Australia's Four-Billion-Year Diary

Study Guide

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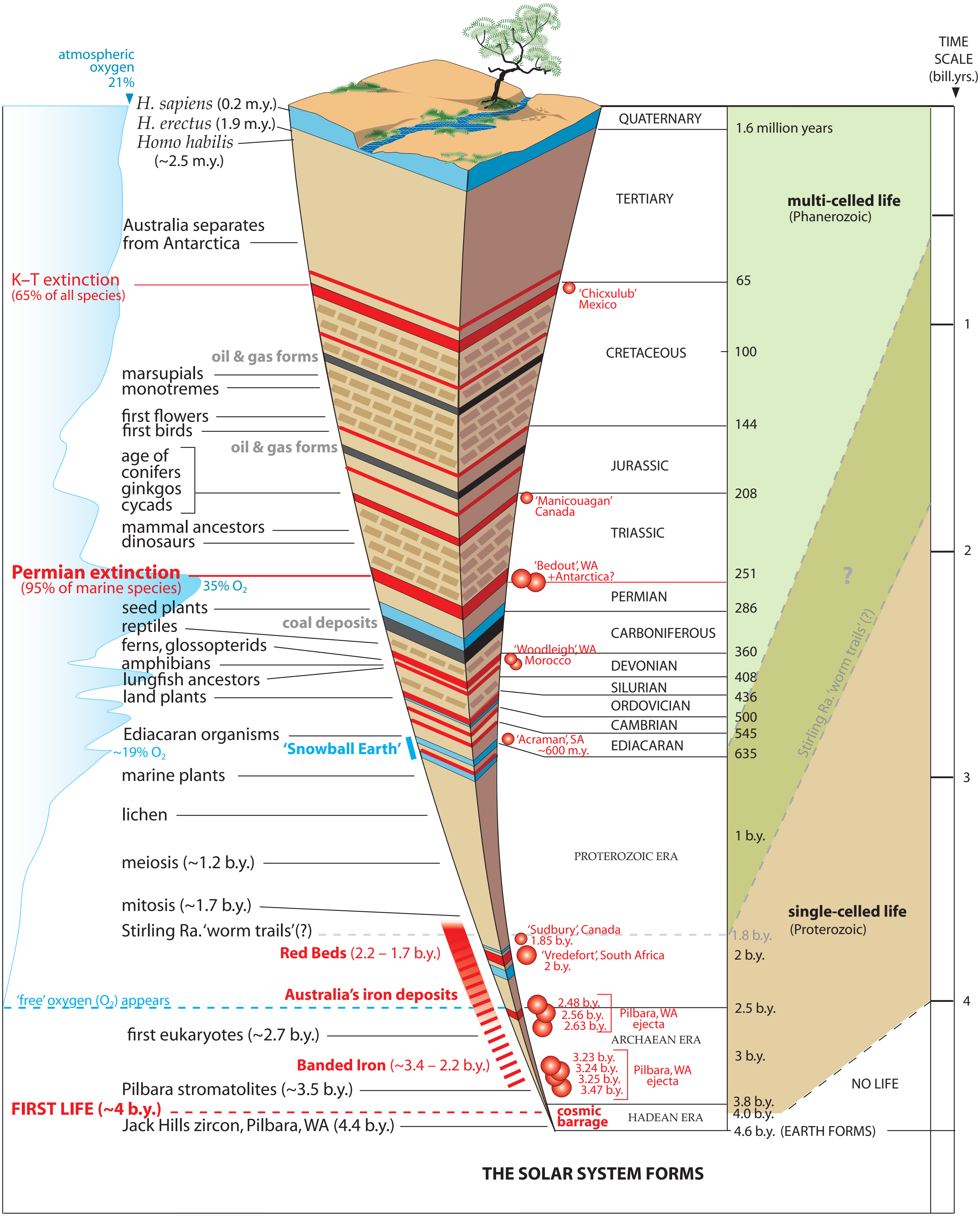
Evolution and the Geological Time Scale

ice age
mass extinction
impact scar (100-200 km diam.)
impact scar (>200 km diam.)
m.y. = million years
b.y. = billion years



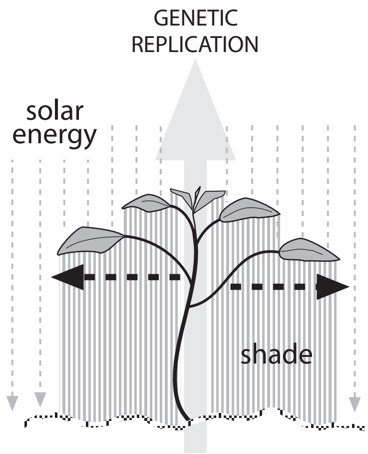
EVOLUTION

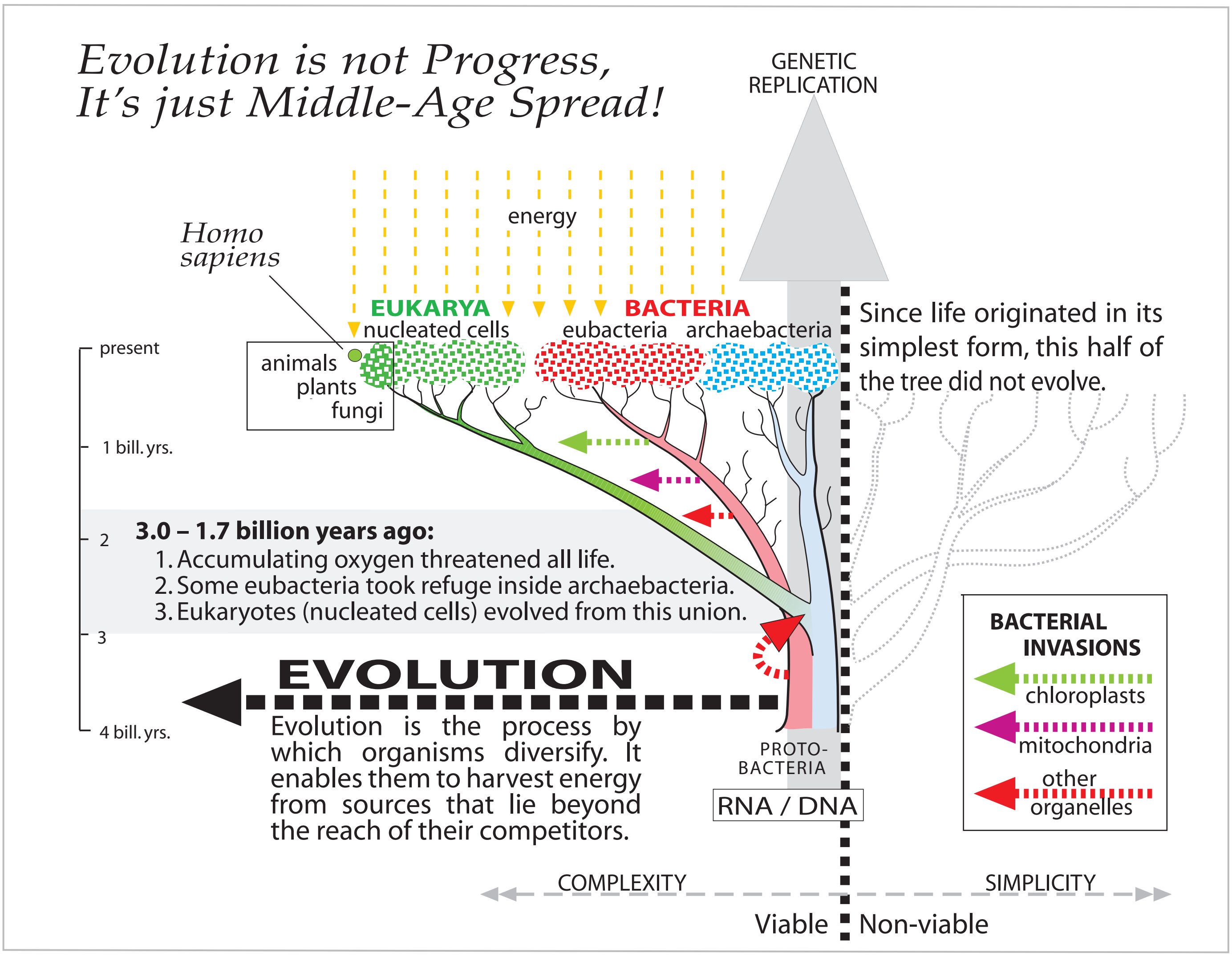
The flow of energy throughout the cosmos conforms to the laws of thermodynamics and confirms the theory known as Chaos. Consequently, all components of the cosmos are governed by the same rules and are universally chaotic and fractal, regardless of scale.

Earth's atmosphere and its weather systems are a prime example of this. Life too, is an expression of the particular energy gradient that invests the biosphere of this small watery planet, so organisms are essentially agents of energy dispersal. They harvest energy from the Sun and from the body of the planet and continually redistribute it through the biosphere until it leaks eventually into the cold and empty matrix of space. Therefore Earth's biosphere and its biota of 30 – 100 million species represent a cooling mechanism that counters the planet's natural Greenhouse gases and maintains optimum conditions for its own survival. This process provides the primary evidence for the theory known as Gaia.

The Tree of Life

All Life shares a single driving mechanism—genetic material (DNA and RNA). These complex molecules can survive only by replicating themselves, so the sole drive of all life is reproduction. This requires energy. Plants, for example, harvest most of their energy from the Sun, thanks to photosynthetic bacterial components in their leaves. But as their leaves grow and multiply, increasing shade from central leaves forces a plant's lower branches to grow continually outward in search of more light. Similarly all life is continually forced 'outwards,' acquiring complexity both in structure and behaviour in order to harvest energy that lies beyond the reach of simpler competitors. Since we humans are not only complex and dominant, but also harvest more energy than other species, we have convinced ourselves that we epitomise evolutionary 'Progress'. This anthropocentric fairytale is our most dangerous delusion.





Relics from the past

Queensland lungfish (Pangaea)

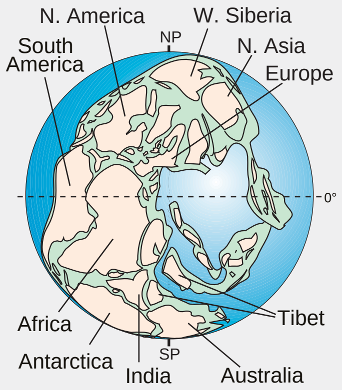
Tasmanian mountain snrimp (Pangaea)

Honey possum (Gondwana)

Pangaea

250 mya

All of the world's major landmasses were compacted into a single gigantic supercontinent, Pangaea, between 300–200 million years ago. This offered land life a rare opportunity to disperse almost from pole to pole. Aquatic species too, were able to disperse easily via the vast network of Pangaean rivers, swamps, and shallow inland seaways. Nowhere is this fact more apparent than in Australia. Among species that best display a Pangaean origin are the Queensland lungfish and the Tasmanian mountain shrimp.



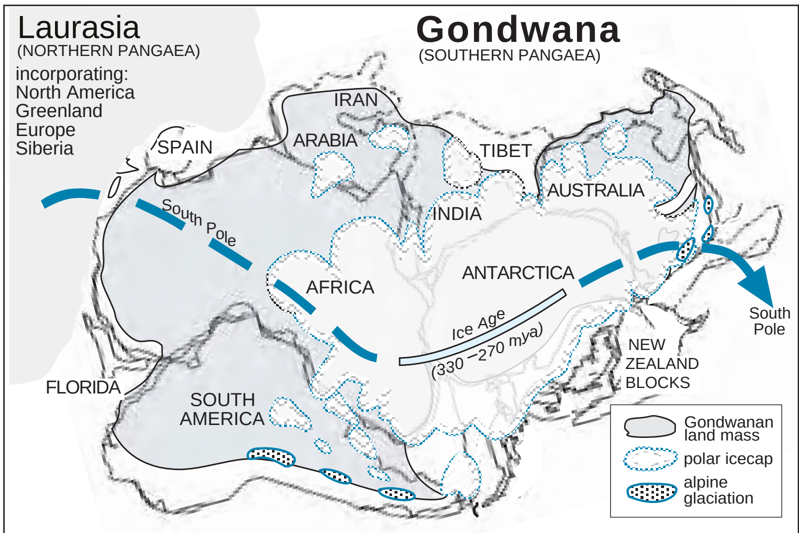
PANGAEA

1. What effect did Pangaea have on the global environment?

2. Name two of the most significant biological by-products of this traumatic environmental period?

3. Pangaea began to tear in half a little less than 200 million years ago. Name the two halves.

4. Where do Australia's marsupials appear to have originated?



Cool Gondwanan rainforests that once shook to the tread of dinosaurs continue to grow in many parts of Tasmania, and the dominant species—Antarctic beech, southern conifers, and tree ferns—have altered little in the past 100 million years. In fact, so similar are Australia's two species of beech to species that grow in New Zealand, New Caledonia, and South America that it is clear that all three species must have shared a common ancestor. If that was the case, then all three landmasses must once have been linked together via Antarctica. It was this evidence that ultimately helped to convince the scientific world that continents do move and that a southern supercontinent, Gondwana, had existed. Once this was understood, the curious family links among species on all southern landmasses made sense.

GONDWANA

1. The map of Gondwana shows what is called a polar wander path, in which the pole appears to have moved. What really happened?

2. Find out the scientific name of the tree family that helped to prove the theory that continents move and that South America, Australia, and New Zealand were once linked via Antarctica.

3. When and where did monotremes originate, and what animal group was their main evolutionary competitor at that time?

4. Marsupials are not native to New Zealand. What does this tell us?

Antarctic beech forest near Cradle Mountain in northern Tasmania.

Land of athletes,

Strong, fast, and tireless over long distances, Australia's kangaroos epitomize the extremes of adaptation that the region's biota had to achieve to survive during the past 40 million years of savage environmental change. Endowed also with one of the most economical and sophisticated reproductive systems in the animal kingdom, kangaroos are the only mammals that are able to nurture three generations of offspring at once, with an embryo in the uterus, a baby attached to one teat in the pouch, and an adolescent joey out and about but returning to feed from a second teat that supplies a modified "adolescent" formula. Meanwhile, should the season deteriorate, the mother can suspend development of the embryo until conditions improve!

Shown here in full flight, this female red kangaroo displays the elegant combination of power, economy, and grace that makes kangaroos the most accomplished long-distance athletes in the animal kingdom.

opportunists,

Australia's arid regions boast an astonishing number of water-dependent animals, especially desert crustaceans and frogs. These shield shrimps, for example, survive from flood to flood by laying vast numbers of dust-sized, drought-proof eggs that blow about on the wind until the rains return. Meanwhile frogs survive by filling their bodies with water as floods recede and then burrow deep into the protective sands of their desert habitat. Once they are safe from the desiccating heat at the surface, they throttle back their metabolism until it is barely ticking. By this process (aestivation) they can survive droughts that may last for years.

and economists

Animals had the advantage over plants as Australia dried out and heated up: they were mobile and could burrow. By moving their homes underground, they found that they could escape the heat of the day in a state of torpor and emerge to feed, fight, and mate in the cool of the evening. With a few notable exceptions (such as the thorny devil, at right) most of Australia's arid-zone fauna now spend their days underground.

LEFT: This daunting face belongs to the timid and harmless thorny devil, a small ant-eating lizard that lives in Australia's deserts. It rarely drinks and need only to brush past dewy vegetation for its skin to absorb some water while siphoning the rest to the corners of its mouth.

LEFT: Filled with nectar harvested from the scale insects that live on desert acacias, clusters of grape-like repletes provide Australia's honeypot ants with a ready source of food. Such well-stocked larder chambers also offer valuable insurance against drought.

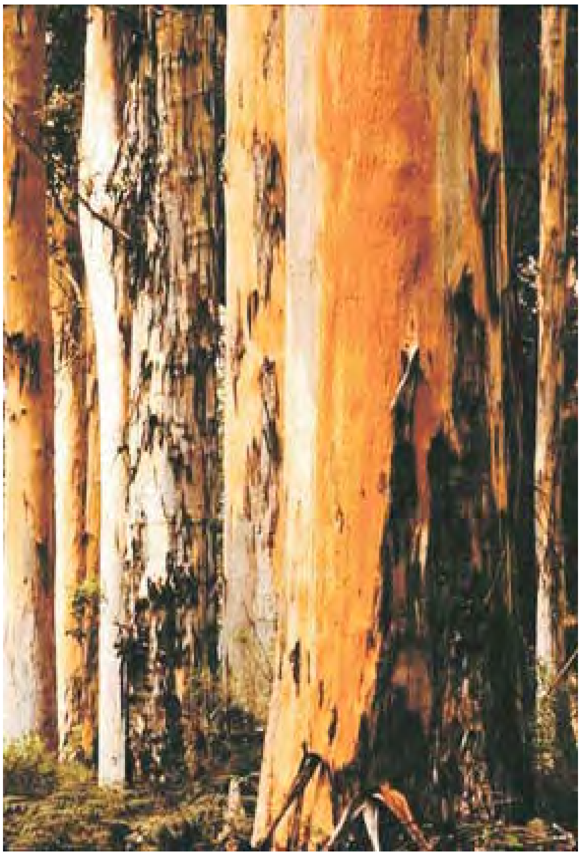
1. Australia is the land of reptiles. Why are they so successful in that environment?

2. There is only one coursing predator in Australia. What is it? How and when did it arrive?

3. What was a diprotodon? How large did it grow?

4. What does aestivation mean?

Land of athletes,



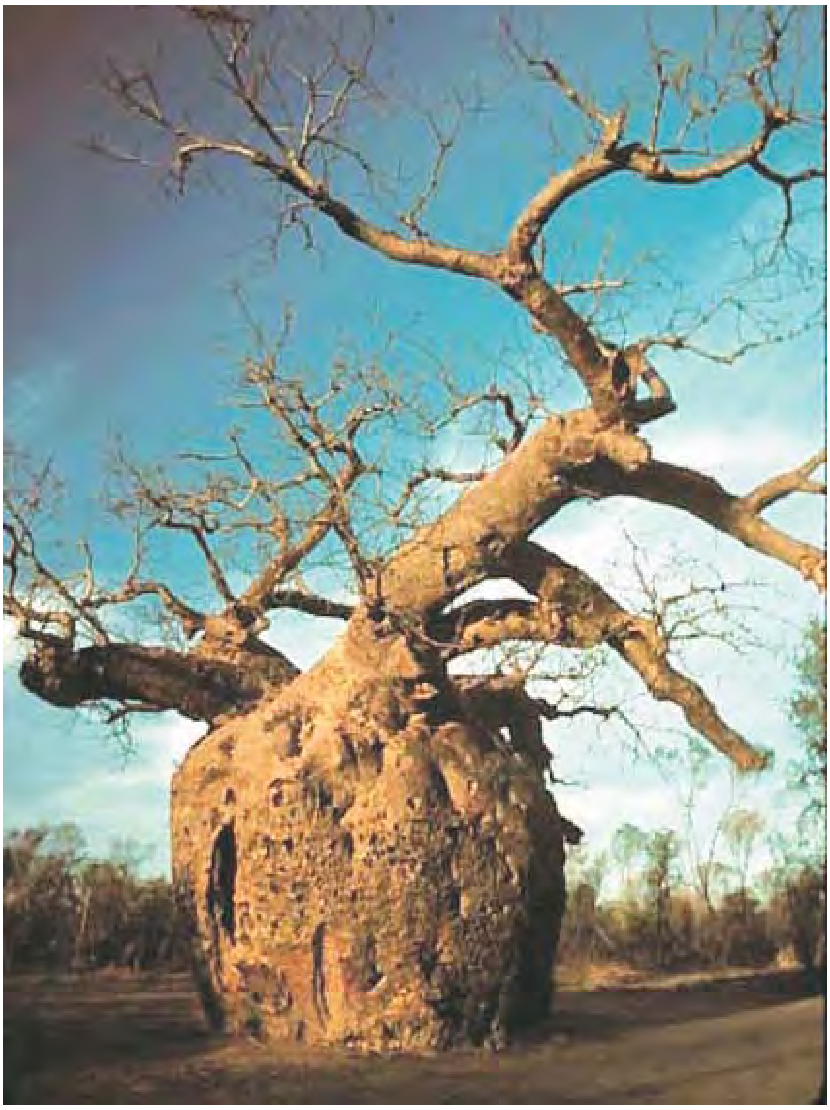
LEFT: The giant karri trees of southwestern Australia are the tallest flowering plants in the world. When loggers first moved into the area, the largest trees were more than 300 feet tall and rivaled the tallest of America's sequoias.

opportunists,

In wet years Australia's desert sands erupt with flowers, in this instance, composite daisies that are affectionately known as poached eggs. Their seeds may lie dormant for years, waiting for such an opportunity.

and economists

Poor soils, and a harsh, unreliable climate have forced plants to minimize their nutrient requirements and cut their water losses to a minimum. Two of the most spectacular water economist are the boab tree and the dunna dunna bush of Western Australia. The boab now sheds all of its leaves in summer and the dunna dunna, a relative of the hibiscus, has reduced its leaves to the point that it looks like a scaly cactus.



1. Australia was cloaked in lush vegetation 40 million years ago. It is now mostly semi-desert. Give two reasons.

2. How did most plants cope with this change?

3. Name the two most successful/common plant families in Australia.

TOP: Caught in a shaft of dawn sunlight, Uluru (Ayers Rock) glows beneath a thunderous sky. Its rock is formed from sediment washed from a chain of mountains that bisected the continent 600 million years ago. ABOVE: The Petermann Range is all that remains of the massive fold mountains that gave birth to the sediment embodied in Uluru. BELOW: Draped here in moonlit winter snow, the Bogong High Plains of northern Victoria are among Australia's youngest mountains.

Bones of a continent

Of all the world's continents Australia is by far the flattest. Most of it consists of waterless sand plains sprinkled with some hardy grasses and a few stunted trees. But it was not always so.

Chains of alpine mountains have risen and fallen here, and inland seas have come and gone. It has been ravaged by mile-high sheets of ice at least four times in the past 2.3 billion years alone, and just 40 million years ago it was cloaked in rainforest. In short, this is a continent worn down to its very bones. The few ranges that protrude through the sand of its modern plains are the skeletal remains of mountainous foundations, and the sands that shroud them are the dusty remnants of their soaring, snowy peaks.

1. Why are zircons used to date ancient rocks?

2. How old are the oldest fossils, what are they called, and what kind of organism made them?

3. Why are continents permanent features of the Earth's surface?

4. How do continents move, and what is the name of the geological science that deals primarily with this process?

5. What is the process of plate movement that underlies all of the world's great mountain chains?

Australia's Four-Billion-Year Diary

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VICTORIA—No references listed
SOUTH AUSTRALIA—No references listed
WESTERN AUSTRALIA—No references listed
NORTHERN TERRITORY —No references listed
TASMANIA—No references listed
ACT—No references listed