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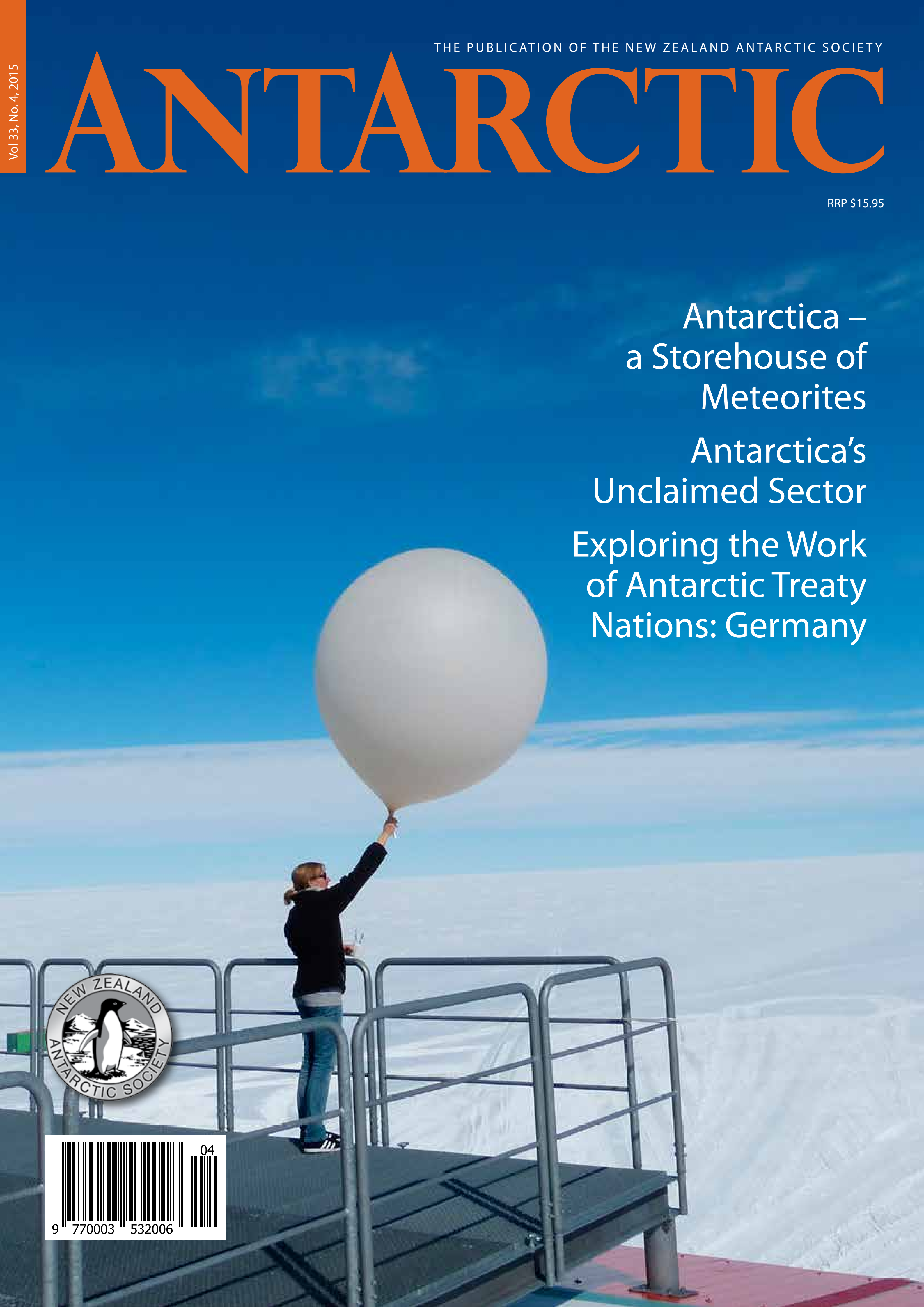

Antarctica – a Storehouse of Meteorites

Antarctica's Unclaimed Sector

Exploring the Work of Antarctic Treaty Nations: Germany

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Patron of the New Zealand Antarctic Society: Professor Peter Barrett, 2008

NEW ZEALAND ANTARCTIC SOCIETY LIFE MEMBERS

The Society recognises with life membership, those people who excel in furthering the aims and objectives of the Society or who have given outstanding service in Antarctica. They are elected by vote at the Annual General Meeting. The number of life members can be no more than 15 at any one time.

Current Life Members by the year elected:

1. Jim Lowery (Wellington), 1982
2. Robin Ormerod (Wellington), 1996
3. Baden Norris (Canterbury), 2003
4. Bill Cranfield (Canterbury), 2003
5. Randal Heke (Wellington), 2003
6. Bill Hopper (Wellington), 2004
7. Arnold Heine (Wellington), 2006
8. Margaret Bradshaw (Canterbury), 2006
9. Ray Dibble (Wellington), 2008
10. Norman Hardie (Canterbury), 2008
11. Colin Monteath (Canterbury), 2014
12. John Parsloe (Canterbury), 2014
13. Graeme Claridge (Wellington), 2015

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Cover photo: Launching a weather balloon at Neumayer III Station. Photo courtesy of AWI.
Photo above: The icebreaker RV *Polarstern* delivering supplies to Neumayer III Station. Photo courtesy of AWI.
Back Cover: Scott Base Antarctica. © *Antarctica New Zealand Pictorial Collection.*

President's Note

Antarctic Society General Meeting

Since the last issue of *Antarctic* we have held the Antarctic Society's AGM, hosted by the Canterbury Branch on 17 October 2015 in Christchurch at the International Antarctic Visitor Centre. Attendees were also offered a tour of the Centre after the AGM.

Congratulations to all the incumbent National Officers who were re-elected. You will find their details on the inside back cover of this issue.

The AGM agreed to award the Antarctic Society's Conservation Trophy to **Ms Lizzie Meek**, for her exceptional leadership in the conservation of Antarctic artefacts. The Society is also pleased to award Life Membership to **Mr Graeme Claridge**, a pioneer in Antarctic soil chemistry. Future issues will cover these awards more fully.

We were delighted to receive a presentation from Mr Peter Beggs, the Chief Executive Officer of Antarctica New Zealand. Peter reflected on his first two years as CEO and the diversity of New Zealand's work in Antarctica. He spoke of policy, science, diplomacy, political systems, collaboration, history, international relations, and the Antarctic Society. One significant theme which Peter highlighted is the value of Antarctic science in contributing to understanding climate change. Internationally, when people think of climate change research in Antarctica, they think of New Zealand, he said. The value of New Zealand's science also enables it to influence global climate change action. Peter also noted the importance of international collaboration. He compared New Zealand's contribution to the Antarctic Treaty System to being the pesky mosquito in a small tent: "A small guy can have a disproportionate impact." Peter reinforced his support for the New Zealand Antarctic Society, including the benefit of having several Antarctic Society members assist with the Scott Base maintenance programme.

Mariska Wouters

From the Editor

One of the lasting memories of my brief trip to Antarctica, was a visit to the Crary Lab at McMurdo Station, where among other things I saw, and held, some meteorites collected in Antarctica, including one from Mars. It wasn't until almost a year later when I was discussing this experience with a geologist here in New Zealand, that I realised how privileged I was. In this issue we look at **Antarctica – a Storehouse of Meteorites.**

We continue our series Exploring the Work of Antarctic Treaty National Antarctic Programmes, with **The National Antarctic Programme of Germany**. John and Margaret Bradshaw recently visited Korea for the 21st International Symposium on Polar Sciences; they report on **South Korea in Northern Victoria Land.**

Have you ever wondered about the seven territorial claims to Antarctic sectors? We look at **Antarctica's Unclaimed Sector**, and its status under the Antarctic Treaty.

Also included in this issue is an obituary for **Malcolm Laird**, a former Life Member of the Society. Mourners at his funeral were invited to make gifts, in lieu of flowers, to the Society's Oral History Programme, and $1,117.30 has been donated. The Society wishes to thank Malcolm's widow, Dr Margaret Burrell, for this generous thought in Malcolm's memory.

In the last issue, members were invited to go in the draw for a copy of John Thomson's book: *Shackleton's Fearless Captain*. The two winners of that draw are Sue Stubenvoll and Bill Conroy. A copy of the book has been posted to each.

Lester Chaplow

South Korea in Northern Victoria Land

By Margaret and John Bradshaw

South Korea has a well established Antarctic Research Programme that dates back to 1987. The country had acceded as 33rd signatory to the Antarctic Treaty in 1986 and, during that same year, two South Korean parties visited Antarctica. One consisted of seven mountaineers who climbed the 4897-metre-high Vinson Massif with support from Adventure Network. The other was a nine-man scientific party to King George Island, who began a biological, geological and meteorological programme and also selected a suitable site for the country's first Antarctic base, King Sejong Station, which was built in 1988.

A year later South Korea became a full consultative party to the Antarctic Treaty. An active Arctic research programme was also initiated with the construction of Dasan Station in 2002. The 6000-tonne South Korean research icebreaker, *Araon* (meaning 'for all seas'), was built in 2009. This was a ship that would visit both the Antarctic and Arctic, and, with its help, South Korea's second Antarctic base, Jang Bogo, was built in 2014, near Terra Nova Bay in northern Victoria Land. The combination of an icebreaker and a new base in Victoria Land has led to a much broader scientific research programme, driven by KOPRI, the Korea Polar Research Institute.

KOPRI has welcomed collaborative research with other countries, such as the US and Italy, and in 2014 Korea signed a letter of intent with New Zealand for bilateral co-operation in supporting research and sharing infrastructure. KOPRI has been generous in welcoming international researchers to their shores to share in discussions of present and future research. It was through this generosity that the authors, both New Zealand Antarctic geologists, visited KOPRI headquarters in Incheon in May this year for the 21st International Symposium on Polar Sciences – *The Polar region as a key observatory for the changing globe and beyond.* KOPRI is housed in a new, purpose-built complex that includes offices, well equipped laboratories and a comfortable lecture theatre. It is sited in a "new town" south of the old port city of Incheon. Parts of the town are still under construction but it already has a centre with shops, many dramatic high-rises, numerous restaurants and interesting parks. The new town is connected to Seoul by an efficient and very clean subway system.

The main business of the meeting included one and a half days of talks and poster sessions covering work that was being done by a range of national programmes, as well as reviews of earlier research and new results from the very active Korean programme. Our interaction was with the earth science programme, which for KOPRI has recently focussed on the area around Jang Bogo Base, and the Bowers Mountains of northern Victoria Land. Here they have supported large parties (eight people) by helicopter at critical localities, such as the Eureka Spurs near the

Photo above: Electron Probe Microanalyzer in the new KOPRI headquarters in Incheon. Photo courtesy of KOPRI.

head of the Mariner Glacier where important trilobite fossils had been found in 1973. The focus has been on modern studies of stratigraphy and sedimentology, updating and amplifying work started by New Zealand parties in the 1970s and early 1980s. Helicopter transport and larger parties allow much more time at the outcrop and more attention to detail than had been possible with sledging parties (who in practice spent half their field time travelling). So far, work has focussed on the central Bowers Mountains, but there is an intention to extend to the west to look at the older rocks west of the Rennick Glacier. In addition, there has been some work on the younger Beacon rocks and Kirkpatrick Basalts to the west. One of the more amazing revisited finds was two fossil trees six to seven metres high, standing upright within a 180-million-year-old lava flow.

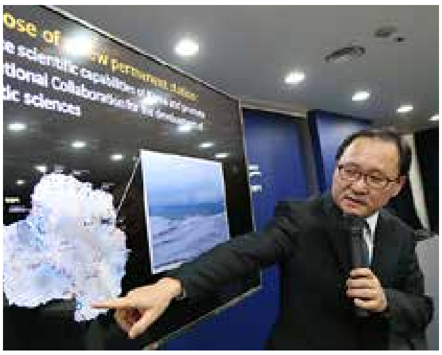
The central themes for KOPRI's geological research are: 1) sedimentary basin development in northern Victoria Land during the Early Paleozoic period around 540–340 Ma (million years ago), and mountain building processes during the same period; and 2) paleoenvironments during the Permian and Early Mesozoic (270 to 180 Ma) and younger volcanic processes, focussing on the still active volcano of Mt Melbourne. All of these topics have been studied before by American, New Zealand, German and Italian programmes, and the Koreans are building on these foundations with strong field support and modern laboratories dedicated to the programme.

For the past nine years, KOPRI has also had a programme of meteoritic research (KOREAMET), both in the field and in conjunction with the University of Florida. Last year a 36.7 kilogram meteorite was discovered, along with 81 smaller specimens, which are now being analysed. The previous year they collected a lunar meteorite on a joint Korea–Italy collecting programme. An important aim of the programme is the development of new laboratory techniques at KOPRI for dating meteorites and analysis of particles as small as 1 micron. We were impressed with their state-of-the-art meteorite laboratory and storage facility.

Future plans for KOPRI's bedrock earth science programme include extending their work through southern Victoria Land (in the near future), then into the Central Transantarctic Mountains, and eventually into the Ellsworth Mountains.

In addition, there are parallel programmes on climate change, including ice-coring coupled with studies of the stratospheric polar vortex. The objectives include understanding the rapid warming of West Antarctica, better winter weather forecasting for East Asia and leading an international ice coring programme to reconstruct a high-resolution climate record for the last 20,000 years. A separate ship-based project (on the *Araon*) is concerned with sea-ice and oceanic circulation and biochemical processes in the Amundsen Sea. These studies are backed by satellite-based research and remote sensing to provide continuous data on the polar front, phytoplankton, on-land vegetation abundance, and marine abundance. Work is also taking place on the Larsen Ice Shelf and the general Weddell Sea and Antarctic Peninsula region with the establishment of an ice shelf monitoring system.

The Korean programme is a true polar programme with parallel activities in the Arctic, extending as far south as the permafrost zone. It is well funded, and supported by laboratories with modern technology. The staff we met were knowledgeable, enthusiastic and determined to succeed in a global context. They were also very hospitable, and the evening they took us out to a Korean barbeque was an incredible experience and totally different to a Western one!



KOPRI President Dr Kim Yea-dong points to the location of Jang Bogo Station in Terra Nova Bay on a map of Antarctica.
Photo courtesy of KOPRI.

Icebreaker *Araon* in Antarctica.
Photo courtesy of KOPRI.

Rare lunar meteorite jointly collected from ice near Mount deWitt by KOPRI and Italian scientists in 2013. Photo courtesy of KOPRI.

Exploring the Work of Antarctic Treaty National Antarctic Programmes:

The National Antarctic Programme of Germany

Germany is an Antarctic Treaty Consultative country and also a very active Arctic nation. The lead agency for the German national Antarctic programme is the Alfred Wegener Institute (AWI), which was established as a public foundation in 1980 and which conducts research in the Arctic and Antarctic, as well as in temperate latitudes. The AWI co-ordinates polar research in Germany and provides the necessary equipment and key infrastructure for polar expeditions. AWI scientists study the natural variability of the climate system from short to long time scales. The Arctic and Antarctic are climatologically the most sensitive regions in the earth system to anthropogenic climate change and in this context they constitute valuable sources of information about possible future global environmental change and its consequences. Key data are obtained on present-day variability of ocean systems and climate, their historic variability in the recent geological past, and in the reconstructions of climate history. Methods exploited range from modern satellite-based remote sensing techniques to deep-sea and ice-core drilling. A priority at AWI is to conduct research on the polar marine regions and their biotas.

Antarctic operations

Germany operates four Antarctic research stations. Neumayer III is the current winter-over base, on the Ekström Ice Shelf, the third station to occupy this space since 1981. Close by, at 757 kilometres away, is Kohnen Station, a summer base that was established in 2001 and was used for deep drilling purposes until 2006 and now serves as a deep ice lab and as an advance base for deep field activities on the Polar Plateau. The Dallmann Laboratory is a smaller seasonal working space annexed to the Argentinian base Carlini and operated jointly with the Instituto Antártico Argentino since 1994. The Gondwana base in Northern Victoria Land is operated as a summer base by the German Geological Survey (BGR) and is presently being refurbished. The pride of the AWI is the icebreaker RV Polarstern, which was first commissioned in 1982. The ship is equipped for biological, geological, geophysical, glaciological, chemical, oceanographic and meteorological research, and contains nine research laboratories. The ship has a maximum crew of 44, and offers work facilities for a further 50 scientists and technicians. Plans for a new icebreaker are currently in advanced stage of development.

There are two ski-equipped polar aircraft (BASLER BT-67) which can be used both for logistic and science purposes. They can be equipped for aerogeophysical, meteorological, glaciological and atmospheric chemistry studies.

The German Antarctic research programme

AWI is responsible for all logistics operations related to the three stations and also for scientific work the falls within three divisions – climate, biology and geosciences. The science programme is structured into four complementary research topics and provides a comprehensive earth systems understanding from a polar and coastal perspective, with special emphasis on vulnerability and resilience in relation to society's needs:

- Changes and regional feedbacks in Arctic and Antarctic
- Fragile coasts and shelf seas
- The earth system from a polar perspective: data, modelling and synthesis
- Research in science–stakeholder interactions

AWI has close ties to many German universities, where joint professorships are established and where formal co-operation agreements are signed. Together with the German Research Foundation (DFG) in its priority programme on Antarctic research, the AWI also funds talented young scientists. The Institute sends scientists to other institutes throughout the world and invites scientists from other nations to cruises aboard RV *Polarstern*, as well as to Bremerhaven and Potsdam. About a quarter of those participating in Polarstern expeditions are scientists from abroad.

More information on AWI can be found at www.awi.de or at www.comnap.aq/Members.

Launching a weather balloon at Neumayer III Station.

Air Chemistry Laboratory in Neumayer III Station.

Garage and foundation of Neumayer III Station.

The icebreaker RV *Polarstern* delivering supplies to Neumayer III Station.

Polar 5 aircraft at Kohnen Station.

Neumayer III Station in summer with Polar 5 aircraft coming in to land.

All photographs courtesy of AWI.

Antarctica – a Storehouse of Meteorites

By Margaret Bradshaw

The cover of the last issue of *Antarctic* (Vol 33, no. 3) shows a Japanese scientist (JARE-54) beside a meteorite discovered in the Yamato Mountains (part of the Queen Fabiola Mountains) in Dronning Maud Land in 2013. The specimen, 18 kilograms in weight, was frozen into the blue ice (and partially covered by recent snow) and the scientist in the photograph is writing the field number directly onto the ice below. Why do we find so many meteorites in Antarctica, now well over 18,000, and why is scientific interest in them so intense?

Since its creation, the Earth has been bombarded by meteorites from space. These are fragments from other bodies in the Solar System – asteroids, planets, our Moon and comets. Meteorites are immensely important, as they provide clues to the origin and history of the Solar System. Most meteorites originate from the Asteroid Belt, a zone of fragments, some quite large (house-sized), that lies between Jupiter and Mars. It is thought that the belt probably developed from the same primordial solar nebulae that created the planets, but was prevented from accreting into a planet by the strong gravitational pull of Jupiter.

Meteorites are fragments that stray into the Earth's orbit. Most burn up due to friction with the Earth's atmosphere (these are meteors), but some have enough mass to land on the Earth as a meteorite without burning up. The largest meteorite known to have landed on Earth impacted over 2,000 million years ago to produce the giant Vredefort Crater in South Africa (380 kilometres in diameter). Giant impacts that have occurred more "recently" include the Chicxulub Crater (180 kilometres in diameter), now recognised in Central America. This was created when a meteorite, estimated to be at least 10 kilometres in diameter, fell to earth 66 million years ago. The global dust cloud produced is believed to have led to a mass extinction that included the dinosaurs. Despite millions of years of erosion and change, indications of a meteorite impact remain, including the presence of "shocked rock", geophysical anomalies and evidence visible from satellite imagery.

The largest recorded impact in modern times was the Tunguska meteor which exploded over a remote part of Siberia in June 1908, flattening forest over an area of 2,000 square kilometres. The meteor is estimated to have been between 60 and 190 metres in diameter. The most recent example was the Chelyabinsk meteor that exploded 30 kilometres above the Ural Mountains region of Russia on 15 Feb 2013. The shock-wave from the blast injured 1,500 people from falling glass and debris, and 7,200 buildings were damaged in six cities across the region. The weight of the disintegrated meteor was estimated to be between 12,000 and 13,000 tonnes.

Many meteorites, some of them quite small, reach the Earth's surface every year, but fragments over one

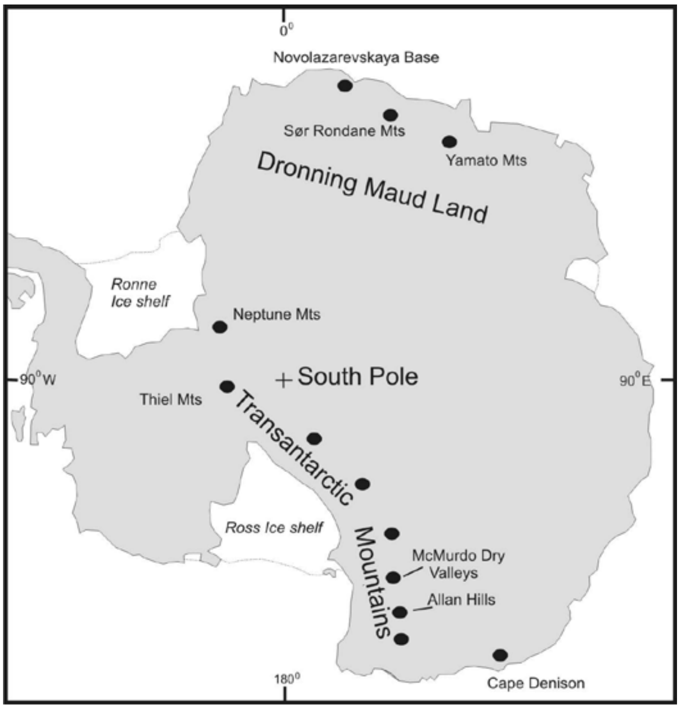
Figure 1: A chance encounter on the Polar Plateau in 1976 – Leading American Antarctic meteorite researcher, Bill Cassidy (right) with colleague Ed Olson (left), explaining their search for meteorites near Mount Fleming to New Zealander Margaret Bradshaw. Photo courtesy of John Nankervis.

Figure 2: ANSMET team recovering a small meteorite on a large area of blue ice west of the Transantarctic Mountains. Photo courtesy of Katherine Joy.

Figure 3: A meteorite from Mars, specimen EET 79001, collected from the Elephant Moraine (inland from Allan Hills). Photo courtesy of Johnson Space Center.

kilogram are quite rare. Some meteorites are seen to fall but most are discovered, often much later. Meteorites tend to decay or erode quickly, especially if water is present. A desert environment will preserve meteorites longer. Antarctica, which is cold, high[1] and very dry, provides one of the best environments for meteorite preservation. The East Antarctic landmass is buried beneath a huge dome of very thick ice that is flowing slowly outwards under its own weight. The ice cap has been in existence for about four million years.

The first meteorite found in Antarctica (a stony meteorite) was discovered in 1912 by Douglas Mawson's Australasian Antarctic Expedition of 1911–1914, 43 kilometres from Cape Denison in Adélie Land. The second meteorite (iron) was found in the Humboldt Mountains by a Russian party in 1961 near Novolazarevskaya, their base in Dronning Maud Land. In 1962 American geologists found two fragments of a rare Pallasite stony-iron meteorite on Mt Wrather in the Thiel Mountains, while a later group of geologists discovered an iron meteorite in the Neptune Mountains in 1964. But the 1969–70 season was a special year for meteorites. A Japanese group studying ice in the remote Yamato Mountains in Dronning Maud Land made the amazing discovery of nine meteorites, all of them compositionally different, and therefore not the result of breakup of a single specimen. This discovery excited international interest, for it suggested that a variety of meteorites were being concentrated at certain blue ice sites.



Map showing position of meteorite collecting sites mentioned in this article.

During the 1973–74 season, 12 more specimens were collected from the same Yamato site. Extending its horizons in the 1974–75 season, the Japanese team collected a stunning 663 meteorite specimens from the Yamato Mountains, with a further 307 specimens the following year.

In 1976–77, in collaboration with Japanese researchers, the American programme began searching for suitable blue ice areas in the Transantarctic Mountains, starting at the head of the McMurdo Dry Valleys area. The project was initiated by Dr Bill Cassidy, University of Pittsburgh, who continued his Antarctic search for 15 further years (Figure 1). Cassidy also set up the ANSMET programme (Antarctic Search for Meteorites), which was funded by NSF, with NASA agreeing to curate specimens and the US National Museum (The Smithsonian) serving as the final repository of all US-collected material. US meteorite recovery was slow in coming. Two meteorites were found in a small area of ice above Vortex Col (Wright ice fall). It was several weeks before a further four specimens were located on a reconnaissance trip to ice patches near the Allan Hills. A return trip to this site led to the discovery of 34 scattered fragments of the same stony meteorite, including a very large fragment, together totalling 407 kilograms.

Scientists were now beginning to understand that the meteorite concentrations were always in stagnant areas of blue ice. The stagnation had resulted from the damming of ice flow by mountains and sub-ice ridges. High winds prevented snow accumulation, leading to areas of blue ice that have been sublimated (direct evaporation from solid ice) for thousands of years, so that buried meteorites become concentrated at the surface. Many suitable locations were found in the Transantarctic Mountains (Figure 2), and further collections were made by the Japanese in the Sør Rondane Mountains of Dronning Maud Land. The Italian and German programmes, the European consortium, and the South Korean and Chinese programmes also became interested in obtaining Antarctic meteorites. By 1999, the number of meteorites collected in Antarctica, largely by the American and Japanese programmes, totalled 17,808.

One of the most exciting outcomes has been the discovery of meteorites at several Antarctic localities that have originated from Mars and from our Moon. Major asteroid collisions with both of these bodies blasted fragments into space,

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1 The height means that it is colder – the main reason why the ice cap initially developed. The height is also the reason the ice spreads "downhill" towards the sea.

Antarctica's Unclaimed Sector

By Alan D. Hemmings[1] and Neil Gilbert[2]

Although none of the seven territorial claims to Antarctic sectors (including the "Ross Dependency") are generally recognised by the international community, they remain on the books, so to speak. The Antarctic Treaty, through its Article IV, preserves the positions of those states that make claims, the position of those states that believe they have a basis for a claim, the position of those states that do not recognise particular claims, and the position of those states that do not recognise the right of any state to claim territory in Antarctica. Notably, Article IV also makes clear that no new territorial claim to Antarctica can be made whilst the Treaty remains in force.

In the meantime, Antarctica, south of 60° south, is managed through a collective governance arrangement by the now 29 Antarctic Treaty Consultative Parties (and in relation to marine harvesting, by the 24 states plus the European Community that constitute the Commission of CCAMLR).

However, there is one sector of Antarctica that has never been claimed. Today it is the only "terrestrial" area on our entire planet that remains unclaimed by any state. As a result, no state has the status of a "coastal state" in the sense of the UN Convention on the Law of the Sea, and so no government can assert a territorial sea or an exclusive economic zone (which, notwithstanding Article IV, has been asserted in other claimed sectors – even if no other state pays any notice). This is the sector from 90° to 150° west (see figure), to which the Amundsen Sea and part of the Bellingshausen Sea abut. This area is often shown on maps as Marie Byrd Land and Ellsworth Land, reflecting the US interwar expeditions in this region. It is the largest part of the area known more recently (and often in the context of increasing rates of ice loss through climate change) as "West Antarctica".

The area has also been referred to as the "American Sector" – in part because of the major expeditions of Richard E. Byrd and the 1935 flight of Lincoln Ellsworth from Dundee Island in the northern Antarctic Peninsula to the edge of the Ross Ice Shelf. But the other factor in this notional naming was the hope (particularly within the interwar British Empire) that British imperial claims to the Falkland Islands Dependencies (UK), the Ross Dependency (New Zealand) and the Australian Antarctic Territory, and the associated agreements on recognition and boundaries in relation to Dronning

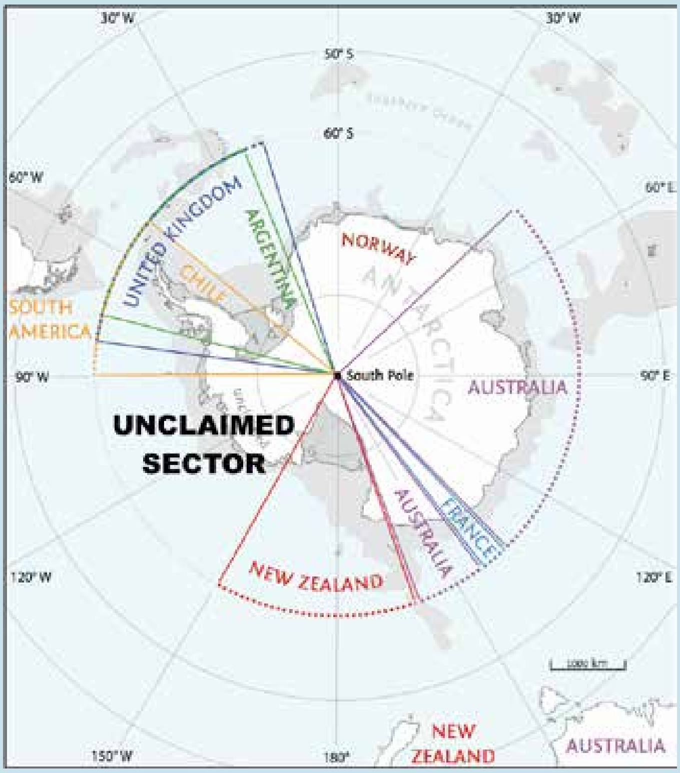

Figure: The Unclaimed Sector and territorial claims in Antarctica. Image courtesy of Alan D. Hemmings

Maud Land (Norway) and Terre Adélie (France) would be joined (and reinforced) by a US claim to the sector 90° to 150° west. If that were achieved, so the argument ran pre-World War II, the realised "American Sector" would ensure that the entire Antarctic continent was parcelled out between the major Western states. For a range of reasons this did not eventuate, and the sector remained unclaimed through to the adoption of the Antarctic Treaty. The adoption of the Treaty and its Article IV essentially closed the overt colonisation ambitions of individual states, and this sector is now generally known as "the Unclaimed Sector".

The sector is something over 1.5 million square kilometres, around 20 per cent of the continent. It is, however, an area in which relatively little human activity has (or is currently) occurring, even by Antarctic standards. It is particularly remote, hard to access and, seemingly, not as attractive for even scientific researchers as other parts of Antarctica (these may have been factors in it not being claimed by anybody in the first place). Research has been conducted there – particularly glaciological and climate-change-related in recent times. But there are no permanently occupied stations in the

1 Perth, Western Australia and Gateway Antarctica, Christchurch

2 Constantia Consulting Ltd, and Gateway Antarctica, Christchurch

sector (aside from "Amundsen–Scott" at the South Pole, which is by definition in every sector). A single, seasonal (though now largely abandoned by Russia) station was established by the Soviet Union in 1980 (the "Russkaya" station at 75° 45' S, 136° 48' W), and the US runs a seasonal camp at "Siple Dome" at 81° 39' S, 149° 0' W. Compare this with the 15 facilities on the small King George Island and you understand that access and flagging territorial interest through occupation and presence may be as significant as objective scientific criteria in station site selection.

Similarly, there are hardly any designated protected areas in this sector. Not one of the 72 Antarctic Specially Protected Areas (ASPA) is located in this sector and only one of the seven Antarctic Specially Managed Areas (ASMA) is – and that is at "Amundsen–Scott" station. Just two of the 90 Historic Sites and Monuments (HSM) are located here: quite reasonably, one designating the site of Amundsen's Tent; the other, perhaps not quite so reasonably, commemorating the first Argentine surface expedition to reach the pole, in 1965.

One might say, with some justice, that the absence of any protected areas in 1.5 million square kilometres reflects the absence of pressures or risks in an area that hardly anyone goes to. However, one might have thought that in meeting the criteria for Annex V of the Madrid Protocol's "systematic environmental-geographic" series of ASPAs, that some areas in the Unclaimed Sector might have warranted consideration. The Antarctic protected areas system has been in place in some form or other since the mid-1960s. And the practice of states since then has been to propose areas for protection only in the area where one's national programme operates. Because nobody claims this sector, activity levels have been lower, stations rarer, and the inclination to see values as warranting special protection much less than elsewhere.

Perhaps the time has come when this will no longer do. Perhaps we should now be arguing that the Unclaimed Sector holds areas that should be "kept inviolate from human interference" as reference points, and that it may as well as anywhere else hold "representative examples of [various sorts of] ecosystems", "areas of outstanding aesthetic and wilderness value", or other values identified in Annex V of the Madrid Protocol. Indeed, the fact of low human activity levels in this sector may mean that in relation to wilderness protection and inviolate reference areas, this sector is in a class of its own. Perhaps New Zealand could stimulate a co-operative approach to ensuring that Consultative Parties jointly propose protected areas in the Unclaimed Sector. We have been having some difficulties around the designation of marine protected areas (MPAs) in Antarctica, and it may be a fool's errand to propose another MPA in this area right now. But, one of the peculiarities of the Unclaimed Sector is that here just about everybody has to concede that the high seas go right up to the Antarctic coastline. We may wish to have some part of this marine area in an MPA before we see fishing activity hereabouts too.

« Antarctica – a storehouse of meteorites **continued from page 43**

some of which have later landed on Earth. Analyses of specimens by NASA show the Martian specimens (Figure 3) to be highly shocked, with gas bubbles trapped in impact-melted rock. Analysis of these bubbles indicates isotope ratios that are identical to those found in the Martian surface by the Viking Landers, but unlike those on Earth. We now know that Martian-derived meteorites are relatively common and have been found in India, Egypt and Nigeria, but only now has their origin been fully appreciated.

Some of the Antarctic meteorites are now believed to be the result of asteroid impact on the Moon's surface. These meteorites have a different composition to Earth rocks, but are very similar to lunar rocks collected during the Apollo missions. By 2002, 35 lunar meteorites had been found, 28 of them in Antarctica and seven from elsewhere (north-west Africa, Libya, Oman, and Australia). Some are believed to have come from the far side of the Moon.

It is possible to calculate when a meteorite fell to Earth. While in space, a meteoroid (a small stony or metallic body travelling through space) is bombarded by cosmic rays that create short-lived radioactive isotopes, which spontaneously decay. When the meteorite falls to Earth the creation of these isotopes stops, and they decay at a known rate, providing a clock that starts at the time the meteorite lands. This is known as the meteorite's "Terrestrial Age" – the time since its fall. Terrestrial Ages for Antarctic meteorites lie within a broad range from one million years to 9,700 years, but nothing older. This result is surprising considering the East Antarctic Ice cap has been in existence for about four million years. It could be that older meteorites are still buried deep within the ice and have yet to emerge.

Malcolm Laird. Photo courtesy of © GNS Science 156786-9040-3. Photographer: S.N. Beatus, 1989.

Malcolm Gordon Laird: Antarctic Explorer, Sedimentologist

Born Ngarua, Waikato 24 April 1935; Died Machu Picchu, Peru, 21 June 2015

By John Bradshaw (JB – University of Canterbury) and David Skinner (DNBS – GNS Science)

Malcolm Laird was a lover of adventure, especially in the Antarctic. He grew up on a dairy farm, the eldest of five children, and was educated at Matamata College where he was co-dux. In 1956, he embarked on a University of New Zealand Mathematics BSc at the then Auckland University College. In those days, it was quite common for third year students to include first year Geology as the last filler unit for their BSc requirements. In 1958, Malcolm arrived in the Geology Department of the College with seven units towards a Mathematics BSc completed, and Geology 1 was to be his eighth unit to completion. However, Malcolm so enjoyed the world of geology that he decided to carry on for another two years to complete Certificates of Proficiency in Geology, and allow him to enrol in and subsequently (in 1962) complete a First Class MSc Honours degree at the now autonomous University of Auckland.

Meanwhile, however, the annual advertisements by the Ross Dependency Research Committee for the 1960–61 summer New Zealand Antarctic Research Programme staff had appeared. Malcolm and DNBS both applied, and although holding only newly minted BSc degrees, we were accepted; Malcolm not only as a geologist but, because of his farm experience, as – of all things – a dog handler! We were to be attached to summer Topographic Survey parties: Malcolm in the southern Central Transantarctic Mountains (CTM) in the Nimrod Glacier region, and DNBS in the Byrd Glacier region of the CTM; no previous geological work had been done in either region.

In preparation, Malcolm arranged through Antarctic Division of the Department of Scientific and Industrial Research for us to meet with Bernie Gunn of the University of Otago, who was one of the authors (with Guyon Warren) of the New Zealand Geological Survey's (NZGS) as yet unpublished bulletin manuscript of the Geology of Victoria Land, which dealt with the region to the north of the CTM. We were thus able to spend a productive few days with Bernie Gunn, examining typical rock samples and learning something of the activities of a field geologist in Antarctica.

After a very snowy Field Training Camp on Ruapehu, on 16 October 1960 Malcolm flew out of Christchurch to Antarctica (with DNBS) on a triple-tailed Super Constellation. The early Antarctic summer of 1960 was a time of very snowy and stormy white-outs at McMurdo Sound and Scott Base, and so it was not until 10 November that Malcolm's field party was able to be flown to their field area. The waiting time at Scott Base had been spent learning to run sledge dog teams, packing food and equipment, repairing sledges, doing "house-mouse" duties (including night watches, emptying "honey buckets", and base cleaning), and cooking Sunday lunches and dinners. It was also a summer of high sunspot activity, so that communications with Scott Base and between field parties were difficult and sporadic. In addition, during much of their time in the field, Malcolm's party suffered from frequent white-outs, heavy snowfalls and dangerously obscured crevasse fields in a very rugged terrain, all in all making their exploration very difficult. Because of the communication difficulties, the northern party (with DNBS) in the Byrd Glacier area did not get to talk to Malcolm and the southern party until 16 December, when he told us that he had collected three lots of the Cambrian fossil *Archaeocyathide* on 10 December. These later became the subject of his prestigious 1962 paper (with Bruce Waterhouse)

"Archaeocyathine limestones of Antarctica",[1] the fossils to be later christened *Archaeocyathis bedfordii-lairdii* in honour of his discovery.

We next heard of Malcolm's party on 25 December, after a Scott Base radio report that an aircraft carrying their mail and food resupply had had to jettison most of the cargo and had then crash-landed. The search for the crashed plane tied up most of the aircraft at McMurdo, and so resupply became a low priority. This left Malcolm and his team facing a hungry week of decreasing food for both the men and dogs. The emergency rations for the men had to be broached for meat-bars, potato powder and cocoa – shades of Captain Scott! Luckily, a resupply landing was successfully made to them on 29 December. However, Malcolm's party's luck was still against them, as they had to eke out their food for a bit longer than planned after the plane that was scheduled to give them their next supply did not arrive until 24 January. Lastly, the plane scheduled to bring them back to McMurdo on 4 February had engine trouble and then had to "mother" a downed helicopter to their south. They eventually arrived back at Scott Base on 9 February.

Having packed up his rock samples for return on RNZN *Endeavour*, Malcolm flew back to Christchurch on a Super Constellation on 16 February and, after a period of home leave, spent a few weeks at the Lower Hutt office of the NZGS making microscope thin sections of the rock samples. He then returned to the University of Auckland to complete his MSc Honours degree, after which he accepted a position with the NZGS and was posted to the Greymouth office. During this period, he published the results of his first Antarctic expedition: "Geomorphology and stratigraphy of the Nimrod Glacier–Beaumont Bay region, southern Victoria Land Antarctica,"[2] as well as significant papers and reports on north-west Nelson and West Coast geology.

In the 1964–65 summer season, Malcolm led a further expedition to the north of the Nimrod Glacier area, into the Queen Elizabeth, Holyoake, Cobham and Swithinbank ranges, covering some 7,770 square kilometres.[3]

In 1965, Malcolm won a prestigious New Zealand Department of Scientific and Industrial Research doctoral scholarship, which he elected to take up at Oxford University, where he completed the doctoral research for which he was awarded a D.Phil in 1969. His thesis was entitled "Sedimentation studies in the Silurian rocks of north-west Galway, Eire," and part of the thesis was the recognition of an important new type of sedimentary fabric, separately published in 1970: "Vertical sheet structures – a new indicator of sedimentary fabric."[4] His DPhil thesis can be accessed online.[5]

During his time at Oxford, Malcolm also did field work in Scandinavia,[6] later publishing the results in two 1972 papers: "Sedimentation of the ?late Precambrian Raggo Group, Varanger Peninsula, Finnmark," and "The stratigraphy and sedimentology of the Lakesfjord Group, Finnmark."[7]

On returning to New Zealand from Oxford, Malcolm recommenced work on the West Coast (or Wet Coast as he usually called it). Meanwhile, the Greymouth Office of NZGS had closed and Malcolm found himself administered from the Christchurch NZGS office although he continued his work on the West Coast. During this time, in 1978, he was appointed to the position of District Geologist. Notwithstanding, Malcolm continued to work on West Coast and north-west Nelson geology until the mid-1990s, often in collaboration with both NZGS colleagues and staff of the Geology Department of the University of Canterbury (especially JB).

Malcolm's career was focussed around four "Cs": Cambrian, Cretaceous, commitment and conscience. The first arose from his 1960s work on the Early Cambrian of the CTM that had made him an internationally recognised expert on the Antarctic Cambrian. In the late 1960s it had become clear that a rather different suite of enigmatic Cambrian rocks also existed in northern Victoria Land and Malcolm was determined to work on those too. His first attempt (with Peter Andrews) in the 1972–73 summer season was cobbled together after funding and logistic problems. It was much too brief, but did result in a first collection of good Late Cambrian fossils, published in 1972 in *Nature* (with Peter Andrews, Phil Kyle and Peter Jennings).[8]

Malcolm was able to participate in two further northern Victoria

1 *Nature*, 194, p. 861.

2 *New Zealand Journal of Geology and Geophysics*, 6, no. 3, pp. 465–484.

3 M. G. Laird, G. D. Mansergh & J. M. A. Chappell, "Geology of the central Nimrod Glacier area, Antarctica," *New Zealand Journal of Geology and Geophysics*, 14 (1971), pp. 427–468.

4 *Journal of Sedimentary Petrology*, 40, pp. 428–434.

5 http://ora.ox.ac.uk/objects/uuid:b8f92dc0-43b6-4d1c-a960-5adde43ff29f

6 "A geologist in Lappland," *Newsletter, Geological Society of New Zealand*, 26 (1968), pp. 10–13.

7 *Norges Geologiske Undersoekelse*, 278, pp. 1–11 & 13–40.

8 "Late Cambrian Fossils and the age of the Ross Orogeny, Antarctica," 238, pp. 34–36.

Land expeditions. The earlier one in 1975 produced in 1977 a third *Nature* paper (with Roger Cooper and Jim Jago).[9] Malcolm's last trip to northern Victoria Land (with JB) was in the summer of 1981–82 as a member of an International Northern Victoria Land Project expedition organised by the US Antarctic Research Program (USARP). A fourth collegial *Nature* paper was published from this work.[10]

Meanwhile, in 1978, his passion for Antarctic geology had resulted in the award of a Polar Medal. His and Peter Barrett's Polar Medals were the first to be made to New Zealand summer field personnel rather than to wintering personnel.

The mid-1970s were the time of the first oil crisis and the refocus of geological investigations in New Zealand on fuels – coal and oil – and from this grew the coal resources survey and the initial phase of the Cretaceous-Cenozoic project (CCP) of the NZGS. With the restructuring of science in the early 1990s and the creation of the Crown Research Institute (CRI) model, out of which GNS Science was one of several institutes to be formed, the original CCP morphed into a major science programme, within which Malcolm's role steadily increased. There was a strong focus on his work on mid-to-late Cretaceous sedimentation in Marlborough and the eastern North Island, and the relationship of Cretaceous Torlesse ("greywacke") rocks to better ordered, younger Cretaceous rocks. By the beginning of the new millennium Malcolm was increasingly involved in the funding and management of the CCP programme. He found it hard to accept the perception by senior management that this was his job, and that he should not be going out into the field to see what his colleagues were discovering but should merely read their reports. Malcolm, like most geologists, wanted to see the evidence with his own eyes and compare it with his own experience. This conflict in approach eventually led to Malcolm leaving GNS Science, while fortunately securing continuing funding and retaining access to the programme data as a Senior Research Fellow attached to the Geology Department, University of Canterbury. A synthesis of the whole programme up to the pre-publication stage was virtually completed before his untimely death, and is being prepared for publication by several of his old colleagues.

Malcolm's Antarctic passion continued while he was attached to the University of Canterbury, particularly as a senior sedimentologist on the Cape Roberts Drilling Program in the 1999–2000 Antarctic summer season. His dedication to Antarctic science was again recognised by his election as a Life Member of the New Zealand Antarctic Society in 2006. After his "retirement" he continued his interests in Antarctica (and the Arctic) by providing science expertise on Quark Expeditions' cruise ships, marking his inaugural trip to the North Pole by leaping into the freezing ocean!

With regard to the other 'Cs', Malcolm's abundant publications on his research projects are testament to his drive to make his data and results available to other geologists. All in all, he published 44 Antarctic papers, 67 New Zealand papers and 5 Scandinavian and Irish papers as either first author or a co-contributing author. In addition, there were another 172 unpublished reports, maps, letters and commercial client reports, these last mainly concerning coal and oil/gas prospects in New Zealand.

Malcolm was generous with his help to students, colleagues and younger staff, from suggestions of localities, access, discussions, background and references, to general and wide-ranging discussions of life in general. He was also a fair and constructive referee for manuscripts submitted to a range of journals. Malcolm and Margaret kept a home that was a refuge for geologists weather-bound on the way to Antarctica or mis-connected on the way back. Overall, Malcolm was a very level-headed, fair and reasonable person, always ready to listen and debate even when he disagreed with the proposition. He was always keen to catch up and learn about what other people were doing, especially within the group of OAEs (Old Antarctic Explorers) from the 1960s, for whom he had organised their Christchurch reunion. Firm and determined certainly, but never angry or self-serving. In spite of his antipathy to the modern science structure, in our opinion, Malcolm was a true gentleman scientist and adventurer.

Vale Malcolm.

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9 "New data on the lower Palaeozoic sequence of northern Victoria Land, Antarctica, and its significance for Australian–Antarctic relations in the Palaeozoic," 265, pp. 107–110.

10 E. Stump, M. G. Laird, J.D. Bradshaw, J. R. Holloway, S. G. Borg, & K. E. Lapham, "Bowers graben and associated tectonic features cross northern Victoria Land, Antarctica," 304 (1983), pp. 334–336.

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A Letter from the Editor – December 2015

This issue of *Antarctic* marks the end of the first full year of my stewardship of your magazine, following the handover from Janet Bray after the untimely passing of our long-serving Editor Natalie Cadenhead. Fortunately, Janet and several editors before her are still very supportive of *Antarctic*, and of my role.

The four issues per year of *Antarctic* are one of the major benefits that the New Zealand Antarctic Society offers to its members. Therefore, it seems vital that the magazine, which you are contributing towards through your membership fees, serves you, the Society's members, by providing the information and services that you require.

As I see it (and I will be very glad to hear from you with other suggestions), *Antarctic* should provide three things:

- *News about the Society, both at a regional and national level.*
- *Broader news about current developments in Antarctica, both in New Zealand programmes, and elsewhere.*
- *Recollections of Antarctic activities over the years – both personal and collective.*

My objective as Editor is to meet these three goals, though the emphasis will vary from issue to issue. You can judge for yourself the degree to which these objectives have been met in this and the previous issues since I took the helm. My personal passion is Antarctic literature, and so there may be some occasional additional coverage of books, old and new, from time to time.

My initial concern as a new Editor was that it might be difficult to find sufficient publishable content. At the time of writing, I have almost enough articles for an extra issue. Next year, the Council will be considering increasing the number of pages in the magazine. Inevitably, a decision to increase the number of pages, subject to availability of articles, comes back to money. By way of example, increasing the size by eight pages would add approximately $2,000 cost per issue. To help inform Council when it considers the business case of increasing page numbers, I am interested in your feedback. How might this be funded? Are you willing to see more advertising in the magazine (currently less than two pages per year, but possibly up to two pages per *issue*)?

As a member of the Society, you should consider this YOUR magazine. Make it your own. Send in a letter, a recollection, an article, a book review, a poem, some of your favourite images. All of these will be gladly received, and, space permitting, appropriate contributions will be reproduced here or on the Society's website.

Perhaps you have a particular interest in, say, Antarctic stamps, or maps, or history, or wildlife, or politics, or another country's national Antarctic programme, or some area of science. Can I ask you to consider becoming a regular or occasional columnist and contribute your thoughts to these pages? I am sure your fellow readers will be glad to learn from your expertise.

And may I ask for feedback? If you like what you are finding in the magazine, I would be glad to hear – both for my own sake – to affirm the direction that I am taking – and for that of the authors of the articles. More importantly though, if you do not like something, tell me that too, especially if you have some suggestion as to how the matter might be addressed.

Above all, fresh content and your personal recollections will contribute to the continuing success of this magazine.

Lester Chaplow

(Adapted from an editorial by David Ellyard, Editor of *Aurora*, March/April 2015.)