On the creation of the Antarctic Circumpolar Current (ACC) – from little quakes, big currents grow.

By Colin Lynam (retired seismologist)

Earthquakes are faulting fracture-bursts of energy, releasing the stress build-up, by the constantly sliding tectonic plates, that we live upon. In Australia, we are moving North – NW, at about 7-10 cm per year, as we are pushing away from Antarctica. The geology beneath becomes compressed and sporadically fractures.

The other day, Friday May 7th, an unusual **magnitude 6 earthquake occurred south-west of Tasmania,** near the spreading seafloor rift that oozes the newest lava rocks, beneath the Great Southern Ocean. It was detected by seismographs across the globe and reported by a Russian science journal.

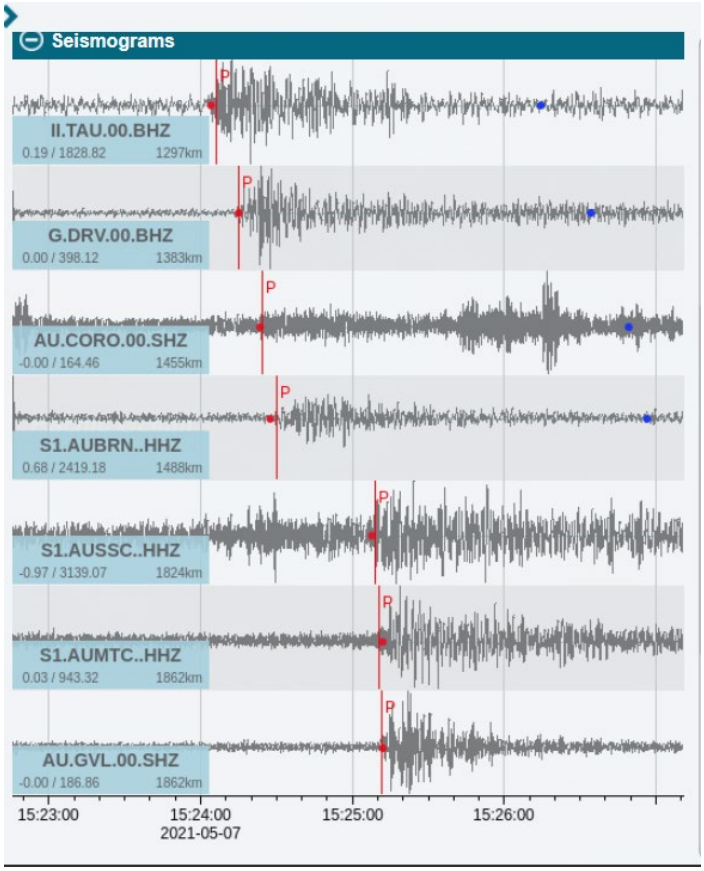
Earthquake M 6.0 - west of Macquarie Island
MOSCOW (UrduPoint News / Sputnik - 08th May, 2021) An earthquake with a magnitude of 6.0 struck off the southern coast of the Australian island of Tasmania on Friday, according to the European-Mediterranean (805 miles) south of the city of Hobart. The quake hit a depth of 23 kilometres.
No damages or casualties have been reported.
(https://www.urdupoint.com/en/world/magnitude-6-earthquake-registered-in-southern-1245354.html)

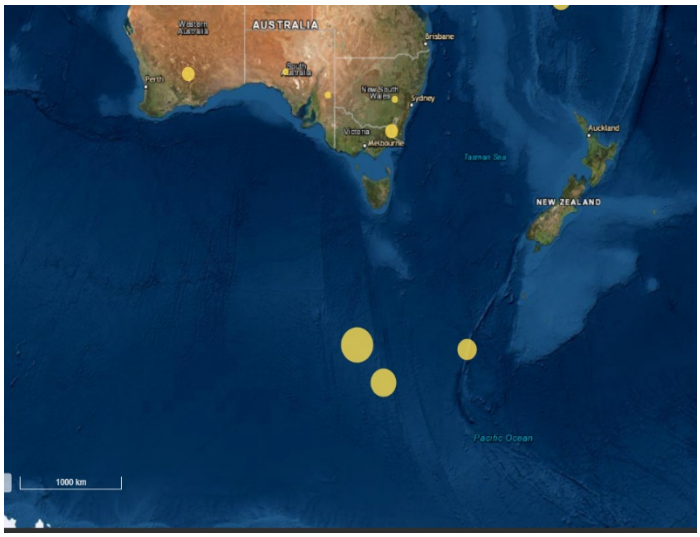
It is evidence of the ongoing tectonic escalator system, further separating the Australian continent from the Antarctic continent. 30 million years ago, this process created the world's largest ocean current – **the Antarctic Circumpolar Current (ACC**). Let's investigate it further.

Earthquake Epicentre information

DATE 2021-05-07 15:21:13 (UTC)
Location 54.407°S 144.195°E
Depth 10.0 km depth and distanced from-

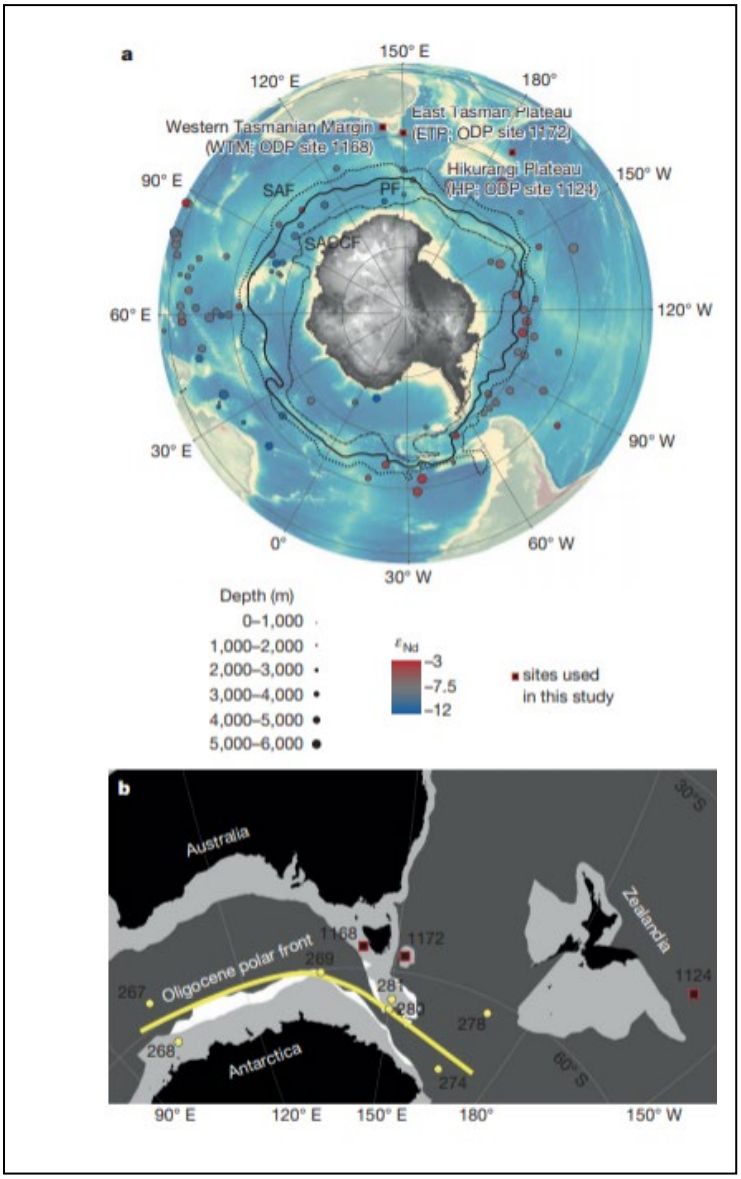
- 1262.7 km (782.9 mi) S of Geeveston, Australia
- 1287.9 km (798.5 mi) SSW of Kingston, Australia
- 1297.1 km (804.2 mi) SSW of Sandy Bay, Australia
- 1298.9 km (805.3 mi) SSW of Hobart, Australia
- 1303.2 km (808.0 mi) S of Glenorchy, Australia





Here, we see some of the seismogram records, that enabled the earthquake epicentre to be located.as shown on the above map. (Courtesy of Geoscience Australia, https://earthquakes.ga.gov.au/)

But this event leads us to a bigger tectonic story. Recent research shows us that "Tasmania (while) separating from Antarctica about 35 million years ago created the Tasmanian Seaway and for a long-



time scientist have thought that the opening of this seaway enabled the onset of the ACC, but we've found out this is not the case." Said Dr Joanne Whittaker from University of Tasmania's Institute for Marine and Antarctic Studies. (Whittaker 2021)

"We discovered that opening the Tasmanian Seaway on its own wasn't enough. It needed to move far enough north to be in the westerly wind band. When the seaway first opened it was too far south. Once it moved further north, the westerly winds were able to drive water through the seaway, and the Earth's biggest ocean current began," Dr Whittaker said. See the sequence of tectonic plate shifts in diagram below.

"The Antarctic Circumpolar Current (ACC) is the world's largest ocean current. It flows clockwise around Antarctica because there are no land masses in the way and it plays a role in maintaining the large ice sheets on Antarctica because it keeps warmer ocean waters away," Dr Whittaker explained.

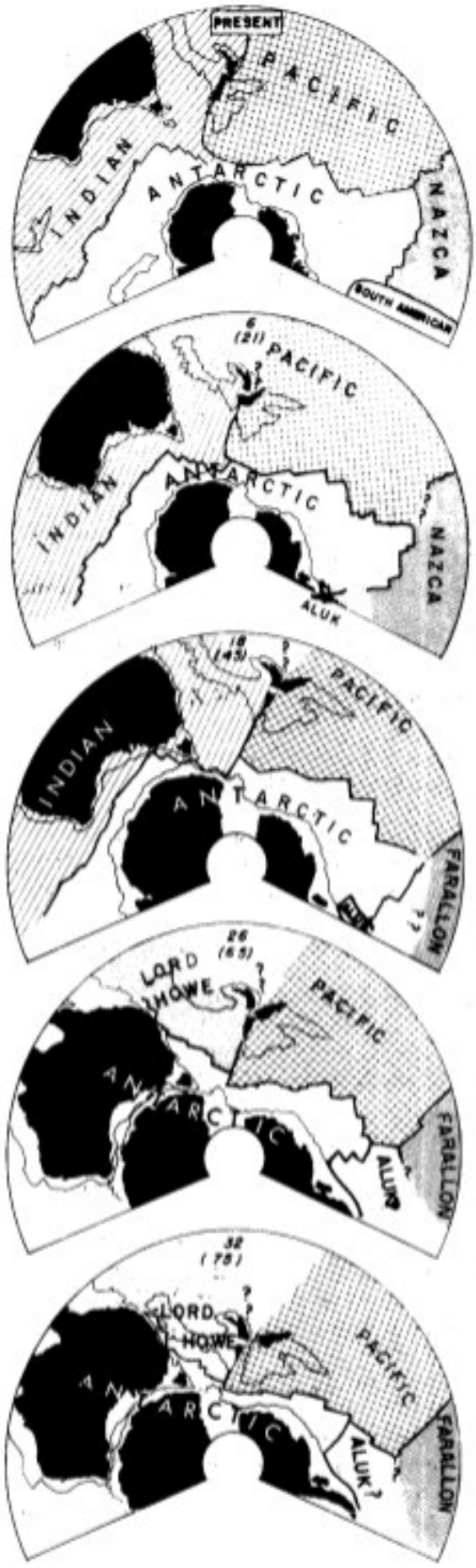
The above maps show the present-day Southern Ocean and relevant study sites. a, **Map showing study sites, present-day zonal eNd distribution**, and major frontal zones. Black squares with red borders show the present-day locations of the sediment cores used in this study. Black lines show the meridional extent of the major frontal zones associated with the ACC30. Circles show the locations of Southern Ocean ferromanganese (Fe–Mn) nodules found on the seafloor 7. The colour of the circles shows the eNd values of the surface layers; these surface layers are in equilibrium with overlying bottom water.

The size of the circles reflects water depth. SAF, Sub-Antarctic Front; PF, Polar Front; SACCF, Southern Antarctic Circumpolar Current Front.

b, **Reconstruction of the early Oligocene (30 Ma) tectonic plates around the Tasmanian Gateway** (the narrow gap between Antarctica and Australia). Continents with present-day shorelines are in black. Light grey indicates the continental shelf; dark grey denotes ocean basin/oceanic crust. White bands along the outer continental shelf illustrate the range between the outermost and innermost geophysical expression of the COB on the South Tasman Rise (light grey and white lobe south of Tasmania) and Antarctic conjugate margins8 . Yellow circles indicate the reconstructed position of Deep-Sea Drilling Program (DSDP) sediment cores, with microfossil assemblage data19 used to reconstruct the Oligocene position of the polar front (yellow band). Red squares indicate the reconstructed positions of Ocean Drilling Program (ODP) sediment cores, used to obtain fossil fish tooth eNd records in this study. (The plate reconstruction was made using GPlates (http:// www.gplates.org)). (Sher et al 2015)

By studying to be a geologist or geophysicist we can learn to create tectonic reconstructions of how the earth looked millions of years ago. Earth is always changing the shape of continents, forming new mountain chains and erupting new volcanic lava, dust and gas and depositing those under lakes and seas.

Tasmania and Southern Australia once had glaciers and ice fields. Watch these diagrams (below) and imagine the climate changes to Tasmania over 70 million years.

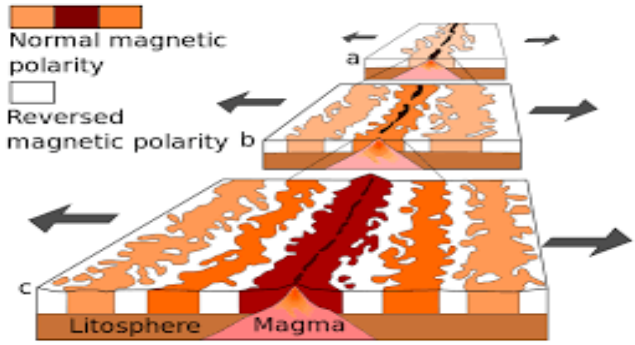


In this sequence of diagrams, we see a collage of tectonic reconstructions, starting from **the present day** and going backwards in time to (**21 M years bp**), then to (**45 M years bp**), then (**65 M years bp**) and finally (**75 M years bp**). Australia began separating from Antarctica around 83 M years bp. (Weissel et al 1977)

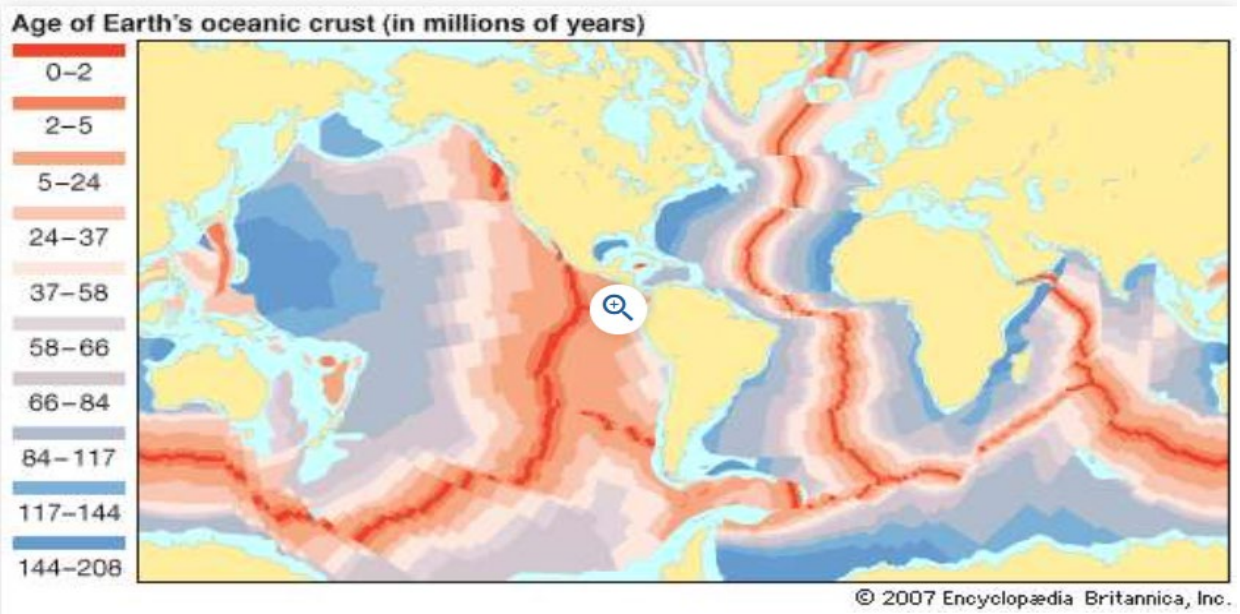
Through dating measurements of subsea sediments, it is estimated that the East Tasman Plateau subsided constantly after separation from Antarctica.

How could they create those reconstructions? Well, they measured the remnant magnetism of each sample taken from the sea-floor. When magma oozes from the volcanic rift chain, the iron molecules align to the earth's magnetic field, present at the time of occurrence. The earth periodically changes magnetic poles and new rocks take on a different alignment, as we see in the diagram below.

A marine magnetic anomaly is a variation in strength of Earth's magnetic field caused by magnetism in rocks of the ocean floor. Marine magnetic anomalies typically represent 1 percent of the total geomagnetic field strength. They can be stronger ("positive") or weaker ("negative") than the average total field. Also, the magnetic anomalies occur in long bands that run parallel to spreading centres for hundreds of kilometres and may reach up to a few tens of kilometres in width.



In this diagram, we can see that the earth exudes the newest rock formations (red) along the constantly upwelling of sea-floor spreading and then pushes the oldest sea-floor rocks down underneath overriding continents (light blue), in a process called subduction.



age of Earth's oceanic crust

The age of Earth's oceanic crust can be presented to show the pattern of seafloor spreading at the global scale.

Image: Encyclopædia Britannica, Inc.

(Luyendyk 2016)

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