A journey through the earth history of
Australia's Coastal Wilderness

Part 7 The coastline and the Tasman Sea

Disaster Bay

Bingie Bingie Point – Gulaga from the north

Aragannu, Mimosa Rocks National Park

7. The coastline and the Tasman Sea

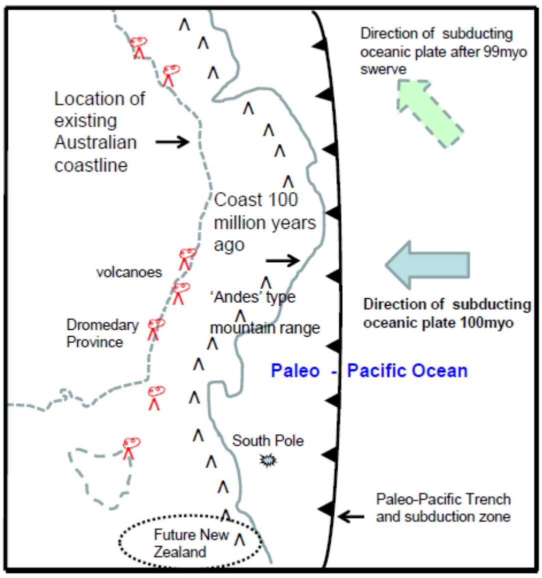
The most obvious landscape feature in Australia's Coastal Wilderness is of course the coastline itself. How did it establish itself at its present location? We have seen that, 20,000 years ago, the coastline was about 20 km to the east. But in the mid-Cretaceous, the region was about 400 km from the ocean, and was part of a remnant of the Gondwana supercontinent. The figure below shows the coast lying 400-500 km to the east of today's coastline.

It is thought that today's east coast formed during continental rifting processes, with thick continental crust being split and a new ocean progressively formed each side of a volcanically active mid-ocean ridge - a process that is underway today in the Red Sea and the Great Rift Valley of Africa. The separated continental pieces rafted away to each side of the widening rift with a new sea appearing in between.

Australia's western and southern margins were formed by this classic continental rifting mechanism. But the east coast seems to lack the signature fault structures and sedimentary basins that typify rifting.

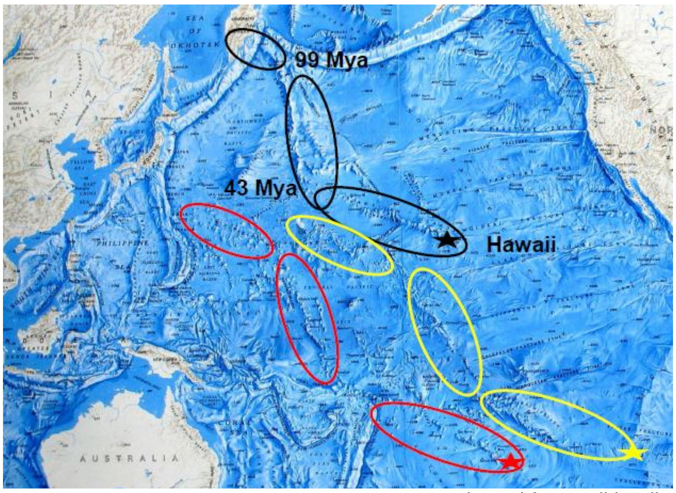
Before 99 million years ago, the Palaeo-Pacific Plate had been moving westward and crunching into what is now the eastern edge of continental Australia (actually the eastern edge of the Gondwanan supercontinent). This ongoing conveyor-belt movement had been happening since 516 million years ago (Mya), in the mid-Cambrian period), a remarkable span of 417 million years. During this time the eastern edge of continental "Australia" stepped outward from just east of Adelaide by fits and starts at an average rate of 3mm per year. This continental growth occurred through welding of oceanic crust and associated sediment to the continental edge, accompanied by volcanic activity and episodes of granite intrusion into the newly added material, stabilising the growing continental edge.

Along the modern coastline, we can see part of this history of addition. The deep-sea black chert at Narooma and Mallacoota now forms part of the land, but originated in the deep ocean thousands of kilometres east of its present location. The oceanic materials moved westwards, conveyor belt style, to become welded to the growing Australian continent.



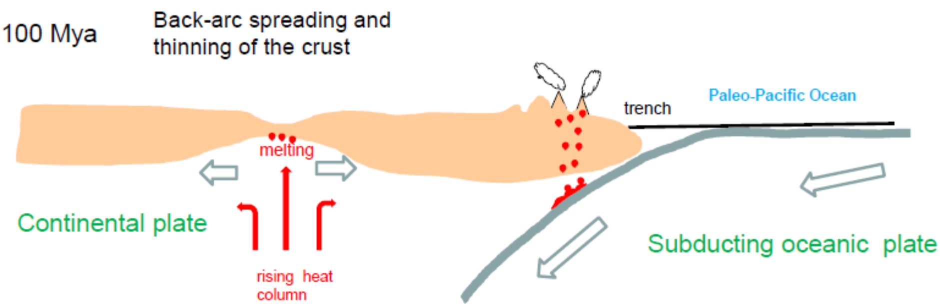
At 99 Mya the head-on collision of the Pacific Plate significantly swerved to the right by almost 60º (and back again 43 Mya). The causes of these swerves are not clear however global scale tectonic events can have impacts on the motion of distant regions.

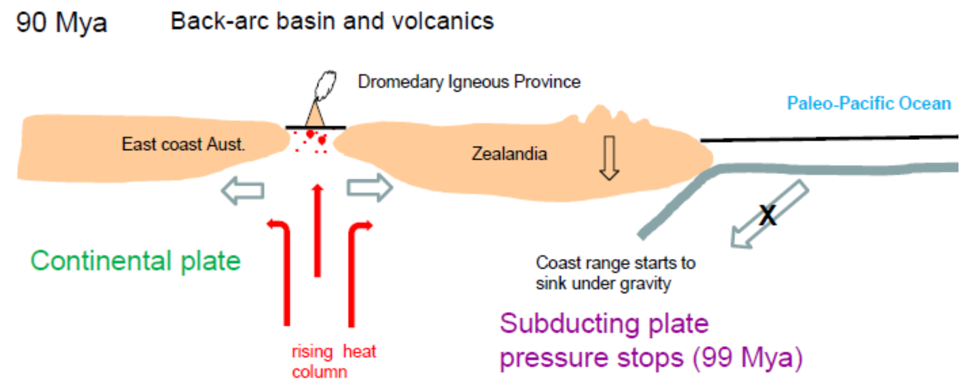
The course of the Pacific Plate can be tracked by the location of deep earth hotspots. The diagram below shows the location of these hotspots currently under Hawaii, and other Pacific sites. The hotspots generate regular volcanoes onto the Pacific Plate moving above it. As the plate drifts away from the stationary hotspot the location of older and older volcanoes record the eruption time and the direction of the drifting plate. The line of progressively older volcanoes clearly shows the 99 Mya and 43 Mya swerves of the direction of the Pacific Plate.

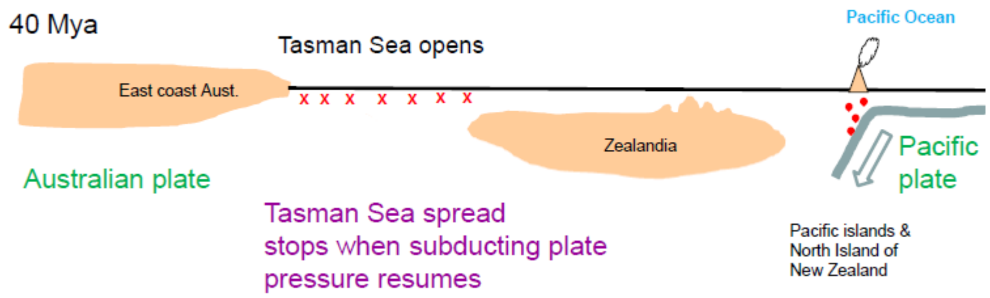


Adapted from Wikipedia

Changes in the motion of the Pacific Plate are thought to have triggered the formation of the Tasman Sea. The change in direction slowed the rate of westward movement of the Pacific Plate. As the plates slowed down, the volcanic mountain belt along East Gondwana, buoyed up by hot melted rock beneath it, began to collapse and spread out. The partly molten layer of rock under the thinning crust pushed upwards and broke through. Further collapse of the crust allowed the Tasman Sea to start to form. Torn off chunks of continental crust became the various segments of Zealandia, including the huge submerged mass of continental crust underlying the ocean east of Lord Howe Island and New Zealand.





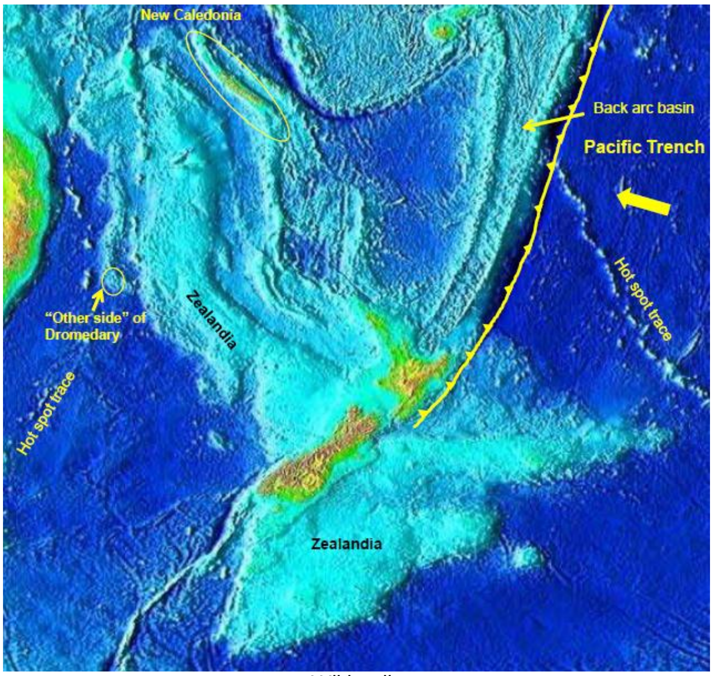


When the Pacific Plate changed direction again 43 million years ago, the Tasman Sea stopped widening. The changes in direction of the plate motions are marked by zigzags in the trails of seamounts – subsea volcanoes – formed above hot spots in the mantle that remained stationary as the crustal plates moved overhead.

Today we see the Pacific Plate's western margin east of Tonga, marked by a deep ocean trench and a line of active volcanoes – part of the Pacific 'Ring of Fire'. This trench system is readily seen on the bathymetric maps above and below.

The rupture with Zealandia opened like a peeling banana from the south with the sea starting as a rift 84 Mya then a narrow gulf at the north, widening to the south. By the end of the Cretaceous (65 Mya), the land of Zealandia would still be visible from our region across the waterway, albeit without its dinosaurs because of the planet-wide mass extinction of that date. By 43 Mya, spreading of the Tasman Sea stopped with the swerve of the Pacific Plate back to the east, an event recorded on the hot spot trace of the Pacific Ocean floor shown above.

These events left their mark on the Pacific landscape, now mostly covered by water, in the bathymetric image below. The separated Gondwanan continental crust, including Zealandia, is lighter in weight and more buoyant than oceanic crust. The lighter crust underlies the shallower areas of the western Pacific Ocean, seen here as light blue areas of sea floor northwest and southeast of New Zealand. The re-established Pacific Plate trench and subduction zone lie off to the east of it all.

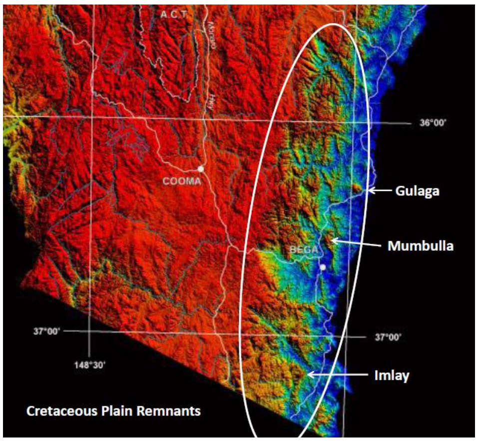


Wikipedia

The 43 million year event also saw Tasmania's connection to Antarctica severed and the acceleration of Australia northward by about 7 cm per year (70 km per million years), ending the cool, dry climate that characterised most of the continent, and taking the northern edge of the continent into tropical latitudes.

It is no coincidence that the Dromedary Igneous Province, part of the Cretaceous igneous province in eastern Australia dates to the 99 Mya change in direction of the Pacific Plate.

The model described above not only explains the location of the east coast and Tasman Sea, but also may explain the landscape between the coast and the escarpment. The inland Cretaceous Plain (Part 3 of this geoheritage journey) collapsed as the crust thinned and ruptured to form today's continental shelf. It was like taking away the legs of one side of a table. The Plain remains on the escarpment (and inland) and the old plain surface extended to the continental edge with an even downhill slope of just over 1º. Since the collapse the forces of erosion have cut deeply into this plain surface, forming the rugged hinterland. Notwithstanding this rugged terrain there is a steadily decreasing surface of the plain remnants that remain as mountain peaks and hilltops.



DPI NSW

The Plain remnants can be beautifully seen sitting above the fog.

NSW National Parks and Wildlife Service

The summit ridge of Gulaga and the inland features such as Stand Alone Peak generally conforms to this 1º model.

Stand Alone Peak, north west of Cobargo