ANTARCTIC

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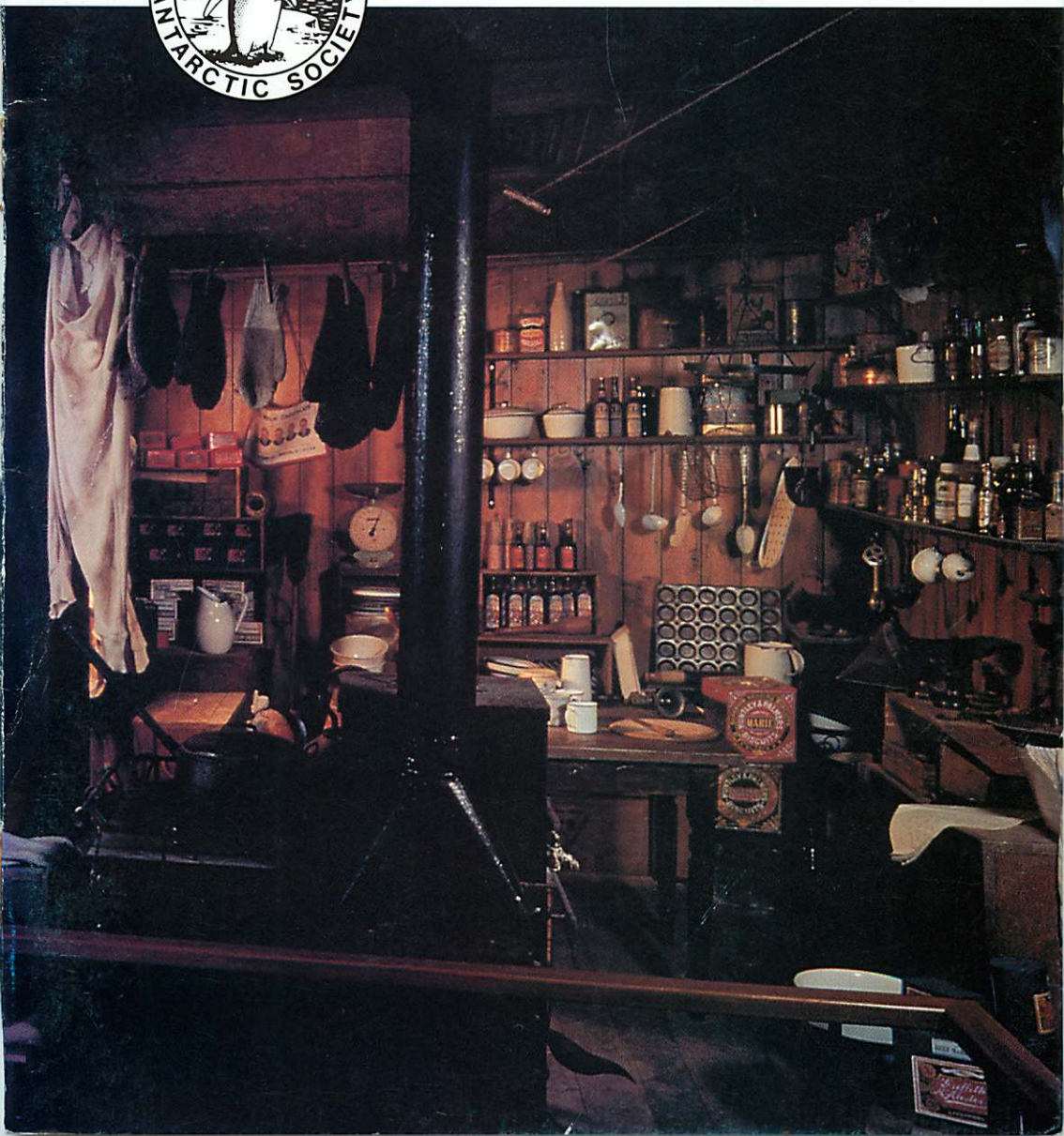

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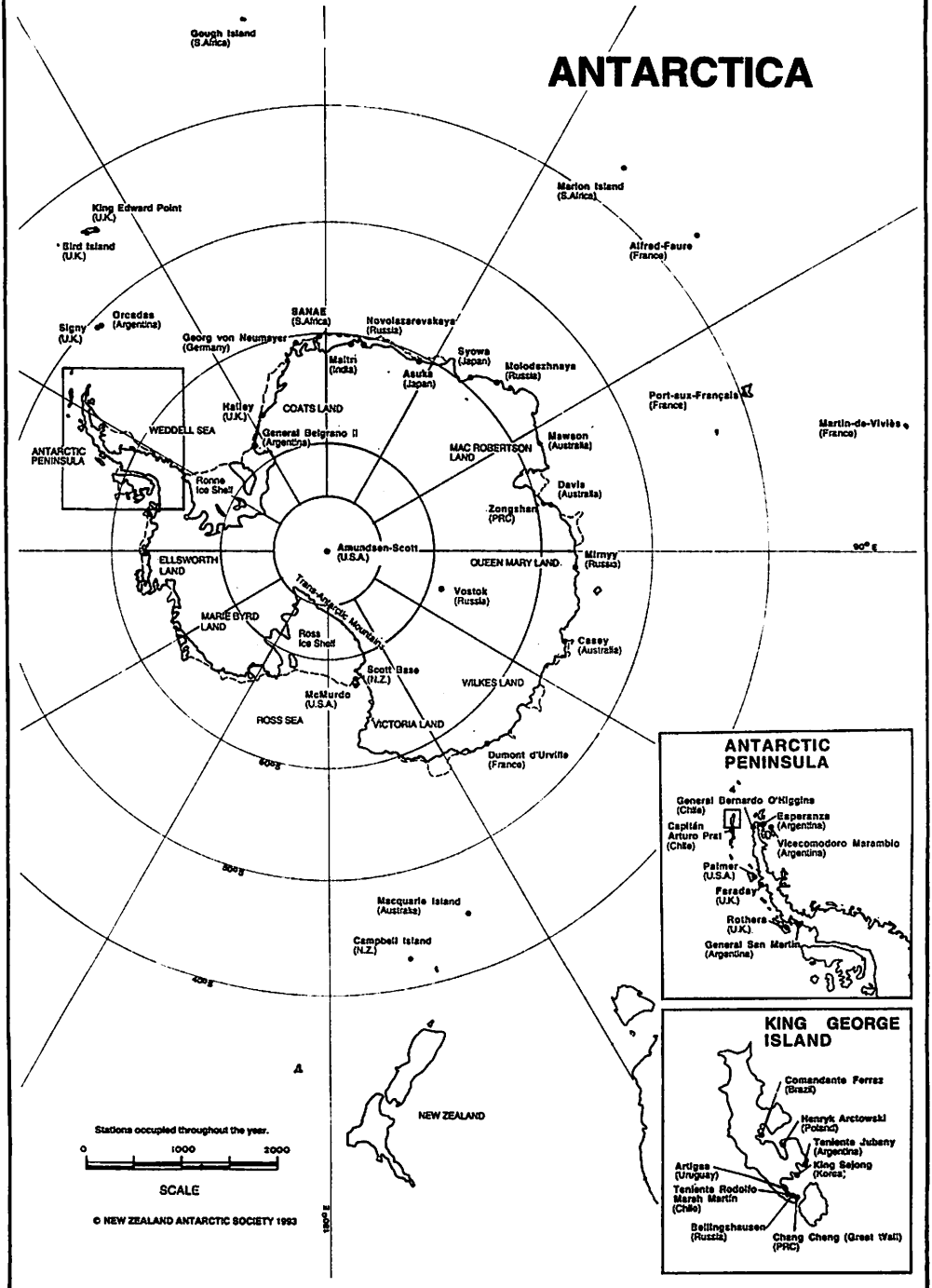
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Marion Island (S.Africa)
Alfred-Faure (France)
Port-aux-Français (France)
Martin-de-Viviès (France)
Halley (U.K.)
COATS LAND
WEDDELL SEA
General Belgrano II (Argentina)
ANTARCTIC PENINSULA
Ronne Ice Shelf
MAC ROBERTSON LAND
Mawson (Australia)
Davis (Australia)
Zongshan (PRC)
Amundsen-Scott (U.S.A.)
ELLSWORTH LAND
QUEEN MARY LAND
Mirnyy (Russia)
90° E
Vostok (Russia)
Trans-Antarctic Mountains
MARIE BYRD LAND
Ross Ice Shelf
Casey (Australia)
Scott Base (N.Z.)
WILKES LAND
McMurdo (U.S.A.)
ROSS SEA
VICTORIA LAND
Dumont d'Urville (France)
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Capitán Arturo Prat (Chile)
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Cover: Part of the interior of Scotts Hut as replicated by Kelly Tarltons as part of their Antarctic experience. The display is in Auckland, New Zealand.

Cape Roberts

First equipment delivered to Cape Roberts in preparation for drilling programme.

This material has been adapted from Cape Roberts News, Number 2, March 1995 and reproduced by permission.

Seven fitted out containers which represent the centre of the main camp for the drilling programme to be started at Cape Roberts in 1996, drill rod, mud and a drilling sea riser were among the equipment loaded onto the Italian supply ship *Italica* on 4 January 1995 and which arrived at Cape Roberts on January 16. The camp buildings include generators, water plant, ablutions and kitchen. This was the first shipment south in this cooperative drilling venture between scientists, administrators and Antarctic support personnel from Britain, Italy, New Zealand and the United States of America who plan to obtain cores that record Antarctic tectonic and climatic history from around 30 to 100 or more million years ago.

The cargo was offloaded from *Italica* by the Italian Antarctic team and the ships crew, in an operation lead by Mario Zuchelli. Three Helicopter New Zealand Squirrel helicopters contracted to ENEA, the Ente per le Nuove Technologie, l'Energea e l'Ambiente (project Antartide) for the season transferred 160 of the 250 tonnes of equipment to the Cape. The New Zealand offload team, led by Alex Pyne, Expedition Manager from Victoria Universitys Antarctic Research Centre, had located a safe route across the sea ice, and checked stacked the loads as they were delivered. The operation was completed by the morning of 19 January.

Throughout the last six months detailed planning for the project has continued with a series of meetings and some further seismic and magnetic surveys as well as the completion of a geological map of the area. At this stage preparations are on target but the project which has a budget for logistics alone of $4,363,400 has a shortfall for completion of $US350,000.

Two other meetings relating to the project were held in Italy during August and September 1994. The Operation/ Logistics Management Group reached agreement on a wide range of issues and reaffirmed the Record of Understanding from the Washington meeting held late in September 1993, as a basis for discussions. The budget shortfall was discussed at this meeting and it was agreed that funding was sufficient for the first drilling season for which planning and staging was to proceed. Further funding for the second season was to be confirmed by the individual parties by August 1995. Other issues resolved at this meeting included the schedule for payments, costs of a possible early termination, rules for costing the project, ownership of equipment and how the value of equipment purchased by the project was to be accounted for on completion.

The International Steering meeting which also met in August-September 1994 at Sienna considered the drilling strategy in the light of continuing work on the seismic data from the area, reaf-

Italica, the Italian supply ship at ice edge with supplies for Cape Roberts Photo: Gillian Wratt, NZAP.

firmed the need for two seasons of drilling and for the first to aim for two 500 metre deep holes to core the younger part of the section. The meeting supported both the seismic and aeromagnetic surveys being carried out off Cape Roberts this last season to improve the basis for the siting of the individual drill holes. This meeting also agreed to a science team of 35 on the ice for each season with numbers from each country in approximate proportion to the logistic contributions. The teams selected will be expected to produce an Initial Report each season to be published as an issue of *Terra Antarctica*, documenting observations and first results. Core processing and logging procedures were also discussed.

In accordance with the discussions and project preliminaries further seismic and magnetic surveys in the drilling region were attempted during this last summer in order to obtain additional and recent data. Between 2 and 4 February 1995 it was planned to run a single channel survey on a two kilometre grid, centred on a line of proposed drill holes and run a multichannel line over the drill sites themselves. However the area of the drilling transect was still ice covered to a longitude of 163deg 38' E, the westernmost point of the survey and between sites one and two holes. A piston core was collected from this location. In addition around 20 nautical miles of high quality SCS data were acquired just east of the proposed drilling area enhancing the data base for the region.

Project personnel consider that a further seismic survey is still highly desir-

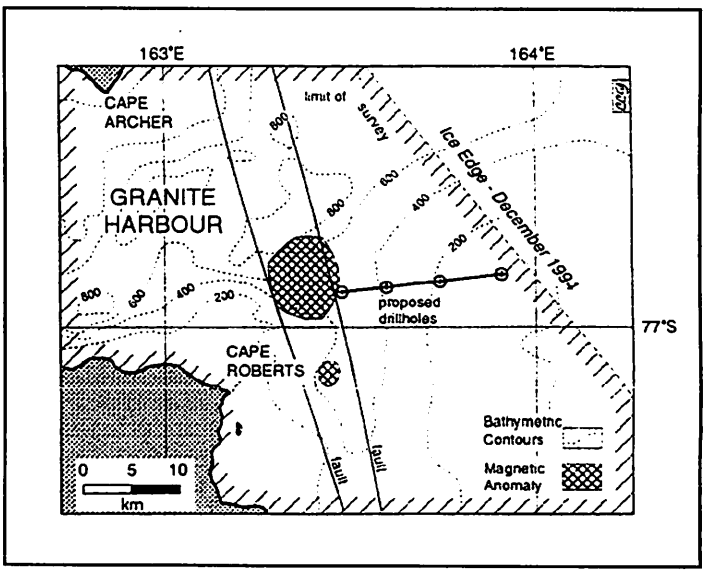
able prior to drilling in order to improve stratigraphic correlation and help make the selection of drill sites. This phase of the programme was undertaken by personnel aboard the *Nathaniel B. Palmer*.

Aeromagnetic data obtained by GANOVEX IV (1984/85) and GANOVEX VI (1990/91) indicated a large positive anomaly northwest of Cape Roberts and close to the westernmost drill sites. The anomaly has a peak to peak amplitude of 130nT and has also been found in magnetic data from USGS line 403 when it was interpreted as a subvolcanic intrusion at a depth of only one km below sea level. The GANOVEX data was obtained from surveys flown at an altitude of 610 m and a spacing of 4.4 km making it, like the US survey, very regional in character. Scientists considered it prudent to define the extent of the anomaly and obtain further data that will allow a more confident interpretation. A new helicopter-borne survey was therefore planned to be flown at an altitude of 125 m with a profile line spacing of 500 metre covering a total area of 800 square km.

Between 28 November and 6 December 1994 GITARA (the German-Italian Aeromagnetic Research in Antarctica) collected some 2085 km of aeromagnetic data off Cape Roberts. Although the sea-ice boundary limited the area of this survey all the proposed drill hole locations were covered. (The team involved in the exercise were E. Bozzo, G. Caneva, M. Gambetta (DISTER, Genova), A. Meloni, M. Chiappini (ING Roma) D. Damaske (BGR) Hannover.)

Preliminary processing has now been completed and the first draft of an anomaly map has been produced. By March it still lacked the correction of the IGRF and the levelling of profile and tie lines. However it is a considered to be a great improvement on the earlier surveys and shows a number of significant anomalies.

The most outstanding feature is a large anomaly shown in the GANOVEX IV map. This new survey was flown at an altitude of 125 m above sea level. The quasi-circular anomaly shows a peak



Map showing the area covered by the survey, the positive anomalies from earlier regional surveys and the drill hole locations.

to peak amplitude of more than 300 nT currently being interpreted as an intrusion like body which is located close to two of the proposed drill sites.

A number of magnetic lineaments can be observed; one of these parallels the coast. It is located right over a steep gradient of a bathymetry map currently in review and has been interpreted as one of the main faults along the Transantarctic Mountain Front. The area further east, away from the coast and south of the larger anomaly shows a "quiet" magnetic pattern.

Further conclusions cannot be drawn until the data have been fully processed at which stage they will be prepared for final interpretation and combined with the results of other geophysical measurements such as the older seismic data and the earlier magnetic surveys.

Also during this season a meeting was held at McMurdo Station in February between representatives of the Office of Polar Programs, the National Science Foundation and project personnel to consider various aspects of the project plan and possible use of the facilities at the Crary Center. Those attending included Chris Shepard, Steve Kottmeier (Manager of Laboratory operations) Peter Webb (Convenor CRP International Steering Committee) and David Harwood (USCRP National Committee and US Investigators Crary Center Users Committee).

The Crary Lab is named for Bert Crary, geophysicist and a chief scientist with the Antarctic Program who died on 29 October, 1987. Bert was 41 when he first visited a polar region. In 1955 he set up the glaciological headquarters for the US National Commit-

Helicopters New Zealand lift supplies onto land at Cape Roberts. Photo: Gillian Wratt, NZAP

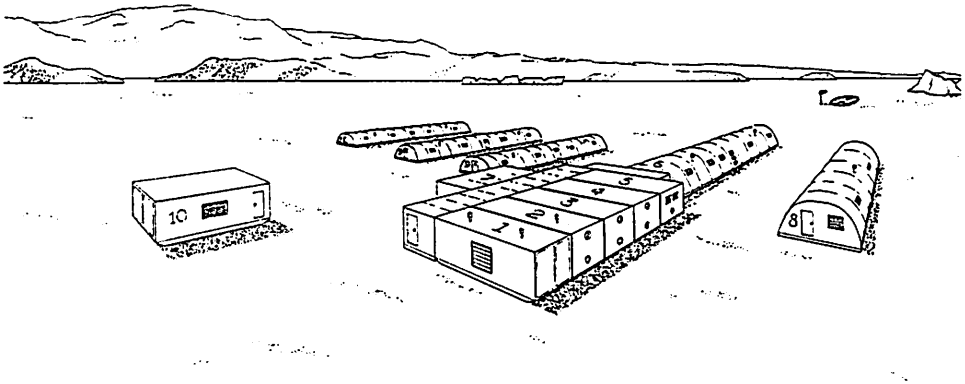
quarters for the US National Committee for the IGY and organised US Antarctic work in Glaciology. He spent the whole of the IGY at Little America leading traverses round the Ice Shelf, up the Skelton Glacier and westwards along the plateau from 1958-59. Later as chief scientist of the US Antarctic Research Programme, he continued to go out into the field whenever possible and in 1960-61 he led a geophysical traverse from McMurdo to the Pole. He pioneered many ideas in geophysics and glaciology and was quick to recognise the potential of radio sounding techniques in polar icecap studies, providing logistic backup for the Scott Polar Research Institute group which developed the method.

As director of the Environmental Sciences Division of the National Science Foundation from the late 1960's he gave strong support to developing the deep sea drilling project which, using the *Glomar Challenger*, was responsible for the holes in the Ross Sea in 1973 heightening, at the time, interest in possible hydrocarbon deposits in the area. (Ref: *Antarctic* Vol. 11. No. 8 p354ff)

Located near the centre of McMurdo Station the laboratory comprises five pods with a total area of 5,000 square metres. Individual pods serve as centres for biology, earth and atmospheric sciences. A large area has been set aside as a telescience room, computer facility, library and lounge. A full computer network has been installed.

Funding and control of the project

Artists impression of the Cape Roberts Camp which is still in the process of development. Buildings 1,2,3,4,5,7, and 10 are at Cape Roberts.



CAPE ROBERTS CAMP

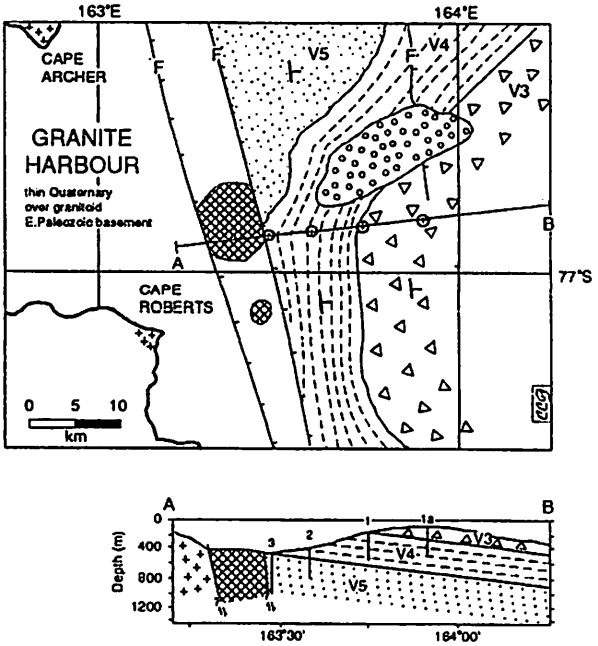
1 Generators
2 R/O Plant
3 Water Storage/Laundry
4 Ablutions
5 Kitchen
6 Mess and Rec.
7 Toilets/Drying Room
8 Science Laboratory
9 Sleeping Accommodation
10 Workshop

as well as how the Crary Center may support field operations at Cape Roberts during the two seasons of activities. If office and laboratory space can be made available it would provide a project center, facilities for receiving core and processing it, stratigraphy and sedimentology palaeontology, geochemistry, geophysics, rock cutting and thin sectioning, photography, a library and meetings. Material staging and core storage facilities were also discussed.

Issues related to the use of the center are now on the agenda for the next meeting of the International Steering Committee of the Cape Roberts project, currently scheduled for Sienna in September 1995.

Other preliminary work completed recently has included the production of a geological map for the sea floor off Cape Roberts from the several seismic lines crossing the area and from estimations of age and lithology by correlation with the CIROS-1 drill hole 70 km to the South. The map shows the distribution of the V series of seismic sequences mapped in 1987 throughout Victoria Land basin. The youngest sequence in the area lies beneath surficial debris is V3 and has been

Geologic map and cross-section off Cape Roberts (modified from Barrett, Henrys et al. submitted)



POSSIBLE LITHOLOGY & SETTING	?AGE
Gravel glacial marine	Quaternary
V3 Diamictite glacial marine	Late Oligocene Early Miocene
V4 Mudstone deep marine	Eocene Early Oligocene
V5 Sandstone shallow marine or terrestrial	Late Cretaceous-Paleocene
Mafic intrusive	Mid Jurassic (Ferrar) or younger (McMurdo)
Granitoids regional basement	Early Paleozoic

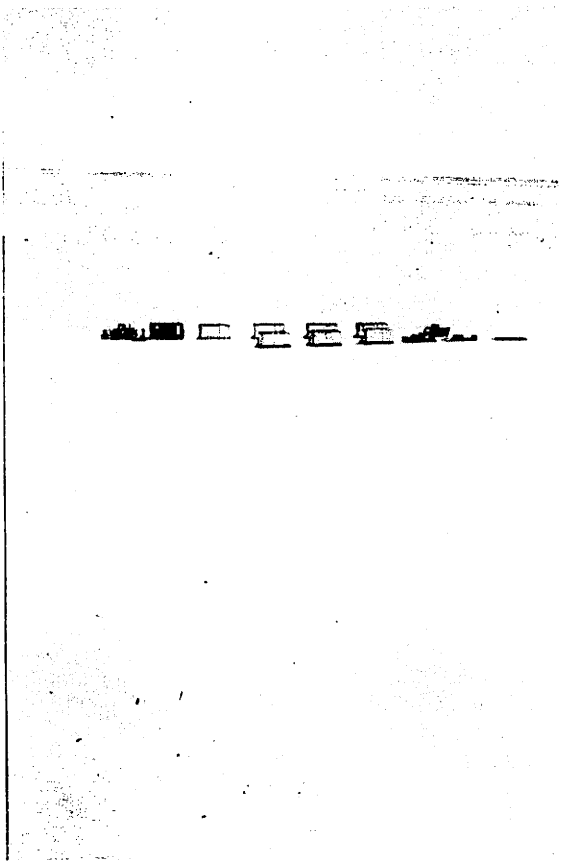
traced to Late Oligocene fluvial to shallow marine glacial strata in CIROS-1, which comprise alternating beds of sandstone, mudstone and diamictite that record a number of glacial advances and changes in sea level.

The base of V3 is a major unconformity in CIROS-1 366 m below the sea floor and represents a time gap of around four million years at the site. The substantial fall in sea level and increase in the proportion of glacial facies at the base of the sequence, along with its regional extent, mark it as a record of a major Cenozoic event.

Sequence V4 is thought to correspond to the interval from 366 to 696 metres below sea floor in CIROS-1 or may go deeper. The upper 100 metres is deep-water mudstone of Early Oligocene age (based on diatoms). Strata below 500 metres below the sea floor include turbidities; and a well preserved mid Eocene dinoflagellate assemblage. The strata contain ice-rafted debris, but less than the beds above.

CIROS-1 ended at 702 metres below sea floor in a six metre thick boulder conglomerate which could be the top of a thick conglomerate sequence (possibly V5) or a coarse debris flow within V4. Around 1000 metres of strata lie beneath the base of the CIROS-21 drill hole, and the strata mapped as V5 off Cape Roberts are at least as thick.

The next stage of the Cape Roberts project comprises a meeting of the Operations/Management Group in Santiago in late July followed by a further meeting of the International Steering Committee in Sienna to review the programme and personnel. This is planned for mid-September.



Units for the Cape Robert Camp are towed into place. Photo; Gillian Wratt, NZAP

In October and November 1995 cargo traverses will be made from Scott Base to Cape Roberts where further preparations for the start of the programme are planned.

In January 1996 a last shipment of equipment will be made to Cape Roberts and in August the advance party will go south on WINFLY to check the sea ice before setting up the camp and rig for the first season of drilling which is scheduled to begin on October 5 and continue until November 20.

One small ice shelf dies, one giant iceberg is born

This item was issued by the BAS Press office in February 1995. Antarctic asked Dr Harry Keys of the Department of Conservation in Turangi, New Zealand to comment on it. Dr Keys has specialised in iceberg research.

The disintegration of an ice shelf and the calving of a new giant iceberg have dramatically changed the outline of Antarctica. Satellite images relayed to Cambridge from the British Antarctic Survey's (BAS) Rothera Research Station confirm that recent warming of the Antarctic Peninsula is having a major impact on the ice sheet covering this climatically sensitive region.

The ice shelf which formerly occupied Prince Gustav Channel and connected James Ross Island to the Antarctic Peninsula has disintegrated. For the first time in recorded history James Ross Island is circumnavigable. The new iceberg calved from the Larsen Ice Shelf and measures 78 km x 37km (roughly the size of Oxfordshire in England) and is around 200 metres thick.

Alerted by glaciologists 9000 miles away in Cambridge on board a BAS Dash 7 aircraft confirmed both the disintegration and calving and reported a dense plume of ice fragments extending several hundred kilometres into the sea.

Speaking from Antarctica, chief geologist, Dr Mike Thomson said, "Looking out of the aircraft window I was utterly amazed to see the dramatic and very recent changes to the Larsen Ice Shelf. In 25 years of Antarctic field work I have never seen anything like it."

These observations came hard on the heels of the distintegration of Wordie Ice Shelf on the west coast of the Antarctic Peninsula, also discovered by BAS scientists. There is now little doubt that the retreat of these ice shelves is, in the short term, irreversible. The retreat is a result of a warming of the regional climate by 2.5degC since the 1940's.

Glaciologist David Vaughan says, "There is no doubt that the climate on the Antarctic Peninsula has warmed significantly over the last few decades. What we're seeing now are changes w only just working through to glaciers and ice sheets. It's an exciting time for glaciologists."

Over the next months and years the icebergs will drift north under the action of ocean a currents and wind. The giant iceberg will melt rapidly once it crosses the Antarctic Convergence and enters warmer water. The calving of icebergs is normal within the lifecycle of ice shelves, which may be quiet for decades. between calving events. Exceptionally the calving of one large iceberg may be a forerunning of a more serious disintegration. It will take time before the implications are completely understood.

Iceshelf breakup in the Peninsula - early warning of Global warming?

When the media reports focused on the iceberg breakup some contained false statements about an assumed consequential rise in sea level. Archimedes

could have told them that a floating body has already displaced its weight of sea water so that its melting will have no effect on sea level, no matter how large it is!

More significant than the big berg is the extensive breakup of the northernmost ice shelves on the east side of the Antarctic Peninsula. Altogether about 5500 km2 of ice shelf has broken off, equivalent in area to over half of the Canterbury Plains on New Zealand's South Island. It seems the disintegration was more extensive than first reported and involved three distinct areas of ice shelf:

The northermost ice shelf in the Antarctic.

This ice shelf in Prince Gustav Channel between James Ross Island and the Peninsula mainland has been retreating slowly for some decades. This last summer the final 700 km2 of shelf ice disintegrated by January 9. This means that the Gustav Channel has become navigable for the first time in history, although, admittedly in terms of human exploration, this spans less than 100 years.

The northern part of Larsen Ice Shelf between Cape Longing and Robertson Island.

This was the most spectacular and glaciologically important of the three events. More than 90% of this section of the ice shelf disintegrated involving about 2500km2 of shelf ice. The breakup occurred between 9 January and February 27 although satellite imagery suggests that it may have been underway on February 12.

The next most northern section of Larsen Ice Shelf between Robertson Island and Jason Peninsula.

This event which spawned the large berg occurred sometime between January 9 and February 12. About a quarter of this section of ice shelf broke away.

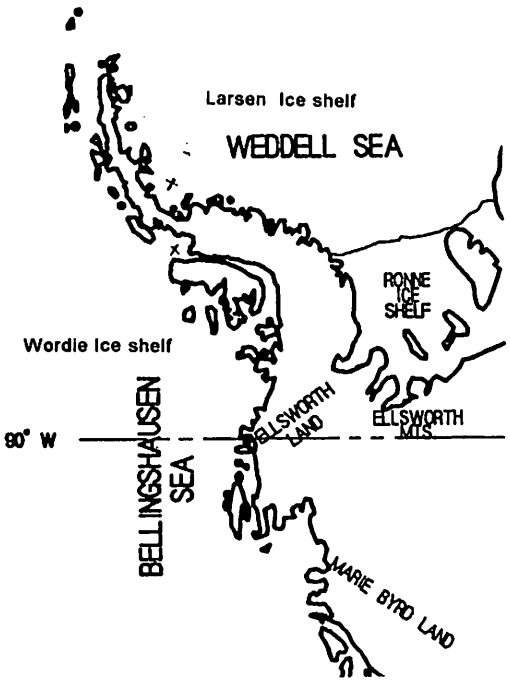
The breakups continue the trend of ice shelf disintegration which started in the late 1960's with progressive breakup of Wordie Ice Shelf. This is the northernmost ice shelf on the western side of the Antarctic Peninsula.

The rate of ice loss from the Wordie may have increased during the 1980's as summers lengthened and January temperatures warmed more above 0deg C in the Peninsula region. But the events of this 1994/95 summer involved more than twice the area of shelf ice and, as the breakups occurred over a single summer, were much more rapid.

Are these breakups abnormal events?

The size of these breakups relative to the size of the original ice shelf distinguish them from natural ice shelf decay processes. Ice shelves usually lose their mass by calving to produce icebergs and by bottom melting. Iceberg calving events normally involve only a small percentage of an ice shelf. For example, the large B9 iceberg that calved in 1987 was less than one per cent of the area of its parent Ross Ice Shelf.

Whether ice shelf calving is abnormal or not can also be determined by the likelihood of it replacing or replenishing itself in the vicinity within a few years or decades. (That this, is the process likely to be reversible or not within a realistic time frame). Where previous calvings have involved a significant proportion of the parent ice shelf (e.g. Lady Newnes, Nansen, McMurdo ice shelves) they have been replaced by *in situ* freezing of sea ice, glacier flow and snow accumulation within a few years to decades. Unfortunately most of these earlier large events have been poorly documented. Therefore it is not easy to demonstrate whether large events are normal or abnormal.



Ice tongues which are more simple structures than ice shelves can break off to form large bergs apparently more regularly and more readily. Experience has shown that large calvings from them tend to be replaced mainly by ice flow within decades.

Although hard data are scarce, none of the processes which build ice shelves seem likely to make up for this summer's ice loss in the Peninsula in the foreseeable future. The Larsen ice shelves appear to have been retreating steadily rather than advancing since earlier maps were published. Ice flowing from glaciers on surrounding land could take decades to replace the lost ice, even if ice flow is sufficient. Sea ice in most of the area is probably too mobile and possibly varies too much seasonally for it to freeze in place for long enough to allow a snow cover and an ice shelf to form. Some of the more enclosed or sheltered bays may develop ice shelves by these processes over the next few decades but in the present climate such shelf ice is unlikely to be as extensive as the former shelves. Nevertheless further research and monitoring will be needed to prove this.

Ice shelf breakup processes.

Ice shelves are limited by oceanic and atmospheric temperatures. In Antarctica where virtually all ice shelves are located, they are absent where surface temperatures rise above 1.5deg C in the warmest months and north of the 0degC air temperature isotherm in January. It is too warm for ice shelves to form north of these places.

Although there appear to be insufficient sea temperature measurements to show whether any sea water warming has increased basal melting, mean annual and January air temperatures have increased by about 2.5 and 1 degC respectively since 1945. The increases are considered statistically significant by most but possibly not all climate scientists. The consensus seems to be that there is at least regional warming in the Peninsula and if so the 0deg C January isotherm is likely to have moved south.

There are various models linking warming with ice shelf breakup:

- US scientist John Mercer suggested that rising air temperatures could produce enough melt water to percolate downwards to destroy the previous winters cold temperature wave. This would create a positive temperature gradient between the base of the ice shelf and the surface and accelerate melting. Many warm summers could be required for this

process depending on the thickness and strength of the ice. So after temperatures rose there could be a lag period of decades before breakup occurred.

- Rising air temperatures could increase ablation and the amount of melt water which weaken the ice and firn and enhance crevassing or rifting. This is the main process which scientists from the British Antarctic Survey think led to the collapse of the Wordie Ice Shelf.

- Warming sea temperatures, possibly due to enhanced incursion of Modified Circumpolar Deep Water, could increase basal melting and so thinning the ice shelf below a critical thickness/strength threshold. This threshold is dependent on the extent of crevassing and rifting, ocean wave climate and sea ice processes, including presence or absence. Such a threshold seems unlikely to be reached over such a wide area of shelf ice in a single summer.

Radiation balance, ice shelf structure, ice flow, tidal and thermohaline circulation, coastal geometry and sea floor topography may also be relevant in all these models.

Glaciological and oceanographic research on ice shelves to the south and remnants of the disintegrated ones are required to determine which of these or other models could explain the breakups. Measurements of ice surface conditions, thickness, structure and temperature and summer ocean temperatures would seem to be necessary. The British Antarctic Survey and the Instituto Antarctico Argentino both have research programmes underway.

Links with global warming?

We cannot yet prove there is a link between the collapse of these northern ice shelves and regional warming, or indeed between Antarctic Peninsula warming and global warming. We do know that the concentration of gases such as carbon dioxide and methane is increased in the Earth's atmosphere due to human activity such as fossil fuel use. Computer models of Earth's climate in an atmosphere enriched in these greenhouse gases generally indicate that air temperatures will warm faster in the Antarctic than elsewhere. Some even have this warming occurring in the Antarctic Peninsula. But we can't be sure that the present warming in the Peninsula is due to enhanced greenhouse warming, even though the Peninsula warming is probably greater than most or all other parts of the globe.

Neither does this more most recent breakup carry any an immediate (and politically sensitive) threat to human or biosphere health such as is posed by the enhanced destruction of stratospheric ozone in the Antarctic ozone hole. Flow of glacier ice off the Peninsula into the sea may now increase where ice shelves are no longer present to slow it down. But there is probably too little extra mass of ice involved to have a noticeable effect on global sea level over any time frame.

If we weigh up the arguments and uncertainties, on balance the disintegration of the northern ice shelves in the Antarctic Peninsula is a dangerous early warning sign which should not be ignored.

Antarctic thanks Dr Harry Keys, from the Department of Conservation at Turangi in New Zealand, and the British Antarctic Survey for this article.

NZAP

Ten New Zealanders running Scott Base this winter

The 1994/95 summer season concluded with the last flight from McMurdo on Sunday 26 February 1995 leaving a ten strong team to keep the base and scientific equipment running over the winter.

Manager for the winter is Warren Herrick from Clyde in Central Otago. A pharmacist by profession, he spent two summers in the field in Antarctica during the mid-1980s' Deputy winter manager is John Williams from Palmerston North. Dave Mitchell, also from Palmerston North, is the base engineer and Bruce Calder from Dunedin is the electrician. The Telecom technician is Jim McKenzie of Christchurch and Joe Ford from Drummond in Southland is the mechanic. Sean Scott from Mt Maunganui is the chef and Jan Stratford from Balclutha is the Domestic and First Aid officer. Sean Flanagan from Wellington is the Science Technician and Tom Hopkins from Christchurch is the Field Support Officer.

The mid winter airdrop is scheduled for mid June and the next anticipated contact will be made at WINFLY when scientists and personnel from NZAP will fly south to continue preparations for the next season which is expected to begin in early October. At this stage the likelihood of an extended WINFLY operation as planned and postponed from last year has not been confirmed.

Preliminary advice has been issued of the principal programmes which will make up the 1995/96 New Zealand Antarctic Programme. Twenty-one different projects are likely to be undertaken. They include the circulatory physiology of Antarctic fish which is the continuation of a programme pursued by the Department of Zoology at the University of Canterbury under the leadership of Dr Bill Davison. The sensory biology of Antarctic fish will again be studied by Dr John Montgomery, and his team, some of whom are from the Experimental Biology Research Group at the School of Biological Sciences, University of Auckland. Last season they were joined by Italian scientists.

Work on the population dynamics of Adelie Penguins will be continued by Landcare Research New Zealand in Nelson. The leader of this project is Dr Peter Wilson. Professor Euan Young from the School of Biological Sciences at the University of Auckland and colleagues will continue their study of Skua foraging and behaviour. Antarctic anaerobes will be further analysed by Dr Henry Kaspar from the Cawthron Institute in Nelson. Dr Clive Howard-Williams from NIWA Freshwater based in Christchurch and his group will continue their work on Antarctic Aquatic Ecosystems. Field work on terrestrial plant performance and adaptation will be resumed by Dr Allan Green from the Department of Biological Sciences at the University of Waikato.

Two major thrusts of climate monitoring embraced by the New Zealand programme will be continued. The study of aerosols as part of climate change

and ozone work, which has been undertaken for several years by Gordon Keys from NIWA at Lauder, is one of the projects while the other is further work on climate monitoring including ozone studies which will be undertaken by a team led by Dr Tom Clarkson from NIWA in Wellington. Italian sciscientists usually participate in this programme.

Tackling climate change from a different aspect will be Dr Tim Haskell from Industrial Research Limited who, with his team, will continue a multiscale, multiprocess study of sea ice, its breakup and effect on the climate of the southern ocean.

The biological impact of Antarctic UV will be studied further by Professor D. Beaglehole from the Department of Physics at Victoria University in Wellington

Work on the preservation of glaciotectonic structures will be undertaken by Dr S. J.Fitsimons from the Department of Geography at the University of Otago. Also from the University of Otago Dr Dave Craw of Geology Department will undertake further field work on the geological evolution of South Victoria Land.

Project leader for a study of ULF Geomagnetic Pulsations in the Polar Cap is Professor B.J. Fraser from the Physics Department at the University of Newcastle in Australia. Work on Antarctic Mesosphere Ionisation and Dynamics will be continued by Dr H.A. von Biel and his team from the Department of Physics and Astronomy at the University of Canterbury while work on the atmospheric corrosion of architectural aluminium will be continued for Mr F.W. Fahy from the Mechanical Engineering Department, also at the University of Canterbury. The Seismic and Geomagnetics Observatory Programme which has international links will be continued for W. Smith IGNS in Wellington

Antarctic Soil Hydrology and Ecosystems will be further studied by Dr I.B. Campbell from Land and Soil Consultancy Services and Biodegradation of oil in Antarctica is the focus of a programme being undertaken by Dr J. Aislabie from Landcare Research New Zealand. A study aimed at predicting contaminant impacts in Antarctica will be undertaken by Dr J. Webster from ESR Environmental. The Antarctic Drilling Programme at Cape Roberts will be taken to the next stage. The principal New Zealand investigator for this project is Dr Peter Barrett from the Antarctic Research Centre at Victoria University in Wellington. *(see* pages 354 ff of this issue of *Antarctic)*.

New Zealand passes Antarctic (Environmental Protection) Act

The New Zealand Government ratified the Protocol on Environmental Protection to the Antarctic Treaty on 22 December 1994. Certain provisions of the legislation (the Antarctica (Environmental Protection) Act), which implemented the Protocol in New Zealand law, came into force on 1 February 1995. The Ministry of Foreign Affairs and Trade is responsible for administering this Act.

The purpose of the Protocol and its associated legislation is to provide for the comprehensive protection of the Antarctic environment and its associated and dependent ecosystems, and the value of Antarctica as an area for scientific research. The Act brings into force important new requirements for all New Zealanders who plan to undertake activities in Antarctica.

The Act applies generally to all New Zealand citizens, whether living in New Zealand or overseas, and to New Zealand permanent residents, including organisations in respect of any activities that they intend to undertake in Antarctica. Similarly, it applies generally to non-New Zealanders in the Ross Dependency and to expeditions organised in New Zealand or proceeding from New Zealand to Antarctica this being the whole area south of 60 degrees south. The Act does not apply to members of official expeditions of other Antarctic Treaty parties.

The Act provides, from February 1, for the Minister of Foreign Affairs and Trade to direct that activities in Antarctica by persons covered by this Act are not to be carried out if he is not satisfied that the effects of the activities on the Antarctic environment will be consistent with the purposes of the Act.

Persons proposing to undertake activities should therefore be giving timely notification to the Minister of their proposed activities. This information should be in sufficient detail to allow prior assessment and informed judgements about their possible impact on the Antarctic environment. Of particular note is the requirement that people must act in a manner consistent with the environmental principles set out in Article 3 of the Protocol. Mineral resource activities will be totally prohibited.

Notifications of proposed activities may be sent directly to the Minister of Foreign Affairs and Trade, or directed to the Head, Antarctic Policy Unit, Ministry of Foreign Affairs and Trade, Private Bag 18901, Wellington, no later than 20 days before the proposed activity is expected to commence.

In the case of tourists and other

NZ/Swiss sign cooperative agreement for Antarctic research

On 28 March, 1995 New Zealand and Switzerland signed an agreement under which they will develop closer scientific links in Antarctica.

Signed by Don McKinnon, Minister for Foreign Affairs and Trade and the Swiss Ambassador to New Zealand His Excellency Dr Ernst Thurnheer the agreement enables the Ross Dependency Research Committee and the Swiss National Science Foundation to consider joint scientific projects in the Ross Sea region.

The origins of the agreement lie in a meeting between Swiss scientists Dr Bernhardt Sporli and Dr Kobe associated with the geology department of Auckland University and the former first secretary of the Swiss Embassy Mr Peter Graf who subsequently advised the Swiss National Science Foundation of interest in co-operative projects in Antarctica. The timing of the advice in Switzerland coincided with the pending visit to New Zealand of Professor Schlucter from the University of Berne who had been working in Antarctica with the Americans. Since the agreement approximately $500,000 Swiss Francs have been put aside for a programme which is currently evolving and is likely to comprise research on the impact of human activities on the Antarctic environment.

casual visitors to Antarctica, notification of their activities may be made by the organiser of the expedition or visit. They should ensure that this is done.

Notification direct to the Minister or the Ministry is not required by participants - scientist or non-scientists - of the annual New Zealand Antarctic research programme (notification of these activities is covered during the Ministerial process of Ministerial approval for the programme.)

For further information and advice contact the Antarctic Policy Unit, Ministry of Foreign a Affairs and Trade - phone Wellington 04 472 8877 or fax 04 472 8039.

France and Italy

Joint agreement should enable Concordia Project to proceed

In March 1993 the managers of the French and Italian Antarctic Programmes signed an agreement defining a joint venture between the two organisations with equal participation in the building and operation of a scientific station at Dome C to be called Station Concordia. Subsequent involvement of other countries was a provision of the agreement. Construction, expected to start next summer, will continue until December 1998. The operational agreement is renewable every four years and the likely duration of the scientific programmes at the base is ten years.

In 1990 a special consultative meeting at Vina del Mar began preparation of a Protocol on Environmental Protection to the Antarctic Treaty. The Protocol, signed in Madrid in October 1991 deals specifically with environmental protection and Annex 1 indicates how environmental assessment should be performed. Basically it defines three categories of impact these being the likely direct effects of activities, the potential indirect or second order effects and the cumulative impacts. Further guidelines were prepared by the COMNAP meetings at Bologna 1991 and in Washington 1992. Although the Protocol has not yet been ratified by all Consultative parties France has introduced the legislation, and under the requirements a Comprehensive Environmental Evaluation has been prepared by French and Italian authorities for the Concordia Project. The first version of the document entitled Study of Environmental Impact of the Construction and Operation of a Scientific Base - Dome C-Concorde Base, was prepared and presented by France at the XVII ATCM in Venice. Subsequently the document was circulated among Treaty members and five, Australia, Germany, New Zealand, the Netherlands, and the UK commented along with Greenpeace and ASOC.

Since the signing of the March 1993 agreement a further document has been prepared along the prevailing guidelines. Called "Concordia Project, the construction and operation of a scientific base at Dome C, Antarctica" it is presented in two parts, the second covering the proposed drilling operations. This article has been based on copies of these documents which were written by Dr Roger Gendrin, Scientist and Direc-

tor of IFRTP Institute Francaise pour la Recherche et la Technologie Polaires in France and Dr Pietro Giuliani, Engineer Responsible for Environmental and International Affairs at ENEA Ente per la Nuove Tecnologie, l'Energia e l'Ambiente, Progetto Antartide, in Italy.

The project was conceived by French and Italian scientists and the agreement signed represents endorsement by their national research organisations. (Concordia is clearly being advertised as a station which will be open to international use. Some adjustments, say the organisers, will be required in order to maximise its science potential, to minimise logistical costs and environmental impacts.)

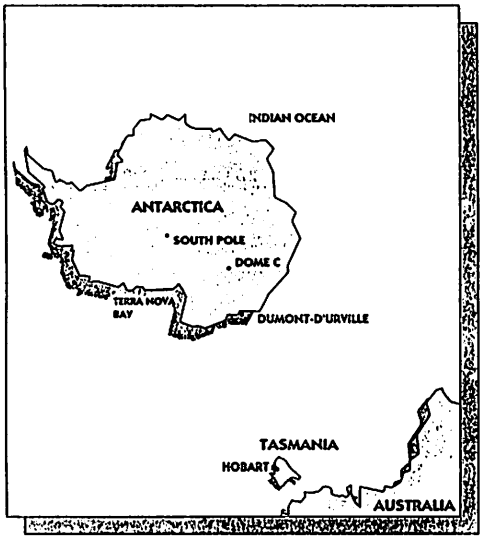
Two institutes are currently in charge of the overall project; the Italian Ente per le Nuove Tecnologie, l'Energia e l'Ambiente - ENEA Progetto, Antartide, and the Institut Francaise pour la Recherche et la Technologie Polaires.

A Steering Committee, which defines the objectives and decides the annual budget, has been appointed. The programme is to be implemented by a directorate responsible for all logistical and technical aspects; seven groups of experts select and control the scientific and technological activities. Fourteen laboratories from France and from Italy are involved in the project and a number of others will have additional input.

Initially the site was chosen because of its suitability for glaciological research but it soon became evident that it would be particularly favourable for continuous measurements of different geophysical parameters relating to the low and middle atmosphere over the continent; meteorological parameters, including atmospheric constituents, ozone content and aerosols and study of the internal structure of the earth below the station by magnetic and seismological recording. Astronomical observations at visible, infra-red or submillimetric wavelengths are likely to be included in the programme. Importantly deep ice coring, to be undertaken mainly during the summer, will complement similar operations at Vostok and Law Dome in Antarctica and more recently in the Arctic.

Station Concorde will also be useful for testing new technologies that are of interest for future planetary explorations as well as the behaviour of human groups working in very isolated and hostile conditions.

Dome C is basically a flat area on the East Antarctic plateau which is devoid of any form of life, flora or fauna. It is featureless and has summer temperatures of around -30deg C and winter temperatures of about -70deg C. Data collected by an automatic weather station which began operating on 5 Febru-



ary 1980 confirms that the wind speeds in the area are low with an average in the last five years of 4m/s. They have not exceeded 15 m/s.

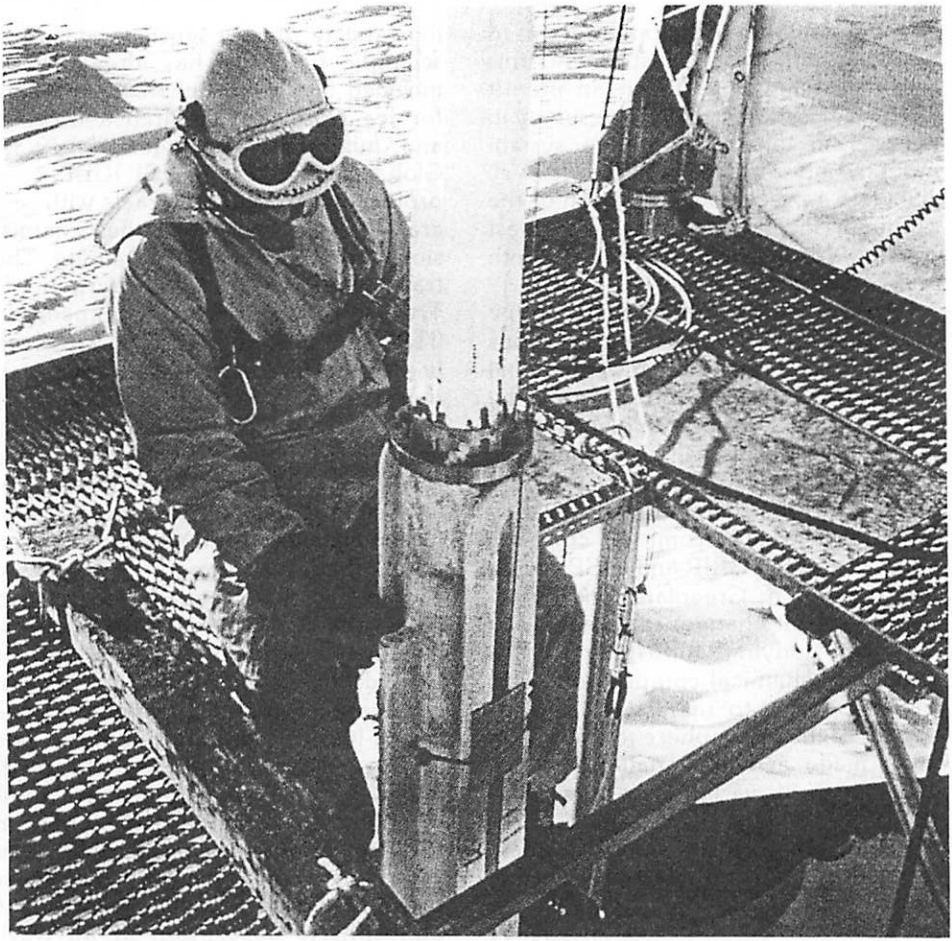
Research activities were started close to the proposed station site in 1974 under the framework of the International Antarctic Glaciological Project (IAGP). This was a joint French/US activity and a field camp was established there in 1979-80 by the US Antarctic Program with eight small buildings, a skiway for aircraft operations and the automatic weather station which began operating on 5 February 1980. With the support of the National Science Foundation, the French conducted a programme of shallow sampling and coring to a depth of 900 metres as well as some sonic logging studies in the borehole. Analysis of the samples allowed scientists to reconstruct recent and long-year climate changes including aerosol and atmospheric composition up to 30,000 years ago. Operations at the site were then hampered by three aircraft crashes and in the early 1980's, after the successful recovery of two aircraft, the camp was abandoned. The facility, which is now partially buried in snow and ice, is not considered suitable for reoccupation or the proposed scientific programme.

There are currently four reasons for selecting the site for the new station: below Dome C the ice is nearly 4,000 metres thick, and this is probably greater than anywhere else over the continent allowing for ice core analysis which will give invaluable information about the Earth's past climate back approximately 500,000 years. It is a site over which the atmospheric water vapour content is one of the smallest over the continent allowing for precise measurement of the ozone and aerosol content of the atmosphere as well as of the cosmological radiation at infra-red or sub millimetre wavelengths. Dome C is situated inside the continent, far from coastal marine perturbations. Modern seismological and magnetic research techniques for studying the Earth mantle can be used there to improve knowledge of the internal structure of the earth in a region that has played a fundamental role in the genesis of the planet's present shape. Because of its isolation and very severe climatic conditions it is a place where future planetary exploration techniques and procedures can be qualified: teleportation or telemaintenance of equipment, physiological and psychological survey and maintenance of isolated groups of human beings.

Using these characteristics the ad hoc groups of scientists working on projects in glaciology, atmospheric sciences, astronomy and solar-terrestrial relationships, solid Earth geophysics, robotics, telescience and data transmission have specified their objectives, their experimental programme and planning as well as their financial needs. This has been endorsed by the Steering Committee and funding is available for the next three years.

For the glaciologists data from the proposed ice core studies are the key to understanding past climate changes, to determining man's impact on the atmosphere and will provide assistance in predicting climate change.

Dome C is considered an excellent location for deep drilling because of the favourable layering of ice which allows for a good time restitution. Around the site the bedrock is often situated below sea level, which increases the thickness of ice that can be explored. The snow accumulation is approximately twice that of Vostok and this allows a better time resolution in the first 100 metres whereas at greater depths the existing pressure will allow a considerable extension in time of records resulting in more precise investigations of the rela



Ice drilling in Antarctica Photo Pierre Laffont/IFRTP

tionships between different climatic parameters such as temperature, air composition, ice volume etc.

A five year drilling programme is planned after which the equipment will be transferred to Dronning Maud Land. Electro-mechanical techniques will be used with a fluid to balance the pressure and prevent closure of the borehole by ice. The fluid is an aviation kerosene with an additive to adjust the density. Full precautions for storage and handling are being taken.

Storage and analysis of the cores will be on ice in a specially equipped facility which will be established in a container model and a specially equipped ice trench.

Although the general area for the drilling has been decided the precise location has yet to be selected. In November and December 1993 the site was reconnoitred by a French-Italian team travelling on a tractor convoy from the French base on the Terra Adelie coast. The team was equipped with a radar system developed and built by Scott Polar Research Institute. Because of technical malfunctions the task was

not completed. A further attempt was to be made with surface instruments this last season and if that failed, an aircraft was to be used to conduct the survey in a program integrated with a system mounted on a tractor. The new survey will yield a precise identification of the optimum location to obtain the best possible results in terms of ice depth and bedrock morphology.

From their programmes they hope to be able to reconstruct a continuous history of climate and environmental changes in East Antarctica during the last 500,000 years or four glacial-interglacial cycles. This will be achieved by acquiring relevant data over several climatic cycles thus extending the existing records obtained from ice cores at Vostok, and the GRIP and GISP coring programmes in Greenland and by assessing recent changes in terms of climate by studying atmospheric trace gases and chemical composition. This will help them to understand the response of the atmosphere to short term (man made activities, natural events) and long term variations and will improve knowledge of the effect of climate change on surface mass balance, ice-flow dynamics of polar ice sheets. The numerical ice flow models will be improved through a better knowledge of the mechanical behaviour of ice, and by associating the analysis of the cores with surface measurements over the station Concordia drainage area and by testing climate models and investigating the sensitivity of climate to various forcing factors.

According to the report the interpretation of ice data will require a surface study programme on the spatial variability of environmental parameters and a flow of the ice sheet in the station area which implies data collection along scientific traverses between the coast and the station, around the drilling site and the development of studies involving satellite remote sensing data. The scientific traverse has already been included in the European Programme for Ice Coring in Antarctica (EPICA) and, fulfils the major targets of the Past Global Changes (PAGES) IGBP core project and strongly interacts with several others supported by the Commission of the European Community. The traverse is also part of the International Trans-Antarctic Scientific Expedition (ITASE), a programme of SCAR which has strong interactions with global atmospheric chemistry programmes. The wider development of the project will improve scientific understanding of the relationship between solar irradiance, atmospheric composition, the extent of ice sheets and climate change.

Planned atmospheric science rogrammes have been divided into two parts, the first covering the physicochemistry of the stratosphere and the second, tropospheric studies, both of which are important constituents of the SCAR-IGBP programme. Because the station will be, for most of the time, under the polar vortex it is at a sufficiently northern latitude to benefit from the long periods during which day/night variations occur. The very low water pressure above the station leads to low atmospheric absorption at all wave lengths.

Dome C has been selected by an international group of scientists as the continental location for monitoring the ozone layer above the Antarctic continent should become the primary site of the Network for Detection of Stratospheric Changes (NDSC) part of the IGBP (International Geosphere Biosphere Programme) core project IGAC (International Global Atmospheric Chemistry).

A lidar facility to be installed at the station will measure the vertical distribution of ozone in a range between eight and 35 km. aerosols and Polar

Stratospheric Clouds ((8 to 30 km) and temperature (8-60km). This facility will be an improved version of the one which has been built and operated at Terra Nova Bay and Dumont d'Urville since 1989 and in the Arctic under a cooperative venture between French and Italian Institutes.

Two spectrometers, one UV visible from France and a UV-B from Italy will be used to measure the profile distribution 9f 03,Cl) and Nox. The French spectrometer has already been operated successfully at Dumont d'Urville and on board ships since 1988 and the Italian one was used since 1990 at Terra Nova Bay.

Ozone sondes and PTU sondes, as usually operated in the main meteorological stations will be included in the programme.

In order to study the climatology of the boundary layer turbulence over the continent and its correlation with the sporadic character of the katabatic winds, as well as making continuous measurements of the wind profiling, a triaxial sodar will be installed. Since at Dome C the height of the troposphere-stratosphere interface is expected to be very low, stratospheric intrusions (that have been already observed in the higher parts of East Antarctica through the presence of stratospheric constituents in ice cores) could be detected in the layers within the operational range of the sodar. The sodar equipment/technique which has been operated at Terra Nova Bay since 1986 and at Dumont d'Urville since 1992. The temperature profile in the lower and upper layers of the atmosphere could also be measured by using tethered balloons but this project has not yet been studied in detail.

Astronomy and solar terrestrial relationships

Astronomers have long expressed a wish to conduct observations in Antarctica because of the interesting astronomical properties of the continent as compared to other ground sites or space born platforms. Antarctica has the darkest sky, the driest, the steadiest and, in some places, the clearest air. It also has the minimal level of anthropogenic interference (visible, infrared, and high frequency) allowing for continuous observations of the same astral object because of its proximity to the Earth rotation axis.

Among the projects being discussed by the international astronomical community are a site for visible and infra red observations and a study of the heterogeneity of the cosmological background radiation in sub millimetre wavelengths.

Italian and French scientists are currently defining an experimental programme that could make use of the specific properties of the atmosphere at Dome C. Australian astronomers are also interested.

Dome C lies near the 90deg invariant geomagnetic latitude at the centre of the auroral oval and this gives the future station the possibility of playing an important role in the study of magnetospheric phenomena; cusp associated particle, cusp associated priometers measured with riometer and VLF, generation mechanisms of the aurora study studied through all-sky camera records. It is also a place where the installation of the AGONET station, part of the Automatic Geophysical Observatory Network programme led by the US and endorsed by SCAR, could benefit from continuous survey. This programme currently consists of between and six and ten automatic stations located within the Antarctic continent designed to collect data relating to local meteorology, magnetism, particle precipitation's and radioelectric emissions. Definitive projects in this group are not yet in the hands of the Concordia Steering Committee but there seems little doubt that Sun-Earth relationships re-

lated programme will be part of the scientific activities at Dome C.

Solid Earth Geophysics programmes have two focii, magnetism and seismology.

Because of the uneven distribution of magnetic observatories between the Northern and Southern hemisphere, the secular variation of the geomagnetic field is not accurately known, especially at latitudes higher than 60deg S and the nine existing coastal antarctic stations are affected by strong crustal anomalies and by tide.

Continuation of the mainfield down to the core-mantle boundary (which is one of the main issues in today's research) can be well achieved at Dome C because the station will be located at about 4000 metres above the continental crust and will therefore be free from contamination by crustal anomalies. It is also about 1000 km away from the shore and therefore free of tidal perturbations. The location at the centre of the polar cap is very favourable for studies of magnetic perturbations induced by solar wind effects.

Data from scalar and vectoral magnetometers will be integrated in the INTERMAGNET international network to achieve the production of real-time magnetic indices. They will also contribute to measurements of Solar-Wind induced magnetic perturbations inside the polar cap.

Seismology

The development of seismic tomography and the global seismic network are leading to more and more refined models of the three dimensional structure of the Earth's interior but the uneven distribution of seismic stations and epicentres biases the solution of the inverse problem. There is growing interest in the installation of such stations in Antarctica and one at Dome C will greatly improve the resolution and accuracy of topographic studies that are performed through the GEOSCOPE programme or similar networks.

Dome C is precisely at the distance interval which is needed to detecting PKIKP phases of seisms originating in one of the most seismically active part of the work (Fidji)..

Initially a seismic station will be installed in a 30 to 50 metre deep borehole some distance from the station. Later a short period network of 20 stations will be installed along a line of 40 km in its vicinity.

Human biology and medicine

The focus with these programmes is human adjustment to hostile, isolated and confined environment and the applied research will result in preventive and care measures to minimise health hazards. The programme currently consists of a preliminary risk assessment study, telemedicine implementation, study of the vascular adjustment under the specific environmental conditions prevailing at the station, study of biological indicators of stress and validation of selection methods as well as psychological training and support.

Part of this programme is already being implemented at different antarctic or arctic polar stations under the auspices of the SCAR Working Group on Human Biology and Medicine. Its extension to the Dome C situation is supported by Space Agencies as the results of such studies can be applied to other extreme environments such as those encountered during space planetary exploration. Classical medical apparatus will be installed at the station and permanent connection with European medical centres will be established through telecommunication lines.

Technology

The focus of these programmes, not fully defined at present, are broadly aimed at testing teletransmission, teleoperation and telemaintenance techniques and procedures that could be of

use in planetary research. These include precise and controlled positioning systems; automatic or semi-automatic operational support through data reception (radar or visible images); robotics, related with remotely controlled scientific instruments or vehicles, telemonitoring of equipment or personnel. This programme is oriented and supported financially by Space Agencies.

The station

The station is to consist of two buildings a linked by a gangway. A double envelope construction system will be used for insulation. Each building will be three floors high, 17 metres in diameter and elevated on piles to avoid the effects of snow accumulation. The piles will be set on hexagonal skids about 6 metres in diameter and half a metre thick. One building will be devoted to "noisy activities" such as power generation, repairs and catering and the other to "quiet activities" such as laboratory work, accommodation and medical services.

Overall the design of the station allows for easy mounting and not too much difficulty in dissembling, an operation that would be expected to take two summers when it is decommissioned. It is expected that within a year there would be no further evidence of activity at the site apart from a capped wellhead which would soon be covered in snow..

Three generators, each capable of yielding 140kVA, will be powered by turbocharged engines using kerosene, selected because of its purity and resistance to cold. Of the sets, one will be in operation with a second on standby for emergencies and the third used for backup. The base will be heated by a network of hot-water radiators using heat recovered from the electric power generators and boilers, also operating on kerosene will provide backup.

More than 90% of water used in the base, other than that for cooking and drinking or that polluted by chemicals will be recycled. Sludge residues will be stored for removal along with an estimated ten litres a day from laboratory activities which will be condensed. Currently simular procedures are in place at Dumont d'Urville from where waste is retrograded to Hobart under a special permit or, if not permitted, it is sent on to France

Up to 16 personnel, five technicians running the installations, and nine scientists or technicians working on the scientific programme, a medical doctor and station chief and support personnel will be able to winter at the station. The construction camp will accommodate these personnel in emergencies. During the changeover period the number of occupants at the station will double for between two and three weeks and each room will include a folding bed for use at these times.

A summer camp is also being built and will accommodate 20 people for scientific support and drilling activities. It will comprise 16 ISO 202 CC containers made of stainless steel with fireproof insulation and mounted on steel sleds for easy transportation. They are capable of withstanding substantial snow loads, temperatures of -70 degrees and windspeeds of up to 70 m/s. The buildings will be relocated in three groups, the first providing living accommodation and for a small surgery, will absorb six of the container models. The second group, also of six models, will provide a kitchen, dining room, small laundry, toilets and showers and the third group of four modules will accommodate the two diesel electric generators, a workshop and food storage area. An enclosed passageway is to connect the first two groups while various electric and service connections will join the

three. The groups are to be assembled on sleds, each of supporting three modules,

During the construction of Base Concordia use will be made of a temporary camp comprising an accommodation unit for 16 persons with eight twin rooms and a room for a doctor. Facilities will include a kitchen and bathroom unit, a restaurant, a telecommunication unit, a power house with two generators and two tents to be used as construction workshops for vehicle repairs.

Logistically building a station 1000km from the coast on the Antarctic plateau poses its own share of problems. Initially it will involve the transportation of materials from Europe to Antarctica and offloading either at Terra Nova Bay or in the vicinity of Cape Prud'home. The cargo will then be traversed by convoy to the Dome.

At this stage it appears likely that most of the construction materials will be shipped to Terra Nova Bay. The estimated cargo for the building, technical and logistical requirements is 1400 tonnes, while the initial scientific equipment is likely to be approximately 200 tonnes and drilling material and the summer camp is likely to be around 400 tonnes representing the total weight of cargo being approximately 2,000 tonnes. Most of the stations operational cargo, estimated at 2,300 tonnes, will probably be landed initially, and weather permitting, at Cape Prud'homme or at iles de Petrels and transferred under settled conditions by pontoons capable of carrying up to 35 tonnes.

Until recently cargo for Dumont d'Urville was disembarked at le Pre which was well protected and freed of ice early in the season by strong currents. But since the construction of the controversial airstrip at Dumont d'Urville the currents around the archipelago have changed and now it is not free of ice until very late in the season. Another disembarking point is likely to be built on il de Petrels involving the construction of a 3, 200 metre long road which will follow the coast and be well below the nesting area of the birds. The final decision for the building of the new disembarkation point will be subject to a full impact at examination by the Committee for the Polar Environment.

Previously Cape Prud'homme was used for disembarking material for earlier traverses and as a place for scientific research, geology, collection of micro meteorites. A flat area where a gantry and hoist can be operated has now been created on the shore and unloading is facilitated by a machine located near the workshop and accommodation units. A coastal fuel depot is to be installed. It will comprise two fixed double hull tanks each able to contain 9,200 gallons as well as a set of mobile fuel tanks ready for the next traverse. The depot is to be surrounded by a concrete berm to pro prevent the spread of fuel should a spill occur. Fuel is likely to be unloaded from the ship with a hose via a hose laid on the ice, a floating hose or an aerial hose suspended from a hawser. A full suite of environmental precautions will be implemented for fuel management as well as for accommodation and removal of waste.

Once on the continent cargo will be transported to D10 a depot site, located five km from the coast where traverse equipment such as sledges, trailers and fuel supplies will remain outdoors during the winter.

Current planning suggests two full convoys from the Cape to Dome C from 1994-95 onwards each trip taking between 20 and 25 days, and possibly a third, part way to D10. Each convoy will consist of seven tractors and sledges. During these operations one tractor at least will be used to tow the living units

and generators and workshop unit and fuel which is to be stored in special traverse tanks. Consumption per trip is estimated to be approximately 5,000 litres.

Once the construction materials have been delivered to the site station supplies for the station will follow. Living units for traverse personnel are to be made out of isotherm containers identical to use those used in refrigerator trucks. Each of the two units will be divided into twin rooms kitchen, dining room, bathroom and powerhouse and workshop. The generator set will be accommodated in a powerhouse room which will provide electricity for the convoy and be used during stops to regulate the temperature of transported containers where necessary, to keep the vehicle engines warm. Heat will also be provided by this unit for the accommodation and cooking; and previously propane gas was used for these tasks.

In January 1994 a storm partially destroyed the runway at Dumont d'Urville and because of the cost and ecological concerns it will not be repaired. Air support for the operation will now be restricted. At Dumont d'Urville light aircraft will be landing some 10 km from the base near D10 to transportation of personnel. Two or three C-130 Hercules flights may bring fuel to the site each year. From Terra Nova Bay, three flights were planned in 1994/95 with a further six in 1995/96 and ten in 1996/97 but the report does not specify the aircraft type. A Twin Otter or similar aircraft is however, likely to be used for this phase of the operation.

An Italian Airforce C-130 was to drop fuel and drilling material by air during this last season in an operation which designed to allow the establishment of two emergency depots along the route from Terra Nova Bay to Dome C.

India

India completes first decade of Antarctic operations

On 8 December 1993 India launched its 13th expedition to Antarctica. It returned to Goa with the summer team in the last week of March 1994 along with the tenth wintering team to have been stationed in Antarctica. Twenty five persons are currently wintering over.

With the return of the tenth wintering team India completed a decade of operations in Antarctica. Since 1981, when it launched the very first expedition, nearly 1000 Indians have visited Antarctica and approximately 240 have wintered over.

The first Indian base in Antarctica was Dakshin Gangotri. Lying at 70deg05minS/12deg00'', it was set up by the third Indian scientific expedition in 1984. Dakshin Gangotri is located in a shelf area which provides good opportunities for biological, geomagnetic and oceanographic studies including iceberg monitoring.

A second station, Maitri 70deg45min52''S-11deg44'03'' was established in the Schirmarcher Hill ranges about 90 km south of Dakshin Gangotri. The ranges have exposed rocks and seven freshwater lakes. The Indian station is well furnished with good living space, laboratories and modern amenities for carrying out field research projects in biology geomagnetism, geophysics, meteorology, physiology, medicine, structural engineering and environmental studies. In addition, geological work has extended into the Wolthat and Humboldt

tended into the Wolthat and Humboldt regions and a map covering 10,000 square km has been completed by the Indians. Their studies include reconstruction of the Gondwana rift hypothesis-

India also carries out some atmospheric science and meteorological programmes and has undertaken sophisticated laser heterodyne system and millimetre wave radio photometer experiments as a result of which significant data relating to ozone measurements is now available throughout the year.

The meteorological studies concentrate particularly on the correlation of the antarctic weather on the monsoon phenomenon.

Programmes relating to human physiology, adaptation to extreme cold and isolated conditions are being undertaken by the scientists who are selected from various national laboratories, universities and government institutions. Logistic support is provided the three armed services and the Defence Research and Development Organisation.

In addition to Maitri the Russians have a station in the Schirmarcher ranges. Their station Novolaszarevskaya is about four kilometres away and basically concentrates on atmospheric sciences.

South Africa

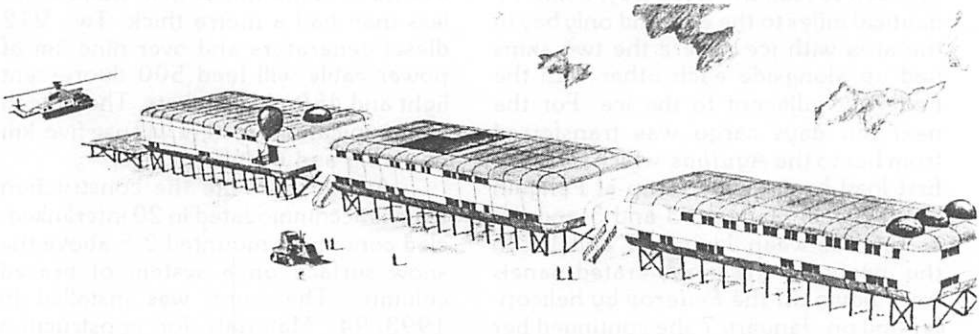
No South Africans wintering in Antarctica until new base is complete

For the first time in 36 years South African scientists and support personnel are not wintering over in 1995. SANAE III, erected in January-March 1979 on the Fimbul Ice Shelf (at 70deg, 18' 36''S/02deg24'10''W), is buried under approximately 22 metres of ice and has been declared unsafe. Last season construction work continued on SANAE IV, 17deg40'S/02deg51'W) which is being built at Vesleskarvet Nunatak (Norse for small mountain or Eskimo for rocky outcrop protruding above the snow) approximately 180 km from the present base and it is expected to be ready for winter occupation in 1996, or if weather conditions are unfavourable and preclude completion of the this may be deferred until 1997.

SANAE III replaced two former stations which have been described as ''simple and cheap structures'', of wood with corrugated iron roofs. The first of the early stations was built in 1961/62 and the second in 1971/72. Each disappeared beneath the ice within eight years.

When it was built in 1978 SANAE III's design was considered revolutionary and the style was later copied by the Germans. It was modelled on the pattern used by the British for Halley III which was rebuilt in 1972-73 and comprised buildings placed in tunnels under metal arches covering trenches two metres deep. Now, after years of *ad hoc* repairs the structure has weakened significantly and no winter team was left behind when *SA Agulhas* left the continent at the end of last summer's programme. (Halley III has also been replaced.)

Wind speed and temperature are determining the pace of construction



Artists impression of SANAE IV- Sketch Department of Environment Affairs

for SANAE IV, which was three years in the planning and preparation before a 40 man team from the Departments of Public Works and Environmental Affairs could start work at the site which lies 15 km from the edge of the ice shelf.

Vesleskarvet was chosen after considerable investigation as a site which complied with requirements such as access, size, position, scientific criteria and provided a solid and stationary foundation. It has a plateau of 160 000 m2 and a perpendicular rock face of approximately 250 metres on its western side. Snow slopes on the northern and southern sides will be used as access routes. The site was cleared of dolerite boulders, half frozen into the ice, before construction could begin.

The first 1400 tonnes of materials and equipment required for the station were transported south aboard the Russian research and supply icebreaker *Akademik Federov* and the South African polar vessel *SA Agulhas*. This phase of this operation began in late 1993 and was reduced by the late arrival in Cape Town of the *Federov*. Built in Finland in 1986 this vessel, has a gross tonnage of 13,000 tons, a service speed of 16.5 knots, a cargo capacity of 6,650 tonnes and carries two 50 ton cranes. She is also fitted with l 12 laboratories so that scientific programmes can be undertaken during resupply of Russian bases.

The *Akademic Federov* arrived in Cape Town on 19 December 1993 and completed loading by 24 December. In the meantime the *SA Agulhas* had discharged her cargo at SANAE, pumped the first load of fuel ashore and was awaiting the arrival of the Russians. By Christmas eve all the ice had broken from the bay exposing it to the sea and leaving the crew with the only option of completing their offloading at the ramp. On 31 December 1993 The *Federov* was sighted rounding the shelf and early in the following morning the captain took the vessel into Penguin Bay to ascertain whether the ramp would be suitable for the discharge of cargo. It was not.

Representatives of the two ships

entered into urgent discussions and it was agreed that both vessels should proceed to Admiral Byrd Bay, some 17 nautical miles to the east and only bay in the area with ice. Here the two ships tied up alongside each other with the *Federov* adjacent to the ice. For the next ten days cargo was transferred from her to the *Agulhas* which took the first load back to the ramp at Penguin Bay between January 3 and 5 and the second between January 7 and 10. In the meantime the heavy crated panels were flown off the *Federov* by helicopter and on January 7 she continued her cruise.

Oval cylinder

The building, in the form of an oval cylinder, will be assembled above ground level in a steel framework which will prevent it from disappearing under the ice and snow. Much of this framework was assembled during the 1993/94 summer. User-friendliness, low maintenance costs, quality, comfort during extreme weather conditions and minimal environmental impact were among the design priorities. Before the onset of the last Antarctic winter drilling activities had to be completed. Steel stub columns and rock anchors were inserted and the steel framework created.

Overall SANAE IV requires about 1,400 tonnes of material and equipment to be moved into the location and this did not include food and other logistical support items. The main contractor for the new station is Petrel Engineering which is based in Salt River and some of the construction is being undertaken by an engineering firm called Transwerks.

Six hundred tonnes structural steel components will be used in the base along with 25 tonnes of bolts, nuts and washers, 16 km of rubber seals and 12 km of silicone seals. Specially designed walls have the same insulating capacity as a three metre thick brick wall but are less than half a metre thick. Two V12 diesel generators and over nine km of power cable will feed 500 fluorescent light and 450 plug sockets. The hi-tech communications system will use five km of wiring and 60 telephones.

At the base site the construction team is accommodated in 20 interlinked, clad containers mounted 2.5 above the snow surface on a system of braced columns. The camp was installed in 1993/94. Materials for construction have been set out on the surrounding ice shelf, the their positions are marked by poles and sketches; they are dug out from accumulated snow by hand and removed by crane. Two of the containers for the construction camp have been converted into a tool shop, equipment store and workshop. Power on site is provided by a sled mounted 100 kVA diesel generator.

This season construction was to comprise further work on the building, the installation of a helipad, diesel bunkers with power supply pipelines and a snow melter as well as the building of pedestals for the radar antenna.

Two vessels were again used to support further construction operations and the scientific programme. They were the *mv SA Agulhas* whose activities were supplemented by the *SAS Outeniqua*, from the South African Navy. This vessel has a gross tonnage of 21 025 tons, a service speed of 17.5 knots, has been in service with the Navy since June 1993 and was to assist with the transport and offloading of further building materials for SANAE IV.

(The *SAS Protea* also supported the operations at Gough Island by undertaking a buoy deployment programme between 6 September and 19 October 1994.)

Because of a stability problem in the

Agulhas which had to be repaired prior to departure from Cape Town, the *SAS Oteniqua* was scheduled to assist with the transport and off-loading of further material for the building of the new base. A large personnel component was also involved and as the department was committed to an international oceanographic voyage in the *Agulhas*, the *SAS Outeniqua* was scheduled to make a second voyage south in January to relieve South African Air Force personnel at the base site.

On a downward leg the ship diverted to the South Sandwich Islands of Southern Thule and to Szavadovski to service two automatic weather stations and it was then to proceed to the ice via the Georg von Neumayer base en route to SANAE. The vessel was also to deploy a number of floating weather buoys during her passage. The use of the *Oteniqua* meant the *Agulhas* could leave Cape Town ten days later after repair to damage and still meet her commitments.

The schedule for the *Agulhas* was therefore altered and she was to leave Cape Town on November 24 arriving at SANAE on December 6 remaining there until the 16th when she would return to Cape Town arriving there on January 29. She was scheduled to leave again on February 19 and arrive at SANAE on March 1 remaining there for a week and returning to Cape Town on March 18. The *SAS Outeniqua* was to leave Cape Town on November 24 and expected to arrive at SANAE on December 6 also remaining there until the 16th and returning to Cape Town on December 24. She was then scheduled to leave there again on 12 January 1995 for SANAE where she was expected on January 22. On February 2 she was due to leave SANAE arriving at a back in Cape Town on 12 February 1995.

The science programmes

When the *mv SA Agulhas* left Cape Town on November 24 last year she carried 35 scientists from the Universities of Cape Town and Rhodes and foreign scientists. The research cruise was the final voyage in the current phase of the Antarctic programme scheduled to end in March 1996. It was led by Dr Mike Lucas from the UCT and focussed on biological and physical processes in the marginal ice edge zone adjacent to SANAE.

Scientists consider these processes important because they govern the exchange of CO2 between the ocean and the atmosphere. Their study is contributing to an international global programme the Joint Global Ocean Flux Study (JGOFS) which aims to elucidate the role of the world oceans in the regulation of atmosphere atmospheric CO2.

This research is also considered important to South Africa because the El Nino-Southern Oscillation related drought in the country during 1991-92 had a serious impact on agriculture and highlighted the sub continent's shortage of water.

Rainfall producing climate and weather systems are dependent on oceanographic and atmospheric circulation patterns around Southern Africa and are crucial to the socio-economic fabric of the country. Any improved understanding of the climatic variability will allow better weather and climate predictions and thus benefit agriculture and water resource management.

In 1991 SANARP, under the South African National Research Antarctic Research Programme, advised by SACAR the South African Committee on Antarctic Research, initiated a new oceanographic programme entitled The Antarctic Marine Ecosystem and Global

Climate Change which was funded by the then Department of Environmental Affairs. The primary objective of the programme was the provision of scientific information to SCAR under the terms of the Antarctic Treaty.

The objectives of this last season's cruise hinged on questions of international interest, notably whether the enhanced primary production frequently observed at the Antarctic Continental Margin in summer is due to water stability induced by sea-ice melt or was it due to the presence of the Antarctic shelf front? It is conventionally thought that enhanced phytoplankton productivity at the ice edge is associated with water column stability which is dependent on freshwater introduced into the surface layer by sea ice melt. However two recent cruises by the British and the Germans observed maximal plankton growth associated with continental shelf edge frontal systems rather than with the retreating ice edge.

The magnitude of the biological and physical processes occurring at the ice edge or Continental Water Boundary during the summer therefore needs to be determined. In the course of the programme the scientists sought to measure the biological and physical processes occurring at the major fronts in the Southern Ocean. However good measurements were lacking for the ice edge region adjacent to SANAE to complement the winter measurements taken in the region in 1992. This will result in the collection of winter and summer data sets for the same region.

Three elements made up the research programme; a seven-day long hydrographic grid survey along the ice edge adjacent to SANAE, which was to consist of four transects perpendicular to the ice edge in a north-south orientation. Fifteen days of Drogue deployment and process studies formed the main component of the biological survey and a hydrographic survey on the same or similar grid which covers the region in which drogues and sediment traps were tracked.

The last joint earth sciences biology expedition to western Dronning Maud Land (DML) in the current five year programme was also undertaken this season with the expedition due to return to Cape Town on January 25.

Seventeen scientists and support staff comprised this years expedition. Eight members of the team were involved in the completion of the mapping of the Kirwanveggen. This is a mountain chain which forms the escarpment along the margin of the Polar Plateau some 350 to 450 km south of SANAE III. It is regarded as an inhospitable "table" which is windy and cold compared to the relatively pleasant climate of Vesleskarvet and Grunehogna. Factors contributing to this are its proximity to the plateau from where the katabatic winds blow down reducing temperatures and increasing wind chill factors.

The mountains are regarded as being very important for an understanding of the geological history of southern Africa because Droning Maud Land was once attached to the southern part of the African continent as part of the supercontinent of Gondwana, which broke up about 140 million years ago.

Current interpretations indicate a collision between two continental fragments, one situated in the present south Africa and the other south of Kirwanveggen in Antarctica. Scientists say a similar collision is currently taking place between India and Asia but the Antarctic and southern African collision may have covered a much larger area than the present one.

Two biology teams were included in the party. One working at Svarthamaren was led by Will Steel from the Percy Fitzpatrick Institute of African Orni-

thology and the other to Robertskollen was led by Ian Newton from the same organisation.

The biologists are studying the effects of products brought in and produced by birds on the ecosystems at inland nunataks in Antarctica. such affects not being well understood at present. The low temperatures and high winds, coupled with long periods of darkness, absence of free water and the fact that 98% of the continent is covered by ice have combined to produce an inhospitable climate. he nunataks support simple ecosystems consisting of lichens and microbiota, rare mosses and mites. Snow petrels and Antarctic petrels breed on some of them and they also visited by South Polar skuas. All the birds may be important suppliers of nutrients and other materials to these ecosystems and an understanding of the effects may lead to a better understanding of survival under extreme conditions.

A base manager at the summer station Grunehogna studied the potential applications of a ground radar system.

The material for this article was obtained from the Exchange of Information, SCAR reports and recent copies of Expeditio, the South African Antarctic Newsletter.

Subantarctic

Manning of Campbell Island Met station concludes in spring

The New Zealand Meteorological Service has ceased its weather balloon operations at Campbell Island. The five staff, currently working there, are rationalising the stations facilities and will be withdrawn in spring. They will leave an unmanned automatic weather station, installed in 1990 and which will continue to provide surface observations as well as being used in forecasting models to assist in oceanic forecasts for shipping. The Met Service will send engineers in once a year to maintain and calibrate the equipment under continued contract to the Minister of Transport. New Zealand's international responsibilities to meteorology will not be affected.

In making the announcement recently the Chief Executive of the MetService Mr John Lumsden, said it was another case of technology overtaking older, traditional methods of weather observation. Improvements in satellite observations and computerised weather forecasting models mean that it is no longer necessary to fly balloons at Campbell Island.

Weather balloons were being released twice daily at 11 am and 11 pm. They would travel up to 25 km into the atmosphere gathering information on wind speed, air pressure, temperature and humidity. Each sounding costs about $200 ($150,000 per year) and the equipment was not retrievable. Balloon launching took staff about four hours a day. Other duties include maintenance

of buildings and equipment as well as some work for the Department of Conservation and the institute of Geological and Nuclear Sciences.

A meteorological station was established at Tucker Cove on 4 July 1941 as part of a wartime coast watching programme codenamed "The Cape Expedition". At first it comprised three parties, two of which were located at Carnley Harbour and Port Ross on the Auckland Islands. At the time it was considered that both Campbell and the Auckland Islands could have potential strategic value to the enemy.

Until 1946 the station was manned by parties of five men who did tours of about 12 months on the island. They were civilians under the control of the Aerodrome Services Branch of the Public Works Department. The met observations were done mostly by radio operators and between 1944 and 1946 these included N. Trustrum. E. Cahilll, A.L.Duthie. R.W. Balham and J.A. Copp. The station at Tucker Cove continued to operate until 1957 when it was closed. From 1952 administration and servicing was the responsibility of Air Department, later being transferred to Civil Aviation Department and finally to the Campbell/Raoul Division of the Ministry of Transport.

Between 1941 and 1952 all radio communication from to and from the island was by c/w radio. On 16 September 1952 radio telephone equipment was installed and since then all communication with the island was by R/t.

From 1949 onwards the meteorological observations were undertaken by employees of the New Zealand Meteorological Service. For the first two years only one observer was stationed there but from 1952 to 1956 there were two and from 1956-58 three observers went south each year.

Tucker Cove lies at 52deg 32minS/ 169deg 08min 7E. It is a sheltered location and the instruments were set up in a small clearing surrounded by Dracophyllum and scrub up to two metres high. However the outlook was very restricted by the adjacent high hills and in most directions visibility was only 1.6 km. Observations at Tucker Cove continued until 30 April 1957 and from 1 January 1957 they began to be made at Beeman Cove. The station here was officially opened between 5 and 8 November 1958.

Beeman Cove lies at 52deg33.33"s/ 169deg 09.3min E. It is 14.9 metres above sea level and the instruments are sited in a rectangular enclosure some 9.1 metres square and surrounded by tussock up to 0.6 metre high. It is on top of a low broad ridge and apart from being mildly over exposed for rainfall measurements it was good for other meteorological observations.

A number of different meteorological measurements have been made at the station over the years the programme being adapted to prevailing requirements.

Pressure was first recorded at Tucker Cove from 4 July 1941 and continued until 30 April 1957 and at Beeman Cove from 1 January 1957. Kew Barometers were used at both sites from July 1941 onwards along with an open scale barograph. Hourly values of pressure were recorded from 1 May 1949 to 31 October 1970.

Temperatures (maximum, minimum, dry and wet bulb) were recorded at Tucker from 1 July 1941 to 30 April 1957 and at Beeman from I January 1957. Grass Minimum recordings began at Tucker Cove on 1 August 1941 and at Beeman on 1 April 1957. Earth (30cm) began at Tucker on 1 January 1943 and continued until 31 March 1957 beginning at Beeman on 1 April 1957. Earth (10cm) began at Beeman on 1 January 1969.

Seawater temperatures were taken

once a week from a site on the shore of North West Bay and below St Col Peak from 28 August 1944 to about November 1946 and then once a week at Beeman Cove from November 1946 until August 1970. A small bi-metallic themograph was in use from November 1945 onwards. Hourly temperature values were recorded from 1 July 1952 to 31 October 1970 and a chimney pattern hair hygrograph has been used since 1 January 1970. A standard Stevenson Thermometer Screen was used at Tucker Cove and a larger screen at Beeman.

Daily manual rainfall measurements taken at Tucker Cove from July 1941 until April 1957 and at Beeman from January 1957 were supplemented by an automatic rain gauge used at Tucker from at least November 1945 until March 1957 and from Beeman from April 1957.

Sunshine was recorded at Tucker Cove from August 1941 until March 1957 and at Beeman from April 1957. At Tucker Cove up to two hours of sunshine was lost from sunrise for most of the year and between two and three hours prior to sunset because of the nearby hills. Beeman was a more sunny location with about 30 minutes being lost at sunrise and prior to sunset. From May to July, however, during the winter solstice the loss followed sunrise only, but commenced at noon reaching a maximum of about an hour at the actual winter solstice because of the summit of Beeman Hill.

Solar radiation was recorded with Rimco equipment installed on 3 January 1977 on a wooden post nearly two metres east of the climatological enclosure. In September 1986 a Licor was installed for the measurements.

On 28 August 1945 a Munro Cup Contact Anemometer and a Munro remote indicating eight point wind vane were installed on the Summit of St. Col

Campbell Island showing approximate location of Met station and camp

Peak some 299.9 metres above sea level. The site is extremely exposed from all quarters and the masts were on top of a rocky outcrop, which is possibly the remnant of a volcanic plug with sheer bluffs of seven to ten metres on all sides. The wind was generally very turbulent. Initially both the anemometer and vane were fixed to two wooden posts about 3.7 metres high and about 1.2 metres apart and held in place by a wooden brace and guy wires.

In March 1948 the vane was raised about 2.4 metres on tubular supports fixed to the top of the wooden posts. The eight light display for the remote wind vane and the buzzer units for the contact anemometer were located in the Met Office with a multipair cable being laid underground in a direct line between St Col Peak and the office nearly 1.1km away. On many occasions the sensors were inoperative because the mercury switch would break or the cups would be pulled off by the wind. Observations continued at this site until early in 1957 when a fault developed in the cable and readings ceased to be transmitted to the Met

Office. On 1 June 1948 a cup counter anemometer was mounted on the mast at St Col Peak and read daily at 1630 NZST until 23 November 1948 but from then until 16 April 1951 readings were reduced to once a week.

On 1 June 1948 until 16 April 1951 a cup counter anemometer was mounted on a 6.1 metre mast near the site of the old sheep station homestead. The instrument was also read daily at 1630 NZST from 1 June 1948 until 23 November 1948 and weekly until 16 April 1951. From 7 May 1950 until April 1951 a recording type cup contact anemometer and wind vane were operating at a site near the old Sheep Station homestead for testing prior to the selection of a site for the proposed new met office.

On 19 July 1957 a Munro Cup Contact anemometer and an eight point remote indicating wind vane with an eight point light direction indicator and speed buzzer units were installed in the Met Office at Beeman. The new mast at the site was a 9.1 mete metre high wooden pole located about 90 yards SSW of the new office. On 14 January 1964 these instruments were replaced by a Munro Cup Generator Anemometer, a remote Indicating Wind Vane and combined direction and speed recorder located in the met office. The equipment operated monthly and the old mast continued to be used.

Synoptic observations were made six times a day from 4 July 1941 until 12 October 1952 and thereafter eight times a day.

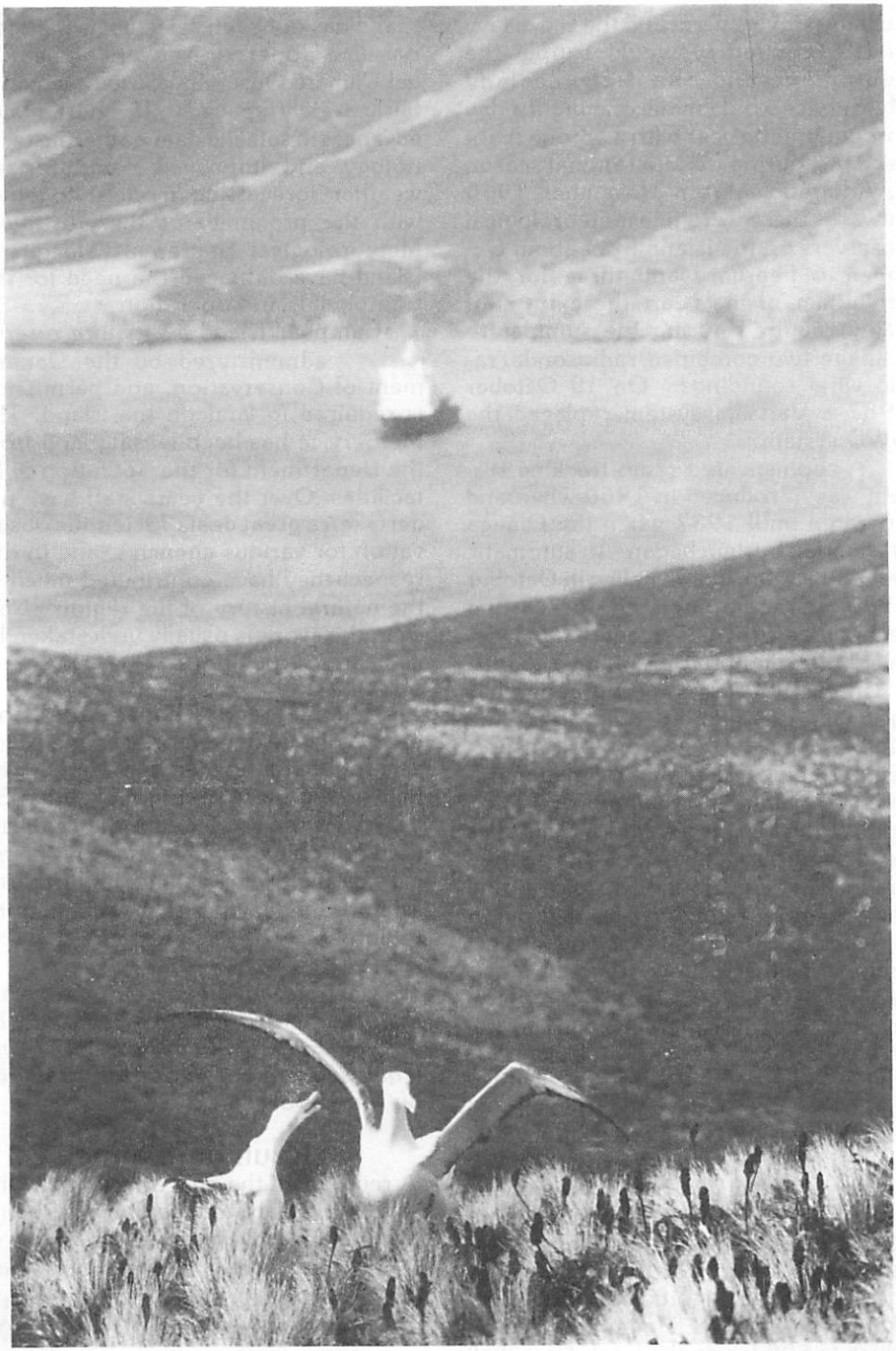
On 1 November 1970 aero observations commenced. These were not transmitted to New Zealand but recorded on cards and cleared once a year.

Pilot balloons observations began at Tucker Cove from 1 January 1949 and continued until 31 March 1957 when, weather permitting two flights were made at 1100 and 1700 NZST. The hydrogen gas required for these flights was from cylinders shipped from New Zealand. On 1 April 1957 pilot balloon observations commenced at Beeman Cove and continued until 13 November 1960. Balloons were flown at 0000 and 1200 NZST with the releases being made up to an hour before these times.

On 23 May 1957 radiosonde flights commenced with the balloons being released at 1200 NZZST and tracked for the pilot balloon sounding. Also from that date the hydrogen gas e required was produced in a low pressure type chemical generator on the island. From 23 May to 17 November 1960 a Diamond Hinman 72.2 mHz type radiosonde was used. Prior to this, between December 1949 and October 1950 modified radiosondes of the same type were flown from Beeman Point and the old Sheep station for tests into the possible effects of down drafts over the Island. These sondes measured pressure only so as to indicate their rates of ascent.

Pilot balloon soundings ceased with the introduction of radio wind soundings on 14 November 1960 shortly after the installation of a GMD-1A Radio Theodolite and TMQ-5 Radiosonde ground station. Soundings were made twice daily from October to February and once a day for the rest of the year. Staff used a Diamond Hinman 1680 mHz type radiosonde. Most of the equipment belonged to the United States Naval Support Force in Antarctica and was operated under an agreement entered into in 1960 between the New

Campbell Island is a nature reserve; permisssion to land must be obtained from the Department of Conservation. Photo: Tim Higham NZAP



Zealand Government and the U.S. Navy under which they would supply the equipment and the New Zealand MetService would make one flight a day throughout the year with a second flight each day during the operational season in Antarctica. From November 1960 onwards there were five meteorological observers on the island from about October to February and three for the remainder of the year, the extra staff being required during the summer to manage two combined radiosonde/radio wind soundings. On 19 October 1987 a Vaissala system replaced the GWD system.

A sophisticated radio tracking system was introduced in 1960 when and operated until 1987 when the Omega Navigation System began. An automatic weather station was installed in October 1990 and computerised forecasting techniques provides accurate and detailed information for Antarctic flights.

In recent years the programme has gradually been modified according the MetService and Ministry of Transport requirements. The major function remaining has been a balloon operation and during the past year its value has been vigorously tested. A full assessment of its contribution to global and regional forecasting was carried out at Bracknell in the UK by a joint project team from the United Kingdom Meteorological Office and the NZ Met Service, which sent a meteorologist to the UK to participate in the study.
They picked a selection of critical weather situations under which the contribution of data from Campbell Island could be expected to have its greatest impact and compared predictions made to sophisticated forecasting models with and without the Campbell Island observation. The joint team found they made no significant difference. Moreover, unlike Macquarie Island which is 600 km to the west, Campbell Island has not been selected as part of a Baseline Upper Air Network of the Global Climate Observing System which is fairly widely spaced. In short major advances in satellite data-gathering technology and improved computerised weather forecasting models, together with the proximity of the Australian Meteorological Station at Macquarie Island have outpaced the need for the Campbell Island operation.

Campbell Island is a nature reserve administered by the Department of Conservation, and permission is required to land on the island. The MetService has been leasing land from the Department for the operation of its facilities. Over the years staff have undertaken a great deal of scientific observation for various agencies and in this respect they have contributed much to the natural history of the region. Now even this work is usually undertaken by dedicated expeditions.

The MetService hopes to be able erect a plaque or memorial on the Island as a tribute to the men and women who had served there during more than 50 years. As the service says they contributed not only to the defence and physical safety of New Zealand but furthered scientific endeavour in this subantarctic region.

This article has been compiled from historical information prepared by J.S. Falconer in February 1977 and from subsequent material provided by the MetService.

Reunion planned

A reunion of the men and women who have worked at Campbell Island is being planned for November or December of 1995. For further information please contact Wendy Taylor, Ripponvale Road, RD2 Cromwell phone 03 445.1882

The Northernmost Hut.....

Along the latitude of 36 degrees south, there is only one place on the globe where you will encounter snow, ice, penguins, anti-freeze fish and an explorer's hut.

From within the hut, sounds of a pianola can be heard along with the scratchy grind of a 90-year old-gramophone working its way through recordings of "Land of Hope and Glory".

The atmosphere upon entering the hut is enveloping. Socks and other woollen garments are hanging over the stove drying before the next outing. The shelves of the kitchen are well stocked with tinned foods and of course, a good supply of Lea & Perrins. The heavy oil smell is unmistakable and the aroma of burning lanterns wafts through the hut.

Kelly Tarlton's Antarctic Encounter is arguably the site of the most real experience to be found outside the icy continent of Antarctica.

Kelly Tarlton's has two goals; firstly to be a world leader in environmental education and secondly, to survive.

Over the past decade, the Underwater World has remained a successful venture enabling millions of people to experience our marine life in a unique and enlightening manner. We felt compelled to do the same for Antarctica.

For many, Antarctica has been poorly represented in New Zealand for decades. The history of heroic explorers is deeply intertwined with our own to possibly a greater degree than any other nation is able to boast.

Talking to people about Antarctica leads to conversations about a continent which holds the honour in people's minds of being a place of the greatest blizzards, coldest temperatures and being the most inhospitable and loneliest place on God's earth.

Antarctica is another world where life by our rules does not apply. It is a mysterious and beckoning giant wooing many who visit with a magical beauty which hides the beast.

It was for these reasons that the Kelly Tarlton's Underwater World team was unconsciously drawn to plan an encounter which would allow Antarctica to touch those who are unable to reach its formidable icy shores.

Our ability to create a realistic Antarctic experience was restricted by three things: available space, money and technology. We had but 2,500 square metres of space with a severe limitation on vertical distance, only three meters in almost 80% of the site.

We had limited funding. Kelly Tarlton's Underwater World is a privately owned business. Our parent company, the Helicopter Line, believed in us enough to invest more than 13 million dollars into the project.

Kelly Tarlton's has come under fire from some environmental groups who suggest we are exploiting animals for commercial gain and should not receive support from government departments. Without our business track record we would never have secured funding to attempt this project. Without more than half a million visitors per year we would not be New Zealand's leading visitor attraction. People visit us to see live fish, sharks, stingrays, crayfish and now penguins.

Philosphically the organisation states be privately owned is to be commercial. To be commercial is to be professional.To be professional is to survive. We are proud to be professional.

Technology was our last limiting factor. Man will never be able to replicate

the work of nature, only in our dreams can we come close to appreciating natural beauty without actually experiencing it. The technology at our Antarctic Encounter merely provides the pages upon which the imagination of our visitors will write their own words. The experience of the Antarctic Encounter is limited only by the minds of those who see it.

The combination of space, money and technology was to finally dictate which species of penguin we were able to display. Ideally we wished for Emperors and Adelies and we knew that this was possible as both species of penguin had been successfully breeding in Sea World, San Diego since the late 1970s. A lot of our initial design was based on the Sea World Penguin Encounter.

With these high Antarctic birds in mind, we altered some of the Sea World design points. An example of this is the ability to control the temperature of our exhibit down to -10deg C. Variable speed control settings on our refrigeration fans provide differing wind strengths across the ice shelf.

Sourcing the birds initially seemed far fairly straightforward. Sea World was able to provide some Adelie eggs, an American scientists working in Antarctica with the National Science Foundation was to be undertaking studies on abandoned Emperor chicks which were destined to die. He was able to make some of these chicks available to us at the conclusion of his work. We also decided to investigate a "Plan B" for the Adelies.

Previous studies in Antarctica had shown that a high percentage of egg loss was experienced among the Adelie colonies and that a well-thought out egg collection would not, in fact, adversely impact on the wild population. On a scientific basis there was no opposition to our plans, but the emotional response from environmental groups was predictable.

Delays in our construction programme led to us missing out on the Sea World Adelies.

More surprises were in store.

One of the Sea World parks was able to make available to us 20 of the King penguins, and the paper work began.

Historically, avian material had never before been allowed to be imported into New Zealand from the United States of America. The recent Review of Avian Imports to New Zealand aligned itself with international disease control protocols. These protocols recognised that in effect, the Sea World penguin exhibit was a virtual quarantine station. The birds had been brought into the facility in the 1970s a building with filtered air and a sub zero temperature. The penguins never mixed with other birds and were under the care of full time curatorial and veterinary staff.

The Kings, though classed, as sub-Antarctic birds, would look magnificent in our encounter.

It became an academic issue as to whether it was Kings or Adelies and Emperors, and perhaps it was only our own vision that was compromised, as the public reaction to the Kings has been quite phenomenal.

We did however, change some of our operational parameters. For example, Kings are probably happier at temperatures around zero degrees and not as comfortable at the original -7 degrees C as was planned for the Emperors and Adelies.

Our light cycle needed to be altered. The original light cycle programme used

The sleeping accommodation at Scott's Hut as replicated at Kelly Tarlton's.


SANDOWS
DEVELOPER

day lengths taken from McMurdo Sound. This would obviously be too far south for the Kings. We settled on a light cycle taken from the Drake Passage at about 55 deg south. This was programmed into the computer and the sun began to rise at Kelly Tarlton's Underwater World.

In order to meet the strict MAF Quarantine Protocols, we needed to send our Curator of Birds, Trevor Bennett, to Sea World, San Antonio to help supervise the pre-export isolation period. Trevor spent seven weeks working at Sea World with their senior staff and veterinarian team.

Back in New Zealand we were in the final stages of constructing this country's first high security Avian Quarantine facility. The building itself was built like a vast freezer. Running at Odeg C, the pool and surrounding shelf of riverstone and ice awaited the arrival of the Kings.

Trevor organised the construction of special transport crates at Sea World. Each crate would hold two birds, about 50 kg of ice and be covered with a special cloth which would act as a fine filter allowing air to pass through it but preventing virus associated particles from penetrating. We were initially concerned about the ability of the "virus cloth" to allow adequate ventilation and as an experiment, one of the Sea World staff was sealed in the crate. These trials may not have reflected actual conditions for the birds, but did result in us designing an alternative air supply system

Our main problem would arise during stop overs and whenever the private chartered DC8 would be under 10,000 feet. The reason for the 10,000 feet mark is that this is the height above which MAF consider avian disease most likely absent. Below the 10,000 feet the virus cloth covers had to be in place and the use of a special fan blower and filter enabled us to supply unlimited fresh clean air to the crates.

The DC8 was maintained at 5degC and Trevor, a MAF officer and accompanying freight agents spent the 26 hour trip in freezer suits and sleeping bags. Included in the homeward bound party was a Sea World senior bird keeping. Her job was to settle the birds into quarantine after the long flight.

It was during the quarantine period that the birds began to moult. This is an annual process which involves the replacement of the birds' feathers and an associated massive weight gain - some birds went from 14 kg to 20 kg in three weeks.

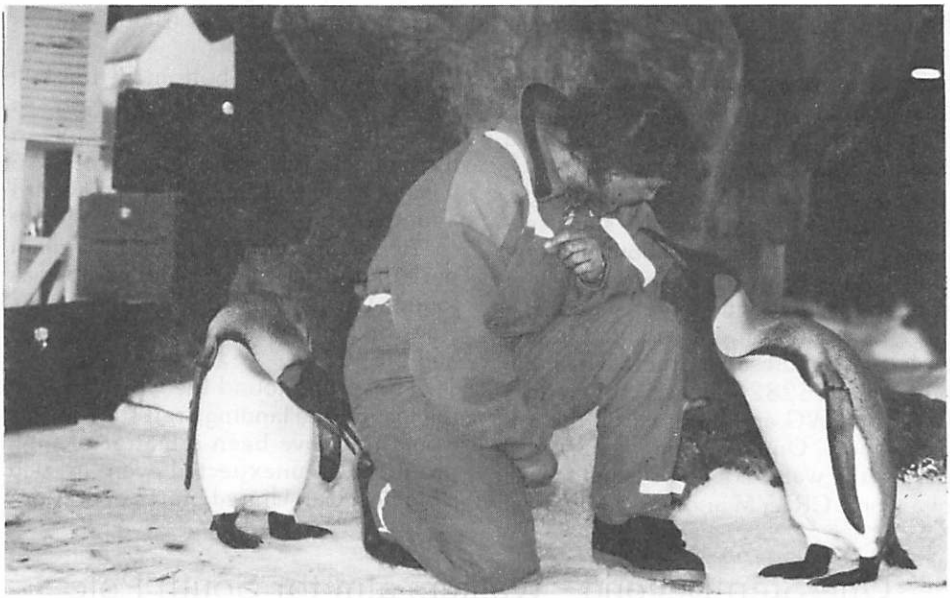
The loss of feathers is amazing to witness. Slowly over many weeks, each bird underwent the moult. Stress on the penguins was now at its maximum, the delicate new feathers coming through were engorged with blood and any unnecessary handling could damage the new season's plumage.

It wasn't until February this year that we felt comfortable moving the first ten birds. The transport went like clockwork. Working in the cool of night, a refrigerated truck was used to carry the birds in the same transport crates used in the original import.

The birds took to their new home immediately. Eliza-Scott, the name of one of our snowcats, was the first car through the exhibit the following morning. This caused no more than a casual glance from the birds and some quiet chatter. Aurora was the next car through, following by the remaining five cars. Each time the reaction was no different.

On February 8, New Zealand got its first look at King penguins, swimming, courting, feeding and sleeping. The response was more than we could have hoped for. Our critics were silent and the remaining eight birds in quarantine completed their moult and came home.

At times, over the last three years,



we wondered if we would achieve this part of our project. But, while one journey is now complete, another has only just begun, for now comes the task of using Kelly Tarlton's as a tool, to teach, for as mankind has proven time and time again, we are very slow learners.

Penguin keeper Brigitte Bakker with two of the King penguins.

This article was contributed by Craig Thorburn from Kelly Tarltons

Wreck of expedition boat found.

The wreckage of a small boat has been found on the northwest corner of Possession Island in the Ross Dependency.

John Charles and Rowley Taylor, sailing with Southern Heritage Expeditions, found the wreck and believe it could relate to Operation High Jump, a major US programme carried out in Antarctica during 1946 and 1947. This operation involved the use of up to 13 United States Naval ships in the area to test service equipment and to train Navy personnel.

The wreckage appears to be of a landing craft or similar type vessel. Members of the Southern Heritage Expeditions Cruise 11/95, led by Rodney Russ, helped locate, interpret and describe the wreckage. It was found about 60 metres from the shore on the northwest corner of the island which lies at 71deg53 min S/171deg 11min E. It appears to have washed onto the island

from the south as some of the heavier small parts such as winches and electrical boxes are scattered in a line from this position along a terrace immediately inland of a ridge at the landward margin of a storm beach.

The main intact part of the wreck, perhaps half the boat, is the stern section of the hull which is about five feet high with a beam of about seven feet and length of about 14 feet. There is a large diesel motor and two built-in fuel tanks. The diesel motor carries the number 5152826-R and the letters CWC or CWG are stamped on the engine block. On the damaged cast iron part of the water cooling system is part of a word: GRAYM and part of the next letter, probably an A. Below this is Ex5105.

Relatively flat-bottomed, the hull shows no sign of a keel. Wire strops were attached to the anchor points in the hull near the rear engine mounts so it was clearly built to be hoisted aboard a mother ship.

About 20 metres south of the main part of the wreck a bilge pump was found. On it were the words Thomas Knutson Ship Building Corp and D.M and M29017.

Those who found the wreck believe the loss of one landing craft such as this would not have been a matter of high profile or an unexpected event in such a big post war United States operation.

One Step Beyond - Walkers aim for South Pole

An international team lead by Professor Robert Swan will set off in October 1996 to walk from the Filchner Ice Shelf to the South Pole.

Professor Swan will be accompanied by his wife Nicky, Dr Misha Malakhov, a much decorated Russian polar explorer, and Crispin Day, a past member of the British Antarctic Survey.

Professor Swan is the first man to have walked to the North and South Poles. Nicky Swan walked with him on the North Pole Light Expedition in 1993.

This 800 mile walk is being supported by UNESCO to celebrate the organisation's 50th anniversary. The expedition, called One Step Beyond, will seek to highlight young people, their achievements and the fact that the Antarctic is now a "safe zone" and valuable scientific resource. The fundamental objective of the trip will be to promote environment and scientific awareness and to create educational material for use at all levels in the education system.

The walkers will set up a base camp at Patriot Hills, 600 miles from the Pole, where Adventure Network International, which provides a range of tourist activities and supports some private expeditions, already has a base.

Joining the team will be Young Walkers, aged between 21 and 26 from eight different countries. Young Visitors, aged 14 to 18, will be chosen from a further eight nations to visit the base camp and fly to meet the walkers when they arrive at the South Pole on 31 December 1996. The young Walkers will be appointed as Special Envoys to the Director General of UNESCO for one year after the expedition to further promote its objectives.

The expedition members, the Walkers and the Visitors will be sponsored by either global or national organisations. During the expedition, the Walkers will do basic scientific experiments and collect data, while making recordings for a live television transmission. The practical application of advanced technology,

including satellite broadcast, a computer and the digital highway, will be used to facilitate the television transmission from Antarctica.

A science programme being developed for the expedition will include research on nutrition and the effects of extreme physical activity on human performance. The study and use of alternative energy sources such as wind and solar power, will be conducted either at the base camp or on the walk itself.

Extensive publicity is being arranged for the expedition. Organisers expect major news coverage based on human interest, stories of the Walkers and the Visitors, and the environmental, scientific and family issues, which the expedition will encompass. Television documentaries and a book will subsequently be produced and a CD ROM about the expedition will be prepared for educational use.

UNESCO Director-General Frederico Mayor says One Step Beyond reaches for a vision of the future while building on the success of the past. It continues UNESCO's work of addressing research, education, training and policy needs in the areas of sustainable development and ecological systems.

Antarctica: The Last Continent CD-ROM for Windows, Cardinal Professional Services, Christchurch. RRP $79.95 Reviewed by Dr Malcolm Laird.

To get access to the material on this CD you need a multimedia IBM-compatible computer with a 486SX25 processor or higher, 4MB RAM or higher, a Super VGA screen, and MS Windows 3.1 or later. These may sound like stiff requirements, especially for those who bought what they thought were "state of the art" computers two or more years ago, but the audience at the Christchurch launch of this CD-ROM title was assured that there are currently about 40,000 multimedia computers in customers' hands, and this figure is projected to have risen steeply by year's end. Cardinal Professional Services have obviously done their sums, and feel that there is a niche ripe for exploitation.

The CD is controlled by a menu system which starts with six main headings - "The History", "The Place", "Animals and Plants", "The Science", "Living on the Continent" and "The Issues" - which break down into hundreds of topics. The topics are illustrated by over 400 photographs, maps and graphics, together with animations, live video and sound recordings, and text. The photographs are stunning and sharp, and are far and away the best part of the production. The best ones are certainly of the wildlife, but Antarctic scenery also gets a good look in. The videos are concentrated on the wildlife, in particular on the Emperor Penguins. Although they perhaps get an unfair share of attention, the short films are brilliant, covering subjects like breeding, feeding and survival. For dedicated followers of BBC wildlife programmes on TV there is the added bonus of hearing a commentary by David Attenborough, who is still panting with the excitement of it all. The blurb accompanying the CD suggests that if your CD-ROM drive is a single speed drive, you may find performance a little slower. Although my CD-ROM has a double speed drive, I noticed that one or two of the videos seemed rather jerky, so if readers are

contemplating buying a CD-ROM system, perhaps a quad speed drive should be considered. Also beware of the User's Guide statement that photographs can be printed from the CD. According to the distributor, this can be done only with a postscript printer.

Articles on global issues, in particular the ozone hole and global warming, are well constructed, and illustrated with excellent simple cartoons. Particularly helpful was an animation showing the seasonal growth and decline of the ozone hole over Antarctica, although no comment was made about its impact on adjacent lands, particularly South America, New Zealand and Australia.

"The History" was generally well-handled, with some good illustrative maps, and good discussion on such topics as "Who was the first person to set eyes on Antarctica?" Other portions were a little disappointing. Text was very brief on some of the early navigators and explorers (James Clark Ross doesn't even get a mention!). Although there is moderate text on Scott and Amundsen and their race to the pole (accompanied by excellent photographs, and a map of their routes to the pole and back), the reader has to turn back to an earlier article to find out who actually reached the pole first. There is no comment on the trek of Scott's doomed party back from the pole.

Some categories under "The Science" and "The Place" could have offered more. The subsection labelled "Rocks and Fossils" is divided into eight subsections, none of which deals with fossils. A check under the section labelled "Gondwana" fares rather better in the fossil category. References here include a photographs of two models of the Triassic amphibian "Lystrosaurus" posed in what looks suspiciously like a modern West Coast beech forest. Brief comment is also made on the widespread distribution of plant fossils and vertebrate remains. I thought I was going to be successful in my search for a real fossil at last under "Geology", but the photograph accompanying the voice-over describing "Wilson" looking at fossils appears to be of an anonymous person draining water through a funnel!. Some "Recommendations for further reading" at the end of the articles (as is done in the Encarta encyclopedia) would be helpful for those who wish to pursue subjects in greater detail.

These comments are relatively small niggles. The CD is not targeted at scientists or others who are already thoroughly familiar with things Antarctic. It is designed to more to attract members of the public who are interested and want to extend their knowledge of the Antarctic: it should also provide school children with good basic knowledge to prepare school projects, not only on Antarctica, but on related topics such as the ozone hole, climate change, and marine life. For these groups, it is likely to be $80 well spent, and I can thoroughly recommend it.

Project work in Antarctica: Observing a resection of the seaice in McMurdo Sound with Mount Erebus in the background. Photo: DOSLI

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