ANTARCTIC

Bulletin Vol. 12 No. 4

ANTARCTICA

SOUTH GEORGIA
SOUTH SANDWICH IS.
SOUTH ORKNEY Is
Orcadas (Argentina)
FALKLAND IS.
Signy I. (U K)
SOUTH SHETLAND IS. (See map below)
ANTARCTIC PENINSULA (see map below)
WEDDELL SEA
Kaiser (U S)
Druzhnaya I (USSR)
Ronne Ice Shelf
Siple (U S)
ELLSWORTH LAND
SANAE II (South Africa)
Georg von Neumayer (Fed Rep of Germany)
Novolazarevskaya (USSR)
Dakshin Gangotri (India)
COATS LAND
General Belgrano II (Argentina)
Syowa (Japan)
Molodezhnaya (USSR)
ENDERBY LAND
Mizuho (Japan)
Mawson (Australia)
MAC ROBERTSON LAND
Davis (Australia)
South Pole
Amundsen-Scott (U S)
QUEEN MARY LAND
Mirnyy (USSR)
Vostok (USSR)
Trans-Antarctic Mts
MARIE BYRD LAND
Ross Ice Shelf
Russkaya (USSR)
McMurdo (U S)
Scott (New Zealand)
Vanda (New Zealand)
WILKES LAND
Casey (Australia)
ROSS SEA
VICTORIA LAND
Leningradskaya (USSR)
Dumont d'Urville (France)
BALLENY Is.

0 500 1000 Kilometres
0 500 1000 Miles

1 Comandante Ferraz BRAZIL
2 Henry Arctowski POLAND
3 Teniente Jubany ARGENTINA
4 Artigas URUGUAY
5 Teniente Rodolfo Marsh CHILE
Bellingshausen USSR
Great Wall CHINA
6 Capitan Arturo Prat CHILE

7 General Bernardo O'Higgins CHILE
8 Esperanza ARGENTINE
9 Vice Comodoro Marambio ARGENTINA
10 Palmer USA
11 Faraday UK
12 Rothera UK
13 Teniente Carvajal CHILE
14 General San Martin ARGENTINA

SOUTH SHETLAND ISLANDS

0 100 km
0 100 mls

ANTARCTIC PENINSULA

0 100 km
0 100 mls

Larsen Ice Shelf

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Photo: Dr. Paul Broddy

Polar activities

Winter life at Scott Base to be filmed by Television New Zealand

New Zealand's 1990-91 Antarctic Research Programme finished on Wednesday February 20 with the departure of the last summer staff and field personnel from Scott Base. Over 260 scientists and support staff took part in the 44 projects undertaken since early October.

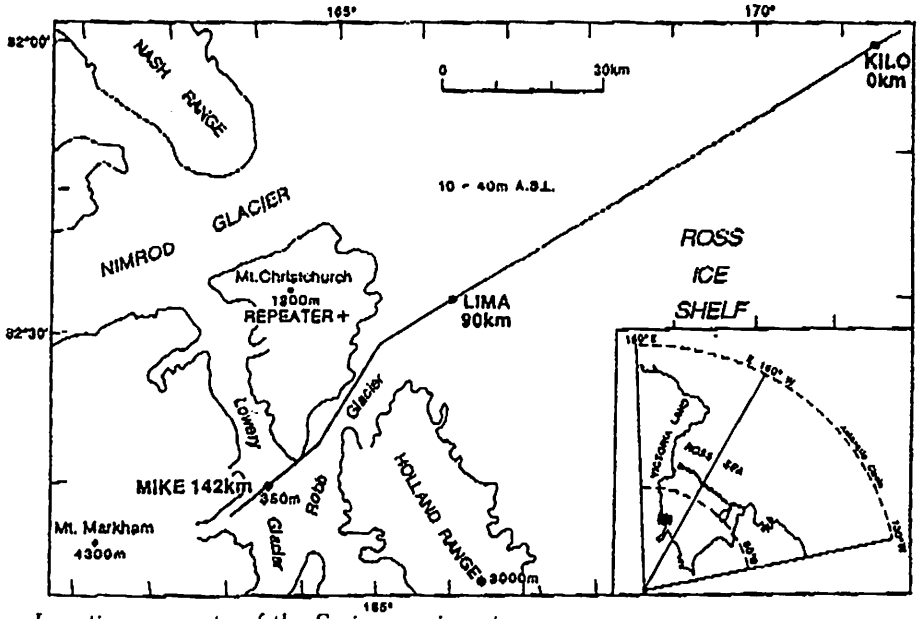
Under the joint logistical arrangements with the United States Antarctic Programme the last flight for the season left McMurdo on 28 February. The two winter teams have now started six months of isolation broken only by telephone calls and winter resupply scheduled for June 25 and 26.

Leader for the winter at Scott Base is Ross Macdonald of Tokoroa who is also Engineering Manager.

Others in the party include Karen Gage, a chef from Burnham, Sally White of Springfield, who is part of the domestic staff; Peter Kraak, Chris McCarrell and Max Olliver, all technicians from Christchurch, Roy Joblin of Hamilton, telecom technician; Helen Wills, also of Hamilton, Telecom Supervisor; Jack Jenniskens, a mechanic from Stratford; Peter Harding, base engineer from Wellington and Phil Clerke from Blenheim, who is storekeeper and provided field support for the summer.

In addition a two man crew from Television New Zealand are spending the winter at the base. They are Max Quinn (producer and director) from Dunedin and Don Anderson (soundman) from Little River.

Among the field programmes successfully completed these season were:



Location an route of the Seris experiment

The SERIS experiment

Crustal seismic investigation across the boundary between East and West Antarctica.

Undertaking one of the first large-scale modern multichannel seismic experiments in the Antarctic interior this season was a joint New Zealand-United States party. Working from three principal camps the team completed a profile 142km long across the Ross Ice Shelf and the Transantarctic Mountain front just south of the Nimrod Glacier.

The purpose of the project was two-fold; firstly to image the geological structures formed at the boundary of East and West Antarctica and secondly to test different seismic acquisition techniques which may be used in future seismic exploration of the continent.

With a total length of 3000-3500km and elevations up to 4500m the Transantarctic Mountains are one of the major Cenozoic ranges in the world. They are bounded on their eastern margin by steep normal faulting and can generally be described as gently tilted block-faulted mountain ranges. Parallel and just offshore in the Ross Sea sector is the Cenozoic age Terror Rift. The Ross Embayment as a whole is a vast submerged region of extended continental crust which has been dissected by several rifts probably during the Mesozoic and Cenozoic. It is commonly assumed that the Transantarctic Mountains form the boundary between the two major continental plates described as East and West Antarctica.

The boundary is of particular interest as it is one of the few continent/continent boundaries on earth where the juxtaposed plates are separating rather than colliding. The result of this process has been the development of a deep basin on one side of the boundary and an elevated Mountain range on the other.

It is anticipated that analysis of data obtained by the use of modern multichannel crustal reflection/refraction techniques, should explain the nature of the faulting across the transition, the variation in crustal thickness across the plate and the presence or otherwise of the southward continuation of the Terror rift.

Led by Dr Tim Stern of DSIR Geology and Geophysics, Wellington and Dr Uri ten Brink, of the Department of Geophysics, Stanford University, California the party comprised 15 people including two drillers, two surveyors (for the initial flagging of the line), three field assistants, a mechanic, camp manager, two seismic engineers and four geophysicists.

The profile was to cross the Transantarctic Mountain front via glaciers and the Ross Iceshelf. Initially the party were to use the Skelton, the only one previously traversed by heavy vehicles, but the orientation and location made this impossible. Instead after extensive inquiry and two C130 reconnaissance flights in January, the interconnected glaciers Robb and Lowery, some 80 km north of the Beardmore Glacier, and just south of the Nimrod, were chosen. In addition to their location, each glacier offered a moderate topographic slope and both were relatively free of crevasses. The Robb-Lowery route was also found to be nearly windless because the Markham Plateau to the west blocked the flow of katabatic winds from the Polar Plateau.

Leaving Scott Base in the first week of December about 12 C-130 flights were required to put the main party into Mike and Lima Camps. The exercise required that some 80 tons of equipment, consumables and people be moved into the field including a Hagglund, two Tucker snocats, one Sprite and five skiddoos. Eleven tons of dynamite were used but this was not detonated all at once. About 1400 shots were fired, each using 5-7 kilos of dynamite. To ensure good radio communication the expedition established their radio transmitter on Mt. Christchurch.

The party carried about 23 km of seismic cable and over 100 geophones. Hot water drilling techniques were used to make the (approximately) 1400 17 - 20 metre deep holes in the ice for detonating the charges. This work was contracted to PICO (Polar (Ice Coring Office, University of Alaska) through the National Science Foundation. Two thousand gallons of fuel were used to melt the snow to produce the hot water and a further 800 gallons were used by the whole expedition.

The first third of the profile took them from just west of Mike, a depot, about half way

between Scott Base and the South Pole,at the junction of the Lowery and Rob Glaciers down the Robb and past the north end of the 3000 metre high Holland Range which rises steeply at the boundary between the Ross Embayment and East Antarctica. The last two thirds of the profile stretched east across the Ross Ice Shelf over ice 200 to 500metre thick. This provided two "sample environments", the first over a grounded glacial ice overlying crystalline basement and the second over floating ice layer overlying both water and sediments.Seismic reflection, refraction and gravity data were collected along the line.

Two different systems were used to collect reflection data. The first was a conventional cable and buried geophone system and the second a towed "snow-streamer" loaned from Norsk-Hydro in Norway. Seventeen to 18 metre holes were drilled in the ice by a hose ejecting water at 80 deg C and at high pressure. Spaced at 200 metre intervals, three to five could be drilled in an hour. Charges were placed at the bottom of each and the results recorded on 48 groups of 14 Hz geophone strings with six units per string and placed at 50 metre intervals for the first 51km of the traverse down the glacier.

The second system using the snow-streamer consisted of a 1.5 km long listening array of 60 gimballed geophones towed by a Hagglund. Two shots were fired every six to seven minutes. With no drilling required the team could move quickly but because the geophones lie on the surface they were susceptible to wind noise.

A further experiment involved the collection of data from wide-angle reflection/refraction. It consisted of four deployments each of a 23 to 25 km long receiving array with an interval of 100 to 300 metres and detonation at between three and five shots for each deployment. Two of the deployments were made over the glaciers over the Transantarctic Mountains and the other two on the Ross Iceshelf.

The team carried at SUN SPARC work station for preliminary processing of refraction data in the field and from this they could ascertain energy propagation over a distance of at least 90 km and wide angle-reflections from deep within the crust.

Analysis of the multichannel reflection and refraction data is currently underway at the DSIR in Wellington and at Stanford University. The results should show a wealth of crustal reflection with the iceshelf portion of the survey and a seismically more transparent crust within the Transantarctic Mountains.

Model building and fossil analysis

Working in the Allan Hills area 150 km north-west of Scott Base from 1 December to 24 January were Ken Woolfe, Dr Peter Barrett, Malcolm Arnot of Victoria University. They were accompanied by Drs Jane Francis of the University of Adelaide and Norm Smith from the University of Illinois.

The Permian-triassic of South Victoria Land contain some of the best exposed fluvial rocks in the world and Allan Hills is one of the better examples. The party were seeking to describe the strata and sedimentary structures they contain in order to reconstruct the channel morphology and flood-plain characteristics of the river system. Their purpose is to provide a realistic depositional model for the strata in order to add confidence and detail to paleogeographic reconstructions from such sequences.

Along with Norm Smith the work of the VUW party focussed on examining the exposures of Permian (250myrs) fluvial rocks.

They resolved the apparently enigmatic occurrence of braided and meandering rivers on the same flood plain and found clear evidence that the remnants of the Permian Ice Sheet remained long after the main icesheet had disappeared. They are now in a position to produce a model that explains the presence of sheet-geometrics in meandering stream depositions, a feature that previous models have been unable to deal with. In addition they completed a 1:20,000 geological map of Allan Hills.

Dr Jane Francis, a palaeoclimatologist who has specialised in ancient climates, undertook a palaeo-botanical survey of the area. She worked on what is one of the best

deposits of tree fossils found so far. The discovery contains thousands of fossilised forest trees felled in huge floods some 250 million years ago and buried in sand at the bottoms of rivers that once flowed across the plain. Although their species is not yet certain they are thought to be ancient relatives of Australian native pines found in Tasmania and the Norfolk Island pine and other species of conifers growing in New Zealand. Metres in diameter, each trunk is a detailed climatic database particularly valuable because most predictive models are computer based; the trees will provide actual evidence on which to test them.

More than 500kg of samples are on their way to England where Dr Francis, who has now moved to Leeds University after five years at the University of Adelaide, will study them.

Zooplankton, counted, examined and filmed

Zooplankton populations are hard to define because of the size and dispersion of the species and the dynamics of the environment in which they occur. Numbers can only be assessed by replicated sampling at restricted locations and times, the results presenting patterns in space and time.

Repeating and extending a zooplankton sampling programme begun in 1985 was Dr Brian Foster of the Zoology Department, University of Auckland, who was accompanied by Rodney Roberts and Peter Broom. The party were on the ice from 29 October until 10 November.

Their research is aimed at defining the zooplankton component of the marine ecosystem and relating it to fish feeding studies. Using two different techniques they obtained samples from four sites. With integrated vertical nets they worked off Scott Base, Marble Point and Cape Royds but used a depth restricted pump off Danger Slopes.

Twenty surface to 100 metres samples were taken off Scott Base from the fish hut site through augured holes. Samples were first obtained from here in 1985 and subsequently in 1987. Some deep samples to 300 metres were also taken. Each of the samples filters about 50 cubic metres of sea water and contains up to 4,000 individual organisms, mostly microscopic copepods. These are identified and counted and by comparing the numbers within and between samples, localities and occasions an idea of the patterns in space and time can be built up. It is already clear that more and larger zooplankters (including krill) occur deeper in the water below about 70 metres.

Preliminary analysis suggests that the variation within each season to be the same in all three years, although fewer of two species were found in 1985 and a more of another in 1990.

Ten surface samples were obtained at Cape Royds by rigging a tripod over seal holes and dropping nets through the ice at approximately the same location as in 1985 and for the first time at Marble Point on the western side of McMurdo Sound. Comparison of the three sample sets revealed no quantitative differences between Marble Point and Scott Base. As in 1985 however Cape Royds was different suggesting changes in ecosystem structure between there and the other two areas.

At Danger Slopes (off Arrival Heights), the party used a pump to draw sea water from depths to about 20 metres filtering the samples through a plankton net. No consistent differences were found in densities of different species at depth discounting the possibility that bottom fishes have access to more dense populations of zooplankton just over the sea bed.

Direct observations made from the US Observation Tube showed the water in 1990 to be particularly rich in various gelatinous plankton (jellyfish, ctenophores siphonophores and pteropods) which could be seen from the tube giving insights into the real world of plankton.

Plankton was caught for the preparation of a high resolution colour video recording and a short 15 minute tape has been prepared showing live microzooplankton in restricted action.This type of close up footage has been lacking from previous nature history films of Antarctic marine life.

The samples have been returned to New Zealand for further analysis.

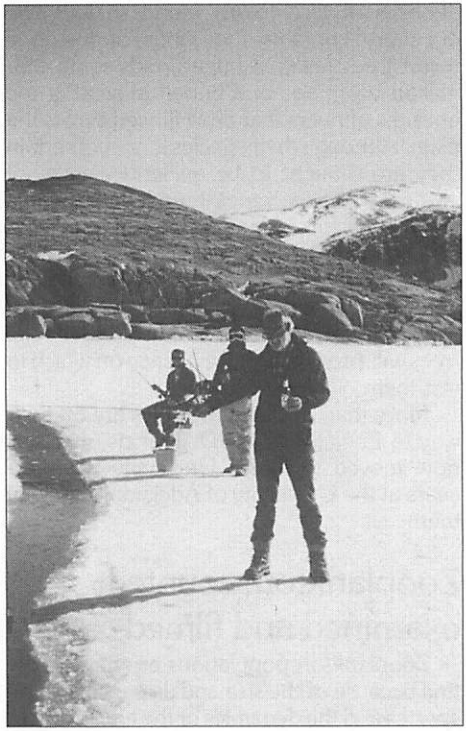
Lateral lines and evolution of Antarctic fish species

Zoologists from the University of Auckland completed their 13th season of studies on various aspects of Antarctic fish. For the last three years they have focussed on the lateral line and the evolutionary relationships between species. Team leader for the season was again Dr John Montgomery who was assisted by Dr John Macdonald. Heiko Weix, an electronics expert and field hand, and Richard Milton and Peter Ritchie from the Zoology Department, also went south as part of the project.

This season the party was divided twice. Dr Montgomery worked with American colleagues, Drs John Janssen and Sheryl Coombs at McMurdo Station while the others worked from Scott Base where they were joined by Drs Guido di Prisco and Maurizio Tamburrini from the Italian Programme. Under the reciprocal arrangement Macdonald and Ritchie also spent some time with the Italians at Terra Nova Bay working on a collaborative study on the role of haemoglobin in Antarctic fishes.

At McMurdo the team were joined by a Russian scientist Dr Valentina Sideleva and they concentrated mainly in lateral line work. One of the primary objectives is understanding how fish catch prey in the darkness of the Antarctic winter when sight is impossible. Observations made in the aquarium at McMurdo proved that the lateral line was used in locating and catching prey. The lines, located over the surface of the head and along the body, are like small canals which are open to the outside of the body through pores in the skin. Inside each of the lines are series of "hydrophones, sets of hairs similar to those in the human ear which can sense vibrations.

Although it has been known for about a 100 years that fish have lateral lines it is only more recently that researchers have established their function and physiology. The common ancestry of the various Antarctic fish species and the shared problem of winter darkness in the extreme environment provides a concentrated focus on the problem for scientists.



Scientists employing orthodox measures to catch fish at Terra Nova Bay - Photo John Macdonald

Work for John MacDonald at Scott Base again concentrated on the temperature lability of acetylcholinesterase the enzyme which breaks down the neuro-transmitter controlling muscle contraction. Fish were caught through a hole in the ice cut with a huge posthole digger (auger) in the sea ice two km from Scott Base. Biochemical extracts were prepared from the brains and the activities of the enzymes measured. Preliminary results revealed that the enzyme is not very temperature-labile.

Using a portable laboratory in the fish hut, Richard Milton monitored the behaviour of fish as they selected and captured prey. Peter Ritchie studied the genetic similarities of Antarctic fish with the aim of establishing an evolutionary tree. He continued this work at Terra Nova Bay where John Macdonald stud-

ied the production of red blood cells in the Antarctic fish, a problem shared with the Italians.

The joint project involved collection of blood samples and purification of hemoglobin in order to assess the variability between the various antarctic fish species. This is significant because each species demonstrates different levels of activity and it is thought that there are specialisations which enable them to work better under higher or lower concentrations of oxygen. By relating the type of haemoglobin the fish have and the oxygen carrying characteristics aspects of the ecology and behaviour of the different species may be explained.

Testing air for pollutants

Camping on the East Antarctic plateau for two months to test the air for pollutants last summer were three scientists and one field assistant. At an approximate latitude of 78deg S, 140 deg E, they endured eight weeks of "thin sun" with a constant windchill temperature of around -40deg.C.

Leader of the party was Chad Dick from DSIR Chemistry in Wellington. He was assisted by John Patterson from the same organisation and David Wylie from the University of Auckland. The field leader was John Gee from Tokoroa. They were flown into the field on November 24 in a C-130 Hercules with 3500kg of fuel and equipment which was then manhauled two kilometers from the landing area to avoid contamination of the site from the aircraft.

Sampling was subsequently carried out approximately 200m upwind of the camp. Low volume air samples were collected in suction pumps using small filters and returned to New Zealand where they are being analysed for rock dust, sea-salt, sulphate and nitrate aerosol particles, while high volume samples, collected alongside by similar methods will be analysed for methane sulphonic acid, (an important species in the atmospheric sulphur cycle), and for toxic organic compounds such as dioxins.

Two snow cores, ten metres deep, were drilled and returned to New Zealand also for determination of rock dust, sea salt, sulphate and nitrate. Other cores drilled to five metres were sub-sampled on site and have been returned to New Zealand for rapid analysis.

A two metre laboratory pit was dug and roofed with aircraft pallets. Inside, a melt vessel and heating system were set up to allow snow to be melted and passed through a polyurethane foam filter which will be analysed for dioxins and other pesticide residues. Approximately 80 kg of snow could be processed in a ten hour day. The scientists worked in two hour shifts usually divided into one hour, at -30deg in the pit, controlling the melt system and one hour, at -20deg, collecting snow from a sample pit 20 metres away. Eight samples were collected at different depths down to one metre to obtain a short historic record.

Meteorological service instruments recorded wind and temperature and counted and sized aerosol particles, the data being logged on a computer. Very few particles were found; about ten per cubic centimeter, compared with hundred or thousands in regions close to sources of contamination such as seawater, exposed soils, or human industrial emissions. Those particles which reached the plateau were almost all in the smallest size range. They are likely to be sulphuric acid or methane sulphonic acid droplets formed by oxidation of such gases as dimethyl sulphide (D.M.S.) released from biogenic activity in the oceans. Although concentrations of these particles varied by a factor of ten no correlation has been noted with the variations in the source of the air mass whether it be marine or continental as suggested by temperature or cloud amount or type. The lack of correlation may indicate a fairly slow reaction rate which allows these gases and aerosols to become well mixed over the continent or could suggest that aerosol removal by precipitation in marine air masses is rapid. A more detailed examination of the results is needed before any conclusions can be reached. The party returned to Scott Base on January 25.

Cyanobacteria and the ecosystem

Building up a detailed picture of the structure and dynamics of Antarctic cyanobacteria and their role in major ecosystems, such as the McMurdo Ice Shelf ablation zone was the objective of three scientists from the Taupo Research Laboratory, Division of Water Sciences, DSIR Marine and Freshwater.

Drs Clive Howard-Williams, Warwick Vincent and Nicholas Russell spent five weeks late in the summer of 1991 working mainly on the McMurdo Ice Shelf. There several hundred square kilometers of moraine coated ice are overlaid by an inter-connected system of lakes, pools and streams. These provide an aquatic habitat for prolific growths of highly pigmented cohesive mats of cyanobacteria. In mid-summer, temperatures of up to + 10 deg C and water containing high nutrient levels and low salt concentrations provide very suitable conditions for microbial growth.

The team were interested in the way in which the mats tolerate the extremely high salt concentrations (equivalent of five times that found in sea water) and the very low temperatures (-12deg C) that occur in the ponds as they freeze at the end of the summer.

Working in the Bratina Island field laboratories the team used minute quantities of radiotracers to follow the changes in the cells which were subjected to experiments simulating those conditions. Infrared gas analysis was used to follow photosynthesis and respiration and Nitrogen fixation was measured by gas-chromatography.

They found that comparatively low concentrations of salt, similar to that of seawater stopped major metabolic activity including photosynthesis. Nitrogen fixation ceased. However, the mats investigated, were able to survive the high salinities and low temperatures experienced at winter freezeup and all recovered within a few days after the introduction of freshwater.

Nick Russell, working for the department of Biochemistry at the University of Wales, will be further analysing the samples to determine the specific biochemical changes in the cells which permit their survival during the extreme conditions.

From their measurements and others being analysed from samples returned to New Zealand and Wales involving dessication tolerance and the influence of UV light on the shallow water cyanobacteria, the scientists are building up a detailed picture of the structure and dynamics of Antarctic cyanobacteria and their role in the McMurdo Ice Shelf Ablation Zone.

Further coverage of the very successful 1990-91 season for the New Zealand Antarctic Research programme will appear in our next issue.

ANARE

Further oil spill occurs at Casey

A further fuel spill occurred at Australia's Casey Station on the afternoon of 22 January 1991. Approximately 19,000 litres of light diesel fuel overflowed from a storage tank, during a transfer from the station's main tanks to another tank at the power house half a kilometre away.

According to sources there is no vegetation or concentration of wildlife in the immediately vicinity and for the moment the fuel has concentrated in a depression just downhill from the main storage tanks.

Station staff pumped the fuel into empty barrels from the depression and early the following afternoon some 4,600 litres had been recovered.

It is the second spill at Casey in the last year. In 1990 the Antarctic Division commissioned a report on spill prevention control measures which draws particular attention to the need to improve procedures and the Division is further developing a programme to implement improved procedures and training at all stations.

Every station is being provided with special materials to clean up spills.

Hazardous waste removed

Environmentally hazardous waste left at the Antarctic station of Wilkes when it was abandoned in 1969 because of encroaching ice was removed by Army personnel in a ten week operation during this last summer season. The waste, which had accumulated during the ten years that U.S. and Australian expeditions were based at Wilkes, comprised pressurised gas, chemicals, fuel and explosives.

The six man Army team, led by Lieutenant Phil Grue of 1 Construction Regiment in Sydney, was transported across the ice seas between Wilkes and Casey Station, three kilometres away in amphibious vehicles from the 10 Terminal Regiment, also based in Sydney. They had to endure frequent interruptions from summer blizzards while rendering the material harmless for collection.

The operation involved decanting over 100,000 litres of fuel, venting 275 gas bottles, recovering chemicals and detonating of explosive material.

Some of the material was used at Casey but the rest was packaged for return to Australia on Icebird undertaking the eighth and last Antarctic voyage of the summer. Leaving Hobart on 28 February she visited Casey to collect 51 returning expeditioners including biologists, glaciologists, physicists, meteorologists, construction workers and other support personnel. She also collected 20 personnel including biologists, an archaeologist and an officer of the Tasmanian Department of Parks, Wildlife and Heritage from Macquarie before her return to Hobart on 22 March.

Nansen's winter hut discovered

Head of Norwegian Arctic research, Morten Berle, who last winter led a Soviet/Norwegian expedition to Franz Josef Land in the Soviet Arctic, sent back news that the team had found the primitive stone hut where the Norwegian, explorer, scientist and humanitarian, Fridtjof Nansen, spent the winter of 1895-96 together with Hjalmar Johansen. The two men had made bid for the North Pole but were forced to turn back and made their way to Franz Josef Land where they erected a hut of stones, driftwood and walrus skins. The expedition erected a commemorate plaque by the hut.

Franz Josef Land has been forbidden territory to the Norwegians since it was annexed by the Soviets in 1929. Last year's expedition was the first to visit the island group in more than 60 years.

Pakistan builds base outside Antarctic Treaty System

Pakistan, which has opposed the Antarctic Treaty system in the United Nations, has built a summer station in Queen Maud Land, on the Weddell Sea side of the continent. It has been named Jinnah after Dr Muhamad Ali Jinnah, remembered as the founder of Pakistan and its first Governor-General in 1947.

Jinnah Station is at 70 deg 24min S/25 deg 45 min E on the Princess Ragnhild Coast of Queen Maud Land and 75 km north-east of the Japanese inland station Asuka (71 deg 31 min 5/24 deg 32 min E) which was built in the 1984-85 season.

Late last year Pakistan's intention to send an expedition to Antarctica was known at the special meeting of the Antarctic Treaty consultative parties held in Chile to consider environmental protection issues. Concern was expressed about countries wanting expeditions except under the umbrella of the treaty system. But this is not the first time a country outside the Antarctic Treaty has established a base and done scientific research in Antarctica. India, was the first and, South Korea was the second. Both are now consultative parties.

As Pakistan is not a party to the treaty it does not have to advise other countries of its intentions or where it has set up a base. One newspaper report in January indicated that the base was in Prydz Bay on the Ingrid Christensen Coast; a second suggested it was near Japan's Syowa Station on the Prince Olva Coast of Queen Maud Land., Prydz Bay is in the main territory claimed by Australia between 45 deg E and 136 deg E.,

Norway believed that the base was possibly being set up in the territory between 20 deg W and 45 deg E which it claims, but by December it had not been approached by Pakistan.

Formal notification of the establishment of the base, its location, and its name, was given by Dr Abdul Farah, Director General of the Pakistan Navy's National Institute of Oceanography. His statement appeared on February 1 in "The Muslim", a newspaper published in the capital, Islamabad.

As Pakistan had to charter an ice-strengthened ship from Sweden, helicopters from Canada and buy German prefabricated huts and British polar clothing, logistic information about the expedition became available.

With 11 scientists, 25 support staff and a crew of 15 or 20, the expedition sailed from Karachi aboard the Columbialand (21,110 tonnes) on December 12. It arrived at Port Louis, Mauritius on December 21 and then headed for the Weddell Sea on December 24.

About January 14 the Columbialand was off the Princess Ragnhild Coast. It has been suggested that the expedition, which was to spend 50 days in Antarctica, would probably use Breid Bay (70deg 15 mins/24 deg 15 min E) where Japanese field scientists worked in the 1984-85 season when Asuka Station was established with the support of the icebreaker and supply ship Shirase.

Pakistan's chartered Swedish ship has operated in Antarctic waters before but under a different name. As the Stena Arctica it provided logistic support for the second Swedish Antarctic Expedition, SWEDARP 88/89, which did scientific work in Queen Maud Land, the Weddell Sea, and the Antarctic Peninsula area. SWEDARP 88/89 also established the main Swedish base Wasa in Vestfjella at 73 deg 02 min S/ 13 deg 25 min W.

Built at Gothenburg in 1978 by Ericksberg's, the Columbialand is a 185 m bulk carrier with six cargo holds, four 20-tonne cranes and can carry 832 5m containers at a speed of 16 knots. The engine-room is aft and container deck space can be used for

helicopters.

Operated by the United Cruising Company Limited, a subsidiary of the owners, Brostrom Shipping Company, the Columbialand has a name change to Seatrain London in 1979. By 1985 she was back to her original name.

In 1989 the name was changed for the second time and as the Stena Arctica, the ship was prepared for her Antarctic voyage. She was equipped for marine research and logistic operations which included the provision of helicopters for the establishment of temporary field camps in the Antarctic Peninsula area.

After her return to Gothenburg the ship went back to her original name. A sister ship built in 1977 is another ice-strengthened bulk carrier. She is the 21,128 tonne Thuleland.

India, which sent its first expedition to Antarctica in 1981-81, chartered the Thuleland for its fifth in the 1985-86 season. Structural alterations were made to provide helicopter decks and accommodation for 80 scientists. The charter was renewed each year until the 1989-90 season.

With Pakistan's establishment of Jinnah Station there are now eight other notions engaged in research in the area claimed by Norway, which has one summer station, Troll. Eight stations are occupied all the year round and nine are used in the summer. All have been built on the coast or inland.

As of 1 February 1991 this year there are 17 summer and winter stations in Queen Maud Land between 20 deg W and 45 deg E. Japan and Germany have three, the Soviet Union, India, Sweden and South Africa two, and Norway, Finland and Pakistan one each. Norway occupied Norway Station for the 1957-58 International Geophysical year. It was taken over in 1960 by South Africa which built its own in 1962.

Since then Norwegian research has been maintained with maritime expeditions which have worked in the Antarctica Peninsula area in the Weddel Sea and Queen Maud Land at intervals of three to five years. Germany became responsible for a third station, Georg Forster, which was operated by the German Democratic Republic within the Soviet Research programme, before unification of Germany last year.

Not surprisingly the Swedish Government is reported to have urged Pakistan to become a signatory of the Antarctic Treaty and to co-operate with other Treaty members.

Swedish scientists and airmen worked in Queen Maul Land with the Norwegian - British - Swedish Expedition (1949-52). Since then the Swedish Polar Research Secretariat, which managed the Arctic and Antarctic programmes, has supported individual scientists and participated in other nation's programmes. Now special priority is given to international co-operation and joint programmes with other nations.

In 1986 the secretariat initiated an Antarctic programme (SWEDARP). The first expedition in 1987-88 had logistic support from the Federal Republic of Germany. A Swedish team joined the FRG icebreaking research and supply ship Polarstern with its own vehicles, field equipment and with German and Austrian geologists made a traverse from Georg von Neumayer station between January 6 and February 22, 1988 to the Heimfrontfjella (Homefront) Range (74 deg 35 min S/11.00 W) and the Vestfjella (West RAnge) of the Kraul Mountains (73deg 30 min S/14 deg 10 min W).

A small summer station SVEA was built at 73 deg 35 min S/11deg 13 min W on the southern rim of Scharffenbergbotnen, one of the peaks of the three groups of the Homefront Range. Food, fuel, field equipment and motor sledges were left for the second expedition.

In the 1988-89 summer the second SWEDARP expedition put in Sweden's main base at 73 deg 02 min S/13 deg 25 min W in the Vestfjella (West Range of the Kraul Mountains). It has provision for winter parties and SVEA is now a satellite station.

Finland, which acceded to the Antarctic Treaty in 1984 and became a consultative party in 1988, has now sent three expeditions to Queen Maul Land. It has ahead a close relationship with SWEDARP in scientific projects and logistic co-operation.

FINNARP, the programme organised by the National Committee on Arctic Research, started in the 1987/88 season. A team of five

technicians and scientists did technical and sea-ice research in the Finnish-built Soviet research and supply ship Akademik Federov during its voyage from Wellington to Buenos Aires by way of Leningradskaya, Russkaya and Bellingshausen stations.

When FINNARP 88/89 established its first station in Western Queen Maud Land Sweden carried the expedition to the Princess Martha Coast aboard the Stena Arctica and provided tracked vehicles, sledges and motor scooters for construction and scientific work.

Aboa was built in the Vestfjella (West Range) of the Kraul Mountains at 73 deg 03 min S/13 deg 25 min W) on Nunatak Basen about 450 m above sea level. It can accommodate ten persons.

Finnish scientists took part in the Swedish expedition and joined Swedish scientists in part joint research projects. FINNARP also arranged for three marine biologists to take part in the European Polarstern STudy (EPOS). Two geologists began studies of Antarctic quaternary deposits with Australians at Davis Station, and a Finnish-Argentininan ozone sounding project was started at Vice-comadoro Marambio Station on Seymour Island.

Between December 1989 and February 1990 FINNARP completed the first large scientific expedition arranged since Finland signed the Antarctic Treaty.

A marine research programme in the Weddell Sea was carried out by the new 1600 tonne vessel Aranda, built for the Marine Research Institute of Finland. Glaciological, climatological, and technological studies3s were continued close to Aboa to which scientists were transferred by helicopter.

A number of scientists from other countries took part in the expedition. Once again there was close logistic co-operation with Swedish scientists in the land-based studies.

USAP

Season on Peninsula involves eight cruises as well as programmes at Palmer Station

The season on the Peninsula opened with the departure of the Polar Duke from Punta Arenas on 6 September. Four days later the vessel was at Palmer Station. Contractor crews assisted in the change from winter to summer operations. Launches of instrumented balloons in support of the National Ozone Experiment and the collection of phytoplankton from the vessel marked the start of the summer science programme. By 20 September the Polar Duke had returned to Punta Arenas with most of the winter team.

Because the Antarctic is now experiencing large springtime losses of stratospheric ozone, the magnitude of ultraviolet-B radiation reaching the surface now approaches that measured in tropical latitudes. Ultraviolet-A and solar radiation used for photosynthesis have, however remain unchanged.

Dr Deneb Karentz, from the Radio Biology and Environmental Health Laboratory at the University of California in San Francisco, was aboard the first cruise of the Polar Duke and remained at Palmer working in the Arthur Harbour before joining the vessel for the cruise departing on 1 October from Punta Arenas with three others of the team. They collected samples during both cruises and from the station area for species identification and culture for comparative purposes.

Their study focussed on the question of DNA repair mechanisms of phytoplankton

communities exposed to increased UV irradiation. Making use of recent improvements in atmospheric modeling and technology in oceanographic instrumentation they spent a total of six weeks documenting the impact of ultraviolet radiation on the phytoplankton community during the ice-edge spring bloom. Special emphasis was placed on defining biological restrains imposed by springtime radiation changes on the balance of ultraviolet-B damage to repair capabilities, as well as protection from UV radiation and mechanisms of photosynthesis used by organisms in the southern oceans.

Between September 10 and 13 November Dr George Brothers and an assistant from NASA in Virginia took daily stratospheric measurements of the ozone from Palmer Station using balloons. Their project, which began in 1987, involved taking a large set of profiles over the period which included the beginning of the ozone depletion as well as the peak. Such profiles will provide clues to changes in the depth, vertical extent, ozone loss rates and seasonal behaviour of the phenomenon as well as correlative performance checks on remote-measurement systems.

The second cruise of the season began on 25 September and concluded on 18 November. In addition to the study of the UV radiation on phytoplankton during a cruise along the Weddell Sea Ice edge, personnel were put ashore at the field camp in Admiralty Bay for an avian biology programe, also supported from Palmer Station.

Other scientific programmes from Palmer beginning with the arrival of the vessel included continued NOZE operations and a study of exoenzyme and bacterial growth rates and chlorophyll measurements.

Investigations of bacterial activity in Arthur Harbour by measrurements of enzyme expression during the spring bloom were made between 25 September and 30 December. The research team, under the leadership of Dr J.T. Hollibaugh of San Francisco State University in California were divided into two parties of three. The first party sampled the water column bacterioplankton on the way to Palmer and the second, collected further samples on the next voyage. In between times further samples were collected from Arthur Harbour.

The project is important because coupling of carbon flows from primary producers to bacteria can significantly influence the patterns of vertical flux in organic matter in the ocean. Bacteria must break down particles and mix them with water before uptake and therefore they assume a central role in carbon flux from particulate organic matter into the microbial loop.

Hypothetically the scientists consider that during the winter, bacyterial-exohydrolase production ceases in high latitudes and therefore particles and polymers produced during the early spring cannot be used by bacteria. They tested the theory off the Peninsula by sampling the euphotic zone pre-bloom through development and decline of the spring phytoplankton bloom.

Using field and laboratory manipulations they examined the environmental cues that regulated enzyme activity, their knowledge contributing to the understanding of biological production mechanisms and variability in the pathways of organic matter cycling in the southern ocean.

From September 30 an early field team of two were put into the Copa Field Hut to begin studying the foraging behaviour and demography of the Adelie, chinstrap and gentoo (Pygoscelis) penguins on King George Island. They were joined on 9 December by project leader Dr Wayne Trivelpiece of the Point Reyes Bird Observatory in California.

For several years the team has banded penguins at Point Thomas (near the Polish Arctowski Station on King George Island) and studied their breeding and feeding ecology. Results of their work indicate that each species responds differently to winter conditions, differs in annual survival levels and has different age and sex requirements for maintain population levels.

This last season, the team, working in the Admiralty Bay area, were able to observe banded penguins daily and by using radio telemetry and time-depth records could col-

lect data on known-age populations to determine the relationships of sex/age and experience to fecundity and survival. They were also able to compare foraging ability of the young, first-time breeding birds, with older, experienced breeders.

The data obtained by telemetry and time-depth equipment enabled them to expand their data base to include information on how the penguins behaved at sea. Their project will significantly improve the scientific understanding of the trophic relationships among the penguins and enable the scientists to test hypotheses on how age affects foraging proficiency and, how in turn, that affects breeding and recruitment patterns.

Four scientists from the Biology Department at the University of California under the leadership of Dr Mark Chappell were based at Palmer from 25 September to March 10.

Focussing on the Adelie penguin they measured rates of energy consumption and changes in body composition in breeding birds and observed their foraging behaviour. The purpose of their work is to determine reproductive effort and to calculate the trophic impact of breeding Adelies on the surrounding marine ecosystem.

The third cruise consisted of a number of separate by logistically intertwined operations. It began on 24 November and finished on 4 January.

During the first part scientists investigated sedimentation rates and stratigraphy at the foot of glaciers and at ice edges by coring, and using high resolution seismics and sediment traps.

The second part of the cruise involved a biological study of the growth rates of krill in terms of space and time and, in addition, a geological field party were put ashore for two weeks on the Beyers Peninsula at Livingston Island.

Also during the cruise a USAP chartered U.S. Air Force (Sepcial Assignment Airlift Mission (SAAM) was flown to King George Island to transfer science and operational personnel as well as support visiting dignatories from the Santiago Antarctic Traty Consultative Meeting at Vina del Mar. Scientists studying meteor burst communications and survey work for a seimsmological network were also landed at Palmer Station.

The study of sediment transport on the antarctic continental margin in the vicinity of floating glacier tongues and restrictive fjord environments was concerned with determining the importance of mid-water and deep-cold-water tongues in the transport processes.

Scientists from the Geology Department, Hamilton College, in New York, were also concerned with determining whether precise links could be established between the observed glacial-climatic regime and the resulting depositional record. Such a record is being reconstructed from the coring programe and high-resolution seismic reflection profiles. The expected thick Holocene sections, with pronounced internal changes in texture and composition were analysed for their implications in the antarctic fjord glacier systems and Holocene climate changes.

During the second part of the cruise, and, on several subsequent cruises, Dr L.B. Quetin and R.M. Ross of the Marine Science Institute of the University of California in Santa Barbara with a large field team studied and collected krill on the ice edge. In all they covered areas near Adelaide Island, Marguerite Bay, the Bellingshausen Sea, southern Bransfield Strait, Gerlache Strait and the Palmer Basin.

In addition they used sonar to track and measure the size of krill populations, measure current, temperature and salinity at selected sites and collected water samples. Divers from the team observed the behaviour of the krill communities.

The results of the project should contribute substantially to understanding aspects of krill biology that are either unknown or poorly understood.

Another group of scientists focussed on the construction of a model to elucidate ocean and atmospheric response to past climate change in order to reconstruct the Holocene climate history of the Antarctic peninsula. Preliminary analysis of benthic foraminiferal distribution, sediment distribution and water column profiles from the Bellingshausen/Pacific sector of the Antarctic Peninsula have

suggested that observed patterns are influenced by oceanographic, glacial and climatic conditions.

A party of two from the Byrd Polar Research Center supplemented the preliminary findings and sought to provide new information on the microhabitat and geochemical associations between the surface sediments and benthic foraminifera. By analysing modern sediment flux and distribution, water column-profiles and benthic foraminiferal distribution, the faunal and environmental associations could be used to formulate an interactive model. Such a model can be used in tern to infer paleo-oceanographic and paleoclimatic conditions in down-core sediments and help to re-evaluate the Cenozoic marine records from samples previously collected in the Antarctic margin region.

Working on the Beyers Peninsula were Drs Anne Grunow and Ian Dalziel also from the Byrd Polar Research Center. They continued their examination of the geological history of West Antarctica and the relationship of West to East Antarctica by collecting paleomagnetic samples from Mesozoic-age rocks. They hope, that by systemically obtaining samples, ranging in age from the Triassic through Late Cretaceous, a more complete apparent polar wander path can be constructed for the Antarctic Peninsula and help constrain its position in respect to East Antarctica in addition to providing information on the time of opening of the Weddell Sea.

Between early December and mid-March Dr William Fraser of the Point Reyes Bird Observatory in California and two colleagues continued penguin and seabird censussing and observations of breeding and reproductive cycles. They operated mainly in the Arthur Harbor area but visited rookeries on several islands including Litchfield and Dream, some four miles from Palmer. Their work entailed the capture of birds for banding, stomach content analysis, weighing, measuring, examining and subsequent release. Radio transmitters were attached to selected birds.

The focus of the study is to determine the impact of the spill of fuel from the Bahia Paraiso has had on the seabirds in the area.

Studies carried out in 1987 and 1989 prior to the January 28 spill, have provided the team with data on the abundance, breeding success, diets and growth rates of many members of the seabird community including chicks marked in 1988, which had not been exposed to oil and those marked in 1989 after the spill. Baseline data such as this can be used for comparative purposes and will enable them to assess seabird mortality and determine the population's potential for recovery.

On 9 January 1991 a further cruise began from Punta Arenas. Most of it was dedicated to high resolution geophysical work in the Northern Peninsula - Weddell Sea area. During the cruise, however, a geological field programme was put ashore at various areas.

In the meantime work at Palmer continued with avian biology and krill growth studies, the latter receiving three days support from the vessel which arrived at King George Island on 7 February at the same time as a second SAAM flight was made to change scientific crews for the completion of the cruise.

Since 1979 scientists from the Department of Geology and Geophysics at Rice University in Texas have collected and described the sediments that blanket the antarctic sea floor and related them to glacial and oceanic conditions. During the cruise Dr John B. Anderson and five others gathered seismic reflection data and collected piston core samples from the Bransfield Basin (north of Palmer Station to King George Island) and along the continental margin (north of the South Shetland Islands). They used sedimentological analysis of deposits and high resolution seismic methods to map the distribution of marine ice sheets and shelves on the continental shelf during the last glacial maximum. By studying such lithofacies in detail, in areas representative of antarctic glacial marine environments, they are increasing their understanding of sediments which occur under such circumstances. In addition they examined the deep sea hemipelagic and turbidity record of the area to see how glacial changes are manifested in deep sea deposits and conducted high-resolution seismic stratigraphic studies

of the continental shelf to learn more about tectonic and glacial evolution.

The next cruise began at King George Island on 7 February 1991. A sediment trap for the RACER programme was recovered and redeployed prior to the vessel heading out to the Weddell Sea and undertaking a major programme to study the formation and circulation of cold Antarctic bottom water. A number of current meters were deployed and water samples taken at various stations. The cruise ended on 17 March in Punta Arenas.

Between 5 and 10 February Dr David Karl and an assistant from the Department of Oceanography, University of Hawaii, Honolulu were involved with the retrieval, data collection, cleaning and redployment of the bottom moored sedimentation traps from the Northern Gerlache strait 64 deg 11.75S/ 61 deg 19.5W. Logistically they utilised the SAMM II flights in and out of King George Island.

The project is a component of RACER and is concerned with microbiology and flux which is important because the southern ocean maintains moderate, if patchy, biological productivity in spite of its harsh environment. Primary production in coastal antarctic ecosystems is characterised by an intensive spring bloom which lasts between two and three months. During this time between 70 and 90 percent of the annual organic carbon is produced and this in turn increases biological productivity at all levels from bacteria to baleen whales.

Precise pathways for carbon transfer and the rates and mechanisms involved have not, however been carefully investigated and the role of microheterotrophs in antarctic food webs and the immediate fate of phytoplankton production in particular need to be examined. The study is attempting to define the mechanisms, pathways and rate of coupling between the photoautotrophic and heterotrophic populations and evaluating the coupling between the pelagic and benthic habitats. Data obtained, during this expedition, will add to the overall understanding of the rates of primary and secondary production and eventually be used to formulate a general model of carbon and energy flow in antarctic coastal ecosystems.

Professor Theodore Foster and nine others from the Marine Sciences Department at the University of California were involved in the investigations of peninsula bottom waters.

In the global context the area is a major water mass modification site, involving open-ocean convection, the continental margins and ice cover.

During the cruise time the various water types combine to form Weddell Deep Water and Antarctic bottom water. The conditions under which the masses form are not known well enough to establish direct physical links and volumetric budgets. The scientists expected that the outflow from the Weddell Sea is restricted to quite narrow boundary currents flowing near the base of the continental shelf, and consequently, could be observed with conventional current-meter moorings from the shelf into the deep ocean.

Investigation involved two expeditions to the Weddell sea in order to measure flow of the newly formed bottom water and to explore the sinking process of the near-surface water in the open ocean to see how these affect the deep water flows.

For three weeks from 1 March a project being undertaken by Dr Umran Inan of Stanford University was supported at Palmer station by an assistant. The project focuses on the bursts of precipitation that lightning discharges induce at middle to low latitudes. The results from their studies will help them determine the role of lighting and thunderstorms in relation to magnetospheric electrons and the way in which the atmosphere, ionosphere and magnetosphere are coupled. They used ionospheric density enhancements to study the phenomenon. Such enhancements are detected as amplitude and phase perturbations on very-low, low and middle - frequency radio signals that propagate along geomagnetic field lines. They also conducted simultaneous, high resolution measurements of the amplitude and phase of subionospheric very low, low and middle frequency signals to determine the spatial distribition, temporal signatures and magnetic conjugacy of lighting-induced precipation.

From 22 March to 29 April the Polar Duke undertook a further cruise in support of a number of other operations.

Physiology of cold water fishes was studied at Palmer while the vessel trawled for samples. Work on the effects of the Bahia Paraiso oil spill continued as did that on krill growth rate. New, was a study on the larval history of antarctic fishes.

Determining the biochemical adaptations responsible for the assembly, stability and function of the cytoplasmic microtubules of antarctic fishes was a team, led by Dr William Detrich from Northeastern University in Boston. While the Polar Duke trawled for samples, the team sought to determine the structural adaptations that enable antarctic fish to chemically assemble and dissemble cold-stable microtubules, and characterise the structure of tubulin and MAPs (microtubule associated proteins) that are involved in the interactions.

From the brain and reproductive organ tissues of two species of antarctic cods and one of ice fish they purified the microtubule proteins and nucleic acids necessary for their studies which are being continued at the University. The work is important became the ordered assembly, maintenance and disassembly of the microtubules play critical roles in cell division, nerve growth and regeneration, cell-shape determination and cytoplasmic transport and at temperatures near O deg C the cold-labile microtubules of warm-blooded vertebrates break down rapidly into their simpler sub-units.

Although fish larvae are important in the zooplankton community, their ecology has received little attention. Four researchers as part of a team working with Dr Richard Radtke of the Hawaii Institute of Geophysics in Honolulu were aboard the Polar Duke on this voyage and spent some time at Palmer.

The function of the larvae affects the dynamics of fish populations and ultimately the entire marine ecosystem. Before the processes can be investigated scientists need to identify the life history stages, environmental events or combination of the two significant to larval growth, survival and recruitment into adult population.

To do this they are studying the microstructural patterns in fish otoliths - calcium carbonate structures in the inner ear that serve as storage sites for chronological information. With this data they hope to develop a schedule for larval fish growth rates, hatching periodicity and environmental histories and to understand the processes better. The data from their laboratory work will be combined with environmental data so they can relate the physical aspects of larval fish to growth and survival and produce results that should help clarify the factors influencing growth and mortality. In addition the model developed from otolith research can be used for studies of how fish maintain population levels and could improve scientific understanding of the early life-history stages of antarctic fish.

Also making use of samples obtained by trawling from the Polar Duke was Dr Bruce Sidell of the University of Maine and three assistants. Their field objectives focused on collections of Notothenoid fishes for biochemical analysis of metabolic processes within tissues. Their goal was to use a cellular/biochemical approach to describe more completely the energy metabolism of antarctic fish and compare how diet and lifestyle affect energy metabolism. The results of the study should help resolve conflicting hypotheses on whether metabolic rates of these fish are cold adapted or whether fats are primary fuels for energy metabolism. The data will also contribute to a better understanding of the role of the fish in the trophic structure of the antarctic marine ecosystem.

Studies of the distribution of hydrocarbons in the area adjacent to the Bahio Paraiso Spill continued during this part of the season. They were undertaken by Dr Mahlon Kennicutt II from the Geochemical and Environmental Research Group, of the Texas A&M University and four assistants. Water samples were collected on their way in and out of Palmer where they were based from 22 March to 29 April.

Sampling included tissues of invertebrates and macroalgae, sediments and water in both affected and control areas. They performed laboratory chemical analysis of samples collected at the site at the time of the accident and

a year later. Their goal is to assess the chemical impact of the accident on the environment and to evaluate, on a broader scale the significance and impact of petroleum releases associated with man's activities in the polar regions.

The marine biological research on cold water fishes and their larval stages continue through the next voyage of the vessel which commenced on May 3 and will end on June 10.

Between the 16 June and July 29 the vessel will be in the Scotia Sea in the vicinity of South Georgia and scientists will be studying the interactions of krill and foraging seabirds. The programme involves an attempt to derive a mathematical model to describe the process.

Nine scientists from the Department of Zoology at the University of Washington, Seattle will be aboard the Polar Duke for this study. Transects utilizing the hull mounted side scan sonar on the Duke will be utilized to determine krill location and densities. The ship board CTD systems will also be utilised for determination of current oceanographic parameters and visual observations will be made for quantification and identification of sea-bird populations. Observations will be made in the South George region at 54deg S/36deg W and continue for approximately 30 consecutive days in the region. In addition, plans have been made to go ashore at one or two locations on King George Island to collect seabird food and phytoplankton samples to substantiate the association. The field team will be lead by Dr Richard Veit.

In addition to the cruises, work at Palmer and around the Peninsula system the Polar Duke supported a major multichannel seismic programme. This was conducted in the Peninsula area from the R/V Maurice Ewing from 20 January to 6 March.

USAP

Dinosaur find provides scientists with samples of three different ages

Fossilized bones from at least two dinosaurs were found on Mt.Kirkpatrick in the Beardmore Glacier region 400 miles from the South Pole by American scientists late in December 1990. Most of the bones are from a herbivorous dinosaur, possibly a prosauropod that walked on four limbs. They date from the late Triassic or early Jurassic and are probably 175-150 million years old. Previous reptiles found in the Trans-Antarctic Mountains have been Triassic, a little older and further north.

The bones were discovered by David Elliot, a geologist from the Ohio State University, doing lava flow work in the area. He alerted a team led by Dr William Hammer from the Department of Geology, Augustana College, Rock Island, Illinois.

Dr Hammer's team of six scientists were some 25 miles south of Mt. Kirkpatrick in the Gordon Valley collecting fossils of 190 million year old mammmal-like-reptiles predating dinosaurs, from an ancient stream channel exposed by erosion, initially identified in 1985-86 and known as the upper Fremouw Formation. They had discovered two new animals (therapsids) and collected about 150 fossil specimens in the first three weeks of the project.

Others in the team included Larry Krissek, a faculty member in the geology department and associate of the Byrd Polar Research Institute at the Ohio State University, Jeff Tamplin, a graduate student/instructor in zoology at Louisiana State University, Steve Krippner, an Augustana graduate in geology and Tim Horner, a graduate student in geology at Ohio State University and Bill Hickerson, also of Augustana College.

The dinosaur fossils were found in rock at 12,500 feet on Mt Kirkpatrick, which, at 15,000 feet, is one of the highest peaks in the

Transantarctic Range, an area where over 97 percent of the surface is covered with ice.

Initial inspection revealed the animal to have been about 20 -25 feet long. Using a jackhammer the scientists were able to extract the front half of a large skeleton, including the skull and lower jaw, four or five limb bones, numerous vertebrae, ribs and a scapula. The bones appear to belong to a single herbivore but more, and most particularly the skull, needs to be removed from the rock matrix before the animal can be identified. Because it was set far back in the rock, the dinosaur's fossilized tail remains in the mountain face. A tooth, one and half inches long with serrated edges and probably belonging to a carnivore was found with the herbivore skeleton.

Bones from both sites were flown back to McMurdo and have been shipped to the States where William Hickerson, a graduate student in geology from the University of Iowa will probably spend about a year at Augustana College extracting them from the siltstone in which they are encased.

The dinosaur find has now provided scientists with samples from three different ages of fossil vertebrates. The oldest group includes the Lystrosaurus fossil, believed to be about 200 million years old and found in the Beardmore region in 1969.

GANOVEX VI

(West) Germany completes its sixth Antarctic Expedition to the Ross Sea area

GANOVEX VI, Germany's sixth expedition to the Ross Sea sector of Antarctica was completed during the 1990-91 summer season. It comprised 20 projects in a programme planned to cover an area comprising the Ross Sea, the Ross Ice Shelf, the Transantarctic Mountains and part of Marie Byrd Land.

Although the area included some of the most extensively studied regions of the Antarctic continent and offshore, many of the significant problems remain and some new ones have been identified.

Logistically the expedition was again divided into three legs, Leg one: An aeromagnetics survey over the Ross Ice Shelf using two Dornier 228 fixed wing aircraft (Polar-2 and Polar-4 of the Alfred-Wegener-Institute). This was also supported by the US from McMurdo as it was a joint US Geological Survey programme and by the National Science Foundation with transfer flights from Christchurch.

Leg two: Comprised a two part aeromagnetics programme over firstly, the Lower Rennick Glacier and secondly the Gondwana Region using the two Dornier 228's and two AS-350 Helicopters from the Polar Queen which served as a floating base and workshop for this leg. Both parts of the leg also involved geological and geophysical field programmes.

Leg three: A Gondwana field programme involving geological and geophysical ground investigations. Logistic support was provided by the four AS-350 helicopters carried aboard the Polar Queen. It began at the end of Leg two and operated from the Polar Queen and Gondwana Station and included a ten day reconnaissance of the Bay of Whales and the edge of the Ross Ice Shelf by the Polar Queen.

The two Dornier 228 aircraft were flown in a three week period starting October 8 from Germany to Punta Arenas and from there to McMurdo via Rothera, the Filchner Ice Shelf and the South Pole. In the meantime the scientists involved in the Geophysical work

came into Christchurch and were flown south by the National Science Foundation and the first leg of the programme was underway. Other field personnel, arriving in Christchurch from mid-November undertook survival training with New Zealand instructors at Mt. Cook before joining the Polar Queen which berthed at Lyttelton during the third week of November. They then sailed south in the vessel, a Norwegian ice class "sealer" with a crew of 14. She carried about 35 expedition personnel in addition to field equipment, fuel for flight operations, the four helicopters, aircraft spare parts and, on this occasion, a new sewage treatment system for the Gondwana Station. After unloading she proceeded to Cape Williams at the north coast to back up aeromagnetic operations from an ice runway.

Most of the field investigations out of Gondwana Station were concentrated in the area south of Terra Nova Bay between the Reeves and Mawson Glaciers. As usual they involved personnel from other nations and these included a scientific team of the Dutch Geological Survey which continued a glaciogeological programme started during GANOVEX V in 1988/89 and an Italian scientist who was included in a volcanological team. Participating organisations from Germany included the Alred-Wegener-Institut fur Polar und Meeresforschung, the Bundesanstalt fur Geowissenschaften und Rohstoff (BGR) as well as the Universities of Frankfurt, Bremen, Munster, Mainz and Wurzburg. A total of approximately 50 personnel. Dr Franz Tessesohn, a geologist with the BGR was scientific leader and Jurgen Koth from the same organisation was logistic manager.

GANOVEX VI was seeking sought to better understand some of the geological and geophysical processes involved in the regions development. The work is important because the Antarctic plate is one of the seven major lithospheric plates that form the surface of the earth and is a critical part of the global geodynamic system; understanding the structure and evolution of the continent, its margins and the adjacent areas of oceanic lithosphere is fundamental to global plate kinematics and dynamics.

Like the African plate the Antarctic plate appears to have remained relatively stationary since the Mesozoic; knowing why would help explain the movement of lithospheric plates and may help answer questions concerning the origin of mid-plate volcanism. However with less than two percent outcrop and only a few scattered inland seismic refraction measurements understanding of the structure and evolution of the Antarctic lithosphere is at present very limited.

An accurate reconstruction of Gondwanaland will help scientists understand the evolution of the Antarctic plate and the inception and growth of the Atlantic and Indian ocean basins. Because West Antarctica forms a portion of the circum-Pacific mobile belt it can provide evidence on the evolution of the Pacific ocean basin. The relationship of West Antarctic to the East Antarctic craton is important for studies of planet kinematics on the active outer Gondwana margin.

Most of the late Mesozoic and Cenozoic fragmentation history of the Antarctic continent is contained either on the continental shelves or in the subglacial basins of East and West Antarctica. The processes involved in the break up of the former Gondwana supercontinent in late Mesozoic and Cenozoic time played a central role in the global paleoenvironmental changes culminating in the Cenozoic glaciation. Moreover the tectonic evolution of the Antarctic plate contains the keys to biogeographic patterns of the late Mesozoic and Cenozoic as well as present day ocean currents and weather patterns in the southern hemisphere.

Because the related scientific problems are best addressed by studying examples of different stages of present development at least two major tectonic features of Antarctica are likely to provide such insights. The Penninsula is an example of a compressive orogen developed like the Andean and North American cordilleras at the plate boundary of the ocean and continent. The recently uplifted Transantarctic Mountains adjacent to the Ross Sea rift system provide opportunities for studying processes of continental extension.

Data on the present structure of the Antarctic lithosphere is best obtained by geophysical investigations on and offshore while the evolution of the lithosphere is deduced mainly from geological investigations and considerations of plate tectonics in accordance with geophysical data.

The evolution of the West Antarctic lithosphere is best seen in formation, along the active Gondwana margin and fragmentation behind the active Andean arc extending from South America through the Peninsula and Marie Byrd Land to New Zealand.

Geophysical data from the Ross Sea area, sub-ice topography and paleomagnetic data indicate that the embayment probably developed during an extension to the Mesozoic to Cenozoic regime. Continued tectonic activity is indicated by Mt Erebus and fumeroles along the East Antarctic margin and in Marie Byrd Land.

Morphologically and structurally the Ross Sea depression is an asymmetric feature with a high rift shoulder formed by the Transantarctic Mountains and a shallow flank in Marie Byrd Land. Three north trending sedimentary basins, probably containing Mesozoic and Cenozoic sediments are separated by basement highs. The east and central basins are about 6-8km deep whereas the Victoria Land basin in the West, immediately adjacent to the Transantarctic Mountains contains a section of sediment more than 10km thick.

Sparse seismic-refraction data obtained near McMurdo Sound indicate that the crust has been stretched and thinned to a thickness of about 20km. Active or young volcanism occurs over a wide range of Marie Byrd Land and along the Ross-Sea front of the Transantarctic Mountains. Aeromagnetic data indicate at least 100 young volcanoes penetrating thick sedimentary basins beneath the Western Ross Sea. Potential sites for an Ocean Drilling Programme have been identified and are being actively considered. The eastern coasts of the Ross Sea is locked by heavy pack ice and no seismic lines exist there. Offshore data collected during Ganovex V is still being processed and interpreted.

In the South the Ross Sea depression is covered by the iceshelf, with the Transantarctic Mountains forming a high flank and the Ross Sea basins continuing beneath the ice. Little is known about the volcanicty in this segment but magnetic anomalies indicate that the completely ice covered Roosevelt Island may be of volcanic origin.

An aeromagnetic investigation of a segment of the Ross Ice Shelf east of McMurdo was a major project during GANOVEX VI.

The Transantarctic Mountains rise from sea level to maximum heights of about 4000m and are made up of Precambrian and Paleozoic mainly crystalline rocks of the Ross Orogen. For over more than 200 km they form the high western and southern flank of the Ross Sea depression. As young fault-block-mountains they are one of the best examples on earth of an uplifted and titled rift shoulder. Recent studies of the uplift history of the mountain range point to an extremely rapid Cenozoic uplift. The "throw" on the master fault between the mountains and the Victoria Land basin is more than 10 km. Cenozoic volcanic rocks occur in this structure in the mountains and in the basin. The volcanism is strongly alkaline and bimodal from alkali basaltic to phonlitic and trachytic. Peralkaline rocks occur also as effusive and intrusive bodies.

On the other flank of the depression (in Marie Byrd Land) the relief is much softer and lower - up to 2000m. Volcanism is manifested on this side mainly by large volcanic edifices aligned on an almost rectilinear grid of faults or feederdikes.

The separation of Antarctica and Australia took place between the Cretaceous and middle Tertiary. Whereas the western parts of the two continents separated along a single comparatively sharp line, the eastern separation was more complicated. The landmass split up into several microplates, among them the Lord Howe Rise, Tasmania and the South Tasman Rise, New Zealand and the Campbell Plateau and Marie Byrd Land; The Ross Sea depression is part of the eastern mosaic of microplates.

All of this makes the Ross Sea Area as a whole is particularly suitable for investigations of the structure and evolution of the Antarctic lithosphere.

The present structure of the lithosphere is characterised by the existence of a large continental rift, a feature that allows the study of the initial processes of lithospheric thinning associated with continental split and break-up. This stage is highly relevant for the later formation of a new ocean.

Comparable in size to the Basin and Range province of North America and the East African rift, this system is unique for the asymmetry of the shoulder uplift in an intracontinental system. Why the rift system is active within an apparently stable and largely aseismic plate is a question relevant not only to Antarctic research but to continental rifts in general and to the forces which drive plate tectonics as well.

The evolution of the West Antarctic Lithosphere was marked by the generation of a new lithosphere at the active Gondwana margin bordering the Pacific or Palaeopacific and the fragmentation of the West Antarctic lithosphere which finally led to the present mosaic of crustal blocks.

Generation of lithosphere at the active Gondwana Margin...

The Antarctic Ross Orogen and the mobile zones on the Pacific outer rim of Gondwana form one of the longest preserved segments of this active margin which developed from the late Precambrian on. The active margin is characterised by the formation of fold belts similar to the present circum-Pacific mobile belts.

The basement of the Transantarctic Mountains consists of Precambrian and lower Paleozoic rocks of the Ross Orogen. Metasediments and migmatites of the Wilson Group crop out mainly in the western and inland parts of North Victoria Land. Adjacent to the east, the slightly metamorphic rocks of the lower Paleozoic Bowers Supergroup and the Robertson Bay Group are found. These three units a occur in zones separated from each other by fault zones and regarded as tectonostratigraphic terranes. The Wilson Terrane contains rocks of the late Precambrian to Cambrian age, the Bowers Terrane is made up of folded fossiliferous sediments and volcanic rocks of Cambrian and Ordovician age, a the Robertson Bay Terrane consists of turbidities that are of Cambrian age too.

All three terranes were deformed and affected by metamorphism during the Ross Orogeny (early Ordovician). At the same time, granites were emplaced in the Wilson Terrane. It must be assumed that at the time of the orogeny the various terranes had already been welded to the outer rim of Gondwana.

To prove this scientists working in GANOVEX VI tried to compare the age of deformation in the three terranes by dating the newly formed micas in the folded rocks by the AR/Ar method. If the ages are the same in all three terranes then their postulation is true. Only if there are large differences in the age of deformation should the terranes be regarded as truly exotic. The same project will compare geochemically and date several Admiralty granites which unconformably intrude the terranes along the northern coast of Northern Victoria Land at Cooper Bluff, Sputnik Island, Znamenskiy Island

One theory holds the mode of attachment of the terranes to be strike-slip accretion but it can also be explained by subduction accretion as evidenced by remnants of ultramafic rocks preserved along the suture line between the Wilson and Bowers terranes.

During GANOVEX V a series of thrust planes were discovered in the basement of Oates Land, other thrusts were investigated in the Terra Nova Bay area. An integrated model was developed for these structures at the active Gondwana margin during the time of the Ross Orogeny (Cambrian to Ordovician). This model fits best the assumption of subduction-related thrusts and back thrusts.

It was intended to do undertake a more detailed investigation of those thrust planes in order to derive the conditions under which thrusting took place, and to deduce the tectonic transport, and check for possible strike-slip motions. Radiometrically dating of the granites and pegmatites cutting the thrust planes was also planned.

The boundaries of the Precambrian East Antarctic Shield, which includes granulite-facies rocks probably belonging to the lower crust have not yet been definitely located. This makes it difficult to fit Antarctic and Australia together in the reconstruction of Gondwana. Since Italian scientists have discovered granulite rocks in the TNB area there is renewed interest in the problem of how to distinguish relict shield rocks within the high grade terrane of the Ross Orogen. Standard radiometric dating does not get back in time through the Ross Event where especially where the head of the widespread granites has reset the radiometric clocks completely. Only U-Pb dating of zircons separated from suitable rock types provides the essential Precambrian data. Based on the first results of a sampling programme carried out during GANOVEX V sampling was continued in the TNB region. This season the programme was comprising mapping, petrography and the dating of pre-Ross relicts.

During previous work, the granite migmatite relations in the Wilson Terrane were found to be less straight forward than assumed. Apart from the bulk of Granite Harbour Intrusives (480-490 my) there may be an older generation of granite which is older, perhaps 530 my. It is not clear whether the migmatites are related to either of the two generations or to just one, and, if so to which one. Petrographical and geochemical investigations were envisaged to solve this question. Field work and sampling was undertaken in the Wilson Hills and in the area between the Priestly and Campbell Glacier. The program was supplemented by p-T determinations in the metamorphic rocks.

Fragmentation of the West Antarctic Lithosphere.

From previous work the scientists have distinguished certain evolutionary steps in the development of the Ross Sea area. These include:

Basin formation by Andean back-arc process during the Cretaceous - early Tertiary.

Separation of Tasmania/New Zealand from Antarctic and the opening of the southern ocean also during the Cretaceous to mid-Tertiary.

Extensional processes forming the Ross Sea depression and the Transantarctic Mountains during the Cenozoic.

Among the significant problems relating to the fragmentation of the lithosphere and addressed by the programme were studies of the nature and thickness of the crust beneath the Transantarctic Mountains undertaken in three projects. These included a Regional Gravity Survey of the lower Rennick Glacier area by the BGR and USGS; a gravity survey on ice with accompanying thickness determinations by radar in the Terra Nova Bay area also by the BGR and a study of the geochemistry and petrology of Jurassic and Cenozoic volcanic rocks by scientists from the Universities of Mainz and Naples.

The Geometry of the faultplane bounding the basins of the Ross Sea rift from the shoulder to the Transantarctic Mountains was covered by the compilation of an inventory of Cenozoic structures in the Ross Sea coastal areas.

Focussing on the time of the major uplift of the Transantarctic Mountains was also included by the inventory and augmented by the dating of Cenozoic tectonism by scientists from the BGR and Fission track sampling of the Cenozoic Granites at the Ross Sea coast by others from the University of Bremen.

The age and episodicity of rift volcanism was studied by scientists from the Universities of Mainz and Naples and from the BGR, some of whom also made a study of the local structure of the lithosphere derived from mantle xenoliths, part of which was extended to cover also the nature of the lithosphere and underlying mantle as derived from isotope investigations of plutonic and volcanic rocks. Recent heatflow in the Ross sea was compared to that in the rift shoulders also by scientists from the same organisation.

Other studies included the style of young tectonism in the Transantarctic Mountains, crustal gradient between the Ross Sea and Polar Plateau derived from regional gravity data, an integration of subglacial and submarine areas by aeromagnetic surveys and under ice morphology inland of the Transantarctic Mountains as derived from Radio Echo Sounding and further work on glacial geology in relation to uplift.

Sub-Antarctic

Six to winter on Heard Island in 1992

Plans are being made for a party of six people to spend 12 months at Heard Island from February 1992. Although selection depends on the evaluation of research proposals there are likely to be four scientists. The leader will be Attila Vrana from Australia's Antarctic Division.

The scientific programme will focus on the biology of elephant and fur seals and bird life in order to understand more of the winter cycle of breeding on the island as part of an overall study of the Southern Ocean Ecosystem. Support will be provided by a medical officer, and a general handyman/mechanic/radio-operator.

Apple/melon type units to be installed at Spit Bay will provide accommodation. The previous ANARE station on Heard Island was in Atlas Cove.

The project will constitute the second time that an ANARE party has wintered away from established bases. The first, of four people, carried out glaciological work on the Amery Ice Shelf during 1968.

During this last season six research projects were planned for the Island but in the event Icebird, while making her approach, in late January was struck by a storm and some deck cargo was lost overboard during rolls in excess of 50 deg. This forced the abandonment of one of the two intended landing places and only a third of the programme could be undertaken. Icebird arrived on January 30 and departed the following day.

During that time Rosemary McFarlane and Anitra Wenden undertook a programme for Ms Janet Hughes, a material conservator of the Australian National Maritime Museum. This entailed making the first field survey of the Island's historic sites for a materials conservation purposes. Because of the short field season they concentrated on collecting data from the Atlas Cove area for subsequent laboratory analysis. Using photographs and previous archaeological reports they compared the damage, recorded the condition of the artifact and coded it according to aid speed. Limited field testing was also undertaken. The results will contribute to the pool of information, determining of priorities and advice on possible methods of preservation in the environment characterised by its harsh climate and constant erosion.

Also working from Atlas Cove was Marian Lillieskold on behalf of Professor Linquist of the University of Stockholm. She collected samples from the margins of the Vahsel, Schmidt and Baudissin Glaciers, the area between them and the isthmus towards Larens Peninsula to undertake subsequent genetical studies of sediments on the Island. The Professor is seeking to analyse the changes in the shape of the grains caused by the action of glacial, fluvial and aeolian processes on fresh volcanic sediments by means of scanning electron microscope and three dimensional image analysers, the results helping to identify deposits by different agents in other areas. Heard Island is a good locality for such studies as it has fresh volcanic sediments in which original features are unaffected by exogenic processes. The sediments have been redeposited by glaciers, wind, fluvial action and beach processes and the way in which the same types of mineral particles are transformed in terms of grain shape and grain surface texture can be easily studied.

Cancelled for the season were projects relating to tourism management strategies, a taxonomic and phytogeographic survey of the mosses and lichens begun in 1971 by Dr Rod Seppelt from Antarctic Division as part of a larger programme, a multidisciplinary programme emphasising studies that facilitate living and working in Antarctica and a mapping programme.

Antarctic Treaty

"Comprehensive protection of Antarctic environment overtakes Minerals Convention"

"...to explore and discuss all proposals relating to the comprehensive protection of the Antarctic environment and its dependent and associated ecosystems" was the primary task of the 11th Antarctic Treaty Special Consultative Meeting held in Vina del Mar, Chile from 19 November to 6 December, 1990. Detailed discussion of six proposals presented to the meeting exposed unanimous support for the "need to adopt a new legally binding international instrument". Although the texts presented different options in terms of forms for such protection considerable agreement prevailed on the structure, which now seems likely to be a protocol to the Antarctic Treaty with annexes as opposed to a separate convention. A single text drafted personnally by Mr Rolf Trolle Andersen of Norway drew on the various documents and was accepted as the basis for further discussion at the next session of the meeting scheduled to be held in Madrid during April prior to its conclusion in Bonn, October 1991.

In the meantime the meeting noted that the present restraint on Antarctic mineral resource activities continued. Although a number of delegations preferred a permanent ban, or CRAMRA, most were willing to consider a lengthy prohibition or moratorium. However, the manner in which a prohibition might be reviewed or terminated needed further consideration while arrangements for taking decisions on mineral activities would also need to be in place before an internationally agreed moratorium could be implemented. CRAMRA, as agreed to in Wellington, New Zealand in June 1988 has to all intents and purposes been shelved in favour of a more comprehensive environmental regime.

The meeting was attended by representatives of the Consultative Parties Argentina, Australia, Belgium, Brazil, Chile, China, Ecuador, Finland, France, Germany, India, Italy, Japan, Sweden, the Republic of Korea, Netherlands, New Zealand, Norway, Peru, Poland, South Africa, Spain, Sweden, Union of Soviet Socialist Republics, the United Kingdom, the United States of America and Uruguay. (Ecuador and the Netherlands were ratified, as consultative parties to the Antartic Treaty at a meeting prior to the ATSCM.) Delegations from parties to the Antarctic Treaty which have not yet achieved Consultative Status also attended. Nations in this category included Austria, Canada, Colombia, Czechoslovakia, Denmark, Greece, Hungary, the Democratic People's Republic of Korea, Rumania and for the first time Switzerland. Observers included representatives from CCAMLR, SCAR. the Commission of the European Communities CRC, IOC, the Intergovernmental Oceanographic Commission, the International Union for the Conservation of Nature and Natural Resources, IUCN and ASOC, the Antarctic and Southern Ocean Coalition. Chairman for the meeting was Ambassador Oscar Pinochet de la Barra, of Chile.

Five interrelated aspects of Antarctic environmental protection, which emerged from the Paris meeting in November 1989 provided a mandate for Vina del Mar. These were (1) formulating principles, (2) reviewing the existing body of measures to identify gaps requiring supplementary measures, or where existing measures require strengthening or improvement; (3) strengthening the legally binding and enforceable nature of obligations to protect the Antarctic environment and (4) establishing new institutional arrangements to secure effective implementation of such measures.

The fifth was to promote environmental assessment and scientific research, monitoring and exploring the role of an information and data base related to effective environmental management in Antarctica.

Following the adoption of the agenda six

documents containing proposals on comprehensive environmental protection were introduced and discussed. They were:

A draft of a Convention for the Comprehensive Protection of the Antarctic Environment submitted by Australia, Belgium France and Italy.

A draft Protocol to the Antarctic Treaty on Environmental Protection, submitted by New Zealand.

Comprehensive Measures for the Protection of the Antarctic Environment and its Dependent and Associated Ecosystems. This was an outline of a Protocol Supplementing the Antarctic Treaty, submitted by Argentina, Norway, United Kingdom, United States of America and Uruguay.

Draft Provisions for a Protocol Supplementing the Antarctic Treaty, submitted by the United Kingdom.

Protocol supplementing the Antarctic Treaty, submitted by the United Sates of America.

Comprehensive Measures for the Protection to the Antarctic Environmental and Dependent and Associated Ecosystems submitted by India.

Following the presentation of the documents and introductory discussion two working Groups were established and their terms of reference defined. The first, chaired by Mr Dietrich Granow, Head of the German delegation, was to identify issues to be considered in elaborating a comprehensive system drawing on the proposals submitted by delegates. These were to include the basic principles, obligation and compliance, institutions and infrastructure, decision making, amendment modification, liability, monitoring and inspection, dispute settlement, the relationship of the proposals to other parts of the Antarctic Treaty System and other substantive provisions including those issues referred to by working group 11. The second working group was asked to initiate the review called for in paragraph 3b of Recommendation XV-1 and to concentrate on marine pollution, waste disposal, environmental impact assessment, the agreed measures for the Conservation of the Antarctic Fauna and Flora, the protected area system, tourism and non-governmental activity and environmental monitoring. The group, chaired by Dr Roberto Puceiro Ripoll, from the Uruguayan delegation, worked mainly on the detailed provisions of New Zealand's draft Protocol, the draft annexes submitted by the United States and the working paper on environmental impact assessment tabled jointly by Australia, Belgium, France and Italy. It added to its agenda, international scientific co-operation, alternative energy uses to reduce environmental impact and fuel management.

On 5 December both groups reported back to the Plenary session, the second group appending to its report additional documents on Marine Pollution, Waste disposal, Environmental impact assessment and the Conservation of fauna and flora. It was agreed that these would be attached to the informal draft protocol for further consideration at the next session of the XIth meeting. A programme for further work was established prior to consideration of general business and the adoption of the interim report.

It is intended that the Protocol and its annexes would build on the Antarctic Treaty supplementing the associated measures already adopted. When considered in conjunction with the commitment to consider the establishment of a secretariat and annual meetings the system would provide a foundation for addressing a full range of concerns to strengthen environmental protection. This seems likely to be achieved through:

- Article 2, which elaborates environmental principles.
- Article 4, which explicitly calls for consultations and cooperation among parties contracting to the Antarctic Treaty and related legal instruments which have entered into force and institutions established to implement them.
- Article 5, which supplements Articles II and III of the Antarctic Treaty obliging contracting nations to cooperate internationally in scientific investigations in Antarctic to reduce impacts on the environment and improve scientific productivity.
- Article 9, calls on ATCMs to draw upon the best scientific and technical advice available, particularly that provided by SCAR and the Committee for Environmental Protection to

define the general policy for the protection of the Environment and its dependent and associated ecosystems as well as adopting such measures as necessary for the implementation of the Protocol and additional annexes; provision for the establishment of the Committee for Environmental Protection is made in Article 10 and its function is to advance effective environmental management and related research and monitoring programmes. Articles 11 and 15 of the Protocol elaborate contracting party obligations to ensure compliance with the provisions of the document and its annexes in relation to both governmental and non-governmental activities and requires each party to report annually on measures taken in this regard.

• Article 12 elaborates the inspection provisions contained in Article VII of the Antarctic Treaty.

• Articles 12 and 15 explicitly require review at the ATCM's of inspection and annual reports by contracting parties.

• Article 13 requires each party to ensure prompt and effective response to accidents particularly those with potential environmental effects and to develop contingency plans for such situations.

• Articles 8 and 23 provide for accelerated entry into force of provisions that modify or update the annexes and articles 8, 17, and 18 provide for compulsory and binding dispute settlement in relation to the obligations set forth in the annexes and the Schedule to the Protocol on Arbitration.

The question of compulsory, binding dispute settlement was one of the most difficult of the clauses in the various proposals to reach agreement on and the different approaches considered:

- How to give effect to the agreement that all Antarctic activities should be subject to prior assessment of their environmental impacts and in particular whether or how collective review by all contracting parties may delay proposed national activities, trigger modification of them and or lead to their suspension.

-Whether to create a new decision making organ to address environmental matters, and short of a decision making role, the extent to which a new environmental advisory body may review the effectiveness of environmental practices and initiate needed improvements;

-Whether to create an independent, institutional inspectorate to supplement the provisions of Article VII of the Antarctic Treaty;

-whether and how to devise a liability regime for damage to the Antarctic environment; and the basis for a compromise on minerals development in Antarctica capable of satisfying both the concern for a prohibition on such activities and the concern that whenever that prohibition is no longer in effect, there be in place internationally-agreed arrangements for taking decisions on any proposed activities before the need arises, which would be no less stringent and effective than those set forth in the 1988 Convention on the Regulation of Antarctic Mineral Resource activities - CRAMRA.

The provisions in the Protocol and its annexes cover all human activities in Antarctica and set out each party's obligation, within their competence, to apply and enforce the requirements of the protocol and its annexes in relation to both governmental and non-governmental activities.

NCPs to the Treaty are encouraged to become parties to the Protocol and would be required to contract before seeking consultative status thus avoiding a situation where different parties were bound by different obligations and clarifying the requirements with which each contracting party must comply. Those requirements incorporated into the annexes, combined with provision for their continuing review and revision, will establish an up-to-date and binding code of conduct for all Antarctic activities. Furthermore the Protocol specifies that nothing in it shall derogate from the rights and obligations of the parties to other treaties at the same time encouraging consistency with other ATS components in the operation of which cooperation and consultation is so critical to consensus and agreement.

In adopting the Protocol and annexes approach the dynamic nature of the requirements of Antarctic operations has been recognised. The draft annexes provide for acceler-

ated entry into force of amendments or modifications; insofar as by incorporating such provisions in annexes, instead of the Treaty, the necessity of changes being subject to parliamentary approval in individual nations is avoided.

To enter into force the Protocol requires that all ATCP's at the time of adoption must formally approve it.

The treaty covers the area south of and including 60 deg south latitude.

SECRETARIAT

A decision regarding the establishment of the Secretariat to serve the Antarctic Treaty System was deferred, by agreement until the next regular Antarctic Treaty Consultative Meeting. It was however agreed that such a body would perform functions entrusted to it by the ATCM's and would therefore grow as required. The question of funding the Secretariat still has to be discussed.

COMMITTEE FOR ENVIRONMENTAL PROTECTION

This committee would be established under the Protocol as an advisory body comprising one representative from each party contracting to the instrument. It's rules of procedure would be established by the ATCM to which it would also report on each of its meetings.

WORKING GROUP II

In its review of existing measures adopted under the Antarctic Treaty the Working Group produced four draft annexes to the Protocol. They represent a transformation of existing ATCM Recommendations on their topics into legally binding obligations which they sought to extend to non-government activities in Antarctica, particularly with respect to Environmental Impact. The annexes cover:

ENVIRONMENT IMPACT ASSESSMENT (EIA)

Together with the environmental principles embodied in Article's 2 and 7 of the Protocol this annex reflects agreement on the need to submit all activities in Antarctica, except those with little or no impact, to prior assessment. Responsibility for such assessment should fall to the organisor of expeditions whether governmental or non-governmental but the means for achieving the latter is still under discussion and for the moment it has been left to each contracting party. Requirements for exchanging lists of Initial Environmental Evaluations (IEE), as well as related decisions have been added, along with strengthened requirements for environmental monitoring, compulsory, binding dispute settlement and procedures for accelerated entry into force of amendments or modifications to the annex. Still to be resolved is the procedure under which the Committee on Environmental Protection would review the applications.

WASTE DISPOSAL

The draft annex on waste disposal transforms Recommendation XV-3 into legally binding and enforceable obligations and improves upon it by incorporating a number of points relating to such disposal in the marine environment. These include a general obligation to incorporate waste storage, disposal and removal into the planning and conduct of all activities in the Antarctic Treaty area; clarification that those who create wastes must dispose of them; strengthened obligation to clean up past waste sites and abandoned work sites; obligation regarding the removal of plastics; agreement on a phase-out date for burning of wastes; prohibition of all disposal onto ice-free areas and into fresh-water systems and strengthened restrictions regarding disposal onto sea ice, ice shelves or grounded ice sheets and promotion of measures that are no less effective in protecting the environment than those applied outside Antarctica.

MARINE POLLUTION

The meeting noted that the Marine Environment Protection Committee (MEPC) of the International Maritime Organisation (IMO) approved on November 15, 1990 designation of the Antarctic Treaty area as a "special area" pursuant to Annexes 1 and V of the Convention for the Prevention of Pollution from Ships 1973, as amended by the Protocol of 1978 thereto MARPOL 73/78 and that the designation is scheduled to enter into force on 16 March, 1992 and will bind all contracting parties to the relevant annexes whether or not they have contracted to the Antarctic Treaty and its Protocol and an-

nexes. Working Group II's draft annexes's on Marine Pollution take into account the special operating circumstances in Antarctica and builds on Recommendation XV-4 by incorporating the specific amendments to the relevant MARPOL special areas just adopted by the MEPC and the relevant annexes.

The Recommendation has been improved in seven ways. These include a requirement that contracting party implement the marine pollution control obligations with respect to their flag ships as well as other nations flag ships engaged in or supporting their operations. Contracting party obligations to address the adequacy of reception facilities for oily residues and garbage from ships in port they utilize traveling to or from Antarctica are articulated as is each party's commitment to ensure that its flag ships entering the Antarctic Treaty area are fitted with sufficient capacity to retain on board that items while in the area and have made adequate arrangements to dispose of them subsequently. Noxious liquid substances, including petrochemicals and others regulated by Annex II of Marpol 73/78 must only be discharged in accordance with the standards of that annex or National standards that are no less stringent. Incinerator ash may not be disposed of at sea and greater precision is called for in obligations to enforce measures consistent with the annex in relation vessels enjoying sovereign immunity but supporting Antarctic operations. An obligation on the part of the contracting parties to take account of marine pollution control requirements in the design, construction, manning and equipping of vessels supporting Antarctic operations has also been included. A further four provisions were also bracketed. They broadly relate to compulsory binding dispute settlement, continuing review and accelerated entry into force of amendments, marine pollution preparedness response including contingency plan requirements and possible liability, insurance and penalties.

CONSERVATION OF ANTARCTIC FAUNA AND FLORA

The most extensive revision of existing measures undertaken by Working Group II related to the Conservation of Antarctic Fauna and Flora, adopted in 1964. It maintains the two levels of protection contained the original Agree Measures; one prohibits in general the killing of native animals or birds and the other grants addition protection to mammals or birds listed in a special annex. Additionally full protection is extended to plant species and provision is made for invertebrate species to be listed in a special annex. The annex defines and prohibits the "taking of native animals, birds or plants except in accordance with permits authorised by a contracting party" and restricts the issuing of such permits as prescribed in the draft annex thereby giving greater precision to conservation requirements. Further improvements include extending contracting party obligations to make known the requirements to all those present or intending to enter the area, disallowing authorisation of "taking" to provide indispensable food for human beings; specifying parameters for "taking"; extending protection to essential habitat; disallowing dogs to run free; strengthening restrictions applied to permitted importation of species including live animals other than sledge dogs essential for maintaining the genetic viability of existing populations; extending prohibitions of importing live poultry to all living birds and imposing requirements on importing dressed poultry and disposal of poultry parts and restricts the importation of non-sterile soil to the maximum extend practicable.

Other items on Working Group 11's agenda including the Protected Areas system, tourism and non-governmental activities, environmental monitoring and co-operation in Antarctica.

Further work on Protected Areas Systems is likely to be undertaken at the next meeting. Such areas have now grown to include "Specially Protected Areas" (SPA's); "Sites of Special Scientific Interest" (SSSI's) which includes those in the marine environment; "Historic Sites and Monuments"; provision for "Specially Reserved Areas" (SRA's); and "Multiple Use Planning Areas" (MPA's).

Tourism and Non-government activities will also be discussed at the next meeting.

Distinction was drawn in the use of the

expressions "environmental monitoring" and "monitoring for compliance with applicable rules". Some aspects, the report notes, could be dealt with in regulations but the Protocol provides that the Committee for Environmental Protection is to give advice on the need for monitoring in relation to the implementation of the Protocol and its annexes as well as the establishment and maintenance of a related information and data base.

The resumed session of the XI special ATCM will take place 22 to 30 April, 1991 in Madrid, Spain. The regular Antarctic Treaty Consultative Meeting will be held in Bonn in October 1991 and is expected to conclude the environmental protection Protocol and its annexes. A preparatory meeting for the Bonn ATCM will immediately preceed the Madrid meeting and will run from 15-19 April, 1991.

References:

Interim Report of the Eleventh Antarctic Treaty Consultative Meeting.
Protocol to the Antarctic Treaty on Environmental Protection, as prepared by R.T. Andersen.
"Report on Antarctica" Lee A. Kimball for World Resources Institute, January 1991.
Assorted press documents and releases.

Delegates:

The New Zealand delegation to Vina del Mar was led by Mr Frank Wong, Director of the Legal Division of the Ministry of External Relations and Trade (MERT). It comprised Mr Paul Tipping, Ambassador of New Zealand to Chile; Mr Gerard van Bohemen, Legal Consultant to MERT; Mr Murray Parrish, Environmental Coordinator to Department of Scientific and Industrial Research; Mr Michael Prebble, Ministry of the Environment and Messrs Grant Harper and Alan Hemmings who represented non government organisations.

Greenpeace

World Park Base resupplied and second leg of programme underway

The first leg of the environmental organisation Greenpeace's sixth season of Antarctic operations concluded with the return of MV Gondwana to Lyttelton on January 26 after resupplying the World Park Base at Cape Evans in the Ross Dependency.

Departing Auckland on April 5 she had sailed to Lord Howe Island and joined to the Nishin Maru whaling factory ship on her voyage to the Ross Sea. The Japanese vessel met with three whale catchers at the convergence and the fleet was observed by Greenpeace for the following week. Few whales were sighted and none was caught.

MV Gondwana arrived at the ice edge off Cape Royds on 31 December 1990, at the position 15 nautical miles from the organisation's World Park Base. Resupply commenced on January 1 and concluded 14 days later. Using the ship's Hughes 500 D helicopters 130 drums of fuel, building materials, nearly four tones of foodstuffs, replacement medical supplies, engine spares, assorted hardware, electrical parts and field equipment were unloaded during the next 14 days.

Two new prefabricated bedrooms were also added to the base during that time. The addition involved the removal of the porch on the satellite communications side of the base but barely added to the floor area. One of the new bedrooms will be used this year by the radio operator.

Keith Swenson, an American is base leader; Sabine Schmidt from Germany and Wojtek Moskal from Poland are the scientists. (See Antarctic Vol 12. 2/3 pages 87 and 88 for details. The radio operator is Oz Ertok, who is from Australia. A fifth member of the team New Zealander Pippa Boyd, who was to be base medical person, has had to return home for personal reasons.

Six days into their return voyage to New Zealand an alternator motor stripped its gears, but as it was one of two on the vessel and only one is required at the time it did not affect the ship's operation. The engine was repaired in

Lyttelton prior to the commencement of the second leg of the voyage on February 16. Captain for the entire voyage this season has been Arne Sorensen of Denmark. Campaigners for the second leg are Janet Dalziel of New Zealand, Dana Harmon of the USA and Ricardo Roura of Argentina.

Recent reports indicate that the Gondwana called in briefly at Peter I Island in the Bellinghausen Sea before continuing down to King George Island to land a field party and temporary camp. Andy Henderson of Australia is leading the field team which comprises Anna Krysczowska, a Polish scientist who speaks Russian, Guillermo Rondini, a Uruguayan interpreter who speaks Spanish and John Gardner, an American interpreter who speaks Chinese. They will visit several of the bases on the Island before the ship collects them on April 6.

In the meantime MV Gondwana called in at Ushaia to collect Roger Grace, a photographer, before heading out to document the fishing practices of the large Russian trawlers operating a the seas surrounding King George Island. She is expected to return to Auckland, New Zealand at the beginning of May.

Environmental database for Antarctica

An environmental database for Antarctica is being developed in Cambridge U.K. It will bring together geographical, environmental and scientific data in a single system covering the whole continent and allow up-to-date maps at a variety of scales appropriate to be produced for different purposes.

The project, is joint undertaking between British Antarctic Survey, the Scott Polar Research Institute, WCMC the World Conservation Monitoring Centre with funding by British Petroleum and international coordination through SCAR.

Maps are essential for studying and monitoring environmental changes but Antarctica's remoteness, and rugged ice covered terrain has hindered the collection of topographic data for map preparation and it is still one of the most poorly mapped continents on earth.

Cook's chart in 1777 ended speculation on the existence of the continent although it was not actually sighted until 1819 with the first landing in 1821. During the rest of the 19th century parts of the continental coast were discovered and charted by different expeditions. Scott and Shackleton first explored the interior from 1908 and the first aerial surveying was undertaken in 1928. By 1947 a reasonably good outline of the coast and ice shelves was available. The International Geophysical Year of 1957-58 enormously increased the research and surveying of the continent but determination of the land limits was not complete until 1975.

From 1949 surveying beneath the ice cap began and by 1983 it was mapped on a continental scale by SPRI in co-operation with other organisations. Mapping of sub-Antarctic Islands was only adequately completed in 1988. The scale of the original maps varies from 1 :200 000 to 1: 300 000 the larger scale maps where available being used for coastal areas.

Remote sensing from satellites from the 1960's onwards, together with airborne remote sensing provides a massive volume of data which can most easily be organised into a digital database.

The database will draw on printed paper maps, manuscript maps, compilations on film, satellite images, aerial photographs and previously digitized data from a number of international sources.

A digital map will provide a uniform basis for multidisciplinary research on the continent and will facilitate the development of powerful information systems. It will also provide a framework for overlaying and combining data from different sources and which can be updated rapidly.

Although most of the data capture is being carried out in the UK other nations are contributing original data to the project under the auspices of SCAR the data is received in either digital form or as prepared linework maps for digitizing. Following selection and validation of the data the digitizing team convert the

maps into digital form at which stage codes are added to every feature indicating their nature, its source and other information such as contour heights and ice-front dates.

After digitizing the data undergoes a quality assurance check and editing when discrepancies between maps from different sources are harmonised to produce a seamless map of the whole continent.

The ultimate product of the project will be a topographical database for distribution on CD-ROM with software to view the data and to export it into other GIS systems. Publication in this form will allow the widest dissemination of the database making it a valuable tool for users at all levels of expertise.

Seven Peaks in seven months

When New Zealand climbers Rob Hall of Christchurch and Gary Ball of Twizel arrived at the top of Vinson Massif in Antarctica at 10.30pm on December 10 1990 they had completed climbs of seven peaks in seven months with nine and half hours to spare.

Mt Everest was the first to be climbed by the pair. They reached the 8,848 metre summit on 10 May 1990. Their achievement was the catylist for the rest of the programme which in terms of climbing seasons could just be achieved. Time however was running out for their ascent of Mt. McKinley and they made straight for Alaska reaching the summit of the mountain, which stands at 6,193 metres, on 28 June.

From Alaska they flew to the USSR to climb Peak El'brus in the Georgian Caucasus in the west of the Union. They reached the peak (5,633 m) on August 8. It was then onto Africa to climb Mt Kilimanjero in Tanzania which stands at 5,894 m and which they summited on 17 August, prior to flying to Australia to climb the 2,230 metre high Mt. Kosciusko in New South Wales, on 26 August.

For the last two they had to wait for the southern summer and so next came Mt Aconcagua a 6,960 metre peak in Argentina on 21 November but time was running short. They had allowed ten days for the climb and spent most of nine of them confined to their tent in stormy conditions. On their descent they traveled to Punta Arenas in Chile where they were joined by an American who they had met on Peak Al'brus; Gary Koppf would accompany them on the final climb.

The trio boarded an Adventure Network International DC-6 for a flight to the southern end of the Ellsworth Mountains and landing on wheels on a blue-ice runway they transferred to a ski-equipped Twin Otter, to fly to the Vinson Massif area 150 miles to the north.

With time still short and stormy conditions prevailing they managed three days climbing in the remaining six; they could if necessary have climed for 24 hours in good conditions. However with just nine hours to spare the pair with their friend had made it to the top of the 5,140 metre peak in conditions so favourable they were able to film with bare hands.

Following their descent they returned to Patriot Hills in an ANI single engined Cessna 185 piloted by New Zealander Max Wendon but shortly after their arrival they were advised of an accident on Vinson Massif. Accompanied by a Canadian doctor the pair returned in the Cessna, again piloted by Max Wendon, to the Mountain to recover an American team. One of the four had been knocked unconscious in a fall; the guide had been hurt while trying to prevent further injury and a third had suffered frostbite trying to help them. Storm conditions again overtook the party and the Cessna was forced to land 18 miles from the mountain. After a further the rescue party reached the group subsequently flying them back to Patriot Hills.

The seven peaks concept was first put together by Dick Bass a Texan in the mid 1980s but he spent three and a half years achieving his objective. Approximately eight climbers have since repeated the exercise but all have taken about the same length of time.

For Hall and Ball it had been an exercise involving careful calculation of seasons; had they missed Aconcargua because they were unable to change their Antarctic flight they would have returned for a second try and climbed Mt. Cook in New Zealand to make it eight peaks in eight months.

Society's Photographic Exhibition opens in Christchurch

Antarctica - the New Zealand Connection is a photographic expedition organised by the New Zealand Antarctic Society with assistance from Canterbury Museum and funded by the 1990 Commission. It was opened, at the Museum in Christchurch, on Saturday 8 December 1990 by the Hon. Don McKinnon, Deputy-Prime Minister and Minister of Foreign Affairs

In his speech Mr McKinnon recalled that "This country's first connection with the Southern Continent dated back to the days of Captain James Cook.... who crossed the Antarctic Circle in his ship the Resolution, on 17 January, 1773. Seventy years later British, French, Russian and American Antarctic Explorers began stopping off in New Zealand.

The first New Zealander to sight the icy shores was John Sac or Tuati, who was half Maori and half Pakeha. He sailed aboard the Vincennes, the flag ship of the United States Exploring Expedition led by Captain Charles Wilkes. The expedition discovered what is now known as Wilkes Land in February 1840.

Mr McKinnon recalled his family's association with the continent which dated back to the 1950's when his father, a Brigadier was closely involved with the setting up of the Deep Freeze facility at Christchurch Airport.

In 1956 and 57 when the Brigadier was head of the New Zealand Joint Staff Mission in Washington, he liaised with Captain Dufek of the US Navy. "During the first of these meetings, Captain Dufek, who later became a Rear Admiral, inquired whether Dunedin would be an appropriate base for the Deep Freeze activities"..... and went on to explain "he had consulted with Admiral Byrd who had stopped off in Dunedin on his way to the ice in the 1920s". Although his father was Dunedin born and bred, and would have loved to see facilities built in his home city he advised Dufek that the Port of Lyttelton would best serve the vessels being used at the time and that the nearby facilities at Harewood and the Wigram Airforce Base were more appropriate for the aircraft.

"Some months later" said Mr McKinnon "my father and Captain Dufek were reprimanded by their respective superiors for negotiating an agreement without using normal diplomatic channels, but the project went ahead."

"For more than 30 years New Zealand and the United States have co-operated on Antarctic matters.....In the pursuit of productive and credible scientific research in Antarctica, the two countries have developed a symbiotic relationship - benefiting both parties.....The International Antarctic Centre at Harewood in Christchurch is another example of a co-operative effort with the United States.....so it is appropriate that this photographic exhibition entitled "Antarctica - the New Zealand Connection" be launched at the Museum.

The exhibition, which comprises a series of panels with text and photographs covers "The Discovery of Antarctica"; "The first New Zealander", "Early New Zealand interest"; "the First landing and the first building". A second section comprises New Zealand and the Heroic era and includes photographs if the Discovery Expedition 1901-4; the Nimrod Expedition 1907-1909; the Terra Nova Expedition 1910-1913 and the Imperial Trans-Antarctic Expedition 1914-1917.

A final section tells of New Zealand's role in taking charge of the Ross Dependency, the period between the wars, pressure on the Government to be more active in Antarctica and then goes on to cover the International Geophysical Year of 1957-58; the Commonwealth Trans-Antarctic Expedition 1955-58 and the consolidation of New Zealand's scientific programme.

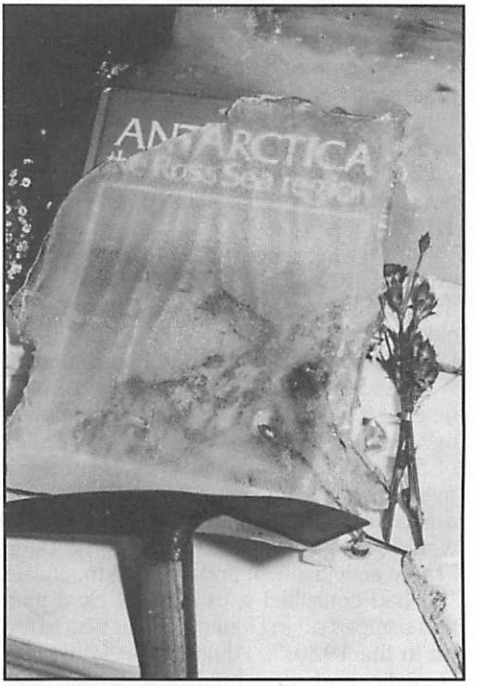
Although the exhibition was opened in Christchurch it will be traveling around the four New Zealand branches of the Society during the next year to 18 months and will be open to the public and members at various venues.

Books Antarctica the Ross Sea region,

edited by Trevor Hatherton, The Bookshop, DSIR Publishing, P.O. Box 9741, Wellington, ISBN 0-477-02586-2. 287 pages NZ $89.95

Dedicated to Sir Holmes Miller, a member of the Ross Dependency Research Committee since its inception in 1958 and its Chairman from 1971 to his resignation in 1983, Antarctica, the Ross Sea Region has been long awaited.

With a forward by Sir Edmund Hillary, the four parts comprise 16 chapters. They cover Exploration of the region in terms of defining the boundaries and completing the picture written by David Harrowfield and Hugh Logan. Part 2, The land of the Ross Sea Region comprises chapters on Geological History by Margaret Bradshaw, Sculpting the landscape by Mike Selby, Developing the Soils by Graeme Claridge and Ian Campbell, Mt Erebus by Ray Dibble and the Shores of the Ross Sea by Murray Gregory and Bob Kirk. The third section is on climate and its effects and includes chapters on Climate and weather by Brett Mullan and Mark Sinclair, the Ice forms by Harry Keys and the Dry Valleys by Trevor Chinn. Life in the Ross sea region covers inhabits of the Ross Sea by Barry Foster, Life in land, ice and inland water habitats by Paul Broady and Warwick Vincent, Birds of the Ross Sea region by Euan Young, Animal adaptions to the Antarctic environment by John Macdonald and John Montgomery. In conclusion Tony Taylor writes of Living and



Sir Edmund Hillary shows his prowess with an ice axe releasing a copy of Dr. Trevor Hatherton's book at the launching in October.

working in Antarctica and Bob Thomson presents a chapter on the international background. In short each chapter has been contributed by an expert in their field and brief biographical note has been included.

The book is liberally illustrated with maps, line drawings and superb colour photographs. Good use, too has been made of the black and white photographs too often overlooked in books of this type. The layout is attractive and a sensitive use of white space enhances the presentation although the heavy black lines mostly across the text pages are arguably superfluous.

So, what of the interest and utility? It is the most comprehensive and authoritative account of the Ross Sea Region so far released. The level is such that there is reading for the novice and expert and all are likely to learn from it. Trevor Hatherton and DSIR publishing deserve warm congratulations on the book which is a fitting tribute to the late Sir Holmes (Bob) Miller. Ed.

Books

Shackleton's Lieutenant

The Nimrod Diary of A.L.A. Mackintosh, British Antarctic Expedition 1907-09
Edited by Stanley Newman, Polar Publications, 1990
ISBN-0-473-00969-2, $27.50

Aeneas Lionel Acton Mackintosh was selected as a member of Shackleton's 1907 - 1909 British Antarctic Expedition and later led the Ross Sea Party of the Imperial Trans-Antarctic Expedition of 1914-17. It was during this expedition that Mackintosh perished crossing the sea ice in McMurdo Sound on 16 May, 1916.

Shackleton's Lieutenant, is an edited version of Mackintosh's two trips south in the vessel Nimrod used to support Shackleton's first expedition.

Mackintosh signed in Poplar on 26 July 1907 as second officer. The diary however begins with their departure from Lyttelton on 1 January 1908. Nimrod, built in Dundee, though sturdy and seaworthy was overloaded with men, ponies, dogs, stores and fuel, a late calculation on which, suggested the supply was insufficient for the ship to complete the return journey to New Zealand. The voyage began under tow from the steel built SS Koonya which cast off her charge on 15 January, 1908 at the Antarctic Circle with we are told "three cheers....with all our lung force on..." Nimrod ploughed her own passage from then on the diary recording impatience with the skipper, Captain Rupert England, who would not start the engines. It was the first mention of the ill-will that was to develop between Shackleton and England resulting ultimately in the ship returning south under the Captaincy of F.P. Evans.

On 22 January Mackintosh signed off the Ship's Articles and signed on an Agreement with Shackleton, thus he was no longer a ship's officer but instead a member of the expedition under contract to "the Boss." The reason remains unstated but presumably reflects Shackleton's growing confidence in Mackintosh's various abilities.

At 9 a.m. on 23 January the Barrier was first sighted and in Shackleton sought to honour the agreement negotiated by Wilson with Scott that the Expedition did not use McMurdo Sound. They steamed eastwards into Borchgrevinks Bight (faithfully misspelt in accordance with the diary) in search of a safe site for landing. It was not to be and during the afternoon they steamed out of the Bay for McMurdo Sound.

By 29 January they had arrived off Cape Royds. Day was busy readying the motorcar for landing but the rest of the expedition had little to do as they waited for a shore-lead Two days later unloading began in earnest. "At 8 a.m. the wind dropped and we commenced to work at the cargo. Whilst thus engaged, a

hook, being let go from a cask swung across the deck and struck me in the eye. The shock and agony of the wound was pretty bad: so this commemorates the last time I used both my eyes." The eye was removed later in the day for a time Harbord kept the diary on Mackintosh's behalf.

Over the next days unloading continued and the hut was built but Mackintosh could do little. The rift between "the boss" and England developed further as the skipper, concerned for the safety of the ship refused to bring it in closer to shore in spite of repeated requests from Shackleton. "At 10.30pm [on 22nd February] "We had finished, and 10.45 we put the Nimrod's head northward and amidst cheers from the ship and shore we sailed towards the known world and civilisation. The last we saw of the shore-party was one solitary figure silhouetted against the sky, gazing after the ship with thoughts mingled with pain, no doubt...."

By 6 March the ship was off Cape Saunders approaching Port Chalmers. The tug Koputai went out to meet her and Mackintosh and two others transferred in order to take passage on a regular steamer to Australia where he would consult and oculist and have a glass eye fixed. Treatment was likely last some months during which he hoped to study the zoology of birds in order to be of more assistance to the expedition during the second leg of the journey south.

The Nimrod went into dry dock in Lyttelton for a refit so extensive that she was never used for the magnetic survey work which Shackleton had promised the Australian and New Zealand governments. England was replaced by F.P. Evans, who had skippered the Koonya on the tow south.

The account of the second voyage begins on 1 December 1908 with a description of the farewell from Lyttelton. It covers the voyage south and eventual arrival at Cape Royds. Included is a detailed account of a life-threatening incident involving Mackintosh and McGillan who had undertaken to deliver the mail bag to Cape Royds but the conditions deteriorated and the ice broke out committing them to an overland journey from Cape Bird to Cape Royds.

Within a couple of days of their arrival at Royds Mackintosh was off the first of two sledging trips to the [Minna] Bluff. At the end of the first day Mackintosh wrote "Had tea: turned in. Wind S.E. fresh. Temperature cool. I have nothing to record whatever." but he goes onto provide a good account of the journey which includes the use of sails on the sledge and the finding of an old Discovery depot.

The diary concludes with a rendezvous with the ship at Hut Point and departure "On our way northwards we had to pick up geological specimens left at Menorite [Monosite] Island, depoted by the Northern Party: but the pack intercepted us, so we had to abandon them; and now we headed out for the Ross Sea: HOMEWOOD BOUND. Mackintosh was discharged at Lyttelton on 31 March, 1909.

The editors Stanley Newman and Richard McElrea of Polar Publications have provided extensive notes, which, for various reasons have been set out at the conclusion of each chapter requiring constant referral. This is irritating, particularly as many of them are quite technical in nature. The editors should however be congratulated on the extent of the noting and their efforts to ensure accuracy.

Beyond that the book provides a largely matter-of-fact account of part of an expedition with a some rare insights into personalities, issues and events. Some useful biographical notes have been included and the book, though not necessarily exciting, has a rightful place as an addition to the accounts of the expedition and in any polar enthusiasts library. It is well illustrated, contains a number of maps and is attractively presented. Ed.

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