Time Warp

YEAR 8
EARTH AND SPACE SCIENCES

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM NETWORK | Queensland Government

Future Makers

Future Makers is an innovative partnership between Queensland Museum Network and Shell's QGC business aiming to increase awareness and understanding of the value of science, technology, engineering and maths (STEM) education and skills in Queensland.

This partnership aims to engage and inspire people with the wonder of science, and increase the participation and performance of students in STEM-related subjects and careers — creating a highly capable workforce for the future.

QUEENSLAND MUSEUM NETWORK

Queensland Government

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

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ELABORATE - EVALUATE

Time Warp

Teacher Resource

Our Earth is constantly changing. In this activity students will explore these changes, and the evidence left behind.

Going Forward

The formation of rocks, minerals and resources depend largely on environmental conditions, and the forces and energy available. In *Time Warp: Going Forward* students will analyse images of different environments and predict the type of rock and/or resource that will form. There may be multiple answers considered correct as many rocks are formed in similar environments, and small differences in environments can result in the formation of very different rocks. For example, the volcanic environment can result in the formation of many igneous rocks, as well as sedimentary tuff. As a result, it is very important that students justify their answers.

This activity can be completed following the introductory video of Zana Williams, a geologist from Shell's QGC business. This video will introduce how some common rocks and resources are formed. You may wish for students to complete *Time Warp* to demonstrate their existing knowledge, or complete it as research task.

Reproducing the Past

Core samples are used by geologists to evaluate available resources in a given area. The five metre core sample in this activity has been donated by Shell's QGC business. It is a small section of a larger 435 metre core produced from a site between Chinchilla, Dalby and Tara in the Western Downs, Queensland. This area is part of the Walooon Subgroup Coal Measures, an area of coal laid down during the Jurassic Period, 201 to 145 million years ago. In the formation of this coal, trees and plant material died, fell to the ground, and were gradually compressed. Under the immense pressure, the decomposing vegetation would first be converted into peat then eventually coal. It takes approximately 30 metres of decomposing vegetation to form one metre of coal!

In this activity students will analyse the core sample, and use information provided from the core sample to infer what the environment was like in the past, and how it changed over time.

Time Warp: Fossil Evidence

We can learn much about past environments by looking at rocks; however fossils are required to help us understand life on Earth throughout geological time. Through fossils, scientists at Queensland Museum, and throughout the world, can extrapolate information on climate, feeding relationships, evolution and more. We can learn how living things responded to change in the past to predict the impact of human and natural changes on our environment today. As we head toward a human-induced mass extinction event, past extinction events can also provide warning signs for the future.

In this activity students will reconstruct the layers of sedimentary rocks using the fossil record to determine the order of the layers. It is recommended that students start with the current period – the layer containing humans. They then identify the layer that has the most common fossils to the current day to find the next layer of rock, and so on. You may check student answers by comparing the order of their sedimentary rock layers against the geological timescale. Remind students that like a core sample, the most recent fossils and most recent layer of sedimentary rock will be at the top, and the oldest rock will be at the bottom of their layers.

You may wish to share the video of Dr Espen Knutsen, a palaeontologist at Queensland Museum as he discusses his experiences in palaeontology and how he got there. Further information on the geological and fossil history of Queensland can be found in *Lost Creatures* on Level 2 at the Queensland Museum in Brisbane, as well as in our loan kits.

Curriculum Links

Science

YEAR 8

Science Understanding

Sedimentary, igneous and metamorphic rocks contain minerals and are formed by processes that occur within Earth over a variety of timescales (ACSSU153)

Science Inquiry Skills

Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate (ACSIS144)

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS148)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Composing texts through speaking, writing and creating

Word knowledge

Visual knowledge

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

Identifying, exploring and organising information and ideas

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

Time Warp

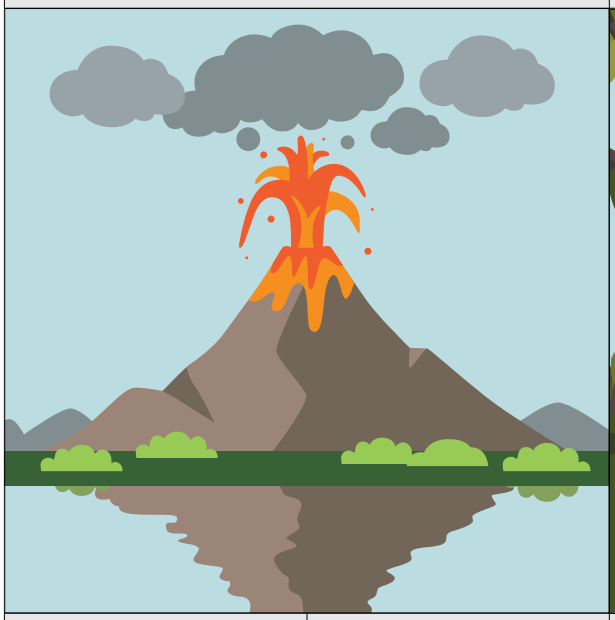
Student Activity

Time Warp: Going Forward

The history of environments and life on Earth can be told through rocks. Over millions of years, sediments such as sand and silt are laid down and compressed to form sedimentary rock layers. These rock layers preserve a record of ancient landscapes, climates and life. The types of rock formed also tell stories about the environment, for example: was the land volcanically active?

Below you will find images of different environments. Analyse the image and predict what rock and/or resource may be formed from the environment. Remember to give reasons for your answers.

What rock and/or resource would be formed in this environment?

<table>
<tr><th colspan="2">Volcanic Environment</th><th colspan="2">Swamp</th></tr>
<tr><td colspan="2">  </td><td colspan="2">  </td></tr>
<tr><td>Rock/Resources Formed</td><td>Formation Time</td><td>Rock/Resources Formed</td><td>Formation Time</td></tr>
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<tr><td colspan="2">Justification</td><td colspan="2">Justification</td></tr>
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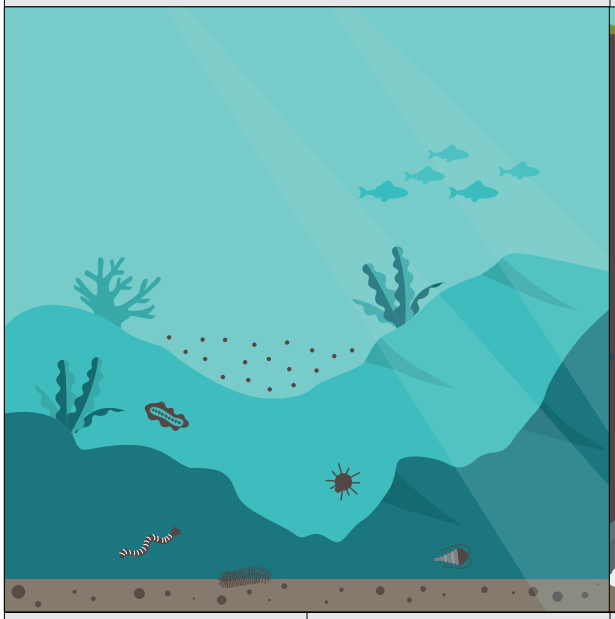
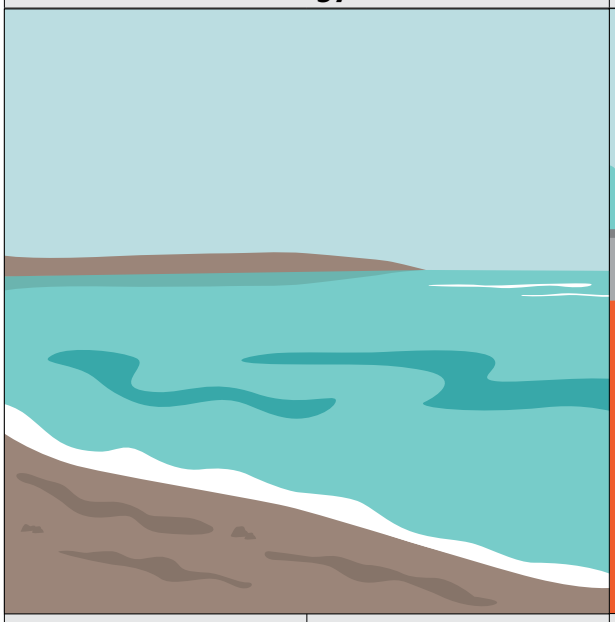
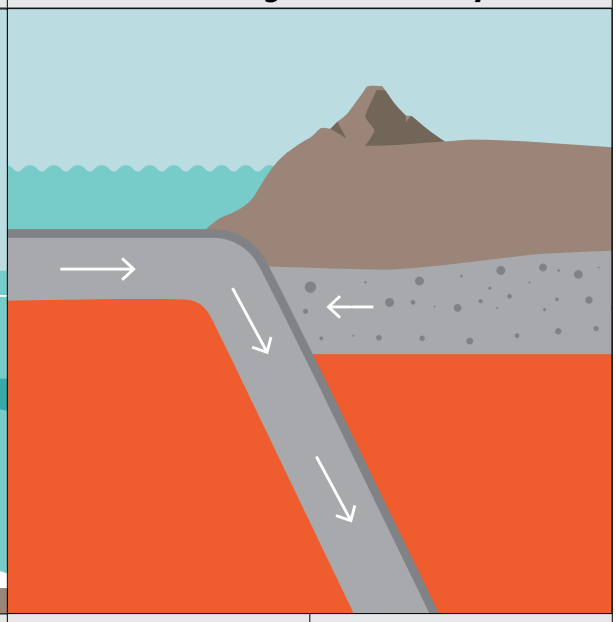
What rock and/or resource would be formed in this environment?

Shallow Ocean		Fast Flowing River	
			
Rock/Resources Formed	Formation Time	Rock/Resources Formed	Formation Time
Justification		Justification	

What rock and/or resource would be formed in this environment?

Low Energy Lake		Subducting Plate Boundary	
			
Rock/Resources Formed	Formation Time	Rock/Resources Formed	Formation Time
Justification		Justification	

Time Warp: Reproducing the Past

We are going back in time to see how an Australian environment has changed throughout history. Rock core samples can show us the depositional environment at the time a rock was formed; for example, coal is formed in a swampy, anoxic environment with lots of trees present. Mudstone forms in drier environments with more fine sediment and less organic material, and sandstone is formed when there is a higher energy accumulation to transport larger sediment.

To the right is a picture taken in the Western Downs, Queensland. We are going to analyse a rock core sample extracted from this area to examine the changes in the environment through time. The rock sample and expertise were generously donated by Shell's QGC business.

Present day environment near the core sample site in the Western Downs, Queensland.

1. Describe the present-day environment by examining the image above.

2. Analyse the rock core sample to explain how the environment changed throughout time.
   a) Observe the core sample.
   b) Draw a key to identify each rock type found in the core.
   c) Complete the chart below to show how the rocks change throughout the 5 m core sample (please note this is a section of a much larger core sample). Use your key to show each rock type in the chart.
   d) Label the rocks throughout the core.
   e) Infer the environment that existed in this location when each rock was formed, and describe how the environment changed through time.
   f) Choose one section of the core and draw a diagram of the environment at the time the rock was formed.

Rock Type **Core Sample** **How was the rock formed?**

Describe the environment at the time of rock formation.

Scale 1:10

Rock Type **Core Sample** **How was the rock formed?**

Describe the environment at the time of rock formation.

Scale 1:10

3. Contrast the changes you identified throughout the core, with the present environment shown in the picture. How was the environment different?

4. Approximately 30 metres of debris is compressed over hundreds of millions of years to create 1 metre of coal.

   Explain if the present environment shown in the picture will create resources such as coal, oil and/or gas in the future? Give reasons for your answer.

5. 300 million years have passed and humans of the future have taken a core sample in the area shown in the picture. What might you see in the section of the core sample relating to the present day?

6. In 300 million years, future civilisation is completing a core sample to learn about life during the 21st century. Where would you recommend they take the core, and why?

Fossil Evidence

Fossils are the preserved remains, impressions or traces of plants, animals and other life forms. Queensland's fossil record stretches across some 1.65 billion years and it is preserved almost entirely in sedimentary rocks. The history of the Earth's surface can be told by looking at the fossils that have been found from different time periods. It is through the study of the fossil record that scientists can trace the evolution of life.

Over millions of years, sediments such as sand and silt were laid down and compressed to form sedimentary rock layers. These rock layers preserve a record of ancient landscapes, climates and life forms. Fossils are found in many, but not all, sedimentary rocks, including limestones, sandstones, shales and mudstones. They are not found in igneous rocks and rarely in metamorphic rocks. Due to the long timeframes, weathering and erosion has obliterated much of the fossil record across Australia, however the records that we do have are internationally important due to our unique flora and fauna.

Explain why fossils are found mostly in sedimentary rocks, sometimes in metamorphic rocks and never in igneous rocks.

The Richmond Plesiosaur, discovered in 1990, is the most complete fossil of its type in Australia. Due to weathering and erosion it is rare to find such a complete fossil specimen. The Richmond Plesiosaur is from the Great Inland Seas of Queensland 100 – 150 million years ago. It is likely that it was very old when it died because these are traces of arthritis in its neck and thorax identified as the bones are irregular and rough, rather than smooth healthy bone. There is also a bite mark in the hind quarters that shows signs of healing. QMF18041, QM, Jeff Wright

Dating Rocks

Scientists at Queensland Museum use two methods to determine the age of rocks – direct and indirect dating. Direct dating uses natural radioactive isotopes to determine the exact age of rocks and fossilised materials. Some isotopes in rocks and minerals are unstable and decay at a consistent rate. The amount of each isotope is measured and from this the age of the rock can be calculated. However, sedimentary rocks are not as reliable for radioactive dating because they consist of recycled fragments of other rocks so only provides direct dates of the source/parent rock.

Indirect dating uses fossils found within a rock and the position of a rock in its geological sequence to provide a relative estimate of age. Scientists often determine the correct sequence of sedimentary rock layers using the fossils found within them. They compare the fossils to figure out if two layers are from the same geologic time period, or if one layer is older than the other.

Certain genus of Ammonite are used as index fossils and can be found in rocks of the same age around the world. It is through fossils such as these that global and regional correlations in time and evolution can be made. Queensland Museum, Peter Waddington

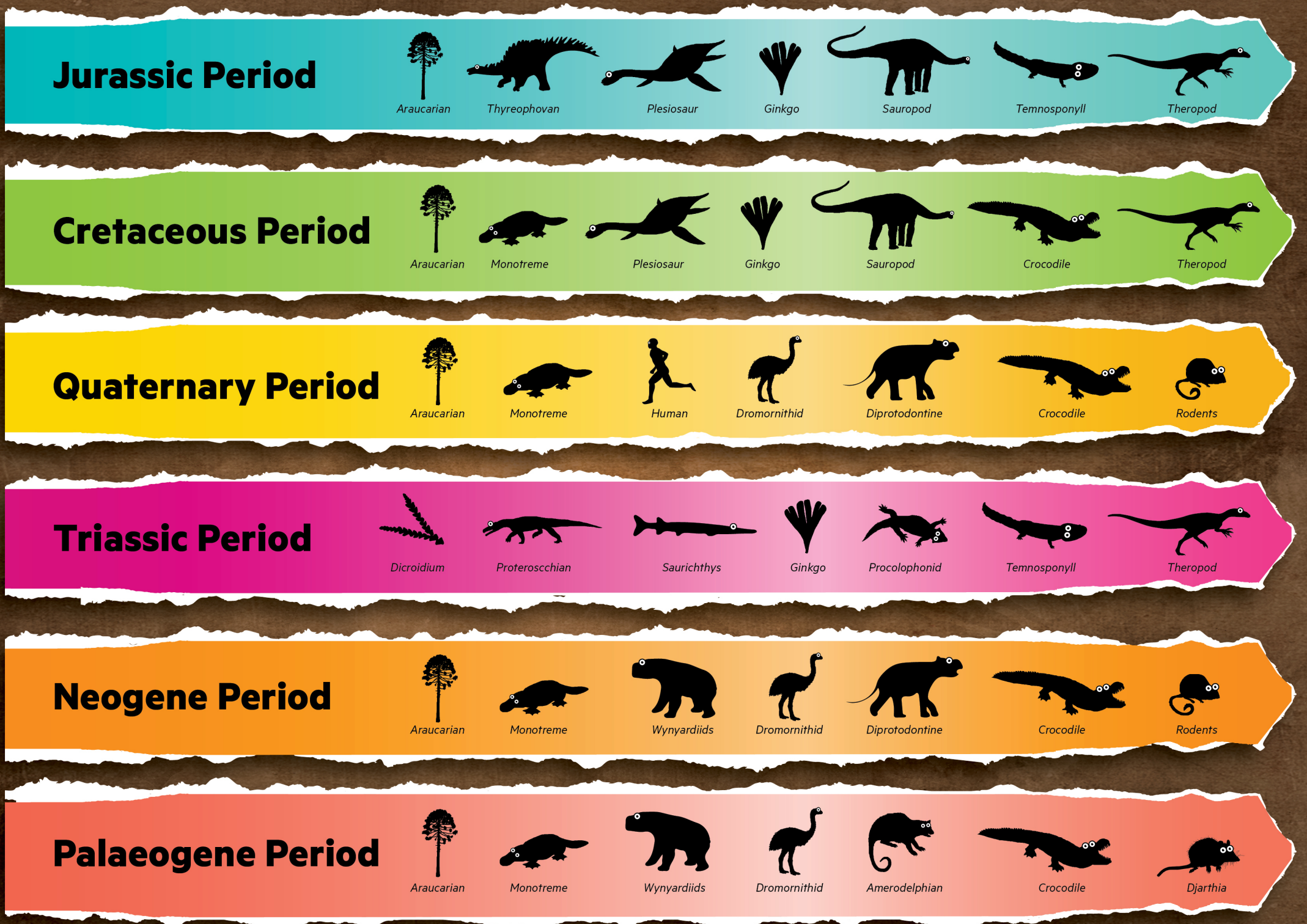
Task

Reconstruct the layers of sedimentary rock below, which contain a selection of ancient Queensland fossils. These fossils tell a story about what the landscape was like in ancient Queensland and how it has changed over time. The Queensland time periods represented in this activity are indicated on each layer.

Instructions

a. Cut out the six (6) layers.
b. Based on the fossils in the images, put the layers in correct order with the most recent time period at the top, and the oldest at the bottom. Clue: The most recent layer includes humans.
c. Decide which layer comes next by looking closely at the life-forms. It will have some of the same life-forms as the older layer but will also include some new ones. Hint: Life-forms do not disappear for a layer then reappear. Why?
d. Once you have the layers in order from newest to oldest, stick them down in order and check your answers.

More incredible Queensland fossils and stories can be found in *Lost Creatures* on Level 2 at Queensland Museum in Brisbane.


Jurassic Period
Araucarian
Thyreophovan
Plesiosaur
Ginkgo
Sauropod
Temnosponyll
Theropod
Cretaceous Period
Araucarian
Monotreme
Plesiosaur
Ginkgo
Sauropod
Crocodile
Theropod
Quaternary Period
Araucarian
Monotreme
Human
Dromornithid
Diprotodontine
Crocodile
Rodents
Triassic Period
Dicroidium
Proterosccchian
Saurichthys
Ginkgo
Procolophonid
Temnosponyll
Theropod
Neogene Period
Araucarian
Monotreme
Wynyardiids
Dromornithid
Diprotodontine
Crocodile
Rodents
Palaeogene Period
Araucarian
Monotreme
Wynyardiids
Dromornithid
Amerodelphian
Crocodile
Djarthia

1. What do the fossils found in each of these layers tell you about the landscape of ancient Queensland?

2. Starting from the top, why are there so many differences between layer 1 & 2, and between layer 3 & 4? What might have happened during these time periods?

3. What can we learn from fossils that we cannot identify from studying rocks?

4. Examine the fossils in each layer. What can you learn about the evolution of living things in Queensland from these fossils?

5. Read the *Changing Surface of the Earth* below, and plot the major time periods and conditions of Queensland on a timeline.

The Changing Surface of the Earth

Queensland has a diverse and complex geology that reflects the varying origins, many environments and different time periods that have helped shape the state's modern topography. Most of the world's major divisions of geological time are represented in the rocks and landforms that occur across Queensland, with the exception of the Archean Era (3800-2500 million years ago). During this very ancient time period, the Earth's crust began to stabilise and the primordial atmosphere and earliest oceans came into being.

Triassic Period—Queensland

252–201 million years ago

240 million years ago all of the world's continents were joined together forming a supercontinent, called Pangea.

The Triassic Period was the beginning of the Age of Dinosaurs and it was marked by continuing climatic and environmental change. On a global scale, the climate varied from hot and dry at the beginning of the Triassic to warm and wet in the later stages. However, Australia experienced cooler conditions because it was further south than it is now.

At this time, Australia was part of Gondwana and was joined to Africa, South America, Antarctica and India. In the early Triassic, erupting volcanoes continually reshaped the eastern edge of Gondwana. Inland, vast rivers flowed across the endless plains dotted with lakes.

During the late Triassic, extensive wetland areas formed in what is now northern New South Wales and south-east Queensland and there were also forests of conifers, cycads and ferns. Some of Australia's major coal deposits were formed within this ancient environment.

The first dinosaurs are known from this time and footprints of these animals have been found in eastern Australia. Amphibians and fishes lived in the lakes and streams and strange creatures who were the ancestors of mammals walked the land.

Jurassic Period—Queensland

201–145 million years ago

A Time for Giants!

Australia still looked very different from the continent we know today. It remained part of the supercontinent of Gondwana, but Africa and South America started to break away.

The warm Jurassic climate and massive networks of fast-flowing rivers carrying sediment through deep valleys created a rich covering of vegetation throughout Australia. Thick pine forests with an understory of ferns and cycads sheltered dinosaurs and other animals.

Horsetails, ginkos and other plants were common. Dinosaurs were the dominant life form.

Cretaceous Period—Queensland

145–66 million years ago

105 million years ago Africa and India have split away from Gondwana leaving Australia and South America connected to Antarctica.

The Great Inland Seas

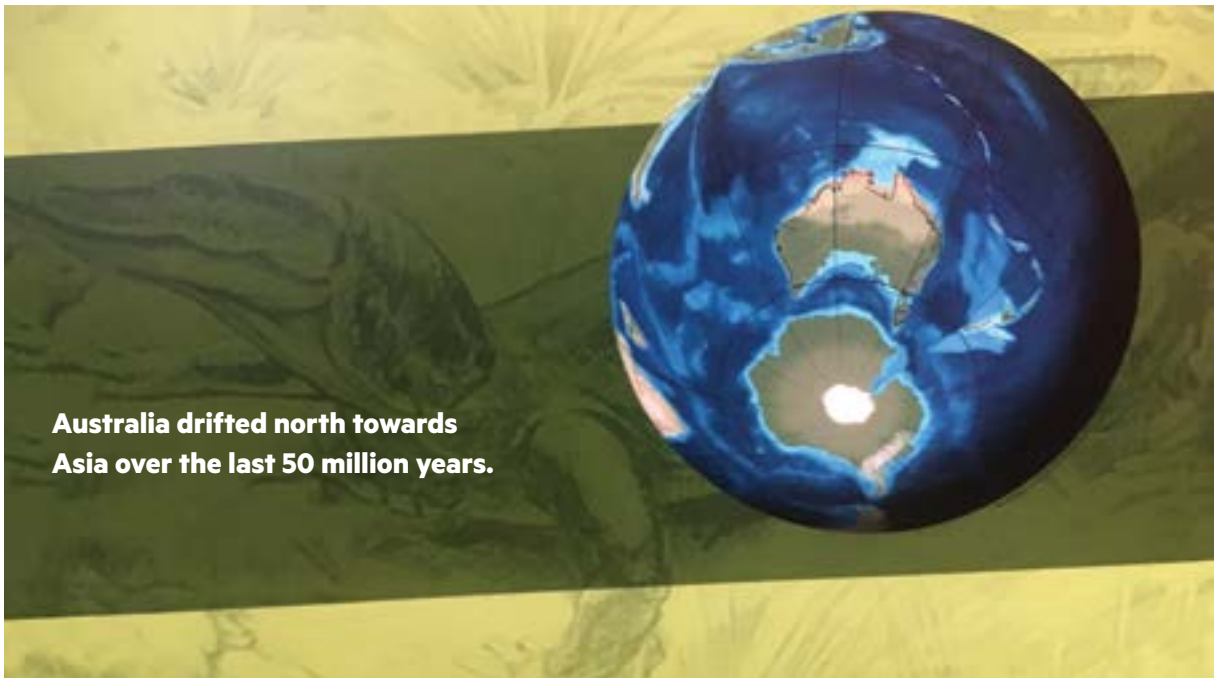
Australia was still well south of the equator, at latitude 55°S, but was slowly travelling north and rotating in an anti-clockwise direction. Violent volcanic eruptions and movements in the Earth's crust were tearing eastern Gondwana apart.

At different times during the Cretaceous Period, eastern Australia was inundated by five separate inland seas. The largest inland sea, about 110 million years ago, covered one-third of the land mass. The shallow waters of the inland seas supported marine reptiles, turtles, sharks and other fish. Giant squid up to 4m long roamed the depths and other squid-like animals such as ammonites, belemnites and nautiloids darted through the cool waters.

Beneath the surface, a wide muddy sea floor stretched for hundreds of kilometres. Conditions were poor, but clumps of sponges, marine plants and oyster-like bivalves, with crabs and lobsters scuttling in between, managed to survive. At the edges of this great sea, dinosaurs browsed on vegetation and pterosaurs hunted for fish. Occasionally, after they died, the bodies of these terrestrial animals were washed into the sea. Today they are found as fossils in the rocks of the Great Artesian Basin.

Palaeogene Period—Queensland

66–23 million years ago



First large mammals appear — 66–56 million years ago

Oligocene extinction event — 56–34 million years ago

Mammals are dominant — 34–23 million years ago

The mass extinction of 66 million years ago marks the end of the dinosaurs and the emerging dominance of mammals. Survivors of this catastrophic event include the mammals, lizards, snakes, frog and crocodiles, and the last surviving group of dinosaurs – the birds.

Australia's final separation from Antarctica occurred during the Palaeogene, as Australia began its slow transit north toward Asia. As an island, our species evolved into animals unlike anywhere else on Earth. This includes unique species of kangaroos, emus and koalas.

The journey north to our present position took millions of years and formed a new southern seaway, the Southern Ocean. Tectonic forces in the east caused buckling along the edges of the Australian continent, lifting the crust by a few hundred metres. A small subsidence to the west also resulted in a series of shallow depressions, including the formation of the Lake Eyre Basin.

Deep weathering and erosion in western Queensland occurred during this period due to high precipitation levels and a warm, humid climate. This resulted in the formation of most of Queensland's opal deposits. Opal is Australia's principal gemstone, with more than 95% of the world's precious opal originating from the rocks of the Great Artesian Basin. In Queensland's south-east this was also the period of peak volcanism.

Neogene Period—Queensland

23–2.6 million years ago

Grasses become widespread — 23–5.3 million years ago

Human ancestors (Hominids) appear — 5.3–2.3 million years ago

The Neogene Period marked the great drying of Australia. During this period Australia had moved significantly northwards to the mid latitudes. The Australian continental plate crashed into Southeast Asia where massive tectonic upheaval forced New Guinea out of the Pacific Ocean, causing a rain shadow effect over inland Australia. Climate change forced rainforests to retreat to the eastern seaboard, reducing this habitat greatly in size. Animals had to adapt to these changing conditions or face extinction.

As the interior of the continent began to dry out, open forests of eucalypts, acacias, casuarinas and grasses began to adapt to the new conditions and flourish. These adaptations can be seen in the way plants have developed strategies to conserve water and avoid water loss. The opening up of new grassland habitats allowed enormous new species to evolve: the megafauna.

Quaternary Period—Queensland

2.6 million years ago — present

Ice Age begins — 2.6 million years ago

Earliest humans appear — 2.6–0.0117 million years ago

Humans are dominant and Ice Age ends — 0.0117 million years ago – present

Extreme climate variability marks the Quaternary Period. Due to alternating ice ages and interglacial periods the climate cycled between moist and arid conditions, and this resulted in rapid changes to ecosystems across the continent.

The unstable conditions impacted most severely on rainforests, which remained greatly reduced and continued to be further overtaken by dry-adapted woodlands and grasslands. Plants and animals had to adapt to environments that were more prone to fire. The semi-arid climate and dry inland areas that are now so typical of much of the modern Australian continent developed in just the past few million years.

However, the Australian climate, and therefore the environment, is not static and is continuing to respond to natural and human influences on both global and local scales. We rely on these environments for survival; extinctions and environmental changes today may impact on human survival into the future.