



# Zealandia: Earth's Hidden Continent

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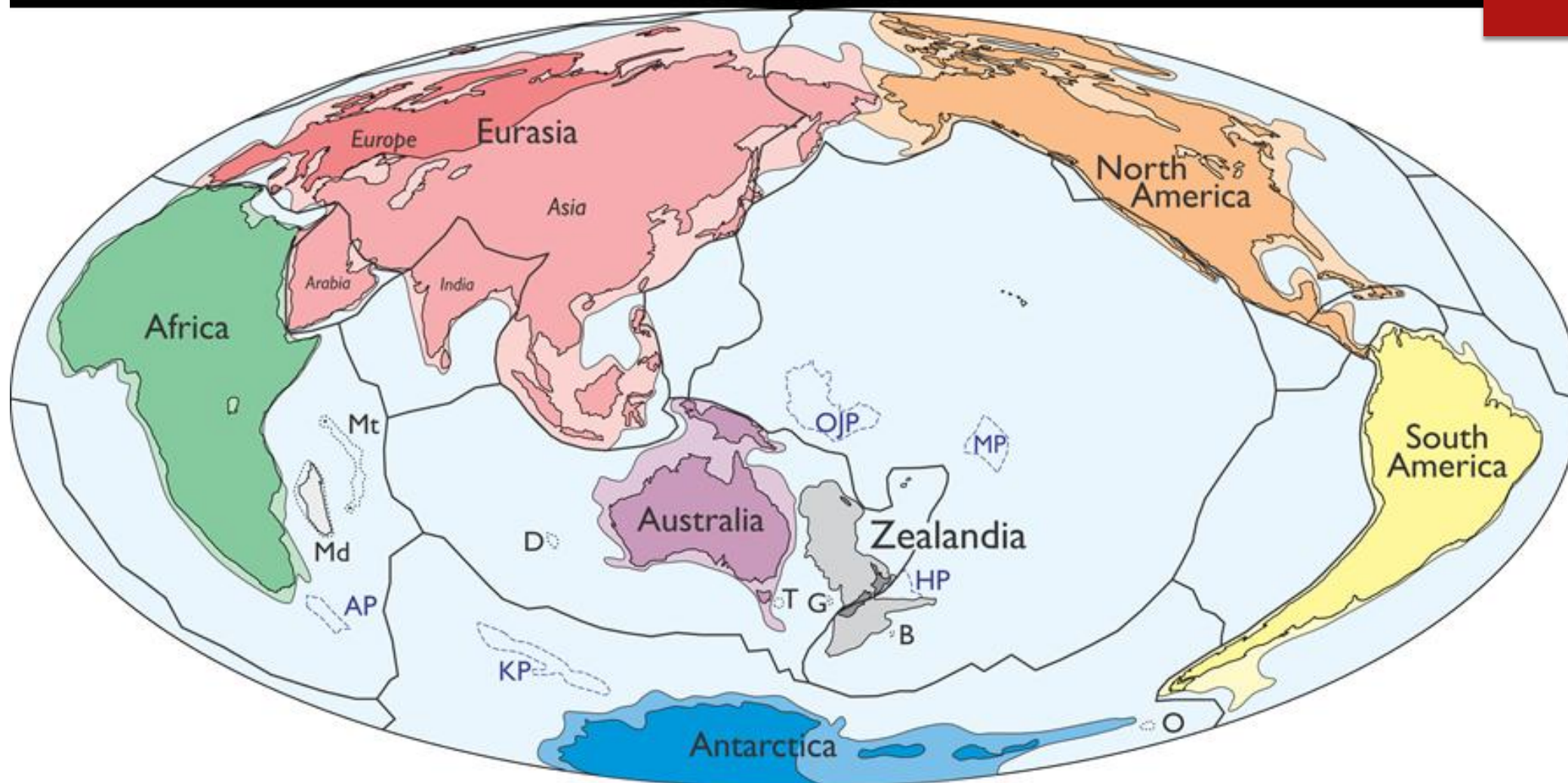
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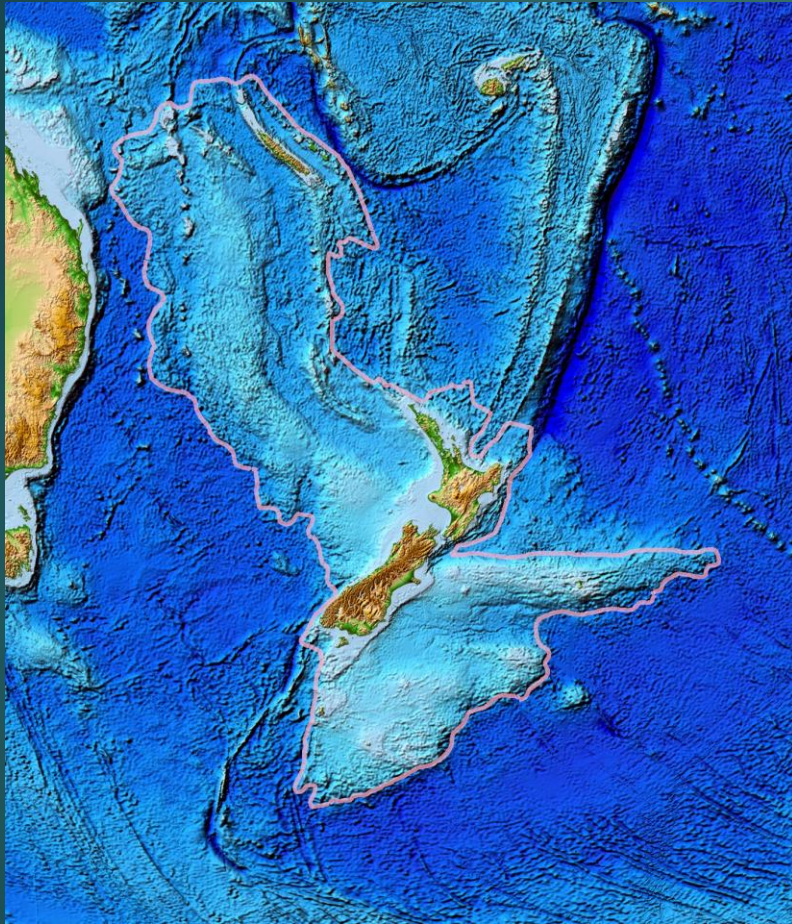
# Zealandia: What is it?

- ▶ 4.9Mkm<sup>2</sup> mass of continental crust in southwest Pacific
- ▶ ~94% submerged mainly as a result of widespread Late Cretaceous crustal thinning preceding supercontinent breakup
- ▶ The total land area of Zealandia is 286,655 km<sup>2</sup>. Of this, New Zealand comprises the majority, at 267,988 km<sup>2</sup>
- ▶ Also known as the New Zealand Continent or Tasmantis
- ▶ Once made up ~5% of Gondwana, its size & other factors are why researchers are pushing for Zealandia to be considered the 8<sup>th</sup> continent of Earth
- ▶ The name Zealandia was first proposed by Luyendyk (1995) as a collective name for New Zealand, New Caledonia, the Chatham Rise, Campbell Plateau, and Lord Howe Rise





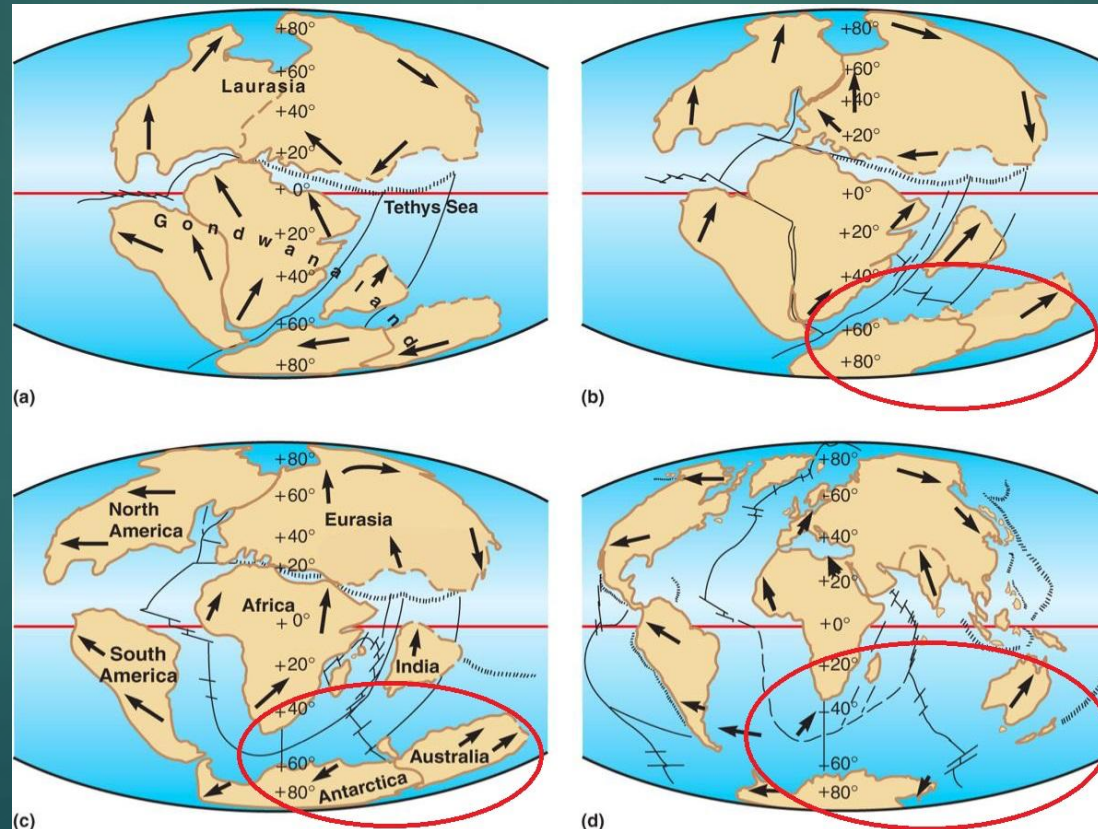
# Map of Area





# Zealandia: When?

- ▶ Once part of Gondwana, Zealandia and Australia separated from Antarctica together approx 85-130 MYA
- ▶ Australia and Zealandia then split from each other approx 60-85 MYA

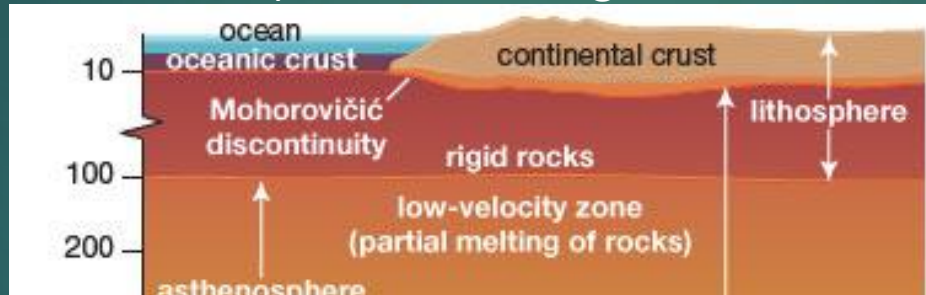


# Purpose of Research Paper

- ▶ “Summarize and reassess a variety of geoscience data sets and show that a substantial part of the southwest Pacific Ocean consists of a continuous expanse of continental crust.”
- ▶ “To formally put forth the scientific case for the continent of Zealandia (Figs. 1 and 2) and explain why its identification is important”
- ▶ To create an “endmember” for continents
- ▶ Researchers want Zealandia to be commonly recognized as the 8<sup>th</sup> continent of the world and for that to be formally taught in schools

# What counts as a continent?

- ▶ 2 types of Earth crust:
  - ▶ 1) Continental - has average density of about  $2.7 \text{ g/cm}^3$
  - ▶ 2) Oceanic - density is about  $2.9 \text{ g/cm}^3$



- ▶ Earth is then divided into 14 major tectonic plates
- ▶ These 2 facts are essential in providing a descriptive framework to understand and investigate Earth's history and geologic processes.
- ▶ Continents are Earth's largest surficial solid objects, and it seems unlikely that a new one could ever be proposed.
- ▶ "one of the Earth's major land masses, including both dry land and continental shelves" (Neuendorf et al., 2005) - *Glossary of Geology*

# What counts as a continent? Cont.

- ▶ To be considered a continent 4 criteria must be met:
  - ▶ 1) High elevation compared to surrounding regions of oceanic crust
  - ▶ 2) Broad range of igneous, metamorphic, and sedimentary rocks high in silica
  - ▶ 3) Thicker crust and lower seismic velocity structure than oceanic crustal regions
  - ▶ 4) Well-defined limits around a large area
- ▶ New Zealand was listed as a continent by Cogley (1984), but he noted that its continental limits were very sparsely mapped



# 1) High elevation compared to surrounding regions of oceanic crust

- ▶ Continents and their continental shelves vary in height but are always elevated relative to oceanic crust (Cogley, 1984).
- ▶ The existence of elevated underwater features north and south of New Zealand has been known for more than a century (Farquhar, 1906).
  - ▶ The accuracy and precision of seafloor mapping have improved greatly over the past decades.

## 2) Broad range of igneous, metamorphic, and sedimentary rocks high in silica

- ▶ Rocks of today's ocean crust are typically comprised of basalt and gabbro
- ▶ Continents are comprised of diverse igneous, metamorphic, and sedimentary rocks, such as granite, rhyolite, limestone, quartzite, greywacke, schist, and gneiss, arranged in orogenic belts and sedimentary basins
- ▶ Truth for Zealandia is provided by the many island outcrop, drill core, xenolith, and seabed dredge samples of greywacke, schist, granite, and other rocks high in silica that have been found within its limits over the past 20 years
- ▶ There is a predictable regional composition and continuity to the offshore basement geology

### 3) Thicker crust and lower seismic velocity structure than oceanic crustal regions

- ▶ Christensen and Mooney (1995) give an average P wave velocity of 6.5 km/s and average thickness of 46 km for orogens and 30 km for extended crust. – Archetype for continent
- ▶ Oceanic crust is typically 7 km thick and typically has a P wave velocity of 7.5 km/s (White et al., 1992)
- ▶ Zealandia has a continental crust velocity generally less than 7 km/s and a thickness from 10 to 30 km throughout its entirety, & up to >40 km under parts of South Island



## 4) Well-defined limits around a large area

- ▶ The six recognized geological continents are not only large, but they are also spatially isolated by geologic and/or bathymetric features.
- ▶ “we propose that the name continent be applied to regions of continental crust that are  $>1 \text{ Mkm}^2$  in area and are bounded by well-defined geologic limits.”
  - ▶ By this definition India, prior to its collision with Eurasia, would be termed a continent
- ▶ Australia and Zealandia continental crust approach to within 25 km across the Cato Trough
  - ▶ 3600 m deep and floored by oceanic crust
  - ▶ Separated by Cato Fracture Zone along which there has been  $\sim 150 \text{ km}$  of dextral strike slip movement
    - ▶ This tectonic separation means that the Zealandia continental crust is physically separate from that of Australia

# Biogeography of New Zealand

- ▶ Several elements of Gondwana biota are present in New Zealand today:
  - ▶ plants, such as the podocarps (an ancient evergreen gymnosperm family of trees) and the southern beeches (genus of 43 species of trees and shrubs)
  - ▶ distinctive insect fauna
  - ▶ unusual frogs and the tuatara (reptiles endemic to New Zealand)
- ▶ New Zealand's pre-human biodiversity exhibited high levels of species endemism (being unique to a defined geographic location)
- ▶ Also had no terrestrial mammals except for bats and seals before humans. The main component of the terrestrial fauna was insects and birds

# Biogeography of New Caledonia

- ▶ world's highest rate of endemism
  - ▶ 5 families, 107 genera and 3,380 species.
    - ▶ 44 species of Gymnosperm in the archipelago, 43 are endemic
    - ▶ *Parasitaxus ustus* – Rare and unique parasitic gymnosperm found only on New Caledonia
- ▶ Some genera originated in the Gondwanian Antarctic flora
  - ▶ Due to this, New Caledonia shares many plant families with New Zealand
- ▶ The New Caledonia Great Barrier Reef is the second largest barrier reef in the world
  - ▶ The reef has great species diversity with a high level of endemism
- ▶ Has a remarkable marine fauna due to the abundance of relic organisms
  - ▶ Ex: some sponges of the Lithistideae and the Tetractinellideae which are considered living fossils
- ▶ New Caledonia and New Zealand share many plant families with Tasmania, the Valdivian forest of South America, Australia, habitats of cloud forest and temperate rainforest



# Zealandia: Why is it important?

- ▶ A more accurate description of Earth's surface is only logical
- ▶ A correct accounting of Earth's continents is important for multiple fields of natural science
- ▶ It is still not well known to the broad international science community
- ▶ At 4.9 Mkm<sup>2</sup> , Zealandia is substantially bigger than any features termed microcontinents
- ▶ With such unique and distinct characteristics of biology and geology, Zealandia cannot be compared to anywhere else
- ▶ "That a continent can be so submerged yet unfragmented makes it a useful and thought-provoking geodynamic end member in exploring the cohesion and breakup of continental crust." - lead author Nick Mortimer

# Why has it gone ignored?

- ▶ Satellite gravity-derived bathymetry maps (e.g., Fig. 2) have been of immense use in visualizing Zealandia, clarifying its limits
- ▶ This is not a sudden discovery but a gradual realization
  - ▶ 10 years ago would not have had the data or confidence to write this paper
- ▶ “If the elevation of Earth’s solid surface had first been mapped in the same way as those of Mars and Venus (which lack the arbitrary datums of opaque liquid oceans), we contend that Zealandia would, much earlier, have been investigated and identified as one of Earth’s continents.”

# Zealandia: Are we sure?

- ▶ Continents are defined by the *Oxford English Dictionary* as continuous terrestrial geographical features.
  - ▶ By this definition, Zealandia is not a continent. Indeed, it is 94% continental margin with an extended shelf.
- ▶ Geologists do not define continents: instead, they characterize the types of crust and geological features.
  - ▶ Geologists and geographers don't always agree. For example, geographers separate Europe and Asia while geologists lump them together into "Eurasia"



# Zealandia: Earth's Hidden Continent

End:  
Questions?

