Tracking the Northward Movement of the Australian Plate

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This resource was developed as a result of participation in CSIRO's teacher professional learning program, Educator on Board.

Tracking the Northward movement of the Australian Plate

Overview:

Students will interpret data on a graph to obtain the N-S offset distance between underwater seamounts of the Tasmantid and Lord Howe Island sea chains. Students are provided with the N-S offset distances to allow them to measure how fast the plate is moving Northwards, rather than total movement in an east or west direction.
Once the data has been obtained students will need to convert their data on a graph and calculate the speed of the Australian plate.

Adapted from a similar activity from the Lunar and Planetary Institute:
https://www.lpi.usra.edu/education/workshops/plateTectonics/HotSpotMotion.pdf

Duration:

This activity, including introduction, should take approximately 2 x 60min lessons

Introduction:

The students must be familiar with the concepts of plate tectonic movement and hot spot activity. Students should also be confident with graphing skills.

Students should be shown the introductory videos found at the link below
"What are sea mounts?" https://www.youtube.com/watch?v=4Lhi3X7PPYQ
"Hot spot Formation" https://www.youtube.com/watch?v=asUXBV12Btg

Then provide students with the Background Information, prior to beginning the activity on the next page. As a class, encourage students to brainstorm methods of determining how fast a tectonic plate is moving, or has moved in the past.

Inform students that a useful method to determine how fast a plate has moved (or is moving) is by taking the ratio of the distance the plate has moved in total, to the age of key underwater features created by hot spots, such as seamounts. Let them know they are going to work out the ratio of movement to age and determine the northward speed of the Australian plate over the last several million years.

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Required Equipment:

Per pair of students

- Map of Tasmantid and Lord Howe seamount chains
- Calculator
- 2 x sheets of Graph Paper
- Pencils and erasers

Activity:

Give the students the following instructions

1. Referring to the map provided, extract key information. For each seamount chain, calculate the distance between the youngest seamount and successive seamounts and record this data in the tables provided. Record the age of each seamount and record this data in the tables provided.
2. For the Tasmantid chain, use the first piece of graph paper to create a graph with age in millions of years on the “X” axis and distance in kilometres on the “Y” axis.
3. Plot your data and draw a line of best fit.
4. Calculate the gradient of your line of best fit (rise/run). This gradient should give you the speed of the plate in kilometres per millions of years.
5. On the second piece of graph paper create a graph for the Lord Howe chain data - age in millions of years on the “X” axis and distance in kilometres on the “Y” axis.
6. Plot your data and draw a line of best fit.
7. Calculate the gradient of your line of best fit (rise/run). This gradient should give you the speed of the plate in kilometres per millions of years.
8. Compare your two calculated “speeds” and discuss your answers with your class mates – are your values similar? Are they different? If they are different, why might they be different? Did your calculated speeds match those calculated by your classmates?

Extension challenge: Convert the speed of the Australian plate from km/millions of years to centimetres per year.

Background Information

There are so many secrets hidden under the sea along the east coast of Australia. Scientists have discovered a lost world of ancient volcanoes along the edge of the Australian tectonic plate, buried under the Coral and Tasman seas. In recent years, scientists have been mapping these volcanoes, now called seamounts, and collecting rock samples to learn more about how they were formed, how fast the Australian plate has drifted over time, and past climates.

These epic ancient volcanoes, believed to be formed by hot spot activity, run in two distinct chains – the Tasmantid seamount chain and the Lord Howe seamount chain. Some seamounts rise 3kms above the ocean floor, however others are concealed over 2km below the surface of the ocean.

Lord Howe Island - Photo Credit: David Stanley

The youngest of these seamounts is Lord Howe Island which formed 7 million years ago. This Island gives now gives its name to the seamount chain that can be found tracking northwards of the island. As you move northward from the youngest seamount in the chain, the seamounts become older and older.

The trend in age of these seamounts is thought to be due to the northwards motion of the Australian Plate over the asthenosphere. Under the Australian plate lies a hot spot – a fixed spot deep in the Earth where magma forms. As the Australian plate drifts northwards over this hot spot, a volcano can force its way through the crust of the plate and create an island. As the plate continues to drift northwards, the volcano stops erupting and a new one is eventually formed further down the plate. With time, the plate continues to drift in a mostly north direction. The volcanoes get older relative to the one active volcano sitting over the hot spot. As these volcanoes age, the crust upon which they sit cools and eventually subsides. This cooling, coupled with erosion of the island, leads to the shrinking of the islands with age. Often these islands eventually become submerged below the ocean surface.

Lord Howe Island is thought to be one such ancient volcano, formed by the hot spot under the Australian Plate.

Map of the Tasmantid and Lord Howe seamount chains

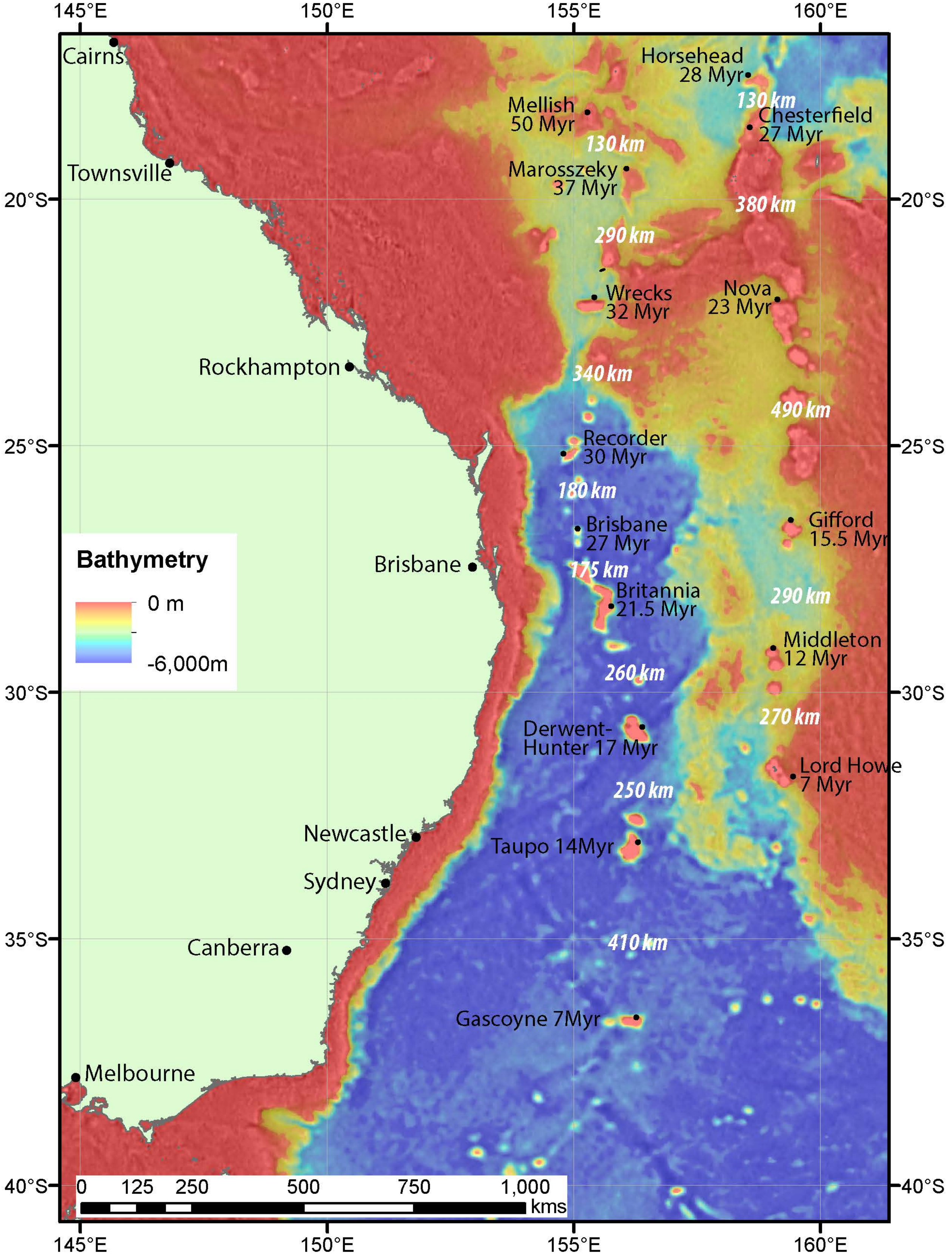


Figure 1: Map of the Tasmantid and Lord Howe Island Seamount Chains by Professor Jo Whittaker, University of Tasmania (shared with permission).

Age of the Tasmantid and Lord Howe seamount chains

Tasmantid Seamount Chain

Seamount Name	N-S Distance from Gascoyne Seamount along chain (km)	Age of Seamount (In millions of years)
Gascoyne	0	7
Taupo		
Derwent-Hunter		
Britannia		
Brisbane		
Recorder		
Wrecks		
Marosszeky		
Mellish		

Lord Howe Seamount Chain

Seamount Name	N-S Distance from Lord Howe Island along chain (km)	Age of Seamount (In millions of years)
Lord Howe Island	0	7
Middleton Reef		
Gifford Guyot		
Nova Bank		
Chesterfield Reef		
Horsehead Reef		

Reference List

ArentsAmityTeacher 2017, *Hot Spot Formation,* video recording, YouTube, viewed 31 October 2019, <https://www.youtube.com/watch?v=asUXBV12Btg>

David Stanley 2016, *Lord Howe Island*, Wikimedia Common, viewed 29th October 2019 <https://commons.wikimedia.org/wiki/File:Lord_Howe_Island_-_panoramio.jpg>

Lunar and Planetary Institute Education/Public Outreach 2019, *Hot Spot Activity*, Lunar and Planetary Institute, viewed 5th September 2019 <https://www.lpi.usra.edu/education/workshops/plateTectonics/HotSpotMotion.pdf>

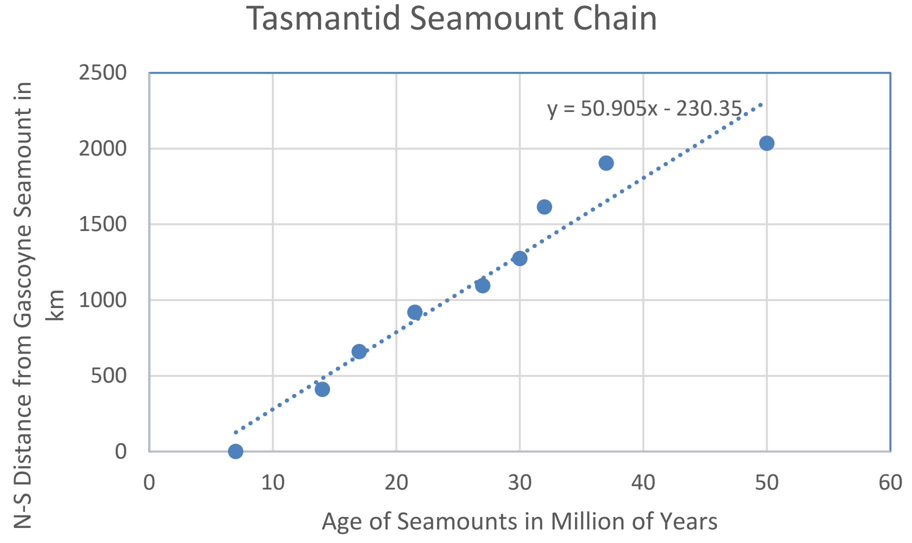
OCEANA 2018, *What Are Seamounts?*, video recording, YouTube, viewed 31 October 2019, <https://www.youtube.com/watch?v=4Lhi3X7PPYQ>

Results

Tasmantid Seamount Chain		
Seamount	Distance km	Age millions of years
Gascoyne	0	7
Taupo	410	14
Derwent	660	17
Britannia	920	21.5
Brisbane	1095	27
Recorder	1275	30
Wrecks	1615	32
Marosszeky	1905	37
Mellish	2035	50

Slope: = 50.905 km/my

= 5.0905 cm/yr

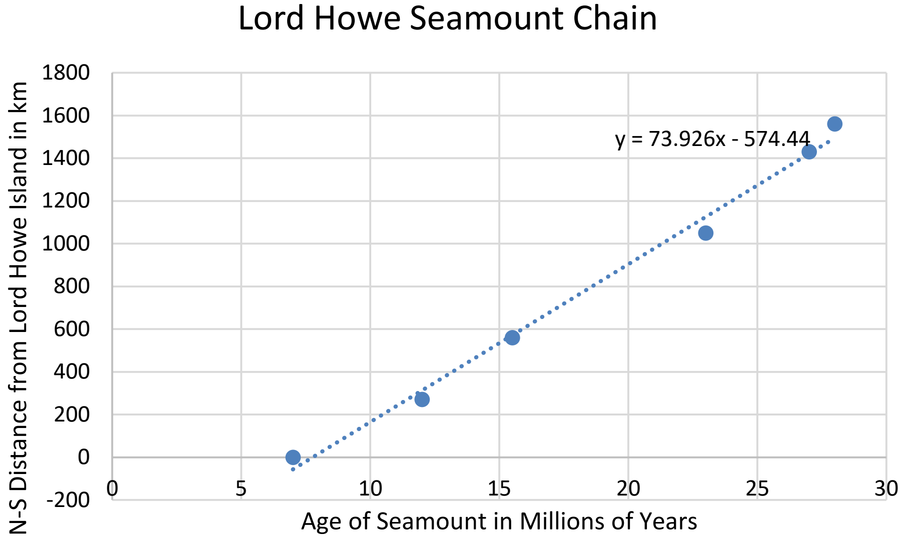


Results

Lord Howe Seamount Chain		
Seamount	Distance km	Age millions of years
Lord Howe	0	7
Middleton	270	12
Gifford	560	15.5
Nova	1050	23
Chesterfield	1430	27
Horsehead	1560	28

Slope: = 73.926 km/my

= 7.3926 cm/yr



Reference article:

Seton, M, Mortimer, N & Williams, S 2019, How we traced the underwater volcanic ancestry of Lord Howe Island. Available at: https://theconversation.com/how-we-traced-the-underwater-volcanic-ancestry-of-lord-howe-island-110503 (Accessed 28 November 2019)

Results section contributed by Emily Fewster.