Antarctic-Australia Separation

Neville F. Exon, Geoscience Australia
James P. Kennett, Department of Geological Sciences, UC Santa Barbara, USA
Mitchell J. Malone, ODP College Station, USA and the Leg 189 Science Party

During the Cenozoic era, between 37 and 33.5 million years ago, Australia separated from Antarctica and drifted northward, which opened the Tasmanian Gateway and allowed the Antarctic Circumpolar Current (ACC) to develop. This current began to isolate Antarctica from the influence of warm surface currents from the north, and an ice cap started to form. Eventually, deepwater conduits led to deepwater circulation between the southern Indian and Pacific Oceans and ultimately to ocean conveyor circulation. Continuing Antarctic thermal isolation, caused by the continental separation, contributed to the evolution of global climate from relatively warm early Cenozoic "Greenhouse" to late Cenozoic "Icehouse" climates.

Using DSDP results, Kennett, Houtz *et al.* (1975) proposed that climatic cooling and an Antarctic ice sheet (cryosphere) developed from ~33.5 million years ago as the ACC progressively isolated Antarctica thermally. They suggested that development of the Antarctic cryosphere led to the formation of the cold deep ocean and intensified thermohaline circulation. Leg 189 gathered data that support this hypothesis.

Leg 189 continuously cored marine sediments in the Tasmanian Gateway, which was once associated with a Tasmanian land bridge between Australia and Antarctica. The bridge separated the Australo-Antarctic Gulf in the west from the proto-Pacific Ocean to the east. This region is one of the few in the Southern Ocean where calcareous microfossils are preserved well enough to provide accurate age dating. The Leg 189 sequences described by Exon, Kennett, Malone *et al.* (2001) reflect the evolution of a tightly integrated and dynamically evolving system over the past 70 million years, involving the lithosphere, hydrosphere, atmosphere, cryosphere and biosphere.

Before 33 Ma
Australia drifting north
Tasmanian land bridge in place
No circum-Antarctic current
No Antarctic ice sheet
Warm climate and oceans
Mudstone near land bridge

After 33 Ma
Australia separated off
No Tasmanian land bridge
Circum-Antarctic current
Antarctic ice sheet
Cooling climate and oceans
Calc. ooze near land bridge

The most conspicuous changes in the region occurred over the Eocene–Oligocene transition (~33.7 million years ago) (Figure 1) when Australia and Antarctica finally separated. Before the separation, the combination of a warm climate, nearby continental highlands, and considerable rainfall and erosion, flooded the region with siliciclastic (silicate minerals — mainly clay and quartz) debris. Deposition kept up with subsidence and shallow marine sediments were laid down. After separation, a cool climate, smaller more distant landmasses, and little rainfall and erosion, cut off the siliciclastic supply. Pelagic carbonate deposition could not keep up with subsidence, so the ocean deepened rapidly.

Leg 189 confirmed that Cenozoic Antarctic–Australia separation brought many changes. The regional changes included: warm to cool climate, shallow to deep water deposition, poorly ventilated basins to well-ventilated open ocean, dark deltaic mudstone to light pelagic carbonate deposition, microfossil assemblages dominated by dinoflagellates to ones dominated by calcareous pelagic microfossils, and sediments rich in organic carbon to ones poor in organic carbon.

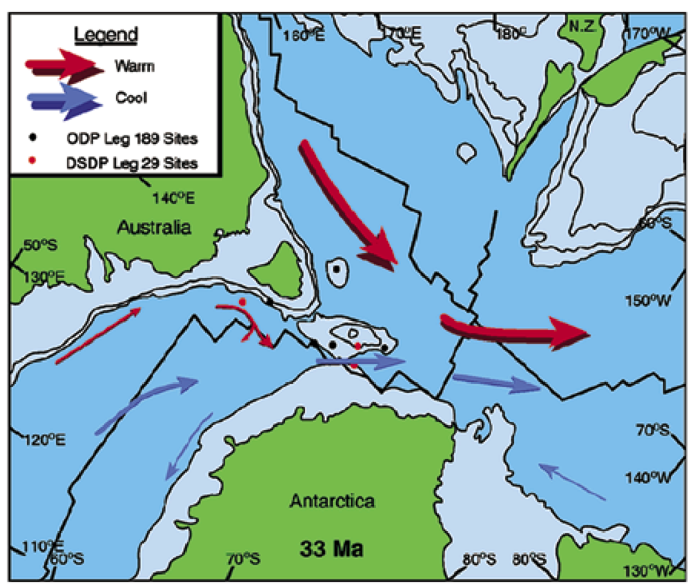

Figure 1