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50 years of the Antarctic Research Centre

- at Te Herenga Waka-Victoria University of Wellington

Drilling in Antarctica

Improving sea level rise projections

Sensitivity of the West Antarctic Ice Sheet

Bratina Island & the ecology of ice shelves

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EDITOR: Nicholas O'Flaherty
Publisher, The Antarctic Report
email: nicholaso@camino.co.nz

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INDEXER: Mike Wing

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Cover photo: A spectacular view of Friis Hills from Taylor Glacier in the McMurdo Dry Valleys, Antarctica. The light-coloured 545-million-year old granite is intruded by a 200m thick sill of 180 million-year-old Ferrar Dolerite. The top of Friis Hills is also remarkable for the 50m of drill core and its record of Antarctica's major climate cooling transition 15 million years ago, research undertaken by Victoria University scientists in 2016 (see p3). In the distance, at far left, Pyramid Mountain (2120m) is visible in the Quartermain Mountains.
Credit: Kaila Colbin

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Photo: Sun dogs and halo frame the Andrill drilling rig. The parhelion phenomenon is caused by ice crystals refracting sunlight.
Credit: Cliff Atkins

The New Zealand delegation to the Antarctic Treaty Consultative Meeting in Tromsø in 1998, the first to include the new Committee on Environmental Protection (CEP). From the left standing: Hilary Willberg (NZ Ambassador to the Netherlands, accredited to Norway), Emma Waterhouse (Environment Manager, Antarctica NZ), Chris Mace (Board Chair, Antarctica NZ), Stuart Prior (Head of Delegation, MFAT), Gillian Wratt (Chief Executive, Antarctica NZ), Felicity Bloor (Deputy Head of Delegation, MFAT), Peter Barrett (CEP delegate, Victoria University of Wellington).
Kneeling: Jennifer McDonald (Legal Adviser, MFAT), Alan Hemmings (NGO observer). *Credit: Antarctica NZ*

Reflections from Antarctic research at Victoria University of Wellington

Our world is now changing at an astonishing pace. Geologists, historians, and young people, including school-aged children, are noticing.

These comments come from reflecting on Victoria University of Wellington's unbroken record of Antarctic expeditions since Scott Base was established in 1957, and the legacy of its Antarctic Research Centre now 50 years old. Over this period we have seen a shifting focus from research driven by exploration and curiosity to concerns at accelerating Antarctic Ice Sheet melt and related issues. Growing discord among nations in recent years can only exacerbate the climate threat. In considering how to make much needed progress on these issues we have past successes in exploration and science in the Antarctic region to reflect on.

Before the International Geophysical Year (IGY) in 1957/58 nations vied to be first to raise a flag and claim a slice. However, in 1959, as a result of the success of IGY, a remarkable agreement among leading nations, the Antarctic Treaty, effectively froze all claims "recognizing that it is in the interest of all mankind that Antarctica shall continue forever to be used exclusively for peaceful purposes and shall not become the scene or object of international discord."

While diplomacy has not always achieved such success for the rest of the world, experience in Antarctic science over the years leads me to suggest three key elements in reaching successful agreements.

The first is respect among negotiating parties, a concept widely understood, though not always practiced. It's the only way of achieving a level of trust necessary for achieving lasting agreements.

The second is openness over intentions and facts of a situation. Misrepresentation is exposed in time, damaging prospects for future agreements.

The third is dialogue that ensures all parties have an opportunity to contribute and understand what has been agreed to, another key factor in lasting agreements.

The Antarctic Treaty has for over 60 years encouraged and enabled international cooperation, freedom of scientific research and environmental protection south of 60°S latitude, even when its members have been involved in conflicts elsewhere. The need for research through international collaboration has never been greater. Such collaboration, coupled with improving efficiency in using assets for operations, logistics and science support, including the stations, and expanding collegiality in the Antarctic community, is critical to our collective success. Current efforts need to be encouraged.

By **Peter Barrett,** *Founding Director, Antarctic Research Centre (1972–2007)*

Remarkable record of Antarctic climate cooling transition 15 million years ago

Friis Hills Drilling Project team members from Victoria University and GNS Science (left to right) – Tim Naish, Richard Levy and Alex Pyne, with Tony Kingan from Webster Drilling. *Photo: Hayden Webster*

The Friis Hills looked like one of the least interesting places to visit in the McMurdo Dry Valleys. Unlike the surrounding peaks, glaciers and valleys, the top is flattish and mostly covered with dark dolerite rubble and large granite boulders, ubiquitous throughout the Dry Valleys.

Part of their perceived insignificance (until recently) comes from them being the floor of the Taylor Glacier 20 million years ago. Around five million years later this inland ice flow divided and cut down around today's Friis Hills forming an inselberg (or mountain island).

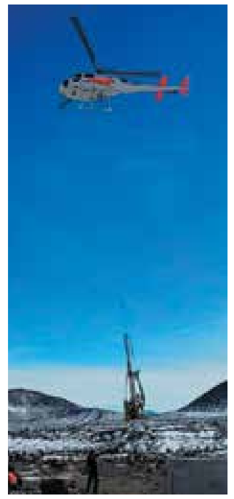
Awaiting discovery beneath that ancient dolerite and granite-covered surface, lay a few tens of metres of sediments. These products of an older warmer proto-Taylor Glacier and its episodic retreats provide a unique window for Antarctica's climate, recovery now possible only with new drilling technology. In brief, they record a period of global warmth when Earth's average surface temperature was 4-5°C warmer, followed by cooling and gradual expansion of the East Antarctic Ice Sheet ~14 million years ago.

The story begins in the 1990s with a group from Boston University and the University of Maine who were investigating the history of the Dry Valleys. They discovered tiny remnants of widespread volcanic ash across the ancient landscape dating from ~4 to 15 million years, suggesting that the surface beneath the veneer of dolerite rubble was ancient and desert-like, and had remained as cold as it is today.

In 1999 Boston University graduate students Adam Lewis and Jane Willenbring were digging pits for more

Delicate carbon film of *Nothofagus* (beech) leaf from interglacial shale. The leaf in this image is 34 mm long. *Photo: Allan Ashworth*

Drill rig being moved from Friis Hills drill site 2 to site 3. *Photo: Richard Levy*



volcanic ash beneath the surface rubble around the western fringes of the Dry Valleys, finding a fossil moss bed near Mount Boreas. Further excavation exposed lake silt layers with a variety of plant remains including beech leaves.

This led to Adam's collaboration with the University of North Dakota's paleoecologist Allan Ashworth. Through National Science Foundation support they spent several field seasons in the early 2000s excavating in the area around Mt Boreas. They went on to make many more fossil discoveries, with preservation in exquisite detail, reflecting a climate that allowed the well-vegetated tundra to thrive. Crucially they also discovered rare volcanic ash that was dated at ~14 Ma. Nearby rubbly cold glacier debris with ash of a similar age showed this to be the transition time from warm- to cold-based ice in the region.

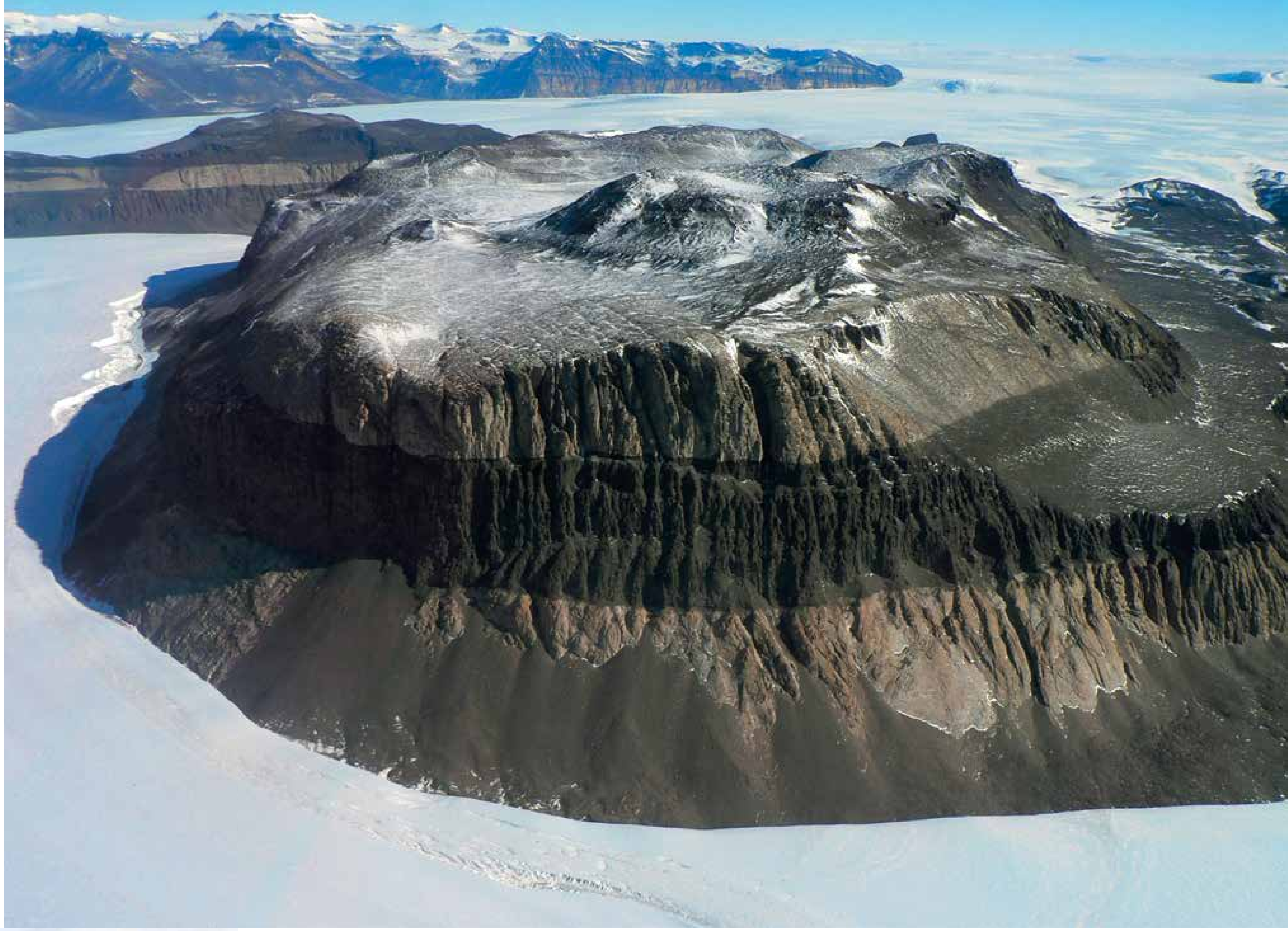
The Boreas site was some distance from Friis Hills, but in 2005 on a tip from a friend Adam and Allan went there. They immediately recognized it as a raised and isolated fragment of the old valley floor and found fossil roots on the first day. They went on to spend five field seasons mapping the many square kilometres in detail, analysing a variety of plant and insect fossil material, and developing a sequence of glacial and interglacial events from strata covering the flat summit area. After discovering a volcanic ash layer dated at 20 million years, they guessed they had a record from then to the climate transition but couldn't prove it.

In the meantime the ANDRILL community were fully occupied with their drilling off the Victoria Land coast and reporting the results (2006-16). Their two drill sites cored an off-shore glacial and climate history covering the last 20 million years. A key issue was reconciling evidence from their offshore cores of major temperature and ice sheet changes with the stories of climate and ice sheet stability preserved in the terrestrial records.

A collaborative breakthrough was made at the American Geophysical Union Fall Conference in San Francisco in 2012 when Adam suggested drilling the Friis Hills sequence to Tim Naish and Richard Levy of Victoria University and GNS Science, two members of the ANDRILL leadership team. The deal was to complement the surface mapping by coring in the middle of the basin and was finalized after visiting Allan and Adam at North Dakota State University in Fargo in 2013. Alex Pyne, then Scientific Drilling Office Projects Manager, with Webster Drilling adapted a helicopter transportable wireline diamond coring rig to use a cold-compressed air system to recover the sediment cores intact and frozen.

Following a seismic survey in 2014/2015 to find the best drill sites, all came together in the 2016/17 season, when the Friis Hills Drilling Project co-led by Richard and Tim, with Adam as an adviser, recovered a near continuous composite 80m thick sedimentary record from three sites across the Friis Hills. The cores were studied in detail by then PhD student Hannah Chorley and record 16 cycles of a temperate ancestral Taylor Glacier advancing and retreating across a vegetated landscape of glacier-fed streams and lakes.

Two new volcanic ashes were discovered within the sedimentary layers and provide age control. The sediments indicated progressively colder climate and bigger ice sheets developed as Earth's climate cooled and atmospheric carbon dioxide fell from 500 to 300 ppm through the middle Miocene Climate Transition (15.1 to 13.8 million years ago) - the first detailed terrestrial record of this major global climate event from the Antarctic continent.



View over Friis Hills southwest to upper Taylor Glacier and the Polar Plateau. *Photo: Adam Lewis*

Adam Lewis and Allan Ashworth in Friis Hills. *Photo: Peter Rejcek*

By **Peter Barrett** *(with assistance from* **Adam Lewis, Richard Levy** *and* **Tim Naish***)*

Further reading:

Lewis and Ashworth, 2016. *Lewis et al. 2008. Mid-Miocene cooling and the extinction of tundra in continental Antarctica. PNAS.*

Lewis and Ashworth, 2016. *An early to middle Miocene record of ice-sheet and landscape evolution from the Friis Hills, Antarctica. GSA Bulletin.*

Chorley et al., 2023. *East Antarctic Ice Sheet variability during the middle Miocene Climate Transition captured in drill cores from the Friis Hills, Transantarctic Mountains. GSA Bulletin.*

Operational Observations: the Drilling Programmes of Victoria University of Wellington

The introduction to MSSTS (McMurdo Sound Sediment and Tectonic Studies) was a baptism by fire, or maybe more accurately a crucifixion by ice! Having arrived in Winfly (August 1979) I replaced Chris Cunningham, the previous Base Sparkie. Chris had appendicitis and had to get home to have an operation. That Winfly period was frenetic as the MSSTS programme started to crank up. Brian Sissons and Garth Varcoe had also come down to Scott Base at Winfly, Brian looking after the VUW aspect of the MSSTS (drilling) programme and Garth to oversee the response from Base staff to ensure all the bits and pieces were brought together.

Dave Rees brings the D4 across New Harbour en route to the MSSTS drill site, Ferrar Glacier in the background, September 1979. *Photo: Rex Hendry*

By mid-September a collection of huts and sledges were ready to go out to the MSSTS site, and a wagon trail ensued, as Garth, Brian, Roy Arbon, Alastair Babbington, Dave Rees, John Marcuson, and myself drove a variety of vehicles onto the sea-ice and headed towards the continent. The trip was undertaken in overcast, near white-out conditions and with temperatures of between -35 and -40°C. Arriving off New Harbour we arranged the huts in a 'U' formation and started setting up the additional tents and services. Lesson number 1: a polar tent is much warmer to sleep in than an unheated hut. Lesson number 2: sea-ice travel is tedious but you need absolute concentration otherwise a piece of unseen sastrugi or an ice-crack will catch you out. Most of us returned to base after setting the outline of the camp up, leaving a skeleton crew to finish the finer details and keep the camp running. The main drilling teams arrived at the start of October, along with the science team led by Peter Barrett, and the rest of the spring was a conveyor belt of people and equipment to and from the site. Most notably from an operational point of view, was Ray Matheson continually driving the D4 bulldozer back and forward from Scott Base to New Harbour as equipment was ferried to and from. The Air NZ DC10 disaster on Mount Erebus overwrote much of the activity, later that year, although the sea-ice drilling portion of MSSTS was completed by then and the camp was being decommissioned.

Returning to the NZ Antarctic Programme in 1995, after a couple of seasons on the Antarctic Peninsula, I had picked up the role of what was previously known as the Scott Base Operations Manager (or DOIC), the Field Operations Officer, the lead Field Training Instructor and a couple of other tasks rolled into one - the Operations Support Manager (and a range of other titles bestowed during this evolutionary period). The role included the off-season operational planning for each and all of the events heading south for the following season and then going down and

MSSTS Camp and drill site up and running, October 1979. *Photo: Rex Hendry*

Garth Varcoe and Alastair Babbington assess the layout of the MSSTS Camp, September 1979. *Photo: Rex Hendry*

managing the operations from Scott Base from the first flight in October through until the helicopters stopped flying in February - for three consecutive years.

In 1996, the NZ Antarctic Research Programme (NZARP - 'Ant Div' as part of DSIR) was also morphing into the NZ Antarctic Institute (Antarctica NZ, reporting to MFAT), under the leadership of Gillian Wratt. It was very testing times and new ground for a lot of people. The planning for the Cape Roberts Project was well underway with Jim Cowie pulling together the programme management for Ant Div. One of the tasks Jim and I worked on was to see if we could have suitable clothing specifically designed for the drillers and scientists for the conditions they would experience - we ended up with some fibre-pile onesies, if I recall! Alex Pyne was the key contact for the operational matters on-site when the project unfolded, with Jeremy Ridgen (JR) as chief engineer and mechanic, Brian Reid as Sparkie and Brian Howart as second engineer on site.

As an international project , what was evident was the higher level of sophistication in the planning and implementation for this project, with planning starting back in 1992, bringing together scientists from the USA, Italy, Germany, UK and NZ. Peter Barrett was instrumental in the internal collaboration and later became the Chief Scientist for the project. The drilling system was designed by Alex Pyne from his experience at MSSTS, plus also CIROS in 1984 and 1986. More than 1500 metres of core was recovered off Cape Roberts in the 1997-99 period, exposing the history of the Antarctic ice sheet from between 34 to 17 million years ago.

This led to the ANDRILL project (2006-08) and the new hot water drilling system for the Ross Ice Shelf Project (2017+). My involvement was limited as the seasonal operations scheduler in the 2005/06 and 2017/18 seasons but still great to be part of - scheduling and spooling up either helicopter or fixed wings flights for scientists as they came and went from each of these sites. There was always a bit of 'bump and grind' as weather hampered flights, on-continent or to and from New Zealand, as people and equipment were held up, but a solution was almost always found.

Without doubt, one of the key aspects of these projects was the incredible amount of people involved - not only in volume but also the diversity and complexity of science and operations. All could and should be named for their involvement, requiring huge commitment over decades. Unless anyone was directly involved, the general public would not have known of the incredible amount of work and effort these projects demanded, all below the radar and over the horizon. However, two people stand out for me over the years - our very own Patron, Peter Barrett, for his overview and hands-on involvement, particularly throughout the 1970s and 1980s, and into the 1990s; and Alex Pyne for his meticulous planning and on-site management for all of these projects. Tu teitei tu kaha, tēnā kōrua, tēnā kōrua. Stand tall, we acknowledge you both.

By **Rex Hendry**, *NZAS President*

Glossary:

ANDRILL *Antarctic (Geological) Drilling Project*

CIROS *Cenozoic Investigations in western Ross Sea*

DOIC *Deputy Officer In Charge*

DSIR *Department of Scientific and Industrial Research*

MFAT *Ministry of Foreign Affairs and Trade*

MSSTS *McMurdo Sound Sediment and Tectonic Studies*

VUW *Victoria University of Wellington*

The Wannagins and tents set-up for the MSSTS Camp, September 1979. *Photo: Rex Hendry*

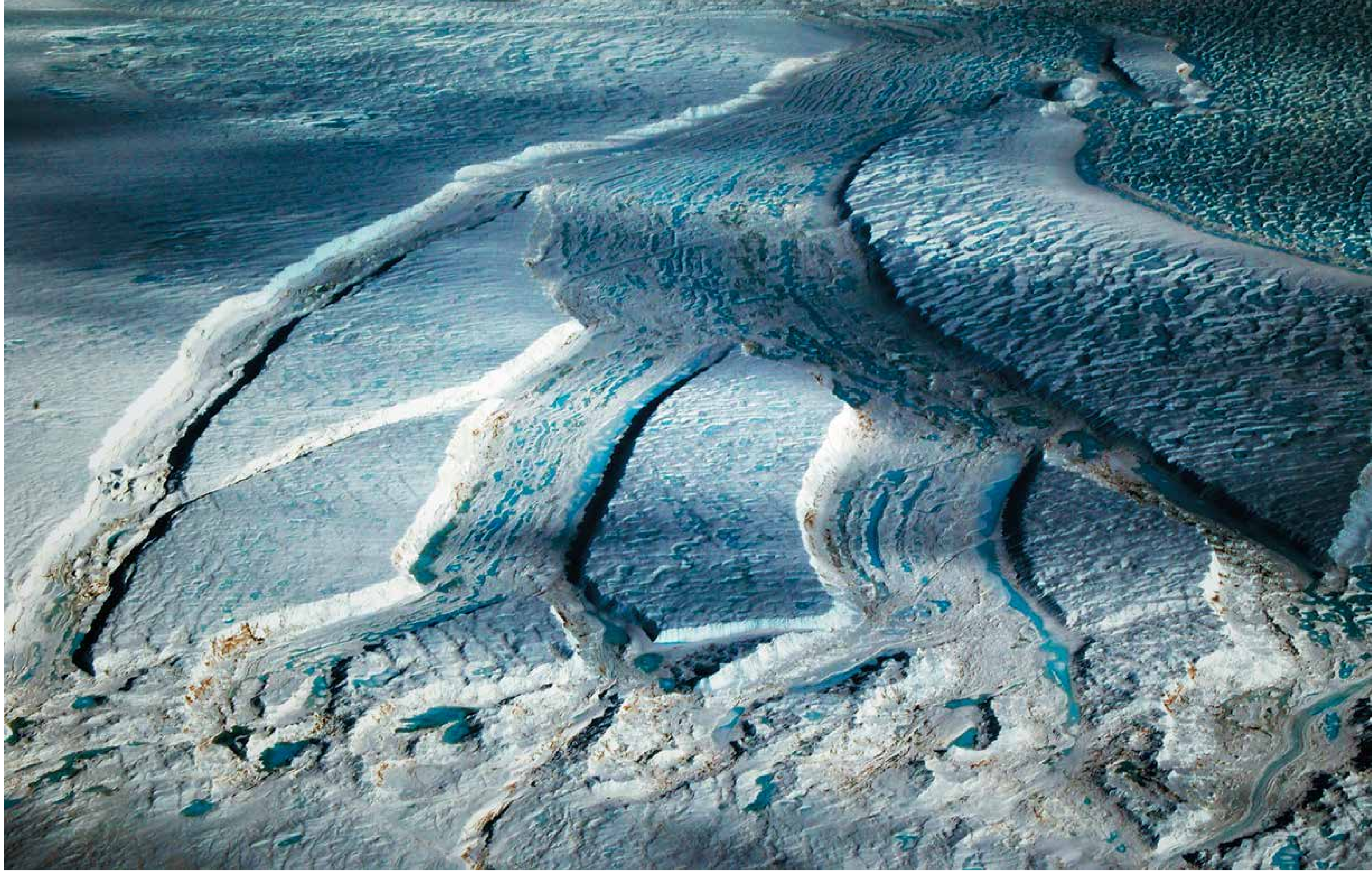
Antarctic Research a Major Factor in Understanding Sea Rise

Cutting-edge scientific work led by Te Puna Pātiotio-Antarctic Research Centre (ARC) at Te Herenga Waka-Victoria University of Wellington is playing a vital role in forecasting the future impact of climate change in New Zealand.

The ARC is heading up a new $13 million, five-year research programme to improve our understanding of the impacts of sea-level rise on coastal communities and infrastructure. The programme, Te Ao Hurihuri: Te Ao Hou-Our Changing Coast, is being co-led by ARC's Professor Tim Naish and Associate Professor Richard Levy.

The research includes advancing previous work to model Antarctic glacier and ice sheet melting. Tim says the programme will improve the ability to predict sea-level rise and the impacts it will have around the country.

"We know the sea around Aotearoa is rising but we don't yet know enough about how coastal regions will be affected to ensure our adaptation measures will be effective and appropriate."



Tabular icebergs from the McMurdo Ice Shelf trapped in sea ice, both exhibiting widespread surface melt ponds, McMurdo Sound, Antarctica, December 2011. *Photo: Nick Golledge*

A key focus of the project is on improving the models currently used to understand the effects of sea-level rise, such as coastal flooding and groundwater salinization, and risks to key infrastructure and cultural sites.

The research will produce a new, publicly available online tool showing sea-level projections, at 100 metre spacing, along the New Zealand coastline. Risk assessment will be possible at the scale of individual houses and buildings. Estimates provided by the new tool will also include the probability of major earthquakes causing changes in land elevation along the coast.

"We know that 50cm of sea-level rise is unavoidable by 2100 and we could see up to 2.5m in some parts of the country. The aim of this project is to help ensure coastal impacts are well-understood so decisions about how we manage coastal areas and adapt to sea-level rise are based on the very best research."

The programme involves a multi-disciplinary team including researchers from GNS Science, University of Auckland, University of Canterbury, University of Waikato, Oceanum Ltd, Takiwā Ltd, and Te Whare Wānanga o Awanuiārangi. The research team will also work with central and local government agencies, iwi, and community organisations. It is being funded by the 2022 Endeavour Fund administered by the Ministry of Business, Innovation and Employment.

It follows on from the work of the NZ SeaRise: Te Tai Pari O Aotearoa programme, also led by Richard and Tim, and hosted at ARC, which in May 2022 revealed alarming new data about the extent of sea level rises across New Zealand over the coming decades.

The pair spent five years working on the study, including trips to Antarctica to drill sediment and ice cores. The samples they collected on the continent enabled them to look millions of years back into the past, enabling them to painstakingly reconstruct a precise climate record to inform their future projections.

The programme, which brought together 30 local and international experts from several research organisations, found that by 2060, sea level rise will approach a metre in some parts of the country, resulting in dramatic inundation, untold damage and the forced abandonment of coastal homes and businesses.

As a result of the work, location-specific sea-level rise projections are now available out to the year

2300 for every 2km of the coast of Aotearoa New Zealand. These projections can be accessed through a new online tool developed by Takiwā, a data management and analytics platform.

Climate change and warming temperatures are causing sea level to rise, on average, by 3.5mm per year. This sea-level rise is caused by thermal expansion of the ocean, by melting glaciers, and by melting of the Greenland and Antarctic ice sheets.

However, local sea-level rise around the coast of Aotearoa is also affected by up and down movements of our land. These small but continuous changes add up, and in areas that are going down (subsiding) the annual rate of sea-level rise can double. The NZ SeaRise programme connected this vertical land movement data with climate driven sea-level rise modelling to provide locally relevant sea-level projections.

ARC's Professor Nick Golledge, a specialist in ice sheet modelling, says the new Te Ao Hurihuri programme provides an opportunity to continue the SeaRise work with a focus on the societal impacts of climate change. It will also have an emphasis on direct public engagement at the social level.

"The original SeaRise programme had a significant Antarctic component because a lot of the modelling work we were doing was Antarctic modelling, in order to get a handle on the sea level contribution from the ice sheets. Now we have the possibility over the coming years to really take that forward and put it into a framework that people can use. Ultimately, that's what we want the science to do."

As part of the Te Ao Hurihuri programme, Nick is leading a new study building a coupled ice sheet and ocean model to better inform future sea level forecasts.

"The reason for doing that is that when you've got the two components working together, you capture their interactions much more accurately. These feedback processes, which could play a big role, are captured in the model," he says.

"The work we've done previously tends to show that when you couple the ice sheets to an ocean model, the meltwater from the ice sheet affects the ocean circulation in ways that change the heat balance of the ocean, so it affects how the heat moves around. That has local consequences for the ice sheets. It tends to accelerate the melting of the ice sheet, but it also has non-local impacts in terms of the global climate because the redistribution of heat in the ocean leads to changes in the near surface atmosphere."

Forecasting the extent of future Antarctic ice sheet meltwater is significant for understanding future climate and weather patterns for New Zealand.

"In terms of future climate patterns, we know that meltwater going into the ocean from Antarctica will affect Southern Ocean conditions, it will affect southern hemisphere climates. In New Zealand, we are influenced extensively by the Southern Ocean, so anything that affects the Southern Ocean affects us."

The country has experienced a growing number of extreme weather events recently, including droughts as well as storms and flooding causing significant damage to roads and other infrastructure.

Nick says New Zealand will continue to experience a more disruptive and less stable climate. But while our understanding of long-term climate change continues to improve, predicting specific extreme weather events is not so easy because of the multi-faceted nature of what causes them.

"Predicting year-on-year weather means we have to get our head around all these decadal scale oscillations, things that are harder to predict such as El Niño. We can predict its cyclicity to some extent, but we don't know whether we're going to have an El Niño or La Niña year until we start seeing the evidence."

Meanwhile, despite the destructive weather events and the increasingly urgent calls for action to tackle the impacts of climate change, on its own, the growing body of scientific evidence doesn't seem to be enough to motive people to address the issues.

"Scientists always like to think that having better data and more data is going to help people make a more informed decision. But societal change, personal perceptions, and beliefs are never really guided by information availability or an information deficit. There's a lot of social

Scientists following the ridge towards Castle Rock, Hut Point Peninsula, Ross Island, January 2020. Mt Erebus (3794 m) in the background. *Photo: Nick Golledge*

science evidence that putting more information out doesn't make any difference. What makes a difference is engaging people in a different way. And the emerging research basically says you've got to connect with people on a much more emotional level.

"There's evidence that pro-social and climate change behaviours are contingent on a sort of altruism through interpersonal connection. It's not just about saying, 'We're all connected, and we've got to look after each other in this society.' Those kinds of general connectedness feelings don't motivate people to change at all.

"What does motivate people to change is a much more personal connection: feeling that they are connected to a caregiver, or that they are the caregiver for a dependent. A lot of what we hear from the social sciences is all around making these sorts of connections and being a more coherent society and so on. But actually, what it comes down to is using terminology like 'Mother Earth' and, 'for our children'. Things like that are much more emotive because people have an innate connection and an innate predisposition to respond to that, because, as humans, as social animals, we're born, prematurely really, we are not able to look after ourselves, unlike many mammals. And so we are hardwired to rely on a caregiver, and that stays with us for the rest of our lives."

The new Te Ao Hurihuri: Te Ao Hou—Our Changing Coast programme ARC is leading has a more socially informed focus than the previous SeaRise work, and Nick hopes that will result in it having a social impact in terms of the public's perceptions and understanding of climate change.

"I think there's a lot we can do in terms of using the social sciences, using a lot of this kind of information to really guide our messaging because mitigation is not about a lack of science; we've got enough science.

"We still need to keep doing the science – because politicians need to have absolute numbers, they want certainties, so that is definitely a key part of the remit that we have – but in terms of getting the message to the public, rather than politicians, we have to connect with people in a very specific and very different way."

Ongoing research at the Antarctic Research Centre

Dr Alexandra Gossart on Ross Island, Antarctica, with McMurdo Sound behind. *Credit: Alanna Alevropoulos-Borrill*

In 2021, **Dr Alexandra Gossart** was part of a ground-breaking Antarctic expedition: the first all-woman research team from Te Herenga Waka-Victoria University of Wellington to head to the ice.

Alexandra is a Research Fellow doing regional climate research at the Antarctic Science Platform's National Modelling Hub at Victoria University.

Her expertise is in atmospheric modelling at high spatial and temporal resolutions, including detailed study of Antarctic climate processes and feedbacks.

Alexandra's work at the Hub involves using regional climate models to provide insights on the impacts of a future, warmer climate on the atmosphere and surface of the ice sheet.

She has also recently developed a coupled model (with NIWA's Dr Alena Malyarenko), where the ocean and atmosphere interact with each other. This is a unique tool for investigating ice-ocean-atmosphere feedbacks and how the local climate and extremes impact sea ice and the ocean water masses, and is essential to understanding the future of the Ross Ice Shelf in a warmer world.

"I run present and future climate simulations using the Polar Weather Research and Forecasting Model (PWRF). My focus is on boundary-layer processes and surface mass balance, especially melt events over the Ross Sea and McMurdo Dry Valleys," she explains.

"My current research focuses on a coupled climate-ocean model using PWRF and MITgcm (MIT General Circulation Model), including a better representation of sea ice."

Dr Lauren Vargo conducting field work on the Gulkana Glacier in Alaska. *Credit: Hannah Perrine*

There's a stark contrast between the flat lands of Ohio, USA, where **Dr Lauren Vargo** *grew up, and the southern glaciers that attracted her to New Zealand.*

"It certainly gets cold and snowy in Ohio, but there's no topography for glaciers," says Lauren, a Research Fellow at Te Herenga Waka—Victoria University of Wellington's Antarctic Research Centre.

She came to the ARC from New Mexico, where she completed her Masters in Albuquerque doing energy balance modelling of glaciers in the arid Andes before working at the Los Alamos National Laboratory on a new version of the Community Ice Sheet Model (CISM 2.0).

Lauren moved to New Zealand in 2016 after learning there was an opportunity for a new PhD student to study annual to decadal variability of glaciers in the Southern Alps.

"Research on the interactions between glaciers and climate was exactly what I had been looking for in a PhD project and I was excited for the opportunity to combine field work and glacial modelling in a project."

Lauren completed her PhD in 2019 and is currently leading an international research project, in collaboration with four overseas researchers and one in New Zealand, into how much glaciers are melting due to climate change.

Drilling to Record Depths to Unearth Antarctica's Climatic History

Scientists are set to drill deep into the ocean floor below the Ross Ice Shelf in a bid to discover if cutting greenhouse gas emissions could avoid catastrophic Antarctic melting.

The Antarctic Research Centre (ARC), at Te Herenga Waka—Victoria University of Wellington, is playing a key role in the research with ARC and GNS scientist Dr Richard Levy co-leading the multi-year, multi-million-dollar investigation known as the Sensitivity of the West Antarctic Ice Sheet at 2°C of warming, or SWAIS 2C.

The aim is to understand what happened to the West Antarctic Ice Sheet (WAIS) 125,000 years ago – the last time global temperatures were as warm as those expected in the coming decades.

Beginning this coming Antarctic summer, in late 2023, the SWAIS 2C team will start retrieving sediment from deep below the ice in a bid to find out how much the WAIS melted during the last interglacial period, and other earlier times when climate was warmer than present.

These geological records could reveal if there is a tipping point in our climate system when large amounts of land-based ice melts, causing oceans to rise many metres.

"We have formed a team of drillers, engineers, field experts and scientists who are up to the task," says Dr Levy, who is co-leading SWAIS 2C with Dr Molly Patterson of New York's Binghamton University.

"Discoveries will show us how much the West Antarctic Ice Sheet could melt if we miss Paris Agreement targets."

During the last interglacial (120,000-125,000 years ago) global temperatures were 1-1.5°C warmer than pre-industrial times, similar to what we will see if carbon emissions targets, outlined in the Paris Agreement of the United Nations Framework Convention on Climate Change, are met.

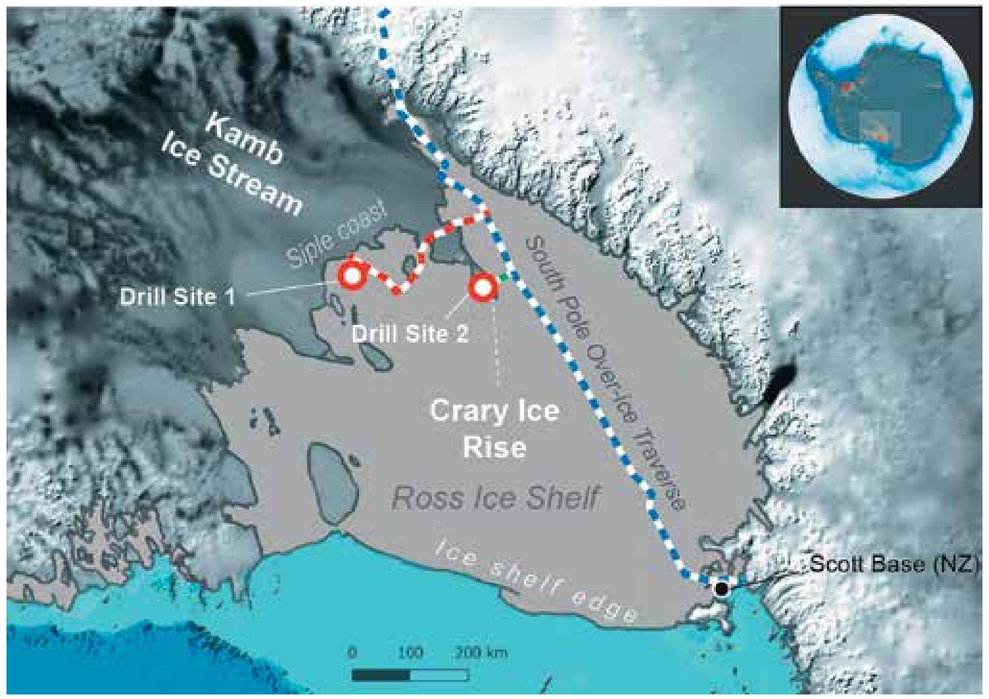
Sea levels may have been 6-9 metres higher than present during the last interglacial due to ice melt, but it is not yet clear how much the Greenland and Antarctic ice sheets melted. The WAIS holds enough ice to raise sea levels by 4 metres.

Sediment samples recovered by SWAIS 2C could help scientists predict what might happen in the future if global temperatures continue on their current trajectory towards 2.7°C above pre-industrial levels.

The WAIS is presently losing mass at an accelerating rate and is considered vulnerable to climate change because much of the ice, which rests on bedrock thousands of metres below sea level, is exposed to the warming Southern Ocean.

Of particular concern

West Antarctica, showing traverse routes to the SWAIS 2C drill sites. *Credit: Antarctic Science Platform, Antarctica NZ*



is that the submarine land surface on which the WAIS sits deepens from the ice sheet margin towards its centre and has potential for runaway and unstoppable retreat. If the large fringing ice shelves that help to hold it in place collapse, ice flow increases, and gravity 'takes over'.

SWAIS 2C aims to understand the timing of past Ross Ice Shelf collapse and WAIS retreat, and the local and regional environmental conditions that drove these changes during past warmer-than-present climatic conditions.

The project is an international initiative involving researchers from Germany, Australia, Italy, Japan, Spain, South Korea, the Netherlands, and the United Kingdom, as well as New Zealand and the United States. New Zealand's participation is supported through the Antarctic Science Platform's Ice Dynamics Project.

ARC Professor Tim Naish, the Antarctic Science Platform Programme Leader, says SWAIS 2C will address one of the biggest questions concerning climate scientists, and humanity: "Did the West Antarctic Ice Sheet collapse the last time the Earth warmed? Can we save the Antarctic Ice Sheet if nations meet the Paris Agreement targets?"

In what is an ambitious and challenging programme, researchers, engineers, and drillers in the SWAIS 2C team will recover sediment cores from beneath the Ross Ice Shelf close to the grounding zone of the Kamb Ice Stream and Crary Ice Rise.

No one has ever drilled deep into the Antarctic seabed at a location so far from a major base, and so close to the centre of the West Antarctic Ice Sheet. To tackle this challenge, ARC engineers have spent years developing a new 'world-first' ice and sediment drilling system.

Drilling operations are scheduled to run over the summer seasons through until 2024/25 and require a 1200km traverse across the Ross Ice Shelf to the Siple Coast, where land ice meets the ocean and starts to float.

Once on site, they will first melt a hole through floating ice with a hot water drill. Then a purpose-built light-weight sediment coring system will drill over a hundred metres into the sea floor. The transportable system is capable of recovering about 200 metres of sediment from beneath the sea floor in places where the combined depth of the ice shelf (or sea ice) and water column is over 1000 metres thick.

Hot Water Drill installed in Antarctica for the Ross Ice Shelf drilling project. The same technology will be used for SWAIS 2C. *Photo: Gavin Dunbar*

SWAIS2C: Sensitivity of the West Antarctic Ice Sheet at 2°C of Warming

The project aims to:

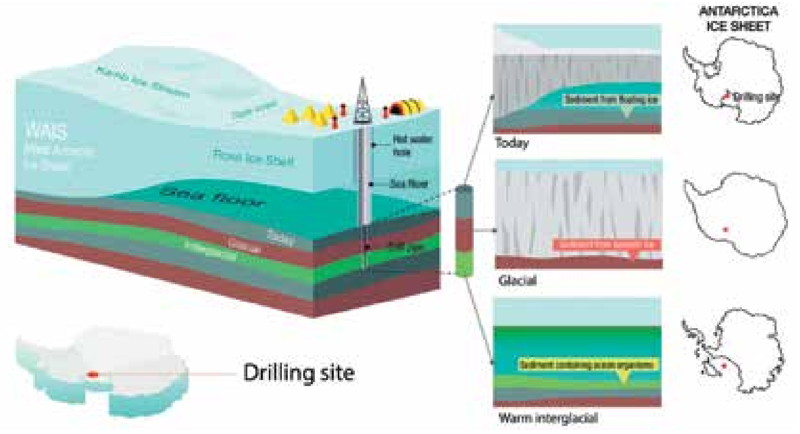
- Determine whether the West Antarctic Ice Sheet has advanced and retreated during the Holocene, a period of relatively stable climate that has characterised the last 10,000 years prior to the industrial revolution and the onset of the Anthropocene.
- Determine how marine-based ice sheets respond to a world that is 1.5-2°C warmer than pre-industrial times.
- Understand the local, regional, and global impacts and consequences of the response of the Antarctic ice sheet to this warming.

To achieve these objectives, the project will:

- Drill beneath the sea floor to recover sediment cores at two locations along the Siple Coast of West Antarctica where land-ice begins to float and form the Ross Ice Shelf. This region where the land-ice begins to float is called the grounding zone.
- Extract geological data from these sediment cores to reconstruct environmental conditions that characterised the drill sites as climate changed in the past. The focus will be on periods of prior warmth to determine whether the Ross Ice Shelf disappeared and how far the grounding zone retreated or advanced.
- Use numerical models to simulate ice sheet response to these past intervals of warmth. Data from the drill cores will provide constraints for the models to test and enhance their ability to simulate prior environmental changes in West Antarctica.

The ARC's Director, Associate Professor Rob McKay, says it is a massively ambitious undertaking, but New Zealand is a recognised world-leader in designing and building such innovative technology.

"The fact that so many countries are joining us in this effort highlights the urgency to understand more about the West Antarctic Ice Sheet, which remains the largest uncertainty for sea level rise projections."



Drilling approach for the SWAIS-2C initiative. *Credit: Antarctic Science Platform, Antarctica NZ*

The two Siple Coast locations where the SWAIS 2C teams will drill differ with the Kamb Ice Stream (KIS) being located beneath the floating ice shelf close to the grounding zone of the WAIS, while the Crary Ice Rise (CIR) ice sits directly on bedrock. A tent camp will be established as their "home on ice" while they operate at each site for up to three months.

At the KIS site, they will melt a 35cm diameter hole through the 620m-thick ice shelf with the hot water drill to access the ocean water cavity below. They will position the purpose-built light-weight drilling rig and lower a series of linked fiberglass pipes (riser) through the ice shelf hole to connect the surface to the sea floor.

A second series of linked steel pipe with a diamond encrusted rock coring bit will be lowered inside the riser and will core into layers of sediment and rock up to 200m beneath the sea floor. There is no ocean cavity at the CIR site so there they will drill directly into sediment and rock from the base of the hole in the ice shelf.

Mud-rich sediments that are devoid of microscopic marine life are accumulating in the dark and cold sub-ice shelf environment above the KIS site today.

Under previous colder-than-present climates – the last ice age – the WAIS advanced across the site and laid down sediment called diamictite that is characteristic of the depositional environment at the bottom of an ice sheet.

Under past warmer-than-present conditions, the WAIS may have completely melted and the KIS site would have been covered by an open sea.

Sediments that settled to the sea floor during these ice-free intervals likely included photosynthetic plankton (diatoms) that were flourishing in the open marine environment that occupied West Antarctica at the time.

The drilling cores recovered by the SWAIS 2C team will be flown back to Scott Base and shipped to the Otago Repository for Core Analysis in Dunedin.

A larger team of international scientists will gather at the end of each drilling season to study the sediments and reveal the environmental secrets currently hidden beneath the ice. The new records will be used to reconstruct past climate conditions and reveal how the WAIS behaved in the past. They will provide evidence to test the climate and ice sheet models that are used to project, understand and foresee possible future scenarios.

Ice sheet and climate modellers will join the SWAIS 2C team to develop experiments to simulate past environmental change using the new observations and data as guides.

The aim is to improve our scientific understanding of ice sheet processes and refine the numerical models in order to reduce the uncertainty associated with Antarctic ice sheet behaviour and its contribution to sea level rise.

These new insights will allow scientists to take a huge step forward as they strive to learn just how sensitive West Antarctica is to a warmer climate. It will bring us closer to understanding whether efforts to reduce greenhouse gas emissions can save the Ross Ice Shelf and West Antarctic Ice Sheet, and limit global sea level rise.

Bratina Island and the McMurdo Ice Shelf - a very special place
Part 2 The fascinating ecology of polar ice shelves

INTRODUCTION

In the previous edition of Antarctic magazine, we provided an outline of the geography of Bratina Island and the adjacent McMurdo Ice Shelf (the 'Dirty Ice'), its history and naming, and the "extraordinary wetland ecosystem" of ponds and lakes on the gravel-covered surface of the Ice Shelf. Here we take readers into the strange world of microbe-dominated ice-shelf ecosystems and their very uncertain future through a look at the McMurdo Ice Shelf (78°S), with a brief detour to consider the fate of its northern counterparts – the Ward Hunt and Markham Ice Shelves in the Canadian High Arctic (83°N).

Figure 1: **(L)** Gravel covered McMurdo Ice shelf with ponds and lakes; **(R)** Sediment on the Ward Hunt Ice shelf, Canadian High Arctic allows formation of ponds and lakes.
Images: (L) Ian Hawes, (R) Warwick Vincent, Laval University

For some years comparative research was undertaken between the McMurdo Ice Shelf (Figure 1) and the Ward Hunt (Figure 2) and Markham ice shelves in Northern Canada. The Ward Hunt and Markham had analogous sediment-lined meltwater ecosystems to those on the McMurdo Ice Shelf, and scientists frequently worked across both systems to identify common features.

Ice Shelves differ from sea-ice in that they are the floating sections of large glaciers that extend out into the sea. Of the world's ice shelves, a few, represented at both poles, have the peculiar properties of being partially covered by moraine gravels – hence 'The Dirty Ice' nickname for the McMurdo Ice Shelf. This dark gravel and sediment absorbs enough heat in midsummer to melt fallen snow and underlying ice, resulting in the intricate array of rivers lakes and ponds that appear on the dirty ice each summer (Fig. 1). These waters are colonised by rich communities of microbial life that have been intensively studied from Antarctica New Zealand's field facility at Bratina Island (see previous issue of *Antarctic*) and the Canadian facility at Ward Hunt Island.

LIFE ON THE ICE SHELF

Small lakes and ponds on the ice shelves are a challenging environment. Biota must survive long months frozen to -30°C or below and grow rapidly in the few months of liquid water in summer.   The dominant life forms there are mat-forming cyanobacteria (Figure 3, 4), long photosynthetic bacterial filaments that exude a polysaccharide as they grow that binds the filaments together. The resulting cohesive mats form a matrix that is home to countless other bacteria, diatoms and protists. The mats are usually a few millimetres thick and are structured with an upper layer of cells that contain black, brown, or reddish coloured pigments that protect against high UV radiation in summer, overlying a blue-green layer that is rich in light-capturing chlorophyll and protein pigments. Below this are layers of bacteria and dead cells rather like the litter layer in a forest or grassland soil (Figure 4).

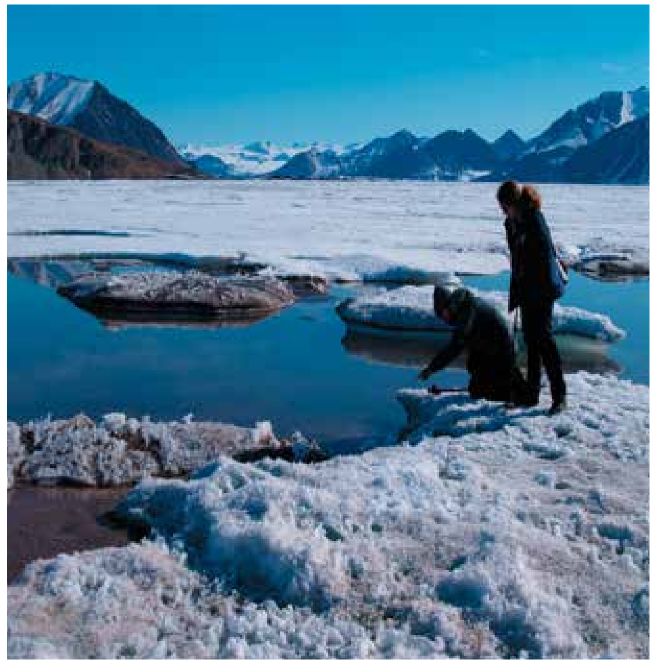


Figure 2: Sediment-covered ice shelves -a bipolar ecosystem type. **(L)** Luxuriant microbial mats in pond on the sediment-covered McMurdo Ice Shelf; **(R)** Scientists study similar microbial mats on the Markham Ice Shelf, Ellesmere Island, Canadian High Arctic. The Markham Ice shelf no longer exists. *Images: (L) Ian Hawes; (R) Warwick Vincent.*

Figure 3: Thick mats of cyanobacteria and algae coat the bottom of the lakes and ponds of the Murdo Ice Shelf. The red-brown pigment protects against UV radiation. *Image: Clive Howard-Williams*

Figure 4: Close up of a cut Antarctic cyanobacterial mat showing layering with green-brown active layers at the top and dead material below. *Image: Ian Hawes.*

CHARISMATIC MICROFAUNA

While dominated by bacteria, the ponds of the MIS do support microscopic, multicellular animals. All are less than 1mm in length and are described as micrometazoa or microfauna. Rotifers are especially common, and the bright red *Philodina gregaria*, endemic to Antarctica, grazes on cyanobacteria, whose red pigment accumulates in the gut of these animals (Figure 5). The name 'gregaria' was given by James Murray, the biologist on Sir Earnest Shackleton's expedition in 1908. It refers to the gregarious nature of these tiny animals which, though about a quarter of a millimetre in length, form dense aggregations visible to the naked eye as bright red, ketchup-like spots on the mats at the bottom of ponds.

Nematodes (roundworms) (eg. Figure 6) and Tardigrades (water bears) are the other common micrometazoa found in the cyanobacterial mats of the McMurdo and Ward Hunt Ice Shelves. As with rotifers both are very tolerant of extremes and enter anhydrobiosis – a dormant, desiccated phase – when faced with extreme aridity or sub-zero temperatures. Nematodes from the McMurdo Sound region are among the few metazoans known to tolerate intracellular freezing, once thought to be a death sentence (Raymond and Wharton, 2016).

ANALOGUES

Mats and mounds of cyanobacteria are amongst the oldest life forms on earth, recorded as fossil stromatolites some billions of years old. They have survived through much of Earth's history and every climate extreme the planet has endured over that time. One of the many distinguished international scientists to visit Bratina Island with the New Zealand programme was the late Professor Richard (Dick) Castenholz. Dick was an expert on cyanobacteria and the evolution of early life on earth. He remarked that "looking at the ponds we could be back in the Precambrian era" with their thick cyanobacterial mats and pillars resembling small stromatolites.

Since then, the McMurdo and Arctic Ice Shelves have been recognised as analogues for life on ancient Earth. Scientists have used these simple, microbe-dominated systems to interpret fossil signatures in ancient rocks, both physical and chemical, with lipids proving to be well preserved

Figure 5: The rotifer Philodina gregaria is particularly common in the ice shelf ponds. *Image: Michael Plewka.*

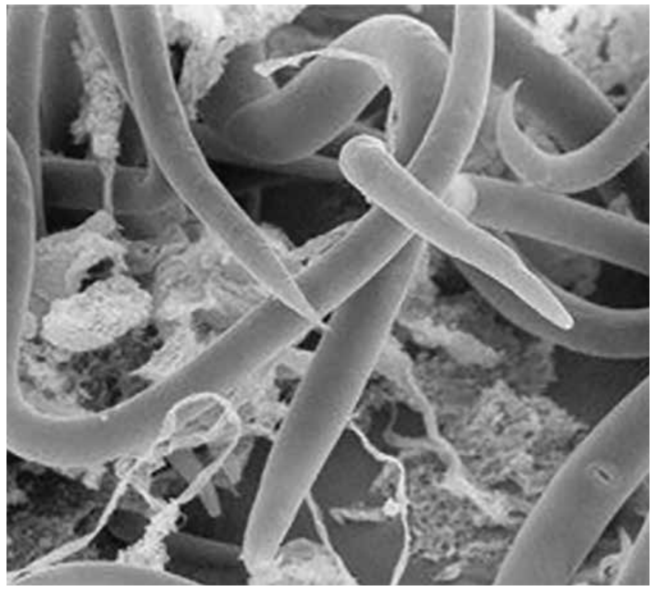


Figure 6: The Antarctic nematode Panagrolaimus davidi from soils on Ross Island. Worms are 1 mm long. *Image: David Wharton.*

and sensitive indicators of ancient community structure (e.g. Evans et al. 2022). A recent focus has been understanding how life survived through the so-called Cryogenian period some 700 million years ago when ice covered most of the Earth's surface, a period known as 'Snowball Earth'. At that time much of the oceans went anoxic, yet the complex life forms that were beginning to evolve prior to the glaciation event somehow persisted. It has been suggested that the few refugia for life at that time may have looked much like the McMurdo and Ward Hunt Ice Shelves (Vincent et al., 2004) and research on the MIS has shown how such habitats potentially provided stable oases, capable of supporting organisms known to have survived the Cryogenian and even exporting

Figure 7: Extended season at Bratina Island in 2008 allowed NZ scientists to follow the freezing process in McMurdo Ice Shelf ponds for the first time. Compare this view of a McMurdo Ice Shelf pond with Fig 2. *Image: Michael Plewka.*

organic carbon to the sub-glacial ocean (Hawes et al. 2016).

WINTER FREEZING

To celebrate the most recent International Polar Year in 2007-08, an unusual access to the field in the early winter months allowed scientists to stay at Bratina Island from January through to April. The goal was to determine, for the first time, how the transition from 'a balmy' summer state (Figure 2) to winter conditions occurs in Antarctic ponds (Figure 7). This work has provided insights into how winter freeze-up develops, and how pond life copes with the onset of winter conditions. Gradual, top-down freezing resulted in substantial stresses on life through freeze-concentration of salts and depletion of dissolved oxygen once photosynthesis was no longer possible reinforcing the extreme conditions to which life on the ice shelf is subjected. Paradoxically, once frozen in for winter, stresses on the organisms decline, and the microbial mats rest safely in cold storage until their thawing and reactivation the next season.

LONG TERM STABILITY AND INVASIVE SPECIES

The keen scientific eyes of the early polar explorers recognised the microbial mat communities as dominant across inland waters and collected and preserved samples to return to home institutions. When our colleague Dr Anne Jungblut, based at London's Natural History Museum, rediscovered samples taken from the McMurdo Ice Shelf in the Museum's historical collections, their careful preservation and documentation provided a unique opportunity to compare modern and century-old communities (Figure 8). Key questions were how stable microbial communities have been over time in such a variable habitat, and in the case of the McMurdo Ice Shelf, whether there was any evidence of new taxa having been introduced to what is a relatively frequently visited part of Antarctica (Jungblut and Hawes 2017). The answers to both questions were reassuring – genetic fingerprinting techniques showed that there were no substantive shifts in the species of cyanobacteria that formed microbial mats over a

Figure 8: Cyanobacterial communities from the McMurdo Ice Shelf: **(L)** a preserved herbarium specimen collected by Captain Scott's Discovery expedition and **(R)** a modern community. Genetic fingerprinting shows very similar communities of cyanobacteria in the two mats. *(Images: Anne Jungblut, Natural History Museum, London)*. Scale bars are 100 mm.

100 year interval, and no evidence to support the view that new species have arrived.

THE FUTURE OF THE ICE SHELF ECOSYSTEMS

What is the future of ice shelves and in particular those very few that support abundant life on their surfaces? We have already lost many of these remarkable ecosystems in the High Arctic as a result of rapid climate change. In existence for at least four millennia, in less than a decade between 2002 and 2010 the Ward Hunt Ice Shelf essentially collapsed, and in August 2008 the Markham Ice Shelf broke away from the shore and drifted into the Arctic Ocean. In 2020, the last remaining Arctic Ice Shelf lost 40% of its area (Vincent and Mueller 2020). With projected ongoing warming, perhaps over the decades ahead we will lose the remaining examples of these planetary unique ecosystems that have been with us for millennia and have served as natural extremophile laboratories for insights into cold-adapted life.

By **Clive Howard-Williams**, *NIWA;* **Ian Hawes**, *University of Waikato; and* **Warwick Vincent**, *Laval University, Canada.*

ACKNOWLEDGEMENTS

We thank Antarctica New Zealand for years of support at Bratina Island. Funding from MBIE, NIWA, the Universities of Canterbury and Waikato covered much of the research. US Navy Squadron VXE-6 and the RNZAF flew many times to Bratina Island in support of the science. We also thank the Centre for Northern Studies (CEN, Université Laval), NSERC, ArcticNet (NCE), Sentinel North (CFREF), PCSP and Parks Canada for supporting our research on the Ice Shelves of the High Arctic.

REFERENCES

Evans, T., Kalambokidis, M.J., Jungblut, A.D., Millar, J.L., Bauersachs, T., Grotheer, H., Mackey, T.J., Hawes, I., Summons, R.E. (2022). *Lipid biomarkers from microbial mats on the McMurdo Ice Shelf, Antarctica: signatures for life in the cryosphere. Frontiers in Microbiology, 31: doi 10.3389/fmicb.2022.903621.*

Hawes, I., Jungblut, A.D., Matys, E.D. and Summons, R.E. (2018) *"The Dirty Ice" of the McMurdo Ice Shelf: Analogues for biological oases during the Cryogenian. Geobiology 16, 369-377*

Jungblut, A.D. and Hawes, I. (2017). *Using Captain Scott's Discovery specimens to unlock the past: Has Antarctic cyanobacterial diversity changed over the last 100 years? Proceedings of the Royal Society of London, Series B. 284:*

Jungblut, A.D., Mueller, D. and Vincent, W.F. (2017). *Arctic Ice Shelf Ecosystems, pp 227-260 in: Copland L. and Mueller, D. (Eds.) Arctic Ice Shelves and Ice Islands. Springer Polar Sciences.*

Raymond, M.R. and Wharton, D.A. (2016). *The ability to survive intracellular freezing in nematodes is related to the pattern and distribution of ice formed. J Exp Biol. 219, 2060-2065.*

Vincent, W.F. and Howard-Williams, C. (2000) *Life on Snowball Earth. Science, 287, 2421.*

Vincent, W.F. and Mueller, D. (2020). *Witnessing ice habitat collapse in the Arctic. Science 370, 1031-1032*

Obituary: William James Peter (Peter) Macdonald

Peter passed away on Sunday 4th September 2022 in Wellington. He was 96. He was one of the (1956-57) NZ IGY Antarctic Expedition that, with NZTAE, helped set up Scott Base and he was also one of the mainstays of the geothermal research group in Geophysics Division that delineated all the geothermal fields in central North Island. He was awarded the Polar Medal in 1960.

Peter was born in 1926 in Kelburn, Wellington. He was educated at Kelburn Primary School, and Wellington College, before going onto Victoria College (University). In 1946 he joined the DSIR in the geophysics section of the Geological Survey. In 1954 he did a year's teacher training, and then a year at Thorndon School. In December 1954 he married Doris Thorogood. In 1956 he successfully applied for a position in the New Zealand International Geophysical Year Antarctic Expedition to Antarctica in 1956-58 and was given the responsibility for solar radiation and tidal records. This expedition initially shared the Scott Base with the NZ Support Party of the Commonwealth Transantarctic Expedition. He sailed on 6 December 1956 on the USS Glacier for McMurdo Sound arriving on 24 December 1956. Scott Base was constructed by MoW and NZ Defence personnel, with the science party assisting with the four science huts. The base was completed by end of February and all IGY science instruments installed and working by 10 April in readiness for the start of IGY on July 1 1957. Peter was responsible for the sunshine hours recorder that was the same one used in Scott's 1902 Expedition. He also measured incoming and reflected solar radiation. One of his most challenging projects was the tide gauge – the major problem was making a hole through the ice shelf several metres thick for the sensor and stopping the hole and recorders freezing up. Several holes were dug and deployments made before a stable system was achieved that recorded data to the end of IGY. Subsequently he also took over the McMurdo ice shelf movement/deformation project and substantially took over the meteorological observations in mid-winter from the NZTAE. On return to New Zealand in January 1958, his results were submitted to IGY World Data Centers and reported in a DSIR Bulletin. Peter authored the glaciology – ice shelf movement report and co-authored the meteorological and sea level reports as well as a research paper with Buzz Burrows on tidal and current data. Although Peter never worked in Antarctica again, he returned to Scott Base in late January 2000 as part of the Millennium trip that saw 11 of the original wintering over party return to Scott Base for 3 days. He retained his interest in Antarctica through his membership of the NZ Antarctic Society until the end. He was Secretary of the Society during the 1960s. He was the last surviving member of the first Scott Base winter-over party.

After writing up results from the NZ IGY Antarctic Expedition, he embarked on a very productive career developing and using the ground electrical resistivity method to locate geothermal areas in the New Zealand central volcanic region (Taupo and district) and overseas. The techniques he developed laid the foundation of 'geothermal exploration'. At the end of 1988, he had completed 40 years with DSIR and had to retire.

Peter was author of 14 published scientific papers in New Zealand and overseas journals (8 on Antarctica, including 3 in Nature), and 39 Conference Proceedings and DSIR reports.

A few years ago, Peter and Doris endowed a Prize for Industrial Design at Massey University and recently Peter endowed the Doris Macdonald Award for scholarship in Vocational Counselling and Practice. Peter will be remembered as a very practical and generous person.

By **Fred Davey**

New Zealand Recipients of Honours relating to Antarctic service

(other than The Polar Medal & The New Zealand Antarctic Medal)

This list is in addition to that published in the previous edition of 'Antarctic' magazine which lists the recipients of the prestigious awards of The Polar Medal and The New Zealand Antarctic Medal.

NEW ZEALAND SPECIAL SERVICES MEDAL (EREBUS) (NZSSM)

The NZSSM was established in November 2006 to recognize service in the aftermath of the crash of Air New Zealand Flight TE901 on Mt Erebus, Ross Island, Antarctica on 28 November 1979. The qualifying service included body recovery, crash investigation and victim identification. Service was performed at the crash site; during support and supply flights in and out of the crash site; at McMurdo Station; or at the mortuary at Auckland University School of Medicine.

Included in the list below are the names of all personnel awarded the NZSSM who assisted in Operation Recovery either at the crash site, McMurdo Station or at Williams Field*, Antarctica. Many American Navy personnel took the place of NZ Police personnel who, due to accommodation issues, were unable to travel to Antarctica. The names of a further 208 personnel who worked at the Mortuary in Auckland and were awarded the NZSSM are not included in this list.

Roy Stuart ARBON
NZARP Mountaineer
WO2 David John ARMSTRONG
Australian Defence Force Air Load Team
Cpl Brownie Phillip ASHBY
NZ Army Air Load Team
Sgt John Thomas ATTEWELL
NZ Army Air Load Team
Arnold John Gilmore BARNETT
NZ Face Rescue Team
AD2 Kenneth Michael BECKER
*US Navy VXE-6**
Constable Russell Alan BLACKLER
NZ Police
John Patrick Cyril BLUMSKY
Radio New Zealand
David M. BRESNAHAM
National Science Foundation Representative
Lt Cdr Darryn James BROWN
US Navy VXE-6 pilot*
Lt Cdr Gaston Reedy BUFORD
US Navy VXE-6 pilot*
WO1 Barry John CALDER
NZ Army Air Load Team
Paul Rawlinson CAVANAGH
NZ Press Association
Peter CHESNEY
*US FAA/NTSB**
Ronald CHIPPINDALE
NZ Chief Air Accident Investigator
Lt Cdr Lee CLARK
US Navy Chaplain
Dvr Bryan Te Hurinui CLARKE
NZ Army Air Load Team
Rev Father John COLLINS
NZ Police
Cdr William Andre COLTRIN
US Navy – Officer in Charge
AMS3 Robert B. COX
US Navy Crew Chief
CWO3 Dale Howard CRAMER
US Navy – Chief PH
Alan CRAWFORD
*US FAA/NTSB**
Dr Sandra Jean Carolina DEEGAN
US Navy Doctor
Cpl Craig Douglas DICKSON
NZ Army Air Load Team
Cdr Paul Richard DYKEMAN
US Navy
AE2 Carl Peter Jude EGGERS
US Navy Crew Chief
PO Reich John EGGERS
US Navy Crew Chief
Lt Cdr Daniel A. ELLISON
US Navy VXE-6 pilot
Lt Cdr William (Woo) FERRELL
US Navy VXE-6 pilot
Colin John FINK
NZARP L&S* Surveyor*
Captain Anthony McCartin FOLEY
NZ Airline Pilots Association
Captain Ian GEMMELL
Chief Pilot, Air New Zealand
Sergeant Gregory James GILPIN
NZ Police
Raymond Charles GOLDRING
NZARP Mountaineer*
Lt Cdr (Dr) James K. GOODRUM
US Navy Doctor
David Gardner GRAHAM
NZ Air accident investigator
Lt Cdr Terry Alan GREEN
US Navy VXE-6 pilot*
AD3 Al GREINER
US Navy VXE-6 crew*
SK1 Dion Christopher GREIR
US Navy Storeman
Dennis R. GROSSIE
US NTSB Investigator
LCpl Raymund Gerard HAANEN
RNZCT loading team
Peter Thomas HALL
NZARP L&S Surveyor
Rex David HENDRY
NZARP Mountaineer
Sgt Kevin Thomas HIBBS
NZ Army Air Load Team
PHAN Charles (Chuck) HITCHCOCK
US Navy Photographer
Sergeant Trevor John HORNE
NZ Police
PH2 Richard L. HORTON
US Navy Photographer
Sgt Antony David Roy INWOOD
NZ Army Air Load Team
Constable Brett Ardron JONES
NZ Police
Cpl Fred JUDENEA
Australian Defence Force Air Load Team
Frank (Kaz) KAZUKAITIS
Photographer - TVNZ
Dr John (Harry) Ross KEYS
NZ Face Rescue Team
Lt Edward (Eddie) KLONOWSKI
US Navy C-130 pilot
PH1 Dennis Howard KYNE
US Navy Photographer
Constable Stuart Barlass LEIGHTON
NZ Police
ACW Ronald Corrado LEWIS
US Navy C-130 technician
Hugh Francis Malcolm LOGAN, QSM**
NZARP Mountaineer
Steven Robert LUND
US National Transportation Safety Board
AD2 Joseph MADRID
US Navy Crew Chief Photographer
PO William MANNING
US Navy Crew Chief
PHAN Thomas E. MCCABE Jr
US Navy Photographer
Flt Lt Ian Owen McCLEOD
RNZAF/VXE-6 pilot*
Lt Cdr Darryn James McREYNOLDS
US Navy VXE-6 pilot*
Inspector Robert Stronach MITCHELL, MBE**
NZ Police
ENS George Emery MIXON
US Navy Storeman
John Theodore MOEHRING
US – GE Company Accident Investigator*
Colin Chalmers MONTEATH , QSM**
NZARP Field Operations Officer
Detective Senior Sergeant Michael John MUDDIMAN
NZ Police
Sergeant Dennis Anthony NATHAN
NZ Army Air Load Team
Capt David E. NEDELA
US Army Operations Officer
PH2 Douglas NORBET
US Navy Photographer
Sergeant Mark Anthony PENN
NZ Police
Capt Victor Louis PESCE
US Navy C-130 pilot
Michael PREBBLE
NZARP Leader, Scott Base*
Chief WO Choyce Alton PREWITT Jr
US Navy Watch Officer
Cpl Kevin John PURU
NZ Army Air Load Team
Captain Peter Macdonald RHODES
NZ Airline Pilots Association
LCpl Alan Robert RICHARDSON
NZ Army Air Load Team
Constable Edward (Ted) WILLIAM ROBINSON
NZ Police
ALM Richard RODABAUGH
*ALM VXE-6**
Sergeant Peter JOHN RODGER
NZ Police
AMS2 Hector RODRIQUEZ
US Navy VXE-6 pilot*
LCpl Gary Douglas ROSS
NZ Army Air Load Team
AD2 Harry Wayne RUSH
US Navy
Eric John SAGGERS
NZ Face Rescue Team
Sergeant Erlc Kevin James SHANKS
RNZAF/VXE-6* crew*
Flt Lt Noel George SMITH
RNZAF Air Load Team
Cdr David A SPRITE
CO VXE-6 Unit
Lt Frankie STAEBLER
US Navy VXE 6 pilot*
Francis John STANTON, MBE**
NZ Face Rescue Team
Cdr Melvin Leroy SUDIN
US Navy Physician Assistant Officer
Raymond Colin SYMONS
NZ Army Air Load Team
Cpl Dave Te PANIA
NZ Army Air Load Team
Lt Cdr John TENNANT
US Navy pilot
Lt Cdr Mark TERRELL
US Navy VXE-6 pilot*
Constable Bruce THOMPSON
NZ Police
Daryll Francis THOMSON
NZARP Mountaineer*
AD2 Brian Jon VORDERSTRASSE
US Navy VXE-6 Parachute Rescue*
Dr David Brice WAGHORN
NZARP Doctor*
LCpl David Neil WALLACE
NZ Army Air Load Team
Sergeant Murray Tehianga WATENE
NZ Army Air Load Team
Cpl Alan WELLS
Australian Defence Force Air Load Team
XD-04 Engineer Frankie WILLIAMS
US Navy VXE-6 crew*
Lt Cdr John WILLIAMSON
US Navy VXE-6 pilot*
WO2 Alan David WILLIS
NZ Army Air Load Team
WO Edward (Ned) WIMMER
US Navy Fire Chief
Constable Alistair Lance WINDLEBURN
NZ Police
Ian Duncan WOOD
Deputy Chief Engineer, Air New Zealand
Keith WOODFORD
NZARP Mountaineer
Cpl Roy WORTHINGTON
Australian Defence Force Air Load Team
Lyle Alan WRIGHT
McDonald Douglas Corporation Investigator
PH2 Brian Richard WURTH
US Navy Photographer
Milton Bruce WYLIE
Ministry of Transport Accident Investigator
Constable Peter YOUNGER
NZ Police

Key:
*
FAA/NTSB = *Federal Aviation Administration/National Transportation Safety Board*
GE = *General Electric Corporation*
NZARP = *New Zealand Antarctic Research Programme*
L&S = *Lands & Survey*
RNZAF = *Royal New Zealand Air Force*
VXE-6 = *Navy Antarctic Development Squadron 6 (Helicopters)*
Williams Field = *United States Antarctic Programme Airfield, 11km from Ross Island*

***Awarded 1981 for services relating to the DC10 recovery operation.*

OTHER AWARDS

Other New Zealanders to receive Honours that include reference to Antarctic service are (medals listed in order of precedence):

Edmund Percival HILLARY, KG (1995), ONZ (1987), KBE (1953)
Robert Alexander FALLA, KBE (1973), CMG (1959)
Robert George Mappin FENWICK, KNZM (2016), CNZM (2008)
Christopher Robert MACE, KNZM (2016), CNZM (2005)
Joseph Holmes (Bob) MILLER, KB (1979), OBE (1958)
Baden Nolan NORRIS, QSO (1977)
Richard Gerald McELREA, QSO (2017)
Paul HARGREAVES, ONZM (2007)
Dr Trevor HATHERTON, OBE (1958)
Robert (Bob) Baden THOMSON, OBE (1981)
Gillian WRATT, MNZM (2004)
Paul Douglas WOODGATE, MNZM (2012)
Francis John STANTON, MBE (1981)
Arthur HELM, MBE (1959)
Leslie Bowden QUARTERMAIN, MBE (1967)
Inspector Robert Stronach MITCHELL, MBE (1981)
Hugh Francis Malcolm LOGAN, QSM (1981)
Colin Chalmers MONTEATH, QSM, (1981)

Prepared by Mike Wing
New Zealand Antarctic Society

Note: *This is a working document and readers are requested to report errors of omission or commission which will be gratefully received. Please contact mikewing46@gmail.com*

Obituary: Dr E (Eddie) I Robertson, OBE, CBE, FRSNZ

Dr E I Robertson (Eddie), who passed away on 31 October 2022 at the age of 103, was one of the most influential persons in New Zealand science from 1951 to 1980. With an impressive academic record, he was appointed the first Director of Geophysics Division, DSIR (1951-64). Shortly after, the International Geophysical Year (IGY 1957-58) was proposed, an important programme for international science. Eddie was appointed to the Royal Society of New Zealand's National IGY Committee and attended the preliminary IGY meeting in Rome in 1954.

As most research covered in the proposed NZ IGY programme was being done by Geophysics Division and NZ Meteorological Office, the detailed work plan for NZ's contribution to IGY and its implementation (1956-59) were developed by the two, led by Eddie. In this role of organising the NZ IGY programme, he was responsible for the NZ IGY Antarctic Expedition led by Dr Trevor Hatherton.

He was also a member of the Ross Sea Committee (NZ Transantarctic Expedition - NZTAE) to ensure that the new base being built by the NZ government also supported the IGY expedition requirements adequately. He was involved in developing the joint IGY science plan and staffing for Hallett Station with the US.

In 1957 he visited Scott Base for 10 days to check on the scientific programmes both at Scott Base and at Hallett Station, With the departure of NZ TAE early in 1958, Eddie, as Director of Geophysics Division, was responsible for the operation of Scott Base until DSIR set up a separate Antarctic Division in 1959. He also led the development of the New Zealand Antarctic Research programme (1958-1970) through chairing (or was vice-chair) of the Ross Dependency Research Committee and led the NZ National Committee for Antarctic Research from 1958 to 1970.

He was the inaugural NZ delegate to the ICSU SCAR (Special (later Scientific) Committee on Antarctic Research) when SCAR was set up, continuing in this role until 1962. In addition, he represented NZ at the first seven meetings of the Antarctic Treaty Consultative Member Countries. Mt Robertson just south of Hallett Bay is named for him.

After IGY, Eddie continued to make significant scientific contributions in New Zealand and the southwest Pacific.
In 1964 he became Assistant Director General of DSIR, subsequently becoming Director General of DSIR (1971-1980), responsible for the efficient running of some or all of the various Divisions of DSIR and associated Research Associations.

In addition, he contributed to a wide range of activities including RSNZ (elected Fellow 1963, Council member 1963-71), NZ Futures Trust (Foundation Trustee), Cawthron Institute, Science Adviser to Ministry of Defence, University Scholarships Committee, Medical Research Council and many more.

By Fred Davey

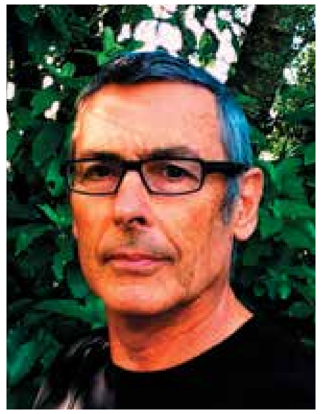
REUNION, YOUTH VISITORS TO ANTARCTICA

In the 1961-62 season three Queen's Scouts set out on the adventure of their lives as the first youth group participants in a program that was to roll for about 40 years, involving Scouts and Guides, St. John Ambulance, Boys and Girls brigade, Air Training Corp, Sea Cadets, and the Navy Cadet League.

If you participated or know someone who did, please contact Peter Duncan, pcduncan137@gmail.com / 0223808932, to express support for a reunion, to be held in Christchurch during the first week of November 2023, coinciding with the 90th Anniversary of the Antarctic Society.

Where is the NZ Antarctic Society heading?

- message from the President of the NZ Antarctic Society



The past three years have given cause, and pause, for thought as our work and personal lives have been disrupted. This has led to a substantial review of the organisation and the development of a transformational strategy. The survey conducted last year identified that the majority of the members are over the age of 60 years, and passive activities like the magazine, social gatherings and presentations were the main services valued. Non-members sighted education and outreach as higher value activities for the society. Two or three key themes have emerged across the survey and the ongoing discussion around the strategy - advocacy, engagement and education.

So how do we do this? The newly approved strategy has identified that we need to take Antarctica to the World, and has provided some clear underlying values that will frame the activities of the organisation going forward. Currently descriptions and plans are being drawn up for actions and services that we can, and should, deliver for what can be described as a bold strategic direction. Will this alone do it? No, it won't.

Our key asset as an organisation is the knowledge that our members hold across a wide range of information related to the Antarctic. So how do we tap into this knowledge and translate it into material that we can then take to the widest possible audience(s)? And how do we broadcast this information and connect with people outside the organisation in a cluttered world? It is you, the members, who hold this key. This year, as the strategy unfolds, we will be asking you to assist, divulge, network, create, collaborate, engage, and generally put your shoulder to the wheel as we look to move the Society forward. This is a call to action.

All the best,

Rex Hendry, President, *NZ Antarctic Society*

Gifting and/or Bequest Form

I give, bequest and bequeath to the NZ Antarctic Society, a not-for-profit organisation (NZ Charities #CC27118), the sum of

$ ____________ to be used in the following manner *(tick those that apply)*:

		%
☐	The NZ Antarctic Scholarship Fund, to be used to encourage young people to engage with issues relating to Antarctica.	
☐	Identifiable strategic initiatives clearly stated in the Society's strategic plan, and this contribution will be recognised accordingly.	
☐	Oral Histories – collecting and storing the memories and anecdotes of previous NZ Antarcticans, and personnel within the NZ Antarctic Society	
☐	The operating costs of the Society to ensure the financial sustainability of the organisation.	
☐	Activities at the discretion of the Society's Executive.	

Name: Signed: Date:

If this is a gift, please place your gift in our BNZ account 02-0800-0685108-02, using your name as reference, and send this form to The Treasurer, NZ Antarctic Society, International Antarctic Centre, Private Bag 4745, Christchurch 8140. If this is a bequest, please pass a copy to your lawyer for your will and send a copy to NZAS Treasurer. Thank you for your support.

Two teams meet on the sea ice in McMurdo Sound to conduct field work. At right, behind the Hägglunds vehicle, the crate marked 'Fragile' contains the EM-31 instrument, used to measure sea ice and platelet layer thickness. NIWA marine physicist and NZAS Vice President, Natalie Robinson is a lead scientist in this research. *Credit: Vanessa Wells, Elanti Media*

Implementing the New Zealand Antarctic Society's Strategic Plan

The members of the New Zealand Antarctic Society accepted its Strategic Plan 2023-2032 at a Special General Meeting on 25 February 2023.

The plan outlines the vision, mission, values, assets, strategic directions and strategies for the Society for the next 10 years. Some initiatives are aspirational and may only be achieved in the longer run, but they help to imagine what the Society may be able to achieve in the future.

The Strategic Plan was developed by the Strategy Subcommittee in consultation with the Society's members. Surveys were conducted, presentations were held and feedback was invited.

NINE STRATEGIES

Nine strategies were developed, which can be categorised in 3 broader categories: core strategies (membership engagement, services and stewardship), support strategies (volunteering, communication and technology) and organisational strategies (constitution, governance and management, and finance).

HIGHLIGHTS

The Society aims to engage with a wider, more diverse audience and be more active and outward focussed. Advocacy is one of the main pillars and aims to:

- promote the health of the Antarctic treaty system,
- the protection and proper management of Antarctica and Southern Ocean across a broad range of topics,
- promote leadership in Antarctic science, and,
- promote environmental and climate change policy and management based on Antarctic science.

Outreach services will set out to improve New Zealand's environmental, climate change and political awareness regarding the Antarctic and inspire the next generation of scientists, historians, politicians and conservationists.

Continued services include the Antarctic magazine, the oral histories programme, the national speaker series and of course local branch services and events.

Communication and technology will underpin the success of these services. An up-to-date website, regular newsletters, a clear calendar of events, using the right language to reach intended audiences, and using the right means and media to reach them will be key to success.

A review of the constitution will take place to allow a review of governance and membership structure, and to allow registration under the 2022 Incorporated Societies Act.

Finally, a finance strategy needs to deliver a financial model that supports the Society's services and initiatives to ensure long term financial viability and legislative compliance, and include third party funding from grants, donations, bequests etc.

IMPLEMENTATION

This ambitious plan will be implemented via the work of subcommittees and working parties. Their terms of reference will confirm their roles and what needs to be achieved. Subcommittees have a permanent role, for example the Science and Policy Subcommittee, and working parties have a shorter term and are project based, for example the Constitution Working Party.

GET INVOLVED

With the implementation lies your opportunity to get involved via subcommittees and working parties. So, please step forward, particularly if you have expertise and interest in areas such as:

- advocacy and policy,
- outreach programming and delivery,
- marketing and communication,
- website management and technology,
- finance and accounting,
- volunteer management, and
- stewardship (preservation of knowledge and items).

General skills are welcome too. A few people have already expressed interest, but more are needed.

To get involved, please contact **Rex Hendry** *(President)* **president@antarticsociety.org.nz** *or* **Hubertien Wichers** *(Chair of the Strategic Planning Subcommittee and South Island Vice President)* **sivp@antarcticsociety.org.nz**. *The Strategic Plan 2023-2032 will be on the Society's website* **www.antarcticsociety.org.nz**

SOUTH POLE TRAVERSE

The tractor train of the South Pole Traverse (SPoT) on the Ross Ice Shelf with the Transantarctic Mountains up ahead, their destination: the Amundsen-Scott South Pole Station operated by the US National Science Foundation.

During the austral summer, three traverses are undertaken (SPoTs 1-3) by the US Antarctic Program comprising 8-12 tractors each, transporting vital fuel supplies over the 1600km journey from McMurdo Station on the coast, to the Pole high up on the Polar Plateau. It takes approximately 28 days to reach the Pole, while the return journey to McMurdo usually takes 15 days.

In this photo, the traverse team is within a day's travel of the Leverett Glacier, the 150km route from the ice shelf up to the polar plateau (visible in this view, is the mouth of the Scott Glacier). One of the biggest challenges of the traverse was surveying a route from the grounding zone (the official shore line) of the Ross Ice Shelf, to the plateau. There are many glacial out flows merging in this area and many other glacial passes were surveyed to find the best way up. The Ross Ice Shelf moves approximately 90m per year in most areas of the traverse route, with major exceptions such as the Shear Zone, 50km from McMurdo.

Elevation at the base of the Leverett is 160m above sea level, and 2450m at the top. Once on the Plateau, the highest point reached by the traverse is 2925m, which lies another 80km beyond the top of the Leverett. The altitude of the South Pole Station is 2835m.

Historically, ski-equipped aircraft delivered all fuel and cargo to the station. However, the NSF developed polar traverses as viable alternatives, with lightweight, high-efficiency fuel sleds that greatly increased the amount of fuel delivered compared to traditional sleds, enabling large cost savings and emissions reductions compared with air transport. These lightweight sleds consist of flexible fuel bladders strapped to extruded sheets of polyethylene plastic.

The NSF has used bladder sleds to transport fuel to the Pole since 2008. An economic analysis showed that traverse operations offset an average of 30 annual aircraft flights for cost savings of US$2 million per annum. Importantly, SPoT consumes one-fourth the fuel, and emits less than 1% of the air pollutants compared with aircraft delivery of the same payload. In addition to the fuel bladders, each traverse tows the team's living quarters, food supply and any spare parts and tools they might need.

Photo: Jake Carruthers