Geology of the Batemans Bay region

Rock age

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Rock age determination

Two methods are commonly used to determine the age of rocks.

1) Stratigraphic age determination - examining the ***fossils*** in sedimentary rocks to determine relative ages.

2) Radiometric age determination - analysing the very small quantities of ***radioactive elements*** present in igneous rocks to determine absolute ages.

Stratigraphic age determination

Organisms once living in or near water and sediments change their biological structure throughout geological time. These changes can be catalogued from their fossil remains found in ***sedimentary rocks*** today. Thus, when a particular fossil is identified in a sedimentary rock, we can tell whether the rock is older or younger than other rocks in the stratigraphic sequence. This information gives us the ***relative age of the rocks***.

Radiometric age determination

When hot ***igneous rocks*** are formed deep in the Earth's crust they entrap small amounts of radioactive elements like uranium and thorium. When these rocks cool they begin to change by radioactive decay at a known rate over millions of years. Thus, by measuring the quantities of these "daughter" decay products, the true ***absolute age of the rock*** can be determined.

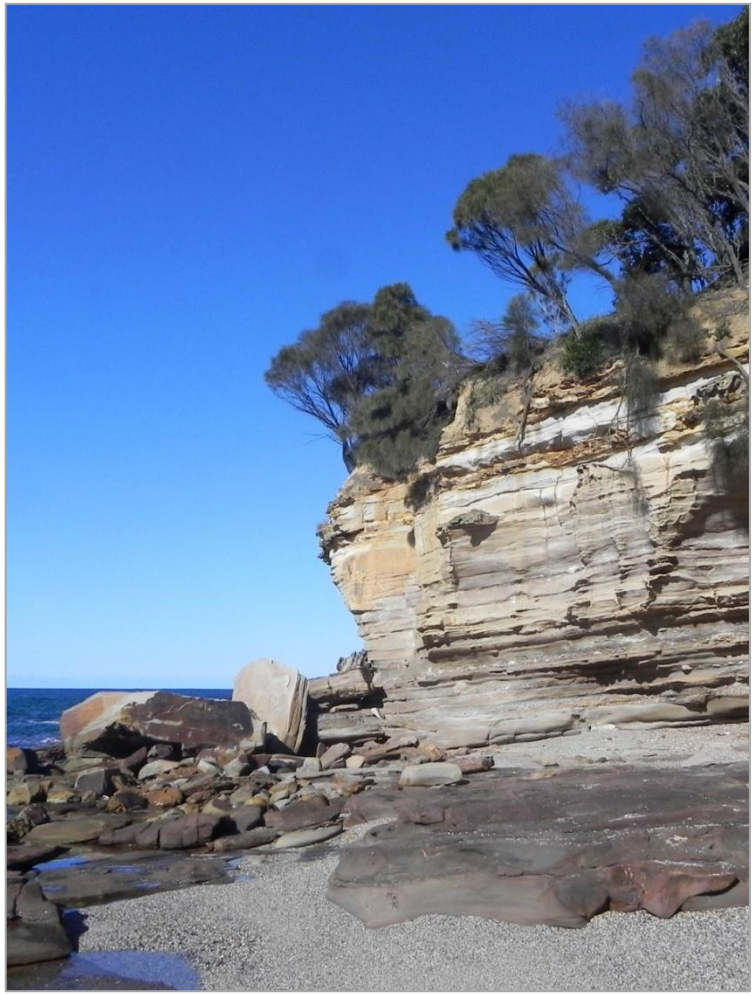
Doug Finlayson
Canberra, 2016

Stratigraphy

Sediments (gravel, sand, silt, mud, etc.) are deposited one on top of another as river systems and marine environments develop over time. Hence the younger rocks are at the top of any sedimentary succession.

The fossils of organisms in such a succession will therefore be younger towards the top. Living organisms change their biological structure over millions of years. The science of palaeontology analyses fossils from around the world and can build up a picture of these changes and hence the relative ages of sedimentary rocks around the world.

Thus, when a particular fossil is identified in a sedimentary rock, we can tell whether the rock is older or younger than neighbouring sedimentary rocks. This information gives us the ***relative age of the rocks.***



Wasp Head sea cliffs, near South Durras

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Permian fossils from the Sydney Basin north of Batemans Bay.

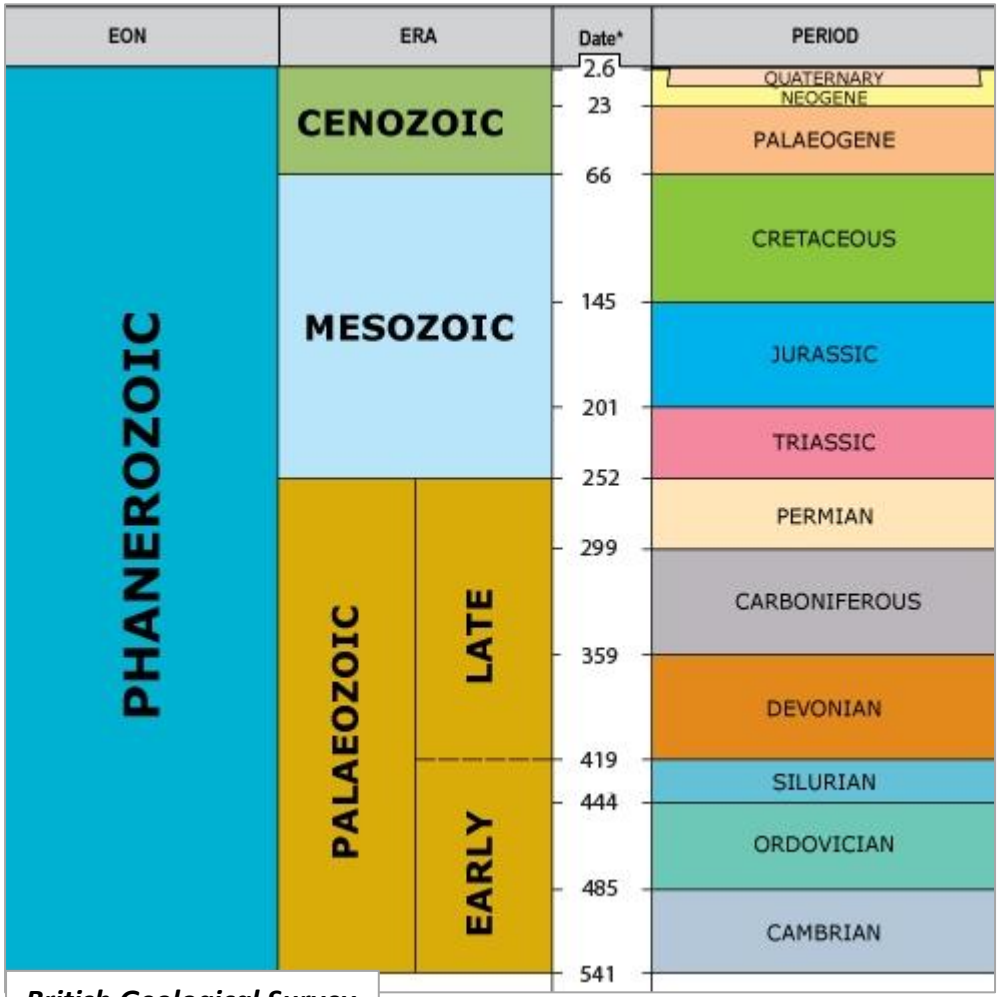
Geological time scale

By analysing fossils from around the world palaeontologists have developed a geological time scale.

Fossils the same as those found in the Jura Mountains of France are described as ***Jurassic.***

Fossils the same as those found in near Perm in central Russia are described as ***Permian.***

Fossils the same as those found in Wales in Britain are described as ***Silurian*** after the local tribe that lived there – the Silures.



British Geological Survey

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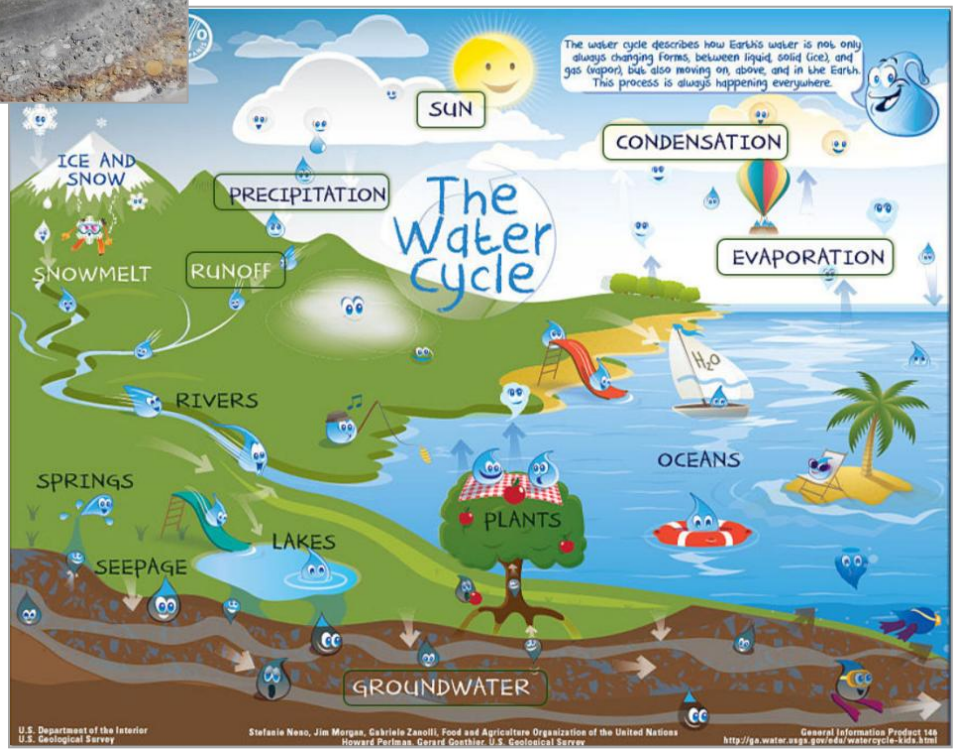
Wasp Head near South Durras.

Stratigraphic analysis

Analysis of the detail in a sedimentary succession can tell us a lot about the nature of the environment when the sediment (gravel, sand, silt, mud, etc.) were deposited – in a fast flowing river, in a lake, in a shallow ocean, in a deep ocean, etc.

The Water Cycle

The water cycle gives us an idea of how erosion of rocks and deposition of sediments can change landscapes and how climate controls many aspects of the landscapes we live in.



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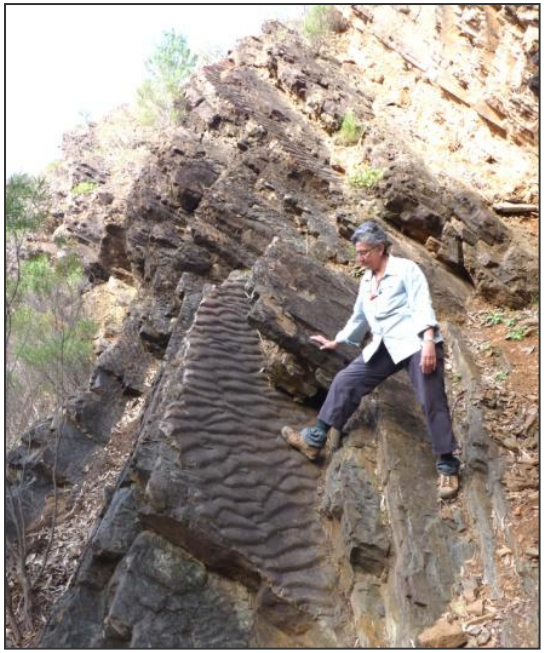
The same geological processes have been active throughout geological history.



570 million year old ripple marks, Flinders Ranges, South Australia.

Present day ripple marks, Fraser Island, Queensland.

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Absolute age dating – atomic spectroscopy

To determine the absolute age of rocks, geologists measure the small amounts of radioactive elements, uranium, thorium, etc., in igneous rocks. They measure the quantities of various isotopes of radioactive elements using a mass spectrometer.

Jack Hills zircon, about 4.4 billion years old.

Super High Resolution Ion Micro Probe (SHRIMP).

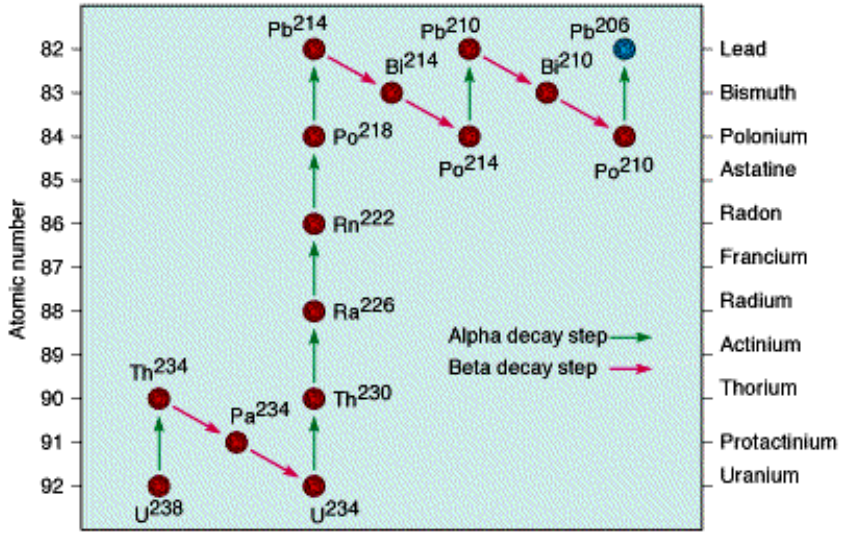
Geoscience Australia

Radiometric age dating of rocks

Alpha particle = 2 protons + 2 neutrons
Beta particle = 1 electron

Igneous rocks deep within the Earth mix with small quantities of radioactive elements that get included in the igneous rock as it is erupted at a volcano or is intruded into the upper crust.

Once the rock cools down, radioactive decay starts and "daughter" products are formed. By measuring the relative amounts of "parent" and "daughter" isotopes the length of time from the start of the decay process can be determined – the absolute age of the rock.



Half-lives for various radio-isotopes

Rad. Parent	Half-life	Stable Daughter
^{238}U	4.47 Billion years	^{206}Pb
^{235}U	704 Million years	^{207}Pb
^{232}Th	14.0 Billion years	^{208}Pb
^{87}Rb	48.8 Billion years	^{87}Sr
^{40}K	1.28 Billion years	^{40}Ar, ^{40}Ca
^{14}C	5,730 years	^{14}N

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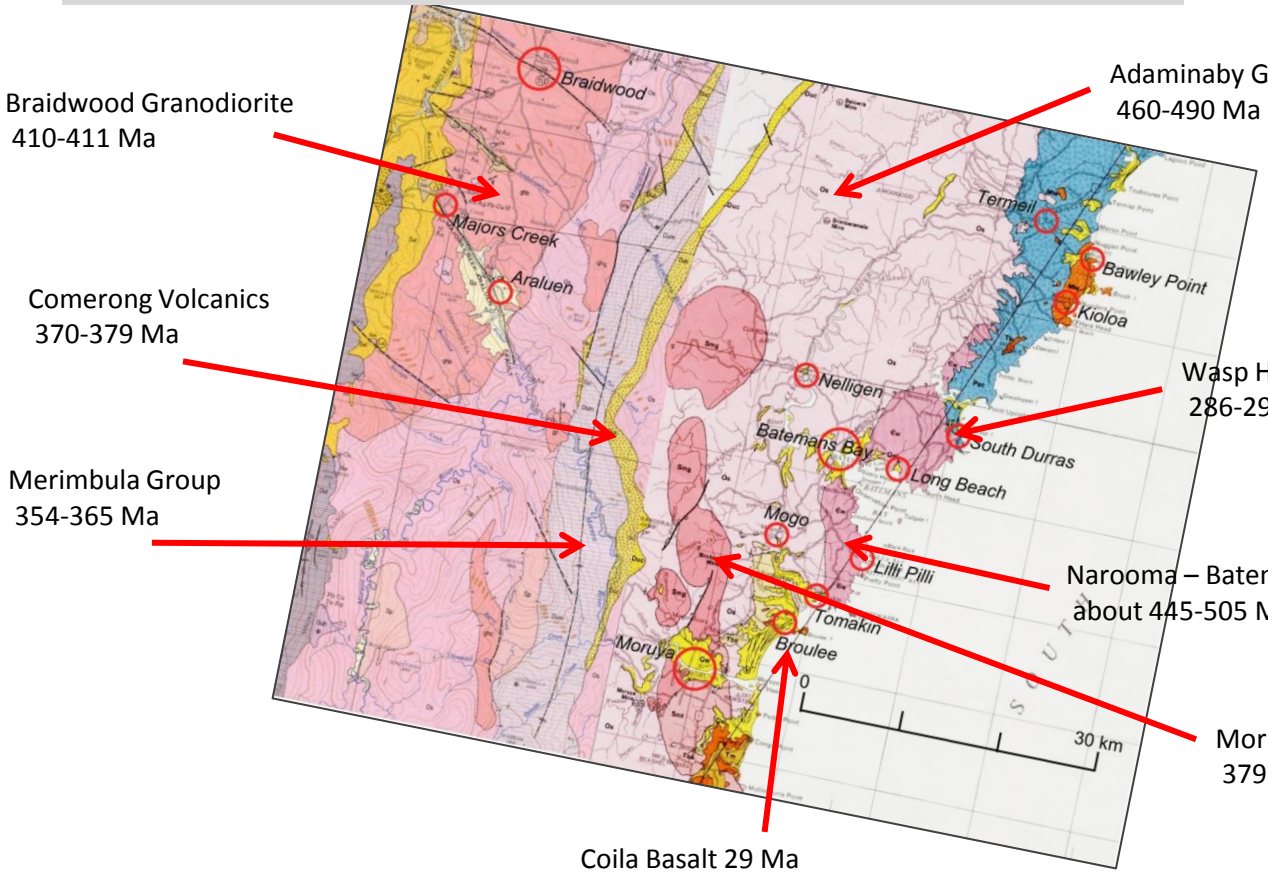
Moruya Tonalite.

- *By analysing volcanic ash layers and other contacts with igneous rocks, sedimentary rocks can also be given an absolute age.*
- *The geological time scale can now be calibrated over the 4.54 billion years of the Earth's history.*



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Adaminaby Group metasediments, Nelligen.

There's much more information on web sites and in books and journals. Some of these are listed below.

Books and publications

- ***The Geology of Australia*** *– D. Johnson, Cambridge University Press, 2004*
- ***Geologica: The origins of the Earth*** *– Millenium House, 2007.*
- ***Earth: the definitive visual guide*** *– Smithsonian Institution, DK Ltd., 2004.*

Web sites

- ***http://www.nature.com/scitable/knowledge/library/dating-rocks-and-fossils-using-geologic-methods-107924044***
- ***http://www.ucmp.berkeley.edu/fosrec/McKinney.html***
- ***http://geomaps.wr.usgs.gov/parks/gtime/radiom.html***
- ***http://geomaps.wr.usgs.gov/parks/gtime/ageofearth.html#date***
- ***http://education.usgs.gov/secondary.html***

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