

# Gondwana

## Geology



When it comes to explaining New Zealand's unique range of flora and fauna to visitors, it is impossible not to refer at some point to the beginnings of our land. The earth's activities of over millions of years have played a major role in determining the make up of New Zealand's natural environment today.

### What was Gondwana?

Two hundred million years ago the continents of Antarctica, South America, Africa, India and Australia were joined together as a single super-continent known as Gondwana, or Gondwanaland. At this stage the area which later emerged as New Zealand lay between southeast Australia and west Antarctica, most of it under the sea.

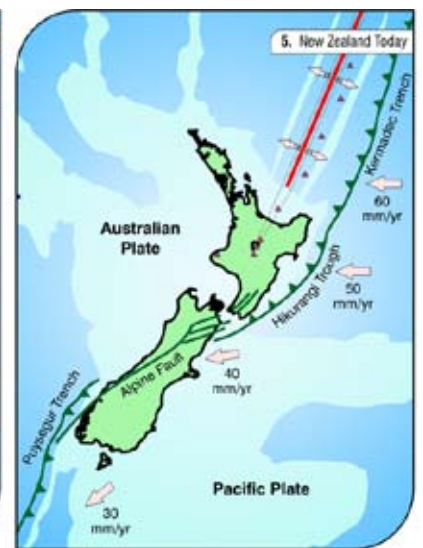
The majority of the older rocks of New Zealand were formed by sand and mud settling on the seabed offshore from Gondwana, with layer upon layer accumulating. Deep burial and plate tectonic movements compressed and shifted these rocks, while others were formed through igneous processes (deep crustal melting forming granites and volcanic rocks) associated with plate boundaries. By 100 million years ago most of the rocks forming the 'basement' of ancestral New Zealand had been assembled on the margin of Gondwana. Plants and animals

from the super-continent spread onto the land that would become New Zealand, including ferns and early conifers, spiders, snails and the ancestors of native frogs and the tuatara.

### The birth of New Zealand

Movements from within the earth caused the break up of Gondwana. About 80 to 50 million years ago the Tasman Sea formed as a result of new sea-floor being created, splitting New Zealand from Australia and Antarctica. During and following this time erosion began to reduce the mountainous land to a flat plain. Low-lying swampy areas were formed, then eventually the sea covered most parts of the land leaving only a scattering of small islands. Limestones were formed, in which bones of whales and penguins were fossilised along with many other smaller sea creatures.

New Zealand next experienced major geological upheaval beginning about 24 million years ago when a new plate boundary between the Pacific and Australian plates began to move. Earthquakes, volcanic activity and the uplift of land began near where the two plates collided. These processes have been particularly active over the last 2–3 million years forming the Southern Alps, the North Island ranges and volcanic zones, and shaping New Zealand as we know it today.



Diagrams: GNS Science /www.gns.cri.nz



## The ice ages

The climate fluctuations known as the ice ages began about two and a half million years ago. During cold times there were extensive glaciations, much lowered tree lines and lowered sea-levels. The cooler parts of New Zealand not under ice were covered in scrub and grasslands, while forest area was much reduced. Our alpine flora evolved and survived in these cycles of climate by shifting up and down mountains to find suitable habitat. Cold-sensitive plants and animals either became extinct during the colder periods or retreated to coastal and northern areas where the climate may have been liveable (refugia). About 15,000 years ago the last cold period began abating and the climate has been relatively warm and stable since about 10,000 years ago.

## Early inhabitants

### Flora

New Zealand had a flora characteristic of Gondwana before it broke away from the super-continent. The southern beech (*Nothofagus*) species, which form extensive forests in the South Island and the ranges of the North Island, date back to Gondwana. This is known because closely related species are also found in distant fragments of the former continent such as Tasmania and South America, whereas beech seeds are only rarely carried by birds and die in sea water. Fossil beech leaves, seeds and pollen have also been recorded from rocks of Gondwanan age. Fossilised remains also show that podocarps, an early family of primitive conifers, were common on Gondwana 135 million to 65 million years ago. These are close relatives of the tall forest trees rimu, miro, totara, kahikatea and matai that commonly dominate current day New Zealand forests. Tree ferns also date back to Gondwana times. These three groups (beeches, podocarps and ferns) being dominant in many forests, New Zealand has the best examples of Gondwana-like forests anywhere in the world. Many species evolved after the split from Australia and other plant seeds carried by ocean currents and winds also found their way here, but the flora of newer flowering trees is less prominent in New Zealand than elsewhere.

### Fauna

One of the most striking things about New Zealand's native fauna is the distinct lack of mammals. Dinosaurs ruled the land at the time New Zealand split away from Gondwana, early mammals were evolving but apparently hadn't yet established themselves on the land that would become New Zealand. Clearly the abundant marine mammals (whales, dolphins and seals) we have had no trouble swimming here. Our only native land mammals are bats (two small species) whose ancestors could fly here after the split.

But as New Zealand drifted away from Gondwana it did carry some passengers, including birds of the ratite family who were the ancestors of kiwi and moa, related to the emu, cassowary, rhea and ostrich of

other Gondwana land masses. Tuatara, earthworms, centipedes, millipedes, spiders, weevils, slugs, snails and weta were all onboard too. Skinks and geckos are believed to have made their way to New Zealand floating on rafts of vegetation. Other birds including the ancestors of the rifleman, kokako and saddleback made the flight here across the opening Tasman Sea while others arrived later when the ocean barrier was much as today.

Birds began to fill the roles which elsewhere in the world are occupied by mammals, such as large browsers like moa and top predators like the giant eagle. Without the predatory land mammals which developed on other continents born out of Gondwana, many of the species which colonised in New Zealand have evolved into the unique species we know today. Most notable is the evolution of flightless birds such as kiwi, kākāpo (night-parrot) and takahe.

## Did you know?

Gondwana was not a stationary landmass before it split into the continents we know today. Great forces within the earth caused it to move with respect to the poles and equator. Scientists can tell that Gondwana (and its fragments after break-up) moved around using the apparent orientation of the earth's magnetic field of those earlier times recorded in some rocks. Some fossils and rocks also show supporting evidence of different climates at different times. The continents aren't stationary today either. The tectonic plates and continents sitting on them are continuously moving, most at speeds of a few centimetres per year.

## For more information

*The Concise Natural History of New Zealand*, Harriet Fleet

*Natural history of New Zealand*, Nic Bishop



### 'Cool' fact

During the coldest parts of the ice ages sea levels were about 120 m lower than present day levels because so much water was locked up as ice (mainly in the great ice-caps of the northern hemisphere). The North, South and Stewart Islands were then all joined as one land mass.



Illustrations: L. Hartley