Southern stratification

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The surface waters surrounding Antarctica are only slightly less dense than the underlying waters, which leads to weak stratification and a surface layer that is only marginally stable. Numerical modelling suggests that the fine regulation of deep water temperatures maintains this surface layer.

Ralph Keeling, of the Scripps Institution of Oceanography and Martin Visbeck, of IFM-GEOMAR, examined the factors responsible for the stability of the Antarctic surface layer, using a two-box model of an Antarctic-like region characterized by deep upwelling. According to their model, if the deep ocean is too warm, the inflow of cold Antarctic Bottom Waters is enhanced, which ultimately cools the deep waters. Conversely, if deep water temperatures dip too low, the surface waters become fully stratified, the inflow of relatively warm North Atlantic Deep Waters increases, and the waters warm.

The net result is a steady-state deep water temperature — controlled by a feedback loop involving Antarctic Bottom Water — and a marginally stable Antarctic surface layer.

Erased landscape

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Glaciers sculpt the landscape to form spectacular, deeply incised valleys. Constraints on the timing of glacier-induced erosion in New Zealand indicate that vast tracts of the landscape were completely reshaped during the last glaciations.

David Shuster at the University of California, Berkeley, and colleagues used uranium, thorium and helium isotopes to date the cooling across Fiordland, New Zealand. Erosion causes underlying deeper rocks to move towards the surface and cool. Determining the precise time at which a rock has cooled provides a measure of the age of the land surface. They found that virtually all of the rocks in Fiordland were brought to the surface less than two million years ago, indicating that the landscape that existed before that time had been completely erased by erosion from the Pleistocene glaciers.

The researchers also found that glacial erosion initiated along the flanks of the Fiordland mountains and rapidly progressed into the core of the mountain range.

Organics from the sea

Atmos. Chem. Phys. **11,** 3037–3049 (2011)

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Marine organic matter contributes to a significant fraction of the carbon and nitrogen in aerosols over the North Pacific Ocean, according to a study of marine aerosols in the region. Marine aerosols influence the Earth's radiative forcing and the cycling of elements in the ocean.

Yuzo Miyazaki, of Hokkaido University, Japan, and colleagues analysed the composition of aerosols over the western North Pacific Ocean — between 10° N and 44° N — in the summer of 2008. Methanesulphonic acid levels — an indicator of biological activity — peaked in air masses over the subarctic Pacific Ocean. Their reconstruction of the trajectory of the air masses suggests that the aerosols were derived from the marine boundary layer. Organic nitrogen and carbon concentrations were highest in the biologically influenced oceanic air masses, with organic nitrogen levels up to 260 ng N m^{-3}. On average, organic nitrogen comprised 67% of the total nitrogen present in marine aerosols, and marine-derived carbon 88% of total carbon.

The organic nitrogen content of marine aerosols increased with wind speed, suggesting that sea spray is an important source of organic aerosols.

Deep anomaly source

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Lavas with an unusual isotopic signature are found in a large band located at about 40° S, which stretches from the Atlantic Ocean eastwards to the Pacific Ocean. Chemical analysis of the potential sources of these lavas indicates that they cannot be derived from the African continent.

Cornelia Class of Columbia University and Anton le Roex of the University of Cape Town measured isotopes in rocks taken from the African continent to test whether the isotopic anomaly arises from the deep mantle or from recent recycling of African continental rocks into the shallow mantle. None of these samples show isotopic signatures similar to those found in the South Atlantic Ocean lavas. Therefore recent, shallow recycling of continental rocks seems unlikely.

Instead the researchers conclude that the source of the oceanic lavas must be located in the deep mantle. Brought to the surface by a giant mantle plume beneath Africa, the magma with enriched isotopes mixed with shallow mantle magmas and erupted in lavas at the Mid-Atlantic Ridge.

Methane precursor

Geology **39,** 431–434 (2011)

A burst of methane preceded the main eruptive phase of the Central Atlantic Magmatic Province — and the end-Triassic mass extinction — by a few hundred thousand years, carbon isotope records suggest.

Micha Ruhl and Wolfram Kürschner of Utrecht University reconstructed carbon cycle perturbations before the mass extinction about 201 million years ago, using the carbon isotopes of organic matter contained in marine and terrestrial rocks from Germany and Austria. They identified a pulse of isotopically light carbon released to the atmosphere before the main eruption of the Central Atlantic Magmatic Province. This pulse coincides with a period of lava intrusion in the area surrounding the province. The researchers suggest that the lava flowed into sedimentary rocks rich in organic carbon that, when heated, released methane to the atmosphere. Between 3,000 and 7,000 Gt carbon were released during this precursor event.

The atmospheric methane was oxidized to carbon dioxide, which could have led to greenhouse warming and the destabilization of marine and terrestrial ecosystems before the end-Triassic event.