

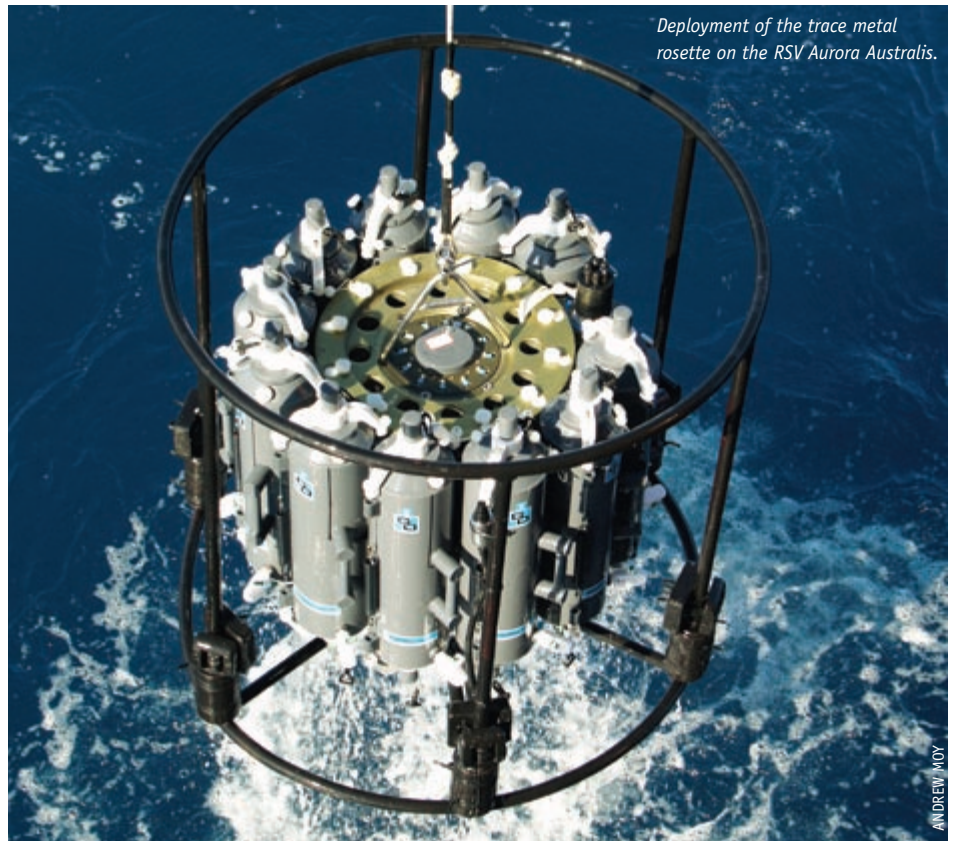
# Iron and the marine ecosystem

New research suggests that iron plays a key role in controlling primary production (photosynthesis) by phytoplankton in the sub-Antarctic Southern Ocean. But sampling this metal from the deck of a steel ship has its challenges.

Primary production in the ocean is dominated by single-celled microscopic plants called phytoplankton, which convert dissolved carbon dioxide into organic matter within the sunlit portion of the upper ocean. This process forms the basis of the marine ecosystem and exerts an important control on the level of atmospheric carbon dioxide. Vast areas of the open ocean support relatively low phytoplankton production, despite an abundance of the major plant nutrients nitrate and phosphate. The largest of these is the Southern Ocean – a region which has a significant effect on Earth's climate. Over the past decade, marine scientists have discovered that phytoplankton growth in the Southern Ocean is limited by the supply of iron, which is typically present at very low concentrations – about five parts per trillion.

The difficulty in accurately measuring iron at such low levels, and poor knowledge of the distribution and chemical forms of iron in seawater, particularly in the Southern Ocean, are major hurdles to our understanding of the role of iron in regulating primary production. However, during the *Sub-Antarctic Zone Sensitivity to Environmental Change* voyage, we undertook a detailed study of iron distribution, supply (either by wind-blown dust or internally via sediments and currents), chemical form, and availability for phytoplankton growth, in the biogeochemically contrasting sub-Antarctic waters east and west of Tasmania. This research will allow us to infer the role iron may have played in moderating Southern Ocean phytoplankton growth in the past, and its importance for climate change in the future.

Studying iron in seawater is a major challenge that requires specialised sampling and analytical methods. The ubiquitous presence of iron in research vessels, laboratories and many manufactured materials causes a high risk of contamination during sampling, filtration, storage



Deployment of the trace metal rosette on the RSV Aurora Australis.

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and analysis. Stringent, clean working procedures must be adopted to prevent this, from the initial bottle cleaning through to the final analysis stage.

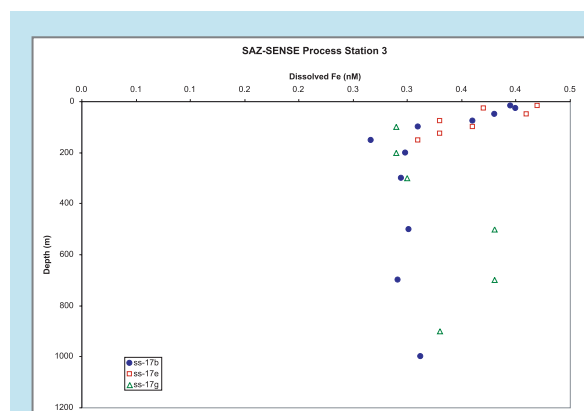
During the voyage we deployed a prototype trace metal sampling rosette (on loan from the New Zealand National Institute for Water and Atmospheric Research). This allowed us, for the first time, to obtain high resolution profiles of iron in the upper 1000 m of the ocean.

The rosette was mostly fabricated from non-metallic materials that would not contaminate samples and was deployed from the trawl deck of the *Aurora Australis* using non-metallic line. A pressure sensor in the rosette triggered each bottle to shut at chosen depths as the bottles were raised to the surface. Large volume 'clean' water samples were also collected for biological incubation and radiotracer experiments. We also made dissolved iron measurements in near real-time at sea, to verify the quality of our sampling techniques during the cruise and identify the best places in which to sample.

This challenging and exacting work provided us with an excellent dataset on our return to Hobart.

Early examination of the dissolved iron dataset indicates that more iron is present in surface waters to the southeast of Tasmania compared to waters to the southwest. This pattern is consistent with that of phytoplankton biomass observed during the voyage by satellite and with the hypothesis that iron has a key role in fuelling primary productivity in this region. Our research also indicates that the iron is supplied internally through filaments of the East Australian Current extending down the east coast of Tasmania, rather than aerosol dust deposition events from the Australian continent. Our studies will now focus on the effect this iron supply has on the productivity of ecosystems of the wider Southern Ocean and how this supply may be influenced by climate change in the future.

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Water column profiles of dissolved iron (Fe) in the sub-Antarctic Southern Ocean to the southeast of Tasmania, showing elevated iron concentrations in surface waters (Bowie et al., unpublished data). Symbols represent different sampling times at the same location.