



# South African Antarctic research programme 1978-1982

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SASCAR

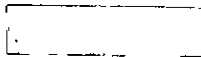
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PREFACE

South Africa is one of the original signatories of the Antarctic Treaty and South African scientists have been involved in Antarctic research since the early sixties. Research in the Antarctic is coordinated internationally through the Scientific Committee on Antarctic Research of the International Council of Scientific Unions. The CSIR is a member of SCAR and coordinates the South African programme through the South African Scientific Committee on Antarctic Research.

This document sets out the research programme which SASCAR has recommended should be undertaken in Antarctica by South African research groups during the next five years. It has been developed in consultation with the scientists and scientific institutions currently active in Antarctic research with due regard also to international activities in the area. It draws on the knowledge and experience gained during the past two decades, takes into account the manpower, facilities and expertise which are available in the country and concentrates on activities which can be regarded as logical extensions of existing research activities.

The programme will serve to direct the efforts of those already involved in Antarctic research, will be of interest to those not involved in the subject and will guide those who may wish to initiate an activity.

ABSTRACT

This document provides a comprehensive review of the planned South African scientific activities in Antarctica and on the sub-Antarctic islands in the five year period starting in 1978.

The scientific programmes are classified under five headings, viz, solar-terrestrial physics, earth sciences, biology, meteorology and environmental monitoring. The contents of the programmes have been finalized after various factors have been taken into account. These factors include national and international needs as well as availability of manpower, finances and logistics. For further details concerning the programmes the table of contents may be consulted.

OPSOMMING

Die dokument verskaf 'n omvattende oorsig van die beplande Suid-Afrikaanse wetenskaplike aktiwiteite in Antarktika en op die sub-Antarktiese eilande vir die vyfjaarperiode wat in 1978 begin.

Die wetenskaplike programme word onder vyf hoofde ingedeel, nl, son-aardfisika, aardwetenskappe, biologie, weerkunde en omgewingsmonitering. Die inhoud van die programme is gefinaliseer nadat verskeie faktore in ag geneem is. Hierdie faktore sluit in nasionale en internasionale behoeftes, asook die beskikbaarheid van mannekrag, finansies en logistiek. Vir verdere besonderhede wat die programme betref, mag die inhoudsopgawe geraadpleeg word.

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## INTRODUCTION

At the end of 1977 South African scientists had been involved in Antarctic research for 17 years and had completed the third five year programme - the first having started in April 1963. In the period 1960 to 1962 funds were made available on an annual basis. Funding is made available on the budget of the Department of Transport which administers the whole programme and is responsible for all logistic support. The research programme is planned and coordinated by the South African Scientific Committee for Antarctic Research (SASCAR).

A number of major developments have taken place during the past five years.

### SOLAR TERRESTRIAL PHYSICS

In the field of solar terrestrial physics, the totally revised picture of the immediate spatial environment of the earth which resulted from the introduction of the scientific satellite two decades ago, has been further refined. The five South African research groups contributing to this international scientific activity now adopt a well integrated, complementary approach to this many-faceted problem, operating on a scale commensurate with South African scientific manpower and other resources. Their work is fully coordinated by the South African National Committee for Geomagnetism, Aeronomy and Space Sciences (SANCGASS) and forms a valuable contribution to the International Magnetospheric Study (IMS). The latter is an international programme undertaken on a collaborative basis by scientists from a large number of countries using satellite, rocket, shipborne, airborne and groundbased techniques.

### EARTH SCIENCES

The economic potential of the largely unexplored and thus far unexploited mineral resources of Antarctica has attracted increasing attention during recent years. The realization that as technology develops, it will be increasingly attractive to attempt to exploit these resources, has led to prolonged discussions in the traditional Antarctic fora of SCAR and Treaty Meetings to attempt to arrive at an equitable arrangement whereby exploration and exploitation, when it eventually becomes a reality, can be controlled. In the light of this and with the funds being made available for the S A Agulhas it became necessary to fully review South African earth sciences activities in Antarctica. With the logistical arrangements in force in the past, the programme was undertaken by a small number of earth scientists who spent a year in Antarctica, overwintered in the hinterland and did field work for only a limited period during the early summer before they had to return to base



in time to return to South Africa. Of necessity, they were often young and inexperienced scientists. The new ship with its increased passenger space and once it is equipped with helicopters will make it possible for an increased number of experienced scientists to undertake field work during the summer and be away from South Africa for only three or four months.

When therefore, the new ship was approved, it was decided to suspend further field work, to produce a memoir on what had been achieved thus far and to prepare a plan for an earth sciences programme geared to the new logistical possibilities which were becoming available. The memoir should be published in 1979. The research programme proposed for execution during summer field seasons appears later in this document.

#### SOUTHERN OCEAN RESEARCH

The world has, during the past number of years, become increasingly aware of the importance of the oceans and in the present context, in particular of the unexplored and untapped resources of the Southern Ocean. It has been estimated that the Southern Ocean may, for example, contain protein resources which, if exploited optimally, may equal all the protein at present being harvested from the world oceans. Oceanographic research in the Southern Ocean is planned and coordinated through the South African National Committee for Oceanographic Research (SANCOR) and will be stimulated by the availability of the new ship which has been designed to be suitable for oceanographic research. It will for the first time, give South African oceanographers regular access to the inhospitable waters of the Southern Ocean.

It is accepted that SASCAR, in terms of its relations with SCAR and for Antarctic Treaty considerations, has a direct interest in all oceanographic research undertaken within the area south of 60°S and also north of 60°S as far as it is of direct relevance to the work being undertaken on the Prince Edward Islands and on Gough Island. However, it is impractical to draw imaginary lines in the ocean, particularly if, as in this case, it is to divide research which has essentially the same objectives.

It has therefore been recognized that the Antarctic programme contains both terrestrial and oceanic components and agreed that the oceanic components will be coordinated through a multidisciplinary steering committee appointed by SANCOR and reporting to both SANCOR and SASCAR. Such coordination will take place within the framework of an integrated Southern Ocean research programme developed by the steering committee and will normally be funded through SANCOR. However, it is recognized that SASCAR may wish to establish and finance certain Southern Ocean projects of higher priority to itself than to SANCOR.

Details of the proposed Southern Ocean research programme do not appear in this document. The programme is contained in a report which will shortly appear in this series.



## ISLAND BIOLOGY

The increased awareness of the importance of the living resources of the Southern Ocean has had a marked influence on the biological section of the proposed fourth five year Antarctic programme. While it has been decided to limit the terrestrial component of the programme to the Prince Edward Islands group, and to limit biological work on Gough Island to seal research, it has also been decided to give more emphasis to the study of the oceanic components of the Marion and Prince Edward Island system.

In addition to this, research is planned on the island animals during the large part of the year which they spend at sea, on other pinnipeds and on the productivity in general of the Southern Ocean between South Africa and Antarctica. The programme has been designed in such a way that, together with the Southern Ocean programme being developed, it will form a contribution to international research in the area - especially BIOMASS, the 'Biological Investigations of Marine Antarctic Systems and Stocks', which is being promoted by SCAR, SCOR (Scientific Committee on Oceanic Research) and other relevant international organizations.

## METEOROLOGY

Meteorology activities within the programme have continued to be concentrated on the provision of the most complete surface and upper air data sets possible from the three meteorological stations at SANAE, Marion Island and Gough Island. However, the continued improvement of techniques for the remote sensing of the atmosphere has had important effects on the way in which the practice of routine weather forecasting by the South African Weather Bureau has developed.

In 1976 a new hemispherical numerical analysis and prognostic system was introduced when powerful computing facilities were acquired by the Weather Bureau. The introduction of this system has made it possible to utilize all conventional and satellite data available for the Southern Hemisphere on a real time basis for analysis and forecasting purposes. Experience with the system has already shown the great value of the indirect temperature profiles provided by polar orbiting satellites. The present frequent availability of Meteosat images helps the analysts to improve the quality of the routine numerical analysis in the whole sector.

The successful feasibility study undertaken in 1976 on the use of satellite tracked drifting ocean buoys to provide sea surface temperature and pressure data has led to continued utilization of this technique within the framework of relevant international programmes. These data will be fed directly into the system and are expected to critically improve the analyses and the accuracy of the prognosis based upon them.

## ENVIRONMENTAL MONITORING

Since 1973, considerable effort has gone into the initiation of an environmental monitoring programme in South Africa. It consists mainly of the monitoring of pollutants in the atmosphere and marine environment. A marine pollution monitoring programme is being conducted on an ongoing basis. Atmospheric monitoring has been partially implemented. Already major pollutants are being monitored on a regular basis in urban and rural areas and a representative South African background monitoring station at Cape Point is operational. With the experience gained in the operation of the programme on the continent, the stage has therefore been reached where the inclusion of an environmental programme on Marion Island is feasible.

Marion Island is generally accepted as sufficiently isolated and uncontaminated to be the most suitable site available to South Africa for providing baseline reference data on environmental pollution concentration levels in the Southern Hemisphere. A proposal for the implementation of a programme on Marion Island is presented.

## GENERAL

The Antarctic research programme which is proposed for the period 1978 to 1982, is more comprehensive and for various reasons also more costly than that which has been undertaken thus far. However, the increasing importance of Antarctica and the ocean which surrounds it, to the world and to South Africa, makes it imperative that South African scientists be in the forefront of the worldwide race to acquire more knowledge about these regions, thereby enabling them to supply answers to some of the most pressing questions regarding these regions in which South African scientists have been active during the past two decades.

## SOLAR TERRESTRIAL PHYSICS

### INTRODUCTION

The general objective of the various solar terrestrial physics programmes throughout the world is to contribute to knowledge on the immediate spatial environment of the earth and in particular on the complex interaction of the sun's radiations with the earth's upper atmosphere and magnetic field, which so greatly influences this environment.

The South African Antarctic STP programme is an integral and major part of the South African National Programme, extending to the Antarctic and to Marion Island the groundbased observations made in South Africa and supplementing these with the occasional series of observations from ships and aircraft in the Southern Ocean. The processing and interpretation of these data and of data from certain scientific satellites, is the responsibility of the participating university research groups and CSIR institutes who are in addition responsible within the logistic framework provided by the Department of Transport for their respective observing programmes.

Much of the work is international in character - currently South Africa is actively participating in the IMS (International Magnetospheric Study). Such participation is of particular importance because of the geographic location of the observing stations and the general paucity of other stations in this region of the Southern Hemisphere.

### RESEARCH PROGRAMMES

The programmes of the four participating universities and the two participating CSIR institutes are directed at various specific aspects of the common overall problem. The immediate objectives may seem unrelated but in the long term all are complementary, highly interdependent and essential for a full understanding of the subject; such complementary programmes having evolved as a result of the participation of all the groups in the activities of the appropriate National Committee (SANCGASS).

A new facet which may become of significance in the future is the possibility that a better understanding of solar terrestrial relationships may bring a new (and at present lacking) clarity into long-term weather forecasts on a global and regional scale.

Ionosphere and Airglow - Department of Physics, Rhodes University

The objectives of the programme are:

- (i) to observe and improve the understanding of the behaviour of the upper atmosphere over the South Atlantic and Antarctic regions;
- (ii) to establish the frequency of occurrence, speed, direction and origin of travelling ionospheric disturbances in the South Atlantic and Antarctic region.

### *Ionosphere*

Ionosonde data will be recorded at SANAE, Grahamstown and on board aircraft and ships. In addition to the vertical ionograms obtained in this way, oblique ionograms will be obtained at Grahamstown from signals transmitted at SANAE. The theoretical work on the scaled ionograms from these stations and Marion Island will help to shed light on various effects in the upper atmosphere caused by precipitating particles. The data will be circulated internationally in a data exchange programme. Satellite data on electron fluxes obtained internationally will be utilized in the theoretical studies to supplement the ionosonde observations.

On the experimental side work will continue to digitize the chirp sounder ionograms. The digitized data retain the phase information of returning echoes which make possible angle of arrival measurements. This will facilitate monitoring of bottomside ionospheric troughs and travelling disturbances, as well as ordinary and extraordinary ray discrimination. Additionally, development work will be done on an auto-correlation ionosonde giving an improved signal-to-noise ratio in the case of ship and aircraft-borne work.

### *Airglow*

Airglow observations will likewise be performed at SANAE, Grahamstown and from aircraft and ships. The wavelengths that will be studied are 391,4 nm, 557,7 nm and 630,0 nm. Airglow measurements comprise an extremely valuable additional technique used in studying the effects of precipitating particles in the upper atmosphere. The South African stations are situated in a fortunate position to study the South Atlantic Magnetic Anomaly - an area where the geomagnetic field intensity is anomalously low.

Development work will continue on the design, construction and calibration of airglow photometers in order to have a spare set for training, voyages and aircraft flights.

### Cosmic Rays - Department of Physics, Potchefstroom University

The specific objectives of the programme are:

- (i) to establish, in relation to solar activity, the macro structure of the interplanetary magnetic field between the sun and the magnetosphere of the earth and to the edge of the heliosphere;
- (ii) to study through radio noise absorption the precipitation of particles from the magnetosphere and the effect of magnetospheric pulsations on the precipitating particles;
- (iii) to study the earth's atmosphere by means of cosmic rays;
- (iv) to derive the energy spectra of precipitating electrons from X-ray spectra taken at balloon heights.

#### *Cosmic Ray Intensities*

Intensity variations of cosmic rays will be measured at SANAE, Hermanus, Potchefstroom and on the S A Agulhas on its regular relief voyages as well as on occasional aircraft flights. Information obtained in this way will serve to establish the nature of the interplanetary magnetic field and the effect of solar activity on it.

#### *X-ray Spectra*

Balloon flights will be undertaken to record X-ray spectra from precipitating electrons. These results together with those obtained from some of the other programmes, will be used to study the effects of particle precipitation, effects of the South Atlantic Magnetic Anomaly, large storm effects and the motion of the auroral oval.

#### *Cosmic Radio Noise Absorption*

Riometers will be in operation at SANAE, Potchefstroom and Hermanus. This comprises still another technique by means of which the effects mentioned above will be studied.

#### Geomagnetism and Aurora - Magnetic Observatory, CSIR, Hermanus

The objectives of the programme are:

- (i) to record continuously three components of the geomagnetic field at SANAE and at Marion Island and to distribute the data internationally;
- (ii) to use geomagnetic data in local studies of the solar and lunar daily geomagnetic variations;

- (iii) to use geomagnetic data in correlative studies with aurora and cosmic radio noise data;
- (iv) to monitor electron and proton aurorae by photographic and photometric means.

### *Geomagnetism*

Continuous recording of the geomagnetic elements D, H and Z will be made at SANAE with a digital magnetometer and at Marion Island with a LaCour magnetograph. A portable Fluxgate magnetometer will be installed at Marion for the recording of geomagnetic pulsations.

At Marion Island, solar and lunar daily variations, their dependence on season and solar cycle and the lunar semidiurnal variation with its effect on the anomalous Z daily variation will be studied. The 'island effect' will be studied at Marion and Prince Edward Islands by means of the portable magnetometer. At SANAE, studies concerning Pi 2's will be done, specifically the dependence of damping on auroral oval and plasma-pause characteristics and the polarisation characteristics of the individual components.

### *Aurora*

The observational programme will consist of monitoring of aurora by all sky camera photography, photometric recording or auroral pulsations in the  $N_2^+$  band at 427,8 nm and recording of proton aurora ( $H\beta$  line) with a meridian scanning tilting filter photometer.

These data will be utilized for investigation of auroral pulsations and pulsations in cosmic radio noise absorption associated with Pi (c) geomagnetic pulsations. In addition, it will be used for detailed analysis of proton aurora events and other correlative studies of magnetic and auroral phenomena which will depend on the state and requirements of the knowledge at that stage.

### Magnetosphere Physics - Department of Physics, University of Natal

The specific objectives of the programme are:

- (i) to understand the micro- and macro structure of the plasmaphere;
- (ii) to understand the micro- and macro structure of the plasmashheet;
- (iii) to understand the interrelationship of the structure of the plasmasphere and plasmashheet over a range of geomagnetic conditions;

- (iv) to investigate possible mechanisms whereby solar activity may influence the weather.

#### *Whistlers and VLF Emissions*

The experimental work will consist of telemetry at SANAE of satellite VLF data, the recording of continuous and synoptic whistlers and the measurement of whistler exit positions by means of a VLF tracking system. This will be supplemented by theoretical studies undertaken on the propagation of VLF emissions.

#### *Auroral Emissions*

Low light-level (sub-visual) auroral emissions will be detected by means of a sensitive TV camera and recorded on magnetic tape. The data will be used to investigate auroral morphology with emphasis on the motion of auroral forms and power spectral analysis of temporal intensity variations.

#### *Atmospheric Electricity and ELF Noise*

Recordings of fair weather potential gradients and integrated ELF noise are being made to investigate the role of atmospheric electricity in a possible mechanism linking solar activity and the weather.

#### *General*

SANAE is one of the chain of stations having the same geomagnetic latitude ( $L=4$ ), the others being Halley Bay, Siple and General Belgrano. These stations have a pre-arranged schedule for groundbased recording of whistlers. Active collaboration on this and other projects is underway with groups in the UK, USA, France and Canada on groundbased and satellite observations.

#### Routine Ionospheric Observations at Marion Island - National Institute for Telecommunications Research, CSIR, Johannesburg

The objective of the programme is to improve the coverage of ionospheric observations in the Southern Ocean region.



*Ionosphere*

The continued routine operation of a vertical incidence ionosonde on Marion Island will be undertaken. These data will be compiled and published for studies of particle precipitation effects.

Direct Data Transmission

With some exceptions the current organization of the solar terrestrial physics programme at SANAE and Marion Island is based upon data being collected and preliminarily analysed at the bases by the expedition members concerned and transported to the responsible organizations when the teams are relieved annually. Detailed analysis and interpretation of the results are therefore undertaken in South Africa during the subsequent year.

The time dependent character of the data makes this an unsatisfactory approach and with the communications technology now available, the point has been reached where attention should be given to establishing direct data transmission facilities.

Funds have been requested to allow for the development of the necessary interfacing equipment between the data recording systems and the communication links at the bases and the communication links and display systems in South Africa.



ISLAND BIOLOGY

## OBJECTIVES

- (i) An understanding of the structure and functioning of the Marion and Prince Edward Islands ecosystems;
- (ii) the conservation of the natural environment of Marion and Prince Edward Islands and in particular the control of exotic fauna and flora;
- (iii) an understanding of the distribution and food availability of Antarctic and sub-Antarctic seals in the South Atlantic and South West Indian Oceans;
- (iv) an understanding of the distribution and food availability of sea birds in the South Atlantic and South West Indian Oceans;
- (v) an understanding of the palaeo-ecology of Marion and Prince Edward Islands.

## RESEARCH PROGRAMMES

Mammalogy - Mammal Research Institute, University of Pretoria

Research on Antarctic and Southern Ocean pinnipeds was initiated in August 1973 at Marion Island where most research has been concentrated while field work on Gough Island pinnipeds was directed at behaviour and seasonal changes in population structure in the summer seasons of 1974/75, 1975/76 and 1976/77. Four surveys in the King Haakon VII Sea have indicated one of the highest densities of Ross seals yet recorded. Studies at Marion Island have covered population dynamics, physiology, reproduction and behaviour of the fur and elephant seals. In addition, a study of the ecology and reproduction of the feral house cat has provided information necessary for an extermination programme. An understanding of the bionomics, structure and functioning of the seals and their ecosystems depends on the availability of fundamental information such as biomass, longevity, mortality, replacement, distribution and seasonal patterns of occurrence.

*Population Dynamics and General Biology of Seals on Marion and Prince Edward Islands and their Mineral and Energy Input into the Ecosystem (objective (i))*

Biomass estimates for ecosystems analyses require detailed censuses which will also monitor population changes. Tagging will continue during the next five years to assess seal migration and dispersal and to obtain information on puberty, longevity and senescence. Predator-prey

relationships will assist in assessing energy turnover and provision of nutrients to the ecosystem. Genetical and taxonomic studies on the two species of fur seal on the island will be aimed at assessing factors influencing niche occupation.

*Spatial and Temporal Distribution of Seals (objectives (i) and (iii))*

This programme of high priority is aimed at following the migratory patterns and dispersal of pinnipeds between Gough, Marion and Prince Edward Islands and (in collaboration with TAAF) Crozet and Kerguelen Islands as well as in the Antarctic oceans. Population trends will be monitored by regular censuses, marking and tagging. Population size estimates of all the species in the Southern Ocean are fundamental for future conservation and management programmes. Effects of density and disturbance on pup survival and differences in social behaviour in expanding and static populations of seals will be estimated. Feeding studies and the relationship of dispersal to food supply such as krill, are also important.

*Control and Monitoring of the Cat and Mouse Populations on Marion Island (objectives (ii) and (i))*

Effects of biological control on the feral cat population will be monitored and other methods of control will be attempted. A full scale investigation into the population dynamics, behaviour, physiology and ecology of the mice will be undertaken as a first step towards eventual eradication. Their influence on the flora and invertebrata will also be examined.

Ornithology - Percy Fitzpatrick Institute, University of Cape Town

During 1973-1978 ornithological studies of the South African Antarctic Biological Programme have concentrated on elucidating the roles played by selected species of sea birds in the transport of minerals and energy to and in the ecosystems at Marion Island. The species chosen for study included all the abundant, surface-nesting, diurnal species. Guano, feathers, eggs, egg-shells and corpses of birds remaining on the islands form an increment to their energy and mineral systems. The project has been designed to provide quantitative data on the avian-derived contributions of energy and chemical elements (P, N, Ca, Na, K, Zn, Mn, Cu, Si, Cd and Mg) to the island. The ultimate objective is to provide estimates of these 'inputs' in relation to both time and space. Thus, it is intended to reveal how much calcium, for instance, is contributed by birds (at individual, species' population and community levels) and when (month) and where (1 km<sup>2</sup> quadrates) the calcium is deposited. Estimates of annual 'inputs' will be available for most of the diurnal, surface-nesting birds at the conclusion of the 1973-1978 phase of the project.

It is intended to concentrate on the nocturnal, burrow-nesting sea birds ('petrels') during 1978-1983. Essentially, the same approach as adopted for the diurnal birds, will be pursued.

*Population Dynamics and General Biology of Sea Birds on Marion and Prince Edward Islands with particular Reference to their Mineral and Energy Input in the Ecosystem (objective (i))*

Primary objectives during 1978-1983 are:

- species composition;
- spatial and temporal distribution;
- numerical and biological (breeding, moulting, etc) status of the burrowing petrels at Marion Island.

There are at least thirteen species of burrowing petrels (Procellariidae) at Marion Island. These birds are nocturnal and many breed inland at relatively high altitudes. They will therefore, be much harder to 'work with' than the species studied in 1973-1978. It is likely that a period of ten years of study will be necessary before our state of knowledge will be roughly equivalent to that gathered for the diurnal species in 1973-1978.

*Spatial and Temporal Distribution of Antarctic Sea Birds (objectives (i) and (iv))*

Biological information on sea birds which breed at Marion Island and elsewhere in the Antarctic and Sub-Antarctic, is almost totally lacking for that portion of the year when the birds are at sea away from their breeding grounds. Studies of sea birds at sea are now sponsored by most of the developed maritime nations and South Africa has been asked to cooperate with and to contribute to a programme of research involving sea birds at sea.

The project will be designed to supplement and complement the land-based studies of sea birds breeding at Marion Island. The present land-based studies at Marion Island cover only about 40% of the life cycle of the sea birds breeding there; perhaps less when we consider that at any time, a large part of the population is away at sea collecting food or does not return to land for several years. The main aim of the project will be placed, initially, on establishing correlations between the distribution and abundance of species of sea birds and their food and feeding behaviour at sea.

*Monitoring of the Effects of Reducing Exotic Animal Populations on the Birds of Marion Island (objectives (ii) and (i))*

A comparison of the avifaunas of Marion and Prince Edward Islands reveals striking differences. It is suspected that some of these differences rest in the fact that feral cats are present at Marion and absent at Prince Edward. The feral cats are responsible for the destruction of many birds at Marion Island and their reduction will have repercussions on the avifauna. It is desirable that censuses of the avifauna in selected study areas be carried out regularly before and after the introduction of measures designed for the control of cats. This monitoring work will be continued.

Plant Ecology - Institute for Environmental Sciences, University of the Orange Free State

Studies of the plant ecology of Marion and Prince Edward Islands will include the completion of the vegetation maps, the phytosociological classification of the vegetation and the development and sophistication of the current programme in productivity of terrestrial vegetation types.

Current and completed projects include phytosociological surveys, estimates of primary production in terrestrial vegetation, chemical analyses of fresh water, rain water, soils, rocks, plant parts and mineral cycling. Future studies will continue these projects to completion and will give attention to the accumulation and decomposition of organic matter, primary productivity of mosses and autecological studies of selected dominant species.

*Accumulation and Decomposition of Organic Products with Reference to Mineral and Energy Cycles on Marion and Prince Edward Islands (objective (i))*

Studies in this field will make use of litter bag, cotton strip and  $C^{14}$ -dating techniques. Specimens will include dry mass, calorific values and chemical analysis of organic matter components. The role of fungi and bacteria in the mineralization processes in soils, excrements and water will be studied with special reference to the N and S cycles. The role of soil fauna in these processes will also be investigated.

*Primary Production, Biomass and Distribution in Terrestrial and Fresh-water Habitats on Marion and Prince Edward Islands (objective (i))*

Current and completed research in the primary production and biomass of terrestrial habitats on Marion Island include measurements of dry mass of stems, leaves, roots, flowers and litter of five dominant vascular plant species and determination of the calorific values.

Continuation of these studies will include the repeat survey of the primary production of these vascular plants and the initiation of studies on the primary production of mosses over at least a two-year period. The vegetation maps and phytosociological survey currently being prepared will be completed within the framework of this project.

*Autecology Studies of Selected Plants on Marion and Prince Edward Islands (objective (i))*

The ecology of the Phanerogams, ferns and mosses of the islands will be studied in the field and in controlled conditions in the laboratory. Aspects to be investigated will include photosynthesis, respiration, water potential, mineral requirements, response to enrichment and reproduction.

Marine Biology - School of Environmental Studies, University of Cape Town

A serious gap in the existing South African Antarctic biological research programmes lies in the field of marine biology. The preliminary marine biological studies that have been carried out, indicate the great interest of the marine fauna and flora and their vital significance to the overall ecology of the islands and the Antarctic seas. Research is required particularly on:

- the distribution and biomass of plankton and pelagic fauna in relation to the feeding of sea birds and seals;
- the identification of food items consumed by sea birds and seals;
- the marine component of the Marion Island ecosystem including the primary production of phytoplankton and macrophytes and fluctuations of abundance of marine fauna on and around the coasts of the islands.

*Distribution and Biomass of Plankton and Pelagic Fauna in Relation to the Food of Sea Birds and Seals (objectives (i), (ii) and (iv))*

If an overall understanding of the biology of seals and sea birds both around the islands and in the Antarctic ocean is to be achieved, it is essential that studies of the marine organisms which form their food, be carried out. This will involve studies of plankton and other pelagic fauna including pelagic fishes. Plankton studies will include primary productivity, phytoplankton standing crop and zooplankton standing crop. Other pelagic fauna will be sampled quantitatively as far as possible by means of pelagic trawls and neuston nets. These studies must be carried out not only in the major areas of interest such as

immediately around Marion Island and in the King Haakon VII Sea but also elsewhere in order to provide comparative data.

*Identification of Food Items Consumed by Sea Birds and Seals  
(objectives (i), and (iii) and (iv))*

This research is required as a service to the programmes on marine mammals and marine birds. The identification of food items is often difficult particularly when they are fragmentary or partially digested so it is desirable that this work should be carried out by biologists familiar with the particular species of organisms concerned. Identifications may depend on parts such as fish otoliths, squid beaks and crustacean appendages. As most of the organisms will be the pelagic and planktonic species being studied in the project on the distribution and abundance of food organisms (above) it is logical that this service to the mammal and ornithology programmes should be carried out by the same marine biology group.

*Quantitative Studies of the Coastal Fauna and Flora of Marion and Prince Edward Islands (objective (i))*

If an overall understanding of the ecology of Marion Island is to be achieved, it is important that quantitative studies of the coastal fauna and flora be carried out. The primary production and biomass of phytoplankton and marine macrophytes and fluctuations of biomass of marine fauna require study. Up to the present, work has been limited to taxonomic descriptions presented in the Marion monograph, descriptive intertidal ecology and studies of hydrology, plankton and benthic fauna around the Islands carried out during cruise MD08 of the Marion Dufresne. Shore based studies to provide quantitative data on coastal phytoplankton and macrophytes, marine invertebrates and fishes are now required. A good basis for this work has been provided by the above-mentioned preliminary descriptive studies. Work on marine mammals, sea birds and plants is now at a sophisticated level so more intensive marine biological work is required to reach a comparable level for a balanced ecosystem study.

Terrestrial Invertebrate Ecology

Studies are required on the spatial and seasonal changes in the structure and biomass of invertebrate populations of terrestrial ecosystems on Marion and Prince Edward Islands. Such information is of great importance in terms of the interrelationship of avian, botanical and invertebrate components of certain mire and bog communities.

Research in the invertebrate fauna has thus far been limited to the taxonomy of the Araneida, Oribatei, Ixodiodea, Insecta, Mallophaga, Oligochaeta and Rhizopoda. Such studies should of necessity be continued as a service to the ecological programmes.

*Distribution and Biomass of the Terrestrial Invertebrate Fauna on Marion and Prince Edward Island with Reference to Energy and Mineral Cycles (objective (i))*

Preliminary studies should be conducted into the seasonal changes in the standing crop of the invertebrates in selected habitats, their faunistic structure and their utilization by the avifauna.

Palaeo-Ecology - Institute for Environmental Sciences, University of the Orange Free State

The islands are situated in the marginal position where very valuable information can be obtained on the glacial history of the Antarctic region.

Completed research includes studies into the geology, palynology and micropalaeontology of the ocean sediments and information on the distribution of pack ice at 18 000 years BP.

*Geomorphological Evidence for Glacial Episodes*

This programme will only include the completion and writing up of current studies in the distribution and chronology of tills and moraines, former sea levels, fossil and recent periglacial landforms, the balance of the permanent ice sheet in the mountains and the dating of geological events.

*Palynological Studies of Terrestrial and Oceanic Deposits*

Further studies will be carried out on the glacial and interglacial history of the islands and on the age and origin of their flora and fauna. Priority will be given to the analysis of glacial and interglacial deposits, the analysis of ocean bottom sediments and long distance dispersal of propagules.

These proposals form part of an international project organized by the SCAR Group of Specialists on Late Genozoic Studies.

Secondary Production in Freshwater Habitats (objective (i))

Numerous freshwater lakes and ponds exist on Marion and Prince Edward



Islands. There is some information available on water chemistry, primary productivity and the nature of the fauna. However, there are not yet any data on secondary production for these water bodies. This is required particularly for the small crustaceans which are abundant at times. Samples have been collected including monthly samples from five selected lakes. Population structure, biomass and calorific determinations are now required. Information on secondary productivity can then be obtained by a combination of sampling data and laboratory studies of generation time, egg production and general biology.



EARTH SCIENCES

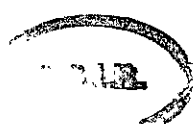
## INTRODUCTION

To the present, with logistics based on over-snow transport, the South African earth sciences programme in Antarctica has been conducted by scientists who had to spend a total of about 14 months away from South Africa to enable them to undertake a maximum of sixty days of actual field work in the spring and early summer. Geologists were recruited from the private sector or directly on leaving university and were often inexperienced. Despite this relative inexperience and the major logistic difficulties that had to be overcome, virtually all the outcrops in the area between 71° and 74°S and from 1°W to 6°W were investigated at least on a reconnaissance scale, while some selected areas were mapped on scales of up to 1 : 25 000. However, the restricted areas seen by each geologist combined with their inexperience caused very real problems in correlating and coordinating their work. In some cases, their work has only pointed out still more problems to be solved.

The rocks of the Ahlmannryggen and Borgmassivet comprise, in part, the oldest platform deposits yet found in Antarctica. These relatively undisturbed sedimentary-volcanic rocks of low metamorphic grade are probably more than 3 km thick. To the east of these rocks and separated from them by the Penck-Jutul rift, which is exploited by the largest outlet glacier in Western Dronning Maud Land, lie the repeatedly remobilised, high-grade metamorphic rocks of the East Antarctic crystalline basement.

In the extreme south-eastern part of the Kirwanveggen, a folded sequence of quartzites and conglomerates, probably of early Palaeozoic age, occurs in tectonic contact with rocks of the metamorphic complex. These rocks are in turn unconformably overlain by about 100 m of flat-lying conglomerates and sandstones of probably Permian age, followed conformably by more than 300 m of Jurassic basaltic lavas.

With the commissioning of the S A Agulhas with its increased passenger capacity and the expected availability of helicopters, it has become possible to adopt a completely new approach to fieldwork in Antarctica. It can now be undertaken during summer seasons, limiting the total time away from South Africa to say three months and thus opening up the possibility of attracting experienced scientists to participate directly in the programme. As a result SASCAR has decided that the new programme will be run on a multi-disciplinary multi-institutional basis to make better use of the experienced geological manpower in the country. To this end, participation will be sought from universities as well as from the Geological Survey. Suitable post-graduate students will be awarded bursaries to work as research assistants on these projects. Pre-expedition training and post-expedition data processing will take place at universities; however, logistic pre-expedition training may be done by a single institution. It is therefore envisaged to have a relatively



large number of scientists participating in the programme without employing them as expedition members. In the same way, few items of equipment need to be bought, as existing equipment at universities and the Geological Survey will be used. In this way it is hoped to run a viable programme without spending large amounts on capital and salaries.

While the geology programme will form a major component of the earth sciences effort, closely related programmes in glaciology, geophysics and survey and mapping will be undertaken simultaneously. These programmes will be interrelated and close collaboration between participants will be essential.

## OBJECTIVES

### Geology

- (i) To complete the study of the geology of the sedimentary, volcanic and intrusive rocks of the Ahlmannryggen and Borgmassivet;
- (ii) to complete the study of the high-grade metamorphic rocks of the Kirwanveggen and to commence the study of similar rocks in the Sverdrupfjella and the area to the east of it;
- (iii) to carry out a detailed investigation of the northward extensions of the Kirwanveggen in the Sverdrupfjella and to study the geotectonic significance of the boundary between this metamorphic terrain and the platform cover of the Ahlmanryggen and Borgmassivet;
- (iv) to carry out an investigation of the Jurassic volcanics in the Kirwanveggen, Heimefrontfjella and Vestfjella with a view to a comparison of the geochemistry and petrology of these and that of the Jurassic lavas of the Drakensberg Group in South Africa.

### Glaciology

- (v) To continue the mass budget studies of the Fimbul ice-shelf and the inland ice with particular reference to the Jutulstraumen and its tributary ice streams.

### Geophysics

- (vi) To continue geophysical surveys in selected areas;
- (vii) to investigate crustal structure by magnetic and gravity profiling along an east-west traverse from the Ahlmannryggen

across the Borgmassivet and the Jutulstraumen to the Sverdrupfjella;

### Survey and Mapping

- (viii) To produce 1 : 50 000 base maps of the area between 6°W and 2°E; and 71°S and 74°S;
- (ix) to produce topographical, geological, glaciological and other maps as required.

### RESEARCH PROGRAMMES

#### Geology

##### *Sedimentology and Volcanology (objectives (i) and (iv))*

A palaeo-current and basin analysis of the old sediments and the study of the petrology, geochemistry and geochronology of the intrusives, extrusives and pyroclastics would help to establish the geological evolution of this part of Antarctica and eventually that of Gondwanaland.

The possibility that the platform previously formed part of the Kaapvaal Craton would make its study a logical continuation of the study of South African geology. Structural, geochemical and other trends established in Southern Africa could be followed up and extended into Antarctica and the pre-drift reconstruction of these two continents could be fixed more vigorously.

##### *Metamorphic and Igneous Petrology and Structural Geology (objective (ii))*

Available literature suggests that rock outcrops in Antarctica in the area to the east of the Greenwich meridian are well exposed, thus permitting the collection of a maximum amount of factual data. The mountains are composed almost exclusively of crystalline basement. Detailed structural, metamorphic and petrologic studies will provide data for comparisons with other basement sequences in different parts of the world, especially in the Southern Hemisphere, thereby establishing criteria for the better understanding of similar terrain in South Africa, another fragment of the Gondwana supercontinent.

The presence of a wide variety of structural elements within the crystalline basement, accompanied by a series of metamorphic events with which are associated partial melting phenomena and the development of charnockites, offers an opportunity to elucidate the interplay of these processes during crustal evolution. This area is well-suited to the study

of structural geology, the succession of mineral paragenesis during progressive and regressive metamorphism and geochemical changes that accompany the metamorphic processes, all of which could be related to the timing of the metamorphic events and the responses to these events at different crustal levels and under different physico-chemical conditions.

Intensive petrological and geochemical studies of the granitoids, syenites, charnockites and layered gabbro-anorthosite massifs intrusive into the crystalline basement will provide information on their genesis, origin of the layering and related problems.

The close spatial association of phenomena covering virtually the whole spectrum of metamorphic, structural and igneous geology, offers an unrivalled opportunity to examine each aspect and, more particularly, to relate them within the broader problems of crustal evolution.

*Boundary between Mobile and Stable Crustal Fragments (objective (iii))*

The juxtaposition of the crystalline basement and the relatively undeformed cover sequences in the vicinity of the Jutulstraumen will enable their relationships to be established, provide geological and geophysical data concerning the nature of the boundary between stable and mobile crustal fragments and permit the reconstruction of the depositional environment of the cover rocks. Clarification of these problems will contribute to the better understanding of Antarctic geology and to the basic principles of geology.

Glaciology (objective (v))

The main purpose of radio echo sounding is the determination of the subglacial topography. This in turn, makes it possible to draw in buried structural lineaments. By measuring certain aspects of bottom roughness, it has now also become possible to draw conclusions about the bottom geology. Attention should be given to this exciting development.

If, in combination with the radio echo sounding, the present set of ice-flow stake lines were to be greatly expanded, mass transport of the ice streams could be calculated fairly accurately. This would contribute to our knowledge of the mass balance of this part of Antarctica.

Geophysics (objectives (vi) and (vii))

The investigation of crustal structure by gravity and magnetic profiling along a traverse across the Jutulstraumen would help to determine the nature of the boundary between the stable and mobile crustal fragments which is one of the basic problems in the area.

Magnetometer array studies which have proven invaluable in mapping basic tectonic features in Southern Africa could form a natural extension of the local work into Antarctica.

The location of the SANAE seismological observatory is ideal for recording of earthquakes in the seismically active mid-oceanic ridge region of the South Atlantic and Indian Oceans and its use should be continued.

#### Survey and Mapping (objectives (viii) and (ix))

The programme of survey and mapping will be dedicated to providing maps on the scale of 1 : 50 000, or as near to that scale as proves to be practicable, of the regions of Antarctica in which South African earth scientists will conduct their exploration over the next five years. Two kinds of maps are visualized:

- Base maps on which are shown as precisely as possible, the principal surface features including those of the land, the ice and the coastline. It is expected that using resources of air photography and satellite imagery as are found to be suitable, the programme will bring up to date the original sheets prepared by the Norwegian expeditions and also produce new maps of the areas which have so far not been mapped at all. The topographic maps so produced, will be used as a basis on which the geology of the area to the west and to the east of Jutulstraumen can be superimposed.
- A subsidiary objective of the geological mapping programme will be the production, from the records of the radio echo sounders, of maps of the sub-glacial topography. Attempts will also be made to present in cartographic form, the results of geophysical surveys in so far as this is appropriate and feasible.

An additional function of the surveying programme will be to establish ground control for field parties, to assist generally in determining positions in the area where the field parties will work and also to provide oblique photographs to assist geologists in interpreting geological features.

The surveying and mapping programme will possess two distinct operational divisions, namely aerial photography and field measurements in Antarctica and photogrammetric work and map construction in the Republic.

METEOROLOGY

## OBJECTIVES

- (i) To take routine surface and upper-air meteorological observations at Gough and Marion Islands and at SANAE and to collect and disseminate these observations in accordance with internationally agreed procedures;
- (ii) to analyse these and other relevant observations in real-time, to prepare prognoses based upon these analyses and to disseminate the analyses and prognoses nationally and internationally;
- (iii) to do research on the variation of the intensity of the Southern Hemisphere circumpolar vortex and the effect of this variation on the weather over Southern Africa;
- (iv) to publish and disseminate meteorological data from these and other stations for research purposes to all parties interested in climatological, synoptic and general circulation studies pertaining to the Southern Ocean and Antarctica;
- (v) to promote the acquisition of meteorological observations from the South Atlantic and Indian Oceans by means other than fixed land stations, e.g. ships, buoys and satellites.

## DISCUSSION

The weather over Southern Africa is directly influenced by disturbances in the circumpolar vortex of westerly winds and the primary purpose of the meteorological stations at the islands and SANAE is to obtain some regular surface and upper-air observations from the large data voids in the Southern Ocean and Antarctica. These observations are carried out, coded and disseminated in real-time in accordance with an internationally agreed Global Observational Programme using the Global Meteorological Telecommunications System. They are therefore not only of local significance but form an integral part of the Global Observational System. A few of the larger weather services are already doing global analyses and prognoses in real-time and more will follow.

There are very few islands in the Southern Ocean suitable for weather stations and meteorologists have long since realized that extensive use will have to be made of satellite remote sensing techniques to augment the existing network of meteorological stations. With the launching of the NOAA series of polar orbiting satellites a large volume of indirect temperature soundings, derived from radiances routinely measured by these satellites, became available for the Southern Hemisphere. Since it is

impossible to collect and analyse such a large volume of data in real-time using conventional methods the Weather Bureau had to computerize its telecommunication system and introduce numerical methods of analysis and prognosis.

At present numerical analyses and prognoses are done twice daily. The analysis model is a ten-level hemispherical model and the operational prognostic model is a five-level, hemispherical primitive equation model using terrain following coordinates. Experience with satellite indirect temperature soundings has shown that significant details of the atmospheric temperature structure, which cannot be obtained with conventional data alone, can be determined. Satellite temperature soundings are not considered to be as accurate as conventional radio sonde soundings but in the Southern Hemisphere their value cannot be disputed. With the introduction of the TIROS-N series, more accurate temperature soundings are expected which would considerably enhance the value of the data.

With the automatic data processing system available it will be relatively easy to absorb and process increasing amounts of additional data requiring, at most, software enhancements to the system and increased computing power. The METEOSAT geostationary satellite, recently launched by the European Space Agency, is another source of extremely valuable data. In a combined project with the CSIR the Satellite Remote Sensing Centre at Hartebeesthoek is intercepting METEOSAT transmissions, processing and retransmitting the data to the Weather Bureau on a regular basis. Although this satellite does not provide quantitative data for direct input to a numerical analysis model, valuable information regarding the positions of vortices and fronts and the orientation of thickness lines (indicative of the temperature structure of the atmosphere) can be gleaned from the imagery. This information is very useful in refining numerical analyses. Winds derived from the displacement of identifiable elements of cloud, as shown by consecutive images, are valuable and can be absorbed directly numerical analysis models.

To determine the three-dimensional mass structure of the atmosphere it is necessary to specify the pressure at a reference level. Sea-level is normally used as a reference level but conventional sea-level data in the Southern Hemisphere are completely inadequate for this purpose. Recognizing this the Weather Bureau cooperated with NRIO in a SANCOR project to explore the potential of small, expendable, drifting or anchored buoys to provide meteorological data at sea-level. This feasibility study, which took place during 1975-1976, was very successful and paved the way for the FGGE buoy project. For FGGE it is planned to launch about 20 similar buoys in an area which extends from 10°W to 40°E between 30°S and 45°S and possibly also in waters south of 55°S. The success of the FGGE buoy project will again determine whether the technique may be used on an operational basis in future.

The circumpolar vortex shows characteristic variations in intensity with a period of the order of one to two weeks. This is a fruitful field for research since the longer term variations in the weather are intimately connected with these variations.

## ENVIRONMENTAL MONITORING

### INTRODUCTION

Environmental monitoring is the systematic collection of data on the parameters required for environmental problem solving. It is undertaken to provide the information necessary to ensure the present and future protection of human health and safety and the wise management of the environment and its resources. In addition to fulfilling national requirements the South African atmospheric and marine pollution monitoring programmes have been designed to contribute to international programmes such as SCOPE (Scientific Committee on Problems of the Environment), GEMS (Global Environmental Monitoring System) and GIPME (Global Investigation of Pollution in the Marine Environment).

Monitoring sites or areas can be classified as impact, intermediate (regional) and remote (baseline). One of the most important requirements when monitoring baseline pollutant levels is a suitable site minimally influenced by human activities (such as a small isolated island). South Africa is fortunate in having such a site at Marion Island.

It is proposed to monitor certain selected marine and atmospheric parameters at Marion, firstly to provide the required baseline data for the already existing programmes in the Republic and secondly to provide some information on pollutant levels in remote southern latitudes, knowledge of which is virtually non-existent.

### OUTLINE OF WORK

#### Atmospheric Monitoring

It is proposed that a limited initial programme be undertaken as the first stage of a long-term programme. The pollutants to be measured are the trace metals, hydrocarbons, carbon monoxide and halogenated hydrocarbons (freons).

The monitoring of heavy metals is the simplest because samples can be collected by relatively unskilled persons with fairly inexpensive equipment. The samples can be stored for long periods before being analysed at the laboratories of the Air Pollution Research Group (CSIR), the Atomic Energy Board or the Nuclear Physics Research Unit (University of the Witwatersrand). These measurements can be commenced in the year the programme is started.

Additional data required include wind charts, humidity, precipitation and temperature during sampling periods, all of which are already being gathered for the Weather Bureau.



For the measurement of the other substances it will be necessary initially to collect samples in suitable containers during short visits to the island and transport them to Pretoria where existing techniques will be implemented or adapted or new techniques developed for measuring the low concentrations which are expected. Once these techniques are available, the necessary equipment can be sent to the island and the programme launched on an ongoing basis, if found to be necessary. It is anticipated that this stage may be reached in the fourth year.

### Marine Pollution Monitoring

The Mammal Research Institute is interested in the determination and possibly the consequent monitoring of organochlorine and heavy metal pollution levels in Antarctic and sub-Antarctic seals, as part of the Antarctic mammal research programme. In addition, the Marine Pollution Section of the National Programme for Environmental Sciences is interested in organochlorine and heavy metal levels in plankton, shellfish, pelagic fish, seaweed and birds eggs, determination of which would complement the marine biology and ornithology programmes at Marion. It is planned that these analyses be done by the Marine Pollution Group of the National Research Institute for Oceanology and by the Sea Fisheries Branch, with possible additional support by the National Physical Research Laboratory (CSIR), the Natal Regional Laboratory of the National Institute for Water Research and the Institute for Chromatography, University of Pretoria.

Marine pollution monitoring will therefore be carried out as a cooperative effort between the mammal research, marine biology, ornithology and environmental monitoring programmes and would not require any additional financial support for the environmental monitoring programmes as such. The costs of sampling, sample storage and analysis and possibly travel could be carried by the existing programmes.



LIST OF ACRONYMS

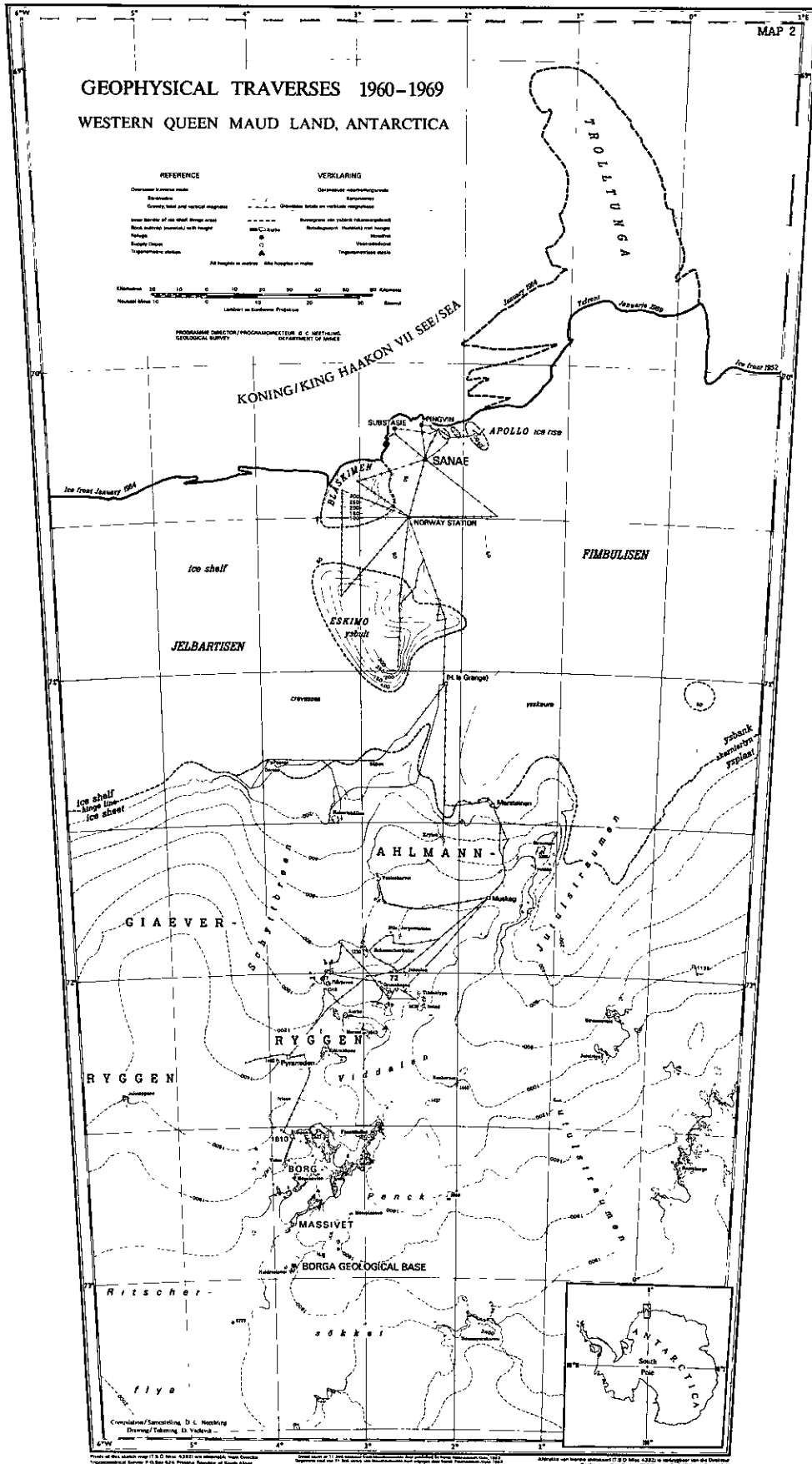
BIOMASS	Biological Investigations of Marine Antarctic Systems and Stocks
CSIR	Council for Scientific and Industrial Research
FGGE	First GARP Global Experiment
GARP	Global Atmospheric Research Programme
GEMS	Global Environmental Monitoring System
GIPME	Global Investigation of Pollution in the Marine Environment
IMS	International Magnetospheric Study
NOAA	National Oceanic and Atmospheric Administration
NRIO	National Research Institute for Oceanography
SANCGASS	South African National Committee for Geomagnetism Aeronomy and Space Sciences
SANCOR	South African National Committee for Oceanographic Research
SASCAR	South African Scientific Committee for Antarctic Research
SCAR	Scientific Committee for Antarctic Research
SCOPE	Scientific Committee on Problems of the Environment
SCOR	Scientific Committee for Oceanic Research
TAAF	Terres Austrates et Antartiques Francaises

LIST OF STATIONS

	<u>Lat</u>	<u>Long</u>
SANAE	70,31	357,64
Marion Island	46,85	37,87
Hermanus	34,42	19,22
Grahamstown	33,28	26,48
Potchefstroom	26,66	27,08
Johannesburg	26,20	28,03

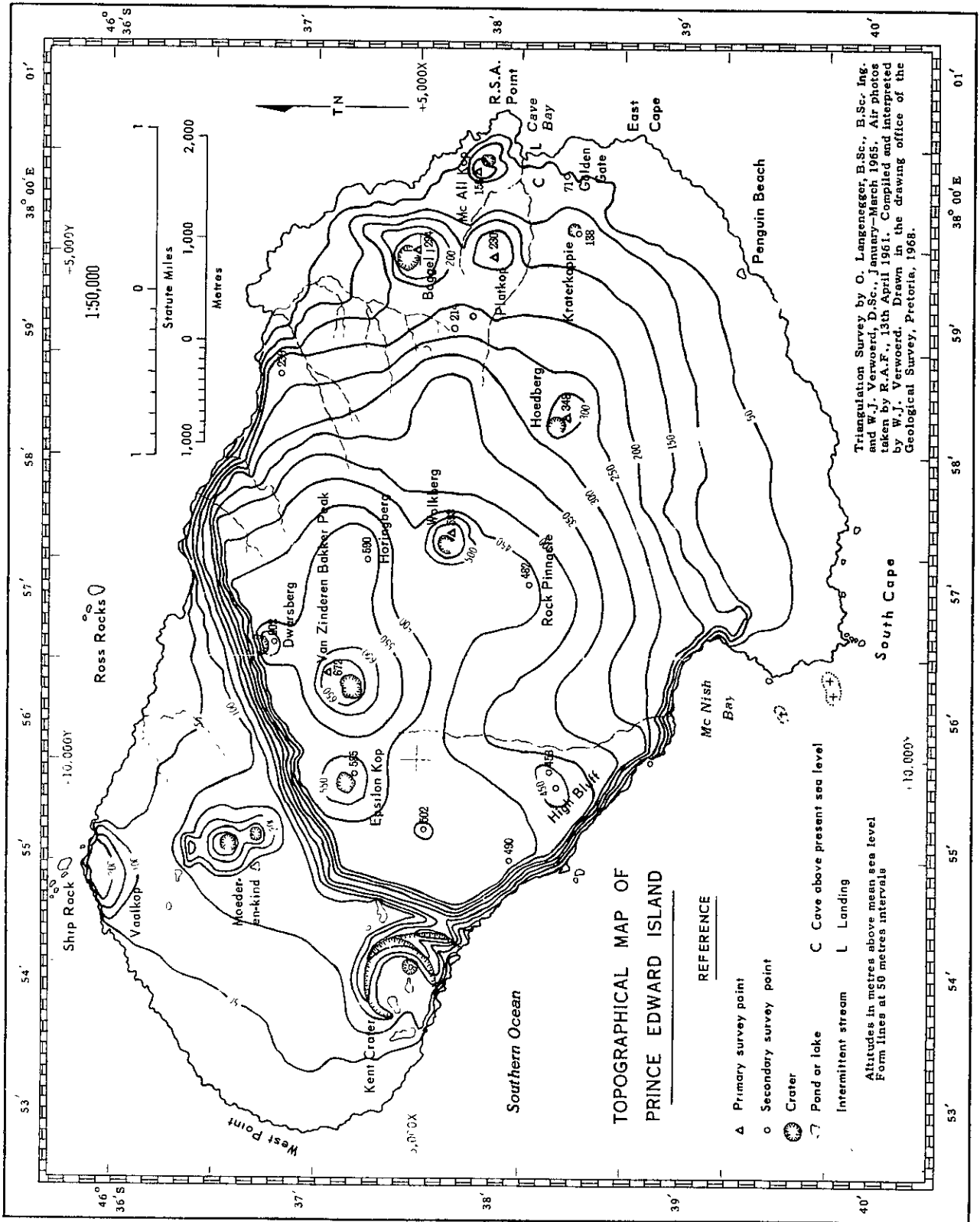


SOUTH AFRICAN NATIONAL ANTARCTIC EXPEDITION  
 SUID-AFRIKAANSE NASIONALE ANTARKTIESE EKSPEDISIE  
 EARTH SCIENCE RESEARCH PROGRAMME  
 AARDKUNDIGE NAVORSINGSPROGRAM



Printed at the Survey Map (P. O. Box 4282) and Information Centre, Department of Survey, P. O. Box 4282, Pretoria, Republic of South Africa.





TOPOGRAPHICAL MAP OF  
PRINCE EDWARD ISLAND

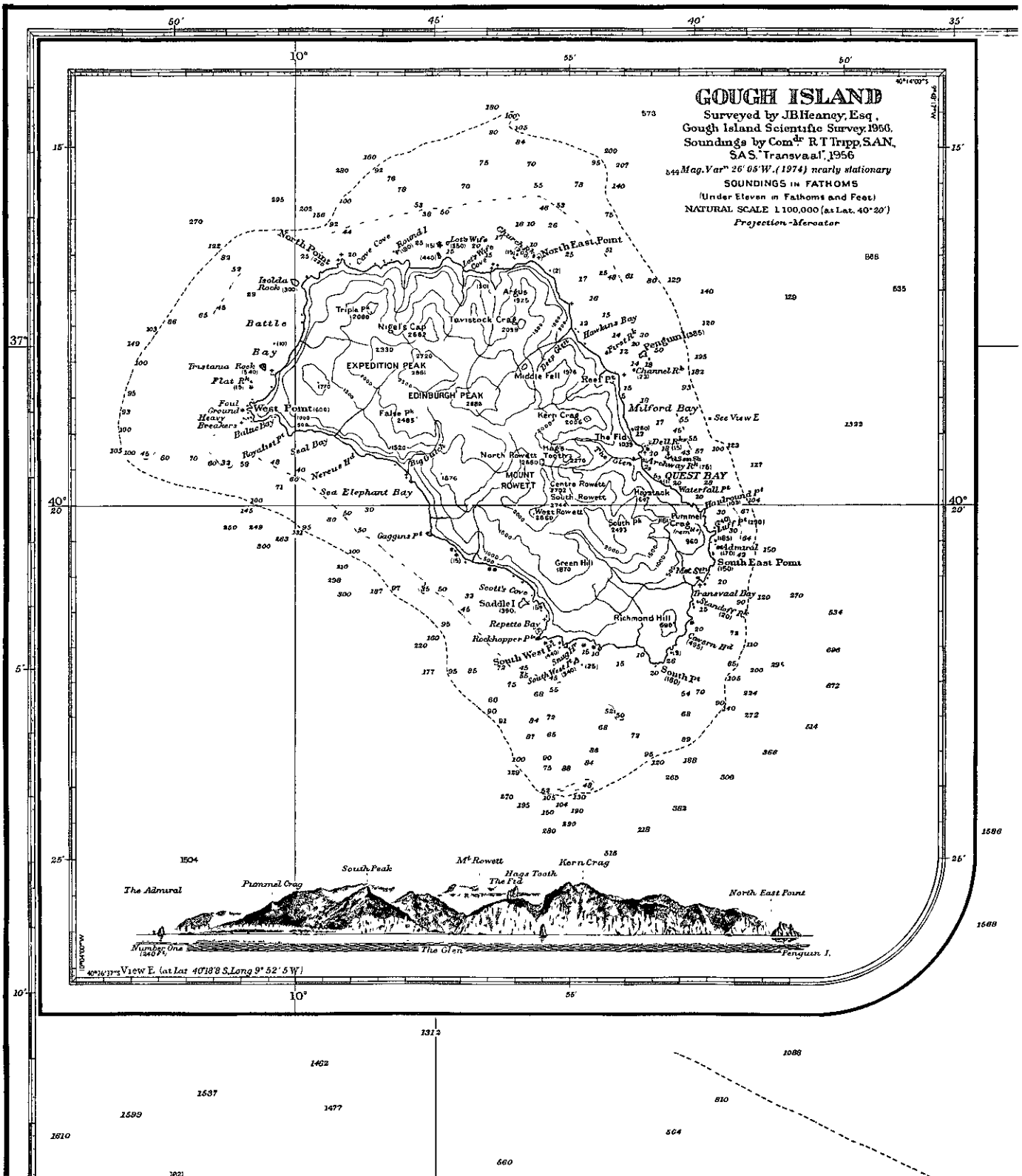
REFERENCE

- ▲ Primary survey point
  - Secondary survey point
  - ⊗ Crater
  - ◌ Pond or lake
  - Intermittent stream
  - L Landing
- Altitudes in metres above mean sea level  
Form lines at 50 metres intervals

Triangulation Survey by O. Langenegger, B.Sc., B.Sc., Ing. and W.J. Verwoerd, D.Sc., January-March 1965. Air photos taken by R.A.F., 13th April 1961. Compiled and interpreted by W.J. Verwoerd. Drawn in the drawing office of the Geological Survey, Pretoria, 1968.

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Underlined figures express in Feet Drying Heights above Chart Datum  
All other Heights are expressed in Feet above Mean High Water Springs  
For Symbols and Abbreviations see Admiralty Chart 5011.



TITLES IN THIS SERIES

1. \*A description of the Savanna Ecosystem Project, Nylsvley, South Africa. December 1975. 24 pp.
  2. \*Sensitivity analysis of a simple linear model of a savanna ecosystem at Nylsvley. W M Getz and A M Starfield. December 1975. 18 pp.
  3. \*Savanna Ecosystem Project - Progress report 1974/1975. S M Hirst. December 1975. 27 pp.
  4. Solid wastes research in South Africa. R G Noble. June 1976. 13 pp.
  5. \*Bibliography on marine pollution in South Africa. D A Darracott and C E Cloete. June 1976. 131 pp.
  6. \*Recycling and disposal of plastics waste in South Africa. R H Nurse, N C Symington, G R de V Brooks and L J Heyl. June 1976. 35 pp.
  7. South African Red Data Book - Aves. W R Siegfried, P G H Frost, J Cooper and A C Kemp. June 1976. 108 pp.
  8. South African marine pollution survey report 1974-1975. C E Cloete and W D Oliff (editors). September 1976. 60 pp.
  9. Modelling of the flow of stable air over a complex region. M T Scholtz and C J Brouckaert. September 1976. 42 pp.
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  11. South African Red Data Book - Small mammals. J A J Meester. November 1976. 59 pp.
  12. Savanna Ecosystem Project - Progress report 1975/1976. B J Huntley. March 1977. 41 pp.
  13. Disposal and recovery of waste paper in South Africa. G R de V Brooks. April 1977. 35 pp.
  14. South African Red Data Book - Fishes. P H Skelton. July 1977. 39 pp.
  15. A checklist of the birds of the Nylsvley Nature Reserve. W R Tarboton. September 1977. 14 pp.
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  27. Nylsvley - A South African Savanna Ecosystem Project: objectives, organization and research programme. March 1978. 37 pp.
  28. A description of the Fynbos Biome Project. June 1978. 25 pp.
  29. Savanna Ecosystem Project - Phase I summary and Phase II progress. B J Huntley and J W Morris. July 1978. 52 pp.
  30. Review of Coastal Currents in South African Waters. T F W Harris. August 1978. 106 pp.
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  32. South African programme for the SCOPE mid-term project on the ecological effects of fire. September 1978. 36 pp.
  33. Fire in South African ecosystems: an annotated bibliography. G U Schirge and A H Penderis. October 1978. 114 pp.
  34. Research on Inland Water Ecosystems in South Africa. R G Noble and J Hemens. October 1978. 150 pp.
  35. South African Antarctic Research Programme, 1978-1982. SASCAR. 39 pp.
- \* Out of print.



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