IODP Proposal Cover Sheet

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Australian-Antarctic Rift-Drift

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Title	Australian-Antarctic rift-drift transition and development of the Antarctic Circumpolar Current
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Keywords	rift, peridotite, ocean crust, paleoceanography
Area	offshore Wilkes Land Margin and Australian Bight

Proponent Information

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Abstract

The Antarctic Circumpolar Current (ACC) is Earths strongest current, connecting the three major ocean basins, allowing for deep ventilation of these basins and thermally isolating Antarctica from warm water influence. Changes in the strength and flow path have profound consequences for global deep-water formation and stability of the Antarctic ice sheet (AIS). Despite many efforts, fundamental questions remain about the timing of onset, steps in development and attainment of present-day vigour of the ACC. Tectonic Australian-Antarctic separation played a critical role in this development, but the true nature of this tectonic opening remains elusive: timing of and mechanisms during the rift-drift transition, as well as post-rift subsidence history, are poorly constrained by the available sedimentary archives. The development of the ACC during subsequent seafloor spreading is poorly documented. Circumpolar flow is suspected from ~50 Ma onwards, during a time of major tectonic reorganization, but whether throughflow was sustained throughout the Cenozoic and with what vigour is as yet unknown, despite the recognized importance of the ACC for ocean circulation and Antarctic cryosphere.

This pre-proposal aims to develop new ocean drilling efforts between Australia and Antarctica. Uniquely, we combine Solid Earth and Paleoclimate objectives to provide critical new rock and sediment archives reflecting the nature of continental rifting and drifting of Australia and Antarctica, as well as a detailed documentation of its oceanographic consequences. Existing sediment cores in the region already enable documentation of Antarctic paleoclimate deterioration leading to the development of a continental-wide AIS, its behaviour during the Cenozoic, and detailed subsidence history of the Tasmanian Gateway proper. Here, we propose to drill and collect the unique rock archive recording the onset and nature of ocean crust formation, and sedimentary archives across the core of the flow path of the ACC, where it is unobstructed by geographical boundaries. Through this, our drilling proposal innovatively connects structural geologic/geophysical objectives with paleoclimate/paleoceanographic objectives. One site from the Australian continental rise/abyssal plain transition will recover peridotite ridge/basement rocks and portray the overlying sedimentary conditions reflecting post-rift subsidence. A site on the Antarctic continental rise will reveal the subsidence history conjugate to the Australian margin. Two sites on the Australian-Antarctic abyssal plain will represent the Cenozoic evolution of the ACC flow. All four sites combined will complete the latitudinal transect of sediments necessary to reconstruct the evolution of latitudinal sea surface temperature gradients, a keystone feature of the present-day vigorous ACC.

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Scientific Objectives

A. Characterize the properties of basement rocks at the transition between Australian-Antarctic lithosphere thinning and sea floor spreading, including its magnetic properties. This will reveal the continent-ocean boundary and the nature and tectonic meaning of the controversial, oldest magnetic anomalies recognized in the Australian-Antarctic spreading history.
B. Understand the subsidence history of the south Australian margin in the context of that of the conjugate Antarctic margin and of spreading conditions. This will be used to reveal the poorly understood apparent symmetry of subsidence on both continental margins.
C. Identify key stages in the development of the ACC, including the attainment of its present-day vigour, and put these into an absolute time frame. This will reveal the nature of development of ACC throughflow through Tasmanian Gateway.
D. Document the Cenozoic evolution of latitudinal sea surface temperature gradients and oceanographic conditions in the Southern Ocean. This will provide crucial constraints on state-of-the-art ocean modelling simulations.

Non-standard measurements technology needed to achieve the proposed scientific objectives

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Proposed Sites (Total proposed sites: 12; pri: 4; alt: 8; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
ATANT-01A (Primary)	-61.3556 130.9659	4570	1000	0	1000	Characterize sediment properties of thick offshore early Oligocene sediment package, full recovery of Oligocene-Neogene offshore Antarctic sediments, latitudinal migration of Antarctic polar front, glacial and terrestrial history of Wilkes Land Margin, Antarctica
ATANT-02A (Primary)	-55.7540 131.0320	4384	350	0	350	Complete recovery of Neogene sediments on abyssal plain offshore Wilkes Land Margin. Neogene development of the ACC, latitudinal migration of subpolar and polar front.
ATANT-03A (Alternate)	-62.4350 132.6504	4380	1000	0	1000	Alternate to ATANT01A. Characterize sediment properties of thick offshore early Oligocene sediment package, full recovery of Oligocene-Neogene offshore Antarctic sediments, latitudinal migration of Antarctic polar front, glacial and terrestrial history of Wilkes Land Margin, Antarctica
ATANT-04A (Alternate)	-61.4654 127.6008	4372	1000	0	1000	Alternate to ATANT01A. Characterize sediment properties of thick offshore early Oligocene sediment package, full recovery of Oligocene-Neogene offshore Antarctic sediments, latitudinal migration of Antarctic polar front, glacial and terrestrial history of Wilkes Land Margin, Antarctica
ATANT-05A (Alternate)	-55.6813 135.9454	3501	350	0	350	Alternate to ATANT02A. Complete recovery of Neogene sediments on abyssal plain offshore Wilkes Land Margin. Neogene development of the ACC, latitudinal migration of subpolar and polar front.
ATAUS-01A (Primary)	-35.8440 130.1296	4990	1000	150	1150	Recover Cretaceous-Cenozoic sedimentary history from off the south Australian margin. Cretaceous-Cenozoic climatic evolution of South Australia. Cretaceous-Cenozoic development and evolution of the (proto-) Leeuwin Current. Recover basement rocks of the ocean-continent transition zone. Evaluate rock magnetic properties in comparison to basement magnetic anomaly signals.
ATAUS-02A (Primary)	-37.2635 129.8425	5540	800	0	800	Offshore sedimentary characteristics of the Australian continental margin. Sedimentary expression and lateral migration of the subtropical front
ATAUS-03A (Alternate)	-35.8317 127.4687	5425	500	150	650	Recover basement rocks of the ocean-continent transition zone. Evaluate rock magnetic properties in comparison to basement magnetic anomaly signals.
ATAUS-04A (Alternate)	-35.9591 128.2132	5610	800	150	950	Alternate to Site ATAUS1A. Recover Cretaceous-Cenozoic sedimentary history from off the south Australian margin. Cretaceous-Cenozoic climatic evolution of South Australia. Cretaceous-Cenozoic development and evolution of the (proto-) Leeuwin Current. Recover basement rocks of the ocean-continent transition zone. Evaluate rock magnetic properties in comparison to basement magnetic anomaly signals.
ATAUS-05A (Alternate)	-35.8139 129.5771	5370	650	150	800	Alternate to ATANT01A. Recover Cretaceous-Cenozoic sedimentary history from off the south Australian margin. Cretaceous-Cenozoic climatic evolution of South Australia. Cretaceous-Cenozoic development and evolution of the (proto-) Leeuwin Current. Recover basement rocks of the ocean-continent transition zone. Evaluate rock magnetic properties in comparison to basement magnetic anomaly signals.
ATAUS-06A (Alternate)	-37.2036 127.1737	5550	800	0	800	Alternate to ATANT02A. Offshore sedimentary characteristics of the Australian continental margin. Sedimentary expression and lateral migration of the subtropical front
ATAUS-07A (Alternate)	-44.6338 129.1881	5464	350	0	350	Alternate to ATANT02A. Offshore sedimentary characteristics of the Abyssal plain, in the heart of the ACC. Sedimentary expression and lateral migration of the Neogene subtropical front.