaur-stampede/lark-quarry/index.html
  Aimed at middle to upper primary students. Includes lesson plans.

References:

http://australianmuseum.net.au/the-geological-time-scale

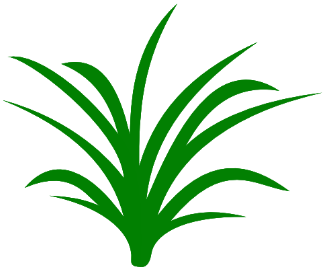
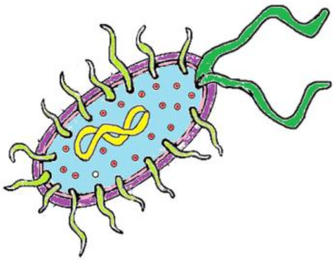
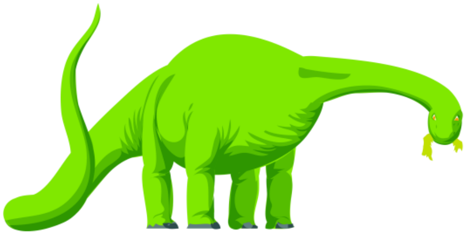
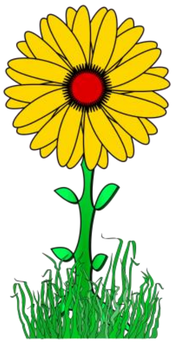
http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/pages/geological.aspx

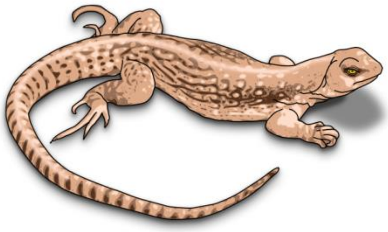
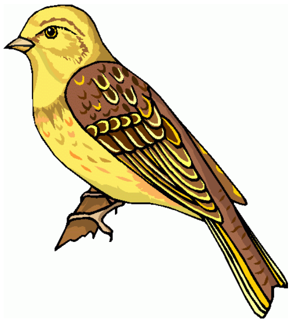
www.ga.gov.au/education

Education inquiries: (02) 6249 9673 or education@ga.gov.au

GeoCat: 89966

Appendix A

 **First amphibians**	 **First grasses**
 **First large trees**	 **First mammals**
 **First unicellular life forms**	 **Mass extinction, end of dinosaurs**
 **First dinosaurs**	 **First flowering plants**

 **First reptiles**	 **First humans (genus Homo)**
 **First birds**	 **First multicellular life forms**

Answers:

First unicellular life forms 3600 Ma

First multicellular life forms 2100 Ma

First large trees appear 340 Ma

First amphibians 390 Ma

First reptiles 310 Ma

First dinosaurs 230 Ma

Mass extinction, end of dinosaurs 66Ma

First mammals 170 Ma

First birds 150 Ma

First flowering plants 175 Ma

First grasses 60 Ma

First humans (*Homo sapiens*) 0.2 Ma (200 000 years ago)

Appendix B

Some of the more significant events in a brief geological timescale are listed in the table below:

Age (millions of years ago)	Significant event
4600	Formation of the solar system including the Earth
3600	First primitive unicellular life forms develop
3200	Early formation of continents and tectonic plates
2800	Oxygen became a significant component of Earth's atmosphere
2100	Multicellular algae evolve
850	First lichens and algae.
541	First fish
390	First tetrapods (ancestors of amphibians)
375	Insects had evolved
340	Large primitive trees appear
310	First reptiles
252	Up to 95% of life on Earth becomes extinct
230	First dinosaurs appeared
175	Flowering plants evolve
170	Monotremes, marsupials and placental mammals evolve
150	Gondwanan supercontinent starts to break up (formation of rift valley between Australia and Antarctica)
150	First birds
66	Mass extinction, end of the dinosaurs
60	First grasses
541-485	Proliferation of multicellular life forms (Cambrian Explosion)
50	Indian Plate starts to collide with Asia, Himalayas start to form
34	Australia completely separates from Antarctica
0.2 (200 000 years ago)	First humans (*Homo sapiens*)