PROGRESS REPORTS TO

SASCAR

1983

VORDERINGSVERSLAE AAN

SAWKAN

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PREFACE

This volume contains the annual progress reports on research projects supported by the South African Scientific Committee for Antarctic Research (SASCAR). The reports cover the period July 1982 to June 1983. This volume has been distributed free to members of SASCAR and its sub-Committees and to participants in the South African Antarctic Research Programme for their information. The contents are not for publication or citing. The Programme is supported financially and logistically by the Department of Transport on the advice of SASCAR.

VOORWOORD

Hierdie publikasie bevat die jaarlikse vorderingsverslae wat handel oor navorsingsprojekte wat ondersteun word deur die Suid-Afrikaanse Wetenskaplike Komitee vir Antarktiese Navorsing (WKAN). Die verslae dek die periode vanaf Julie 1982 tot Junie 1983. Hierdie publikasie word gratis en slegs ter inligting aan die lede van WKAN en sy sub-komittees, en aan deelnemers aan die Suid-Afrikaanse Nasionale Antarktiese Navorsingsprogram versprei. Die inligting hierin is nie vir publikasie of verwysing nie. Op aanbeveling van WKAN word hierdie program finansieël en logisties deur die Departement van Vervoer ondersteun.

1. SOUTH AFRICAN ANTARCTIC RESEARCH PROGRAMME 1982/83

1. SUID-AFRIKAANSE ANTARKTIESE NAVORSINGSPROGRAM 1982/83

SOUTH AFRICAN SCIENTIFIC COMMITTEE FOR ANTARCTIC RESEARCH (SASCAR)

JULY 1982 TO JUNE 1983

The year under review saw a number of changes in the membership of SASCAR and the establishment of a SASCAR oceanographic sciences subprogramme. The latter, which originally developed under the aegis of SANCOR (South African National Committee for Oceanographic Research), was transferred to SASCAR from the onset of the 1982/83 financial year.

Two new ad hoc Working Groups were established - one to develop a Conservation Policy for the Prince Edward islands and and to investigate the status and future of the earth sciences subprogramme.

The Interdepartmental Antarctic Committee (IAC) under the chairmanship of the Director General: Transport, met in November 1982 for the first time in many years. A Liaison Committee for the IAC was established and this has met three times since its establishment. These two committees bring together all the various facets of the National Antarctic Research Programme (e.g. science, logistics, building programme, Treaty affairs etc) for review and policy making.

SCAR REPRESENTATIVES

South African representatives on SCAR and its various Groups were:

Mr J P de Wit (Permanent Delegate, Vice-President of SCAR); Prof W R Siegfried (Working Group (WG) on Biology); Mr E Fitschen (WG on Geodesy and Cartography); Prof D R Hunter (WG on Geology); Mr J G Nel (WG on Logistics); Mr J van Heerden (WG on Meteorology); Prof L O Nicolaysen (WG on Solid Earth Geophysics); Prof J A Gledhill (WG on Upper Atmosphere Physics); Dr P R Condy (Conservation Subcommittee of WG on Biology); Mr P le Roux (Telecommunications Subcommittee of WG on Logistics) and Mr I Hampton (Group of Specialists on Southern Ocean Ecosystems and their Living Resources). There is no individual South African representation on the WG's on Glaciology and Human Biology and Medicine.

The SCAR XVII meeting in Leningrad from 28 June to 10 July 1982, was attended by Mr J P de Wit, Prof W R Siegfried, Mr J G Nel and Prof J A Gledhill. The SCAR WG's on Geology, Glaciology and Solid Earth Geophysics met in Adelaide in conjunction with the Fourth SCAR Symposium on Antarctic Earth Sciences in August 1982. Prof D R Hunter represented South Africa at the WG's on Geology and Solid Earth Geophysics.

At SCAR XVII in Leningrad, Mr J P de Wit was elected one of the two SCAR Vice-Presidents. He holds this office for four years.

MEMBERS OF SASCAR COMMITTEES

Members of SASCAR and its subcommittes, working groups etc during the year were as follows:

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SASCAR - Mr J P de Wit (Chairman), Dr P R Condy, Mr L N J Engelbrecht, Mr E Fitschen, Prof J A Gledhill, Mr I Hampton, Dr G Heymann (Vice-Chairman), Prof D R Hunter, Dr D C Neethling, Mr G G Nieuwoudt, Mr H M J O Brien, Mr P D Oelofsen, Prof R N Pienaar, Mr J B Shearar, Prof W R Siegfried, Mr G H Stander, Mr O A van der Westhuysen and Mr J van Heerden.

SASCAR Subcommittee for Biological Sciences - Prof R N Pienaar (Chairman) Dr P R Condy, Prof T Erasmus, Prof J R Grindley (Project leader for Coastal Marine Biology), Mr B J Huntley, Mr J G Nel, Prof W R Siegfried (Project leader for Ornithology), Prof J D Skinner (Project leader for Mammalogy), Prof D F Toerien (Project leader for Botany, Entomology and Palynology) and Mr D J van Schalkwyk.

Ad Hoc Working Group on Conservation at the Prince Edward Islands - Dr P R Condy (Convenor), Prof J R Grindley, Mr J G Nel, Mr P D Oelofsen, Prof A Rabie, Dr G A Robinson, Mr G H Stander and Mr D J van Schalkwyk.

SASCAR Subcommittee for Earth Sciences - Mr L N J Engelbrecht (Chairman) Dr P R Condy, Mr E Fitschen (Project leader for Geodesy and Cartography), Prof D R Hunter (Project leader for Geology) Dr D C Neethling, Mr J G Nel, Prof L O Nicolaysen (Project leader for Solid Earth Geophysics) Prof A M Reid, Mr O A van der Westhuysen, Mr D J van Schalkwyk and Mr L G Wolmarans.

Geology Working Party - Prof D R Hunter (Chairman) Prof H Allsopp, Dr J M Barton, Dr P R Condy, Commdt R Dean, Mr J Krynauw, Mr C Potgieter, Mr D J van Schalkwyk, Prof W J Verwoerd and Mr R Wonnacott.

SASCAR Subcommittee for Oceanographic Sciences - Mr J P de Wit (Chairman), Prof B R Allanson, Dr P R Condy, Prof J R Grindley, Mr I Hampton, Dr P A Hulley, Dr J R E Lutjeharms, Mr H M J O'Brien, Prof M J Orren, Dr G J B Ross, Prof W R Siegfried, Prof J D Skinner, Mr O A van der Westhuysen and Mr D J van Schalkwyk.

Local Organizing Committee, 4th SCAR Symposium on Antarctic Biology (Wilderness, September 1983) - Prof W R Siegfried (Chairman), Dr P R Condy, Mrs M Meyer, Mr H M J O'Brien, Prof R N Pienaar, Mr O A van der Westhuysen, Mr D J van Schalkwyk.

SANCGASS - Dr G Heymann (Chairman), Prof N D Clarence, Dr P R Condy, Mr P S du Toit, Prof J A Gledhill (Project leader for Airglow and Ionospherics) Dr G J Kühn (Project leader for Aurora and Geomagnetics) Prof M W J Scourfield, Prof P H Stoker (Project leader for Cosmic Rays) Mr O A van der Westhuysen, Mr R W Vice and Prof A D M Walker (Project leader for Magnetospherics).

SANCGASS Antarctic Working Group - Prof M W J Scourfield (Chairman), Mr M B W Arlow, Dr P R Condy, Mr R Haggard, Mr J G Nel, Mr A W V Poole, Mr M S Potgieter, Dr P R Sutcliffe, Mr D J van Schalkwyk and Mr P Wakerley.

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BIOLOGICAL SCIENCES

As in previous years, most work was carried out on Marion Island. However, SASCAR-funded biologists were also active on Gough Island during the 1982 relief voyage there.

One of the major activities in the year was the preparation for and hosting of the Fourth SCAR Symposium on Antarctic Biology, with the theme "Nutrient Cycles and Food Chains", held in September 1983 at Wilderness near George.

An ad hoc working group commenced work on the preparation of a Conservation Policy for the Prince Edward islands. The first step, in the form of a Code of Conduct, is expected to be completed in 1984.

Work on a guide to the fauna and flora of Marion Island was commenced. An initial version should be completed early in 1984 for distribution to team members and visitors. A more comprehensive, illustrated guide is envisaged in the future.

Projects funded during the 1982/83 and 1983/84 financial years were as follows (* = new projects for 1983/84; ** = projects completed in 1982/83):

(a) Botany, Entomology and Palynology (Project leader - Prof D F Toerien; Home Base - Institute for Environmental Sciences, University of the Orange Free State, Bloemfontein and Department of Entomology, University of Pretoria)

- ** Plant ecology of Marion Island
- Nitrogen cycling on Marion Island (ending March 1984)
- Palynology of Marion Island (ending March 1984)
- Decomposition studies on Marion Island (ending March 1984)
- * Multivariate synopsis of Marion Island soil, climatic and botanical data (ending March 1984)
- * Ecology of the dominant insects involved in decomposition processes on Marion Island

(b) Coastal Marine Biology (Project leader - Profs J R Grindley and G Branch, Home Base - School for Environmental Studies, University of Cape Town)

- Energy flow and biological interactions in the littoral of Marion Island

(c) Mammalogy (Project leader - Prof J D Skinner; Home Base - Mammal Research Institute, University of Pretoria)

- * Migration of the southern elephant seal Mirounga leonina from Marion Island
- Genetic and ecological relationships between two species of fur seals A. tropicalis and A. gazella at Marion Island (ending August 1983)

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- Population ecology of the southern elephant seal Mirounga leonina at Kerguelen Island

- Influence of feral house cats on Marion Island and the effectiveness of hunting as an additional means for their control

- Population ecology of the southern elephant seal Mirounga leonina at Marion Island

(d) Ornithology (Project leader - Prof W R Siegfried; Home Base - Percy Fitz-Patrick Institute for African Ornithology, University of Cape Town)

- Population dynamics and biology of selected species of seabirds at Marion and Prince Edward islands, with particular reference to their mineral and energy contributions to the terrestrial ecosystem (ending March 1984)

- Relationships between the population dynamics of selected species of seabirds (chiefly penguins) and their prey at the Prince Edward and Gough islands (ending March 1984)

*- The feeding ecology of four species of avian predators at Marion and Prince Edward islands

EARTH SCIENCES

Field work in western Dronning Maud Land continued during the 1982/83 austral summer. Geological work on Marion Island was also resumed during the year, with the focus on Pleistocene stratigraphy and vulcanology.

During the year an ad hoc Working Group chaired by Mr L N J Engelbrecht examined, at the request of SASCAR and the Interdepartmental Antarctic Committee, the future of the Antarctic earth sciences subprogramme. Their report was made available to SASCAR in 1983.

Three persons (Prof D R Hunter, Dr J M Barton and Mr J R Krynauw) attended the Fourth SCAR Symposium on Antarctic Earth Sciences in Adelaide during August 1982.

During the year work progressed well on a description of the South African Antarctic Earth Sciences Programme, to be published in the CSP's South African National Scientific Programmes Report series later in 1983 or early in 1984.

Projects funded by SASCAR during the 1982/83 and 1983/84 financial years were as follows (* = new projects for 1983/84; ** = projects completed in 1982/83):

(a) Continental Geology and Geophysics (Project leader - Prof D R Hunter; Home Bases - Department of Geology, University of Natal, Pietermaritzburg; Department of Geology, University of Stellenbosch and the Bernard Price Institute for Geophysical Research, University of the Witwatersrand)

- Investigation, by fission track dating method, of Gondwanaland break-up and the spreading of Antarctica from southern Africa

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- Geochronologic and isotopic investigations of crust-mantle evolution in Queen Maud Land, Antarctica and in sub-Antarctic islands

- Geochemistry and petrology of the Ahlmannryggen

- Study of the metamorphic and plutonic rocks of the Sverdrupfjella

- Sedimentologic-stratigraphical investigation of the Högfonna, Raudberget and Fassettfjellet formations in the Borgmassivet (ending December 1983)

*- The Pleistocene stratigraphy and vulcanology of Marion Island

*- Sedimentologic-stratigraphical investigation of the sedimentary deposits in the Ahlmannryggen

*- Palaeomagnetic and aeromagnetic interpretations of the areas surrounding the Jutulstraumen Glacier, Queen Maud Land, Antarctica

(b) Geodesy and Cartography (Project leader - Mr E Fitschen; Home Base- Surveys and Mapping Branch, Office of the Director General of Surveys, Mowbray, Cape Town)

- Small scale LANDSAT maps

- Large scale orthophoto maps

**- Design of special camera mountings for the installation of air survey cameras in the Antarctic Programme helicopters

(c) Open Ocean Geoscience (Project leaders - Prof L O Nicolaysen and Prof A M Reid; Home Bases - Bernard Price Institute and the Department of Geochemistry, University of Cape Town respectively)

- Southern Ocean lithosphere project

**- Southwest Indian Ridge

*- Africa-Antarctica plate boundary

OCEANOGRAPHIC SCIENCES

During 1982/83 the SANCOR Southern Ocean Programme was transferred to SASCAR. The marine geology and geophysics components of this programme were incorporated into the SASCAR Earth Sciences Subprogramme, while the remaining components were grouped to form the SASCAR Oceanographic Sciences Subprogramme, giving rise to a new, fourth subprogramme in the National Antarctic Research Programme.

An interim SASCAR Subcommittee on Oceanographic Sciences was created to manage the programme on a caretaker basis, while a framework for the new oceanographic research programme is prepared. Once this has been done a programme subcommittee with relevant membership will be established.

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Most activity during the year was directed towards preparing for the SIBEX I voyage on the SA AGULHAS in March/April 1984.

Projects funded by SASCAR during the 1983/84 financial year were (* = new projects for 1983/84):

(a) Marine Biology (Project leaders - Prof B R Allanson, Dr G J B Ross and Prof W R Siegfried; Home Bases - Department of Zoology and Entomology, Rhodes University, Grahamstown; Port Elizabeth Museum and Percy FitzPatrick Institute, University of Cape Town respectively)

*- The distribution and production of plankton in the seas around the Prince Edward islands

- Species diversity and trophic relationships of the marine avifauna in prescribed sectors of the Southern Ocean (ending March 1984)

*- Central data bank for coordination of Antarctic bird banding

*- Prey identification service

(b) Marine chemistry (Project leader - Prof M J Orren; Home Base - Department of Analytical Science, University of Cape Town)

- Marine chemistry in the Southern Ocean

UPPER ATMOSPHERE SCIENCES

As in previous years, most work was carried out at Sanae. Some work continued at Marion and Gough islands as well as aboard the SA AGULHAS A highlight in this respect was the successful completion of Project ISAAC, a 34-day winter cruise through the South Atlantic Anomaly in June/July 1983 with international participation.

Members of SANCGASS involved in the Antarctic Programme held two further workshops in the year under review, to continue their examination of a particular magnetic substorm that occurred at approximately 0040 on Day 208 of 1979. The data base used for this study came primarily from observations made at Sanae, with inputs from Halley Bay, Siple, South Georgia and Geos satellites.

Projects funded by SASCAR during the 1982/83 and 1983/84 financial years were as follows (* = new projects 1983/84; ** = projects completed in 1982/83):

(a) Airglow and Ionospheric Physics (Project leader - Prof J A Gledhill; Home Base - Department of Physics and Electronics, Rhodes University)

- Investigation of the ionosphere over the Antarctic, Southern and South Atlantic Oceans

- International South Atlantic anomaly campaign (ISAAC) (ending March 1984)

- Design and construction of a miniaturized, pulse-coded, transportable ionosonde (ending March 1984)

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(b) Aurora and Geomagnetism (Project leader - Dr G J Kühn; Home Base - Magnetic Observatory, CSIR, Hermanus)

- Monitoring and investigation of the geomagnetic field and aurora at Sanae, Marion and Gough Islands
- Sanae electronicist (support project)

(c) Cosmic Rays (Project leader - Prof P H Stoker; Home Base - Department of Physics, University of Potchefstroom)

- Modulation of cosmic rays by the sun, magnetosphere and atmosphere and magnetospheric particle precipitation

(d) Magnetospheric Physics (Project leader - Prof A D M Walker; Home Base - Department of Physics, University of Natal, Durban)

- Solar terrestrial physics

PUBLICATIONS

South African Journal of Antarctic Research - Volume 10/11 (1981) was published in February 1983. Volume 12 (1982) is due for publication in November 1983.

Supplement 2, SAJAR - published in August 1983 and entitled "Geological Investigations in Western Dronning Maud Land, Antarctica - a synthesis".

South African Antarctic Research Report to SCAR · No 24 (1982) was published in September 1982.

Progress Reports to SASCAR - No 3 (1982) was published in November 1982.

SASCAR Newsletter - No's 8 to 12 (1983) were published during the period under review.

Copies of these are available from CSP.

A bibliography from SASCAR-funded upper atmosphere physics research is contained in the back of this volume. Bibliographies from the SASCAR biological and earth sciences sub-programmes were published in Volumes 2 (1981) and 3 (1982) respectively. Once established, these bibliographies are kept updated and copies are available on request.

FINANCES AND STAFF

The following table summarizes financial and staff aspects of the National Antarctic Programme over the three financial years 1981/82, 1982/83 and 1983/84:

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		1981/82	1982/83	1983/84
1.	Total funds requested on NP 10 forms	995 268	1 589 331	2 035 077
2.	Total funds available at time of allocation	815 000	880 000	1 295 000
3.	Distribution of allocated funds:			
	- biological sciences	35%	30%	25%
	- earth sciences	16%	23%	22%
	- oceanographic sciences	-	-	10%
	- upper atmosphere sciences	49%	47%	42%
	- SASCAR Reserve Fund	-	-	1%
4.	New funds for the year	-	-	245 000
5.	Number of research projects funded:			
	- biological sciences	14	12	15
	- earth sciences	6	10	12
	- oceanographic sciences	-	-	5
	- upper amtosphere sciences	5	5	7
	Total	25	27	39
6.	Average cost per project:			
	- biological sciences	20 500	22 400	22 000
	- earth sciences	21 100	19 900	23 800
	- oceanographic sciences	-	-	25 900
	- upper atmosphere sciences	78 800	82 400	77 500
	Overall	32 600	32 600	33 200
7.	Full-time staff employed on SASCAR Funds (ARO's):			
	- biological sciences	28	21 (3)	26 (3)
	- earth sciences	4 (1)	8 (1)	18 (1)
	- oceanographic sciences	-	-	8 (1)
	- upper atmosphere sciences	30 (7)	28 (7)	30 (8)
	Overall	62 (8)	57 (11)	82 (13)

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	1981/82	1982/83	1983/84
8. Number of different research groups participating:			
- biological sciences	4	4	5
- earth sciences	5	5	5
- oceanographic sciences	-	-	3
- upper atmosphere sciences	4	4	4
Total	13	13	17

P R CONDY
SCIENTIFIC COORDINATOR: ANTARCTIC PROGRAMME
MARINE AND EARTH SCIENCE PROGRAMMES
CSP - CSIR

2. ATMOSPHERIC SCIENCES

2. ATMOSFERIESE WETENSKAPPE

SANCGASS CHAIRMAN'S REPORT

September 1982 - September 1983

Participating Groups

- The Magnetic Observatory of the CSIR
- The National Institute for Telecommunications Research of the CSIR
- Department of Physics, Potchefstroom University for CHE
- Department of Physics and Electronics, Rhodes University
- Department of Physics, University of Natal, Durban

Status of the Programmes

The groups carry out a broad programme of experimental and theoretical research into physical problems in the earth's upper atmosphere, the ionosphere, the magnetosphere and reaching out into interplanetary space. The scientific field is unusual in that progress is best obtained by the intercomparison of different data sets which may have been obtained by a variety of techniques over long periods of observation and from workers in many countries. The working place is thus of a global size and no worker can work in isolation. Because of the influence of magnetic fields on the various phenomena studied the earth's magnetic poles are regions of special interest.

The projects associated with the programme are of two types, the first being data gathering projects which build up data sets over a period of years. These projects are either based in Antarctica as it is here that the Groups have access to a region which is unique or at various points and stations spread over the whole of the RSA and SWA from Hermanus to Tsumeb. Observation over shorter periods are also made on islands in the southern seas and on voyages of the S A Agulhas between Cape Town and SANAE.

The projects include the study of

- Magnetospheric substorms
- Precipitation of electrons and their interactions with the upper atmosphere
- The ionosphere
- Auroral phenomena
- Cosmic particle radiation and cosmic radio noise
- Plasmasphere dynamics
- Magneto-telluric exploration methods
- Modulations of the motions of particles through the heliosphere

Findings and Highlights

An auroral substorm recorded at SANAE has been studied collaboratively by groups from Durban, Grahamstown, Hermanus and Potchefstroom. A serie of nine papers on this work is about to be submitted to the South African Journal of Physics. As a result of numerous workshops on this substorm the groups have a greater awareness of the significance of their individu observational techniques.

The proposed cruise of the S A Agulhas between Cape Town, Gough Island and South America which was the data taking phase of Project ISAAC (International South Atlantic Anomaly Campaigne) was very successfully completed. Project ISAAC involved collaborations from SANCGASS groups as well as participants from the USA, Brazil, Chile, Argentina, France, the United Kingdom and Japan. Preliminary results show that there are indeed effects in the South Atlantic Anomaly that can be attributed to electron precipitation. Analysis and comparison of satellite and groun based data by the various participants should enable a quantitative acco of these effects to be given.

A study has been conducted of the relationship between ground-based VLF (recorded at SANAE) and satellite observed VLF (recorded by ISIS 1 and 2 satellites). A new method has been developed for determining plasma temperatures and temperature profiles as a function of invariant latitud

Much to the delight of the Natal group, a VLF Goniometer which was insta at SANAE at the beginning of 1983, has met all specifications. The

instrument allows determination of the bearing of whistler duct exit points. It is being operated in conjunction with similar equipment at Halley (British) and Siple (USA). The results from the three stations will enable the study of the function and drift of duct enhancements in the magnetoflux.

A method has been developed to determine the spectrum of protons from the sun at SANAE by means of the two neutron detectors 3NM64 and 4NMD and this work was presented at the 18th International Conference on Cosmic Rays which was held in Bangelore, India.

The relative amplitudes of absorption of cosmic radio noize at 20,30 and 51 MHz have been studied in order to determine the hardness of precipitating electrons that cause such absorption. From this it followed that during absorption it is not unusual that electrons occur with energies greater than 200 keV and that absorption peaks registered by riometers are caused by an increase in hardness of the precipitating electrons and not necessarily through an increase in the integral intensity of such electrons.

It is generally accepted that the magnetic signature characteristic of an auroral westward travelling surge (WTS) is a positive spike in the geomagnetic D-component. Recently a number of researchers have proposed three dimensional model current systems to explain this magnetic signature. Although these models are very satisfactory in explaining the positive D-spike in the northern auroral region, a discrepancy appears to arise when they are applied to auroral breakups and surges observed at Sanae. Observations made during a number of substorms at Sanae indicate that the magnetic signature of a WTS is also a positive D-spike. However, when the model current systems are mapped to the southern hemisphere, they suggest that the signature of a WTS should be a negative D-spike. We are presently looking through data recorded at Sanae since 1960 in an attempt to find more examples of WTS events in order to determine whether the signature at Sanae is different to the northern hemisphere due to its being in the southern hemisphere, or due to its being at a lower L-value, or some other reason.

ULF pulsations propagate from the ionosphere to the ground as electro= magnetic waves. At the atmosphere/ground interface and at interfaces

between crustal layers of different electrical conductivity, these waves will be partially reflected and partially transmitted. Conse= quently spatial variations in ground conductivity can be expected to affect observations of pulsations from the same source. The characteristics of Pc3 pulsations recorded at two locations with a large difference in ground conductivity have been studied with a view to shedding more light on this problem. The main conclusion is that large differences in ground conductivity can significantly affect pulsation characteristics observed at different sites - something which should be taken into account when comparing results from different observation sites.

Shortcomings

All the groups involved complain of a shortage of suitably trained man= power. The university groups find it increasingly difficult to attract post graduate students, particularly Ph.D students since military service cannot with certainty be deferred for D-degree studies. This is a very unfortunate situation since it is at the Ph.D stage that the most significant research contribution is made. Apart from this programme the number of Ph.D's produced locally is of the utmost concern to those interested in South Africa's technological future.

All the teams that have activities at SANAE expressed their concern about the availability of expedition members to man the experiments at SANAE. The situation being aggravated by the small number of good prospects being further reduced because they inexplicably fail psycological tests. There seem to be all round agreement that the solution is not entirely to be found by offering members higher salaries but that partial remission of military service duties could be a more effective inducement in recruiting better qualified expedition members.

Prospects

All the groups have expressed great hopes for and interests in the future of the programme. Many are looking forward to further collaborati between groups within as well as outside the country.

Some have acquired new equipment and are excited about new data and results that could be forthcoming. Even so there is concern about the availability of funds for replacing old or obtaining new capital equipment.

G Heymann
CHAIRMAN: SANCGASS

Design and Construction of Miniaturized, Pulse-coded, Transportable Ionosonde (microbal)

Progress report on MICROBAL project

Title of Project: Design and construction of a miniaturized, pulse coded transportable ionosonde (microbal).

History: The project involves the application of modern digital techniques to the design and construction of a miniaturized ionosonde using pulse coding and correlation techniques. The ionosonde will be particularly useful for sea - and aircraft-based measurements. The design was practically complete and construction was well-advanced when funding was stopped in 1980. Completed units are the power supplies, clock, programmer, correlator and receiver. The transmitter is completed except for the power amplifier. The frequency synthesizer is only partially complete. No work has been done on the data capture system.

Progress: The work has not kept up to schedule owing to the unexpectedly heavy calls on technicians' time, mainly in getting the digitized Barry ionosonde ready for Project ISAAC and operating it on board the S A Agulhas. Arrangements have now been made for a three-man team to work on the project and it is expected that we shall meet the deadline of March 1984 in spite of the delays.

PROF J.A. GLEDHILL
G Evans & A Poole

INVESTIGATIONS OF THE IONOSPHERE OVER THE ANTARCTIC AND SOUTHERN SOUTH ATLANTIC OCEAN

Gledhill, J A &
Poole, A W V

ANNEXURE 1

EXPLANATORY NOTE

A specific research project in upper atmospheric physics will often require, amongst other things, the comparison of extended data sets with those of other workers. In the South African context, some of these workers are local and some abroad. This requires that, in the first instance, much team effort be devoted to the development and maintenance of experimental apparatus and to the acquisition of data sets that are extended in time. It is thus not possible to associate any individual worker exclusively with a specific research project, nor is it possible to link a research project with any specific amount of funding, either in terms of salaries, or in terms of running expenses. Rather, it is the combined efforts of all the group personnel in the fields of administration, training, equipment development and maintenance, data acquisition and analysis, together with those of other groups, which enable progress to be made.

As this NP10 form is an application for funds to finance such a general research effort, only those aspects appropriate to the general programme (items 1 - 6, 12 - 16) have been detailed. Information regarding the objectives, rationale, key questions and research approach, proposed work plan and end products of specific research projects, where appropriate, may be found by referring to the detailed progress report, Annexure series (2).

Annexure 2(a)

Project No 2

Observations of precipitating electrons in the South Atlantic Anomaly from D M S P satellites and with the Photoelectron Spectrometer on Atmosphere Explorer C

Duration: 1980 - ?

Project Leader: Prof J A Gledhill

Objectives: To extend to lower and higher energies the spectra of electrons in the South Atlantic Anomaly studied in Project No 1.

History: Contact with staff members of the World Data Center in Boulder, Colorado, U S A during 1980 suggested that the electron spectrometers on several D M S P (Defence Military Satellite Program) spacecraft had measured electron fluxes in the S A Anomaly for some years at energies in the range 30 - 250 keV. Three magnetic tapes of data for 1976 were therefore ordered and eventually delivered.

Similarly, workers at Goddard Space Flight Center pointed out that the Photoelectron Spectrometer on AE-C had measured fluxes below the 200 eV limit of the low-energy particle detectors. Computer prints of sample data were brought back to South Africa for study.

Scientific Progress: Investigation showed that the D M S P tapes were corrupted, as reported last year. During a visit to the World Data Center in Boulder in August last year I discussed this with Dr H Kroehl, who promised to look into it and send new tapes. He pointed out that this would take some time since he was short-staffed. Until the present nothing further has been received.

The photoelectron fluxes are about two orders of magnitude greater than expected. This matter has still not been resolved with Dr Doehring.

One of the main problems is that these records are old history

to those who work in the U S A and they are very reluctant to spend time on them. It may be that only personal presence in their institutions will solve the problems. The project is nevertheless of considerable scientific value and we shall continue with our efforts to resolve the problems.

Publications: None.

Annexure 2(b)

Project No 3

Theory of the Interaction of Electrons with the Upper Atmosphere

Duration:	1975 - ?
Project Leader:	Prof J A Gledhill
Co-workers:	Dr D A Gagliardini — Both at CAERCEM, Buenos Aires, Argentina Miss H Karszenbaum Dr E Mravlag
Objectives:	To develop a relatively simple theory which can be used economically on a medium-sized computer, by means of which the ionization, airglow emission and radio-wave absorption caused by precipitated electrons can be calculated for comparison with experimental results.
History:	Dr Gagliardini and his wife, H Karszenbaum, worked on this project at Rhodes for 8 months in 1975. A preliminary paper was read at the S T P Conference in Boulder, Colorado in 1976 and a modified version was submitted to J. Geophys. Res. in 1978. After modification this was acceptable to one referee but not to the other. Since then development has been hampered by unaccountable delays and non-delivery of postal material between the two groups.
Scientific	With the aid of a grant from the Rhodes University Council, Dr E Mravlag joined our group from Innsbruck. He was able to improve the program and test it out in comparison with the results of the original very much more complex one published by Banks et al in 1974. The program now gives results which compare very favourably with those shown by Banks et al and is now publishable. It is being written up in stages as time permits and will be resubmitted before the end of 1983.
Publication:	None

Annexure 2(c)

Project No 4

Synoptic Observations of the Ionosphere at Sanae and Grahamstown

Duration: 1962 -

Project Leader: Mr R Haggard

Co-workers: Prof J A Gledhill, Mr A W V Poole, Mr D Kriel, Mr R I M Fisher, Mrs J Scrooby, Mrs L Williams

Objectives: To study the long-term behaviour of the ionosphere at Sanae and Grahamstown. To contribute synoptic observations of ionospheric characteristics at these two places to the world-wide data bases at the World Data Centers in Japan, the U K, the U S A and the U S S R. To use the observations for the better understanding of the agencies that control the ionosphere and their mode of action.

History: The first ionograms were made at Sanae in May 1962 and the project has continued ever since, now covering nearly two complete sunspot cycles. Several papers have been published on the analysis of these data and their comparison with those from other stations. Monthly bulletins are circulated to the World Data Centers and to 35 other interested bodies in various countries.

Scientific Progress: With the changeover from the ICL 1904 computer to the CDC Cyber 825 last year, problems were encountered in running the bulletin program, especially in so far as the sporadic E median values were concerned. Unfortunately, the previous program was written in a style incompatible with the CDC computer. The part-time services of a student, Mr C Hannah, have therefore been used to rewrite the program, which is now almost ready for running again. As a result,publication of monthly bulletins has been held up, but it is expected that they will begin to flow again very shortly.

Data taken during the event of 17 July 1979 have been analyzed carefully and have given very encouraging results for precipitated electron spectra.

Publications:

Gledhill, J A, Haggard, R and Dore I S (see also project No 8) The ionosphere at Sanae, Antarctica, during a magnetospheric substorm on 27 July 1979, from ionograms and airglow photometry, Paper D 10 and at 27th Annual Conference of SAIP Stellenbosch July 1982.

Gledhill, J A, Haggard, R and Dore, I S.
The ionosphere at Sanae, Antarctica, during a magnetospheric substorm on 27 July 1979, from ionograms and airglow photometry. Paper read at URSI International Radio Symposium, Fairbanks, Alaska, August 1982.

Annexure 2(d)

Project No 5

Investigation of the Ionosphere between Sanae and Grahamstown by means of Oblique Incidence Ionograms

Duration: 1975 - ?

Project Leader: Prof J A Gledhill

Co-workers: Mr A W V Poole, Mr R Haggard, Mr D Kriel, Mr R I M Fisher, Mr G P Evans

Objectives: To use oblique ionograms recorded at Grahamstown from Sanae to deduce conditions in the ionosphere in the reflection regions between. To use oblique ionograms to compare predicted maximum usable frequencies for communication on the South Africa - Sanae path with those actually observed.

History: With the installation of Barry Vertichirp Ionosondes at both Sanae and Grahamstown it became possible to record oblique ionograms automatically every 15 minutes on the same film as the vertical ionograms. Two-way flight-time calibrations, carried out once a week, showed considerable drifts to occur between the timing standards at the two stations, however, and these have yet to be traced and remedied.

Scientific Progress: With the change of Ph.D subject by Mr G E Oberem, reported last year, there has been no-one to work on this aspect of the Antarctic research programme. Oblique ionograms are regularly recorded and it is hoped that a Ph.D candidate will again be found to undertake this most important aspect of the interpretation of our records. Meanwhile Dr Rash and Prof Gledhill are continuing with the publication of the results of his thesis in this field.

Publication: Rash, J P S and J A Gledhill: Ionospheric propagation over the 4469 km path from Sanae, Antarctica to Grahamstown, South Africa: A preliminary analysis
Paper read at Symposium on Antennas and Propagation, SA Institute of Electrical Engineers, 16 May 1983 and published in the Transactions thereof.

Annexure 2(e)

Project No 6

Digitization of Barry Vertichirp Ionosondes - Phase 1

Duration: 1975 - 1983

Project Leader: Mr A W V Poole

Co-workers: Mr G P Evans

Objectives: To convert a standard ionosonde to give digital output, so enabling measurements of angle of arrival and Doppler shift of the signal returned from the ionosphere, as well as the normal ionospheric parameters of virtual height and critical frequency.

History: Experience in operating the Barry ionosondes led to the conclusion that it should be possible, with modern electronic techniques, to obtain the output in computer-compatible digital form, thus simplifying the processing of the data, and to extend the system to measure angle of arrival and Doppler shift, thus making it possible to observe quantitatively ionospheric motions and structures, such as the mid-latitude trough, which passes over Sanae frequently. At the same time the ionosonde could be modified for microcomputer control, making it comparable in versatility with the most advanced instruments overseas.

Scientific Progress: The receiving antenna system has been completed and calibrated, and final testing of the controller is complete. Initial results are very encouraging. The system is thus ready for shipment to Sanae at the end of 1983. This work is to be published in Radio Science and will be reported at the 1983 SAIP Conference. The success of this project has been such that Mr Poole has been asked to act in a consultative capacity by the NITR and the manufacturers, BR Communications in recent negotiations to purchase a similar device for the NITR. Because of the prospect of co-operative research with the NITR, it is hoped that a second system can be built in 1984.

This project can be considered complete.

Publications: Evans, G P. Microprocessor control of a Barry Research "chirp sounder', Paper D23 read at the 27th annual conference of the S A Institute of Physics, Stellenbosh, 1982.

Poole A W V , Angle of arrival measurements using a digitized "chirp" ionosonde, Paper D 24 read at the 27th annual conference of the S A Institute of Physics, Stellenbosch, 1982.

Poole, A W V, Evans G P and Gledhill J A. First results from the digitized chirp ionosonde destined for Sanae, Antarctica Paper read at URSI International Radio Symposium, Fairbanks, Alaska, August 1982.

Annexure 2(f)

Project No 7

Investigation of the Ionosphere over the South Atlantic and Southern Oceans from Shipboard

Duration: 1974 -

Project Leader: R Haggard

Co-workers: Prof J A Gledhill, Dr J P S Rash

Objectives: To make vertical incidence investigations of the ionosphere in the unknown regions to the south and west of South Africa, including the South Atlantic Anomaly. To interpret these observations in terms of the particle precipitation which is unique to this region of the atmosphere.

History: The portable ionosonde "Minibal", constructed in the Department in the early 1970's, has been operated on the R S A and the S A Agulhas on relief voyages to Sanae, Gough and Marion Islands, and on special great-circle voyages between Sanae and South Africa, for comparison with the other method of investigating the ionosphere in this relatively inaccessible region, oblique incidence sounding (Project No 5). Analysis of a series of observations made at Gough Island indicated that the E-region showed an unusual diurnal variation which could be accounted for by precipitation of electrons from the magnetosphere.

Scientific Progress: The project has been held up by the very slow response of some stations in supplying ionospheric data for the period of the Gough Island observations, but enough has now been collected to allow us to look at the Gough Island data in comparison with others. It is expected that this aspect of the project will result in a publication early in 1984.

The data from the great-circle voyage of 1976 have been compared with those from the oblique-incidence ionograms taken simultaneously between Sanae and Grahamstown. A paper is in process of preparation by Rash and Gledhill and will be submitted for publication before the end of 1983.

The observations of the ionosphere over the path of the winter cruise of July 1979 have been scaled for the period of the event of 26/27 July 1979 for comparison with those from other stations, Sanae, Hermanus, Grahamstown and Johannesburg.

Publications: Haggard, R. Observations of the ionosphere over the South Atlantic at 35^{o}S 10^{o}W (L = 2,3) during the event of 26/27 July 1979. Paper D8 read at the S A Institute of Physics Conference, Stellenbosch, July 1982.

Annexure 2(g)

Project No 8

Observation of Airglow at Sanae and Analysis of Data

Duration: 1976 -

Project Leader: Mr I S Dore

Co-workers: Prof J A Gledhill, Miss H Mackay, Mr R I M Fisher

Objectives: To measure the intensity of radiation from the upper atmosphere at 391,4; 557,7 and 6,30 nm during dark night periods at Sanae. To interpret the observations in terms of aeronomic processes and particle precipitation in the ionosphere, especially during events such as the magnetospheric storm of 27 July 1979 being studied by the SANCGASS group.

History: Airglow photometers of the tilting-filter type with analog output have been operated at Sanae since 1976 during the winter months, April-September. Interpretation of the records has suffered from lack of manpower but papers have been read on isolated events at Conferences of the S A Institute of Physics.

Scientific progress: The photometers have been operated at Sanae during 1982/3 and a preliminary examination has been made of the 1982 records to pick out interesting events for study.

During 1982 several new circuits were built up and successfully installed in the Sanae airglow system during the 1982/83 take-over. These circuits have made it possible to observe airglow at more zenith angles in a meridian scan, and to perform meridian scans more often. This will considerably improve the usefulness of the data obtained.

Quarter-hourly data have been carefully scaled for the event of 27 July 1979 and the calibration procedure and constants were critically examined. The data from the meridian scans have been presented as contour maps with time and zenith angle as the coordinates. These are very useful for comparison with other data such as the $H\beta$ records from the Hermanus group and the ionosonde data.

Publications: Gledhill, J A, Haggard, R and Dore, I S. See Project No 4 for details of paper read at SAIP Conference, Stellenbosch and URSI International Radio Symposium, Fairbanks, Alaska.
A draft paper has been written on this event and will be discussed at a workshop later this year before submission to the S A Journal of Physics as one of a group from the four research teams combining to study the event.

Annexure 2(h)

Project No 9

Digitization of Tilting Filter Airglow Photometers

Duration: 1980 -1983

Project Leader: Mr I S Dore

Co-workers: Prof J A Gledhill

Objectives: To replace the present analog output of the airglow photometers by digital output and to institute microcomputer control of their functions. By doing this the operator will be spared long watches of up to 16 hours during midwinter and the output will be available in computer-compatible form without manual scaling of paper chart records as at present.

History: The project was started by Mr C Grujon in 1980. He completed most of the hardware and paid particular attention to the photon counting technique, filter temperature control and shutter control.

Scientific Progress: Digitization of the photometers is complete and they will be used on the ISAAC cruise. After a further period of testing they will be sent to Sanae at the end of 1983.

Publications: None

Annexure 2(i)

Project No 10

Observation of Airglow at Grahamstown and Analysis of Data

Duration: 1981 -

Project Leader: Prof J A Gledhill

Co-workers: Mr I S Dore

Objectives: To measure airglow intensities at 391,4; 557,7 and 630 nm at Grahamstown, for comparison with ionograms, to look for effects due to electron precipitation from the magnetosphere.

History: An analysis of Grahamstown ionograms for 1976 showed at least eight occasions on which a typical particle-E layer appeared during the night, at times when no E layer is normally present. It was desirable to measure airglow simultaneously, since the presence of 391,4 nm airglow would confirm the particle origin of the ionization. An airglow photometer at Sutherland was kindly made available by the N I T R. Unfortunately, owing primarily to the absence of documentation, it took much longer than anticipated to get it working, to the detriment of the other airglow programmes. It was operated successfully during suitably dark periods during 1981 and 1982 and the records have been scanned for events.

Scientific Progress: No events of sufficient magnitude to warrant further study were observed in 1982. The project has been discontinued in 1983 because no student assistance could be found to run the photometer during nights. It appears now that there may be a sunspot cycle effect and that 1985-88 may be a better period for study. The project will nevertheless be continued as and when assistance is available.

Publications: None

MODULASIE VAN KOSMIESE STRALE DEUR SON, MAGNETOSFEER EN ATMOSFEER EN MAGNETOSFERIESE DEELTJIEPRESIPITASIE

NAVORSINGSWERK TE POTCHEFSTROOM WAT AANSLUIT BY DIE ANTARKTIESE NAVORSINGSPROGRAM OP KOSMIESE STRALE EN WAT NIE DIREK DEUR DIE FONDSE VIR ANTARKTIESE NAVORSING ONDERSTEUN WORD NIE.

1. DOELSTELLINGS VAN PLAASLIKE NAVORSINGSPROGRAMME OP KOSMIESE STRALE

Die doelstellings kan in die volgende gebiede gestel word:

1.1 Modulasie van kosmiese strale

Dit is die studie van die transport van kosmiese strale deur die heliosfeer, sowel vanaf die galaktiese (interstellêre) ruimte na die Aarde as vanaf die Son na die Aarde.

1.2 Registrasie met aardgebonde detektore

Ons meetinstrumente is aardgebonde, naamlik neutronmonitors te Tsumeb, Potchefstroom, Hermanus en Sanae, asook op die S.A. Agulhas. Slegs primêre kosmiese strale (d.i. gelaaide deeltjies wat bo die atmosfeer aankom) met energieë $\geq$ 1 GeV kan deur hierdie instrumente op grondvlak waargeneem word. Die aarde se magneetveld beperk waarnemings tot kosmiese strale met styfhede groter as die afsnystyfheid Pc. Met Pc = 9,4 GV vir Tsumeb, 7,3 GV vir Potchefstroom, 4,7 GV vir Hermanus en 1,02 GV vir Sanae kan veranderinge in die primêre spektrum van kosmiese strale bestudeer word m.b.v. relatiewe veranderinge in die teltempo's van hierdie neutronmonitors. Dit is daarom belangrik om atmosferiese absorpsie-effekte en beweging van gelaaide deeltjies deur die Aarde se magneetveld te bestudeer.

1.3 Bepaling van primêre spektrum deur breedtegraadopnames

Breedtegraadopnames is veral belangrik gedurende sonstiltetydperke om die primêre spektrum van kosmiese strale in die styfheidsgebied tussen 1 GV en ~ 18 GV te bepaal. In hierdie tydperk is daar 'n minimum modulasie van kosmiese strale in die heliosfeer. 'n Wêreldwye opname op seevlak word vir 1986/7 in vooruitsig gestel in opvolging van die vorige drie opnames in 1954 (Rose e.m.), 1965 (Carmichael e.m.), en 1976 (Potgieter e.m.).

2. JAARVERSLAG 1982/3

2.1 Modulasiestudies

2.1.1 'n Model vir die modulasie van Galaktiese Kosmiese Strale (M.S. Potgieter en H. Moraal)

Die verandering in die spektrum van galaktiese kosmiese strale soos die strale deur die heliosfeer beweeg, word as funksie van posisie, energie en

tyd bestudeer. Die doel van enige modulasiestudie is om 'n kwantitatiewe verklaring vir modulasieverskynsels soos op die Aarde waargeneem word, te vind. Die 11-jarige modulasiesiklus is hier die bekendste voorbeeld. 'n Kwantitatiewe beskrywing vir die waargenome 22-jarige modulasiesiklus is egter nog uitstaande.

Die meganismes vir langtermynmodulasie soos in die invloedsfeer van die Son, of kortweg die heliosfeer genoem, voorkom, kan saamgevat word in 'n transportvergelyking vir kosmiese strale. Indien $U_p(\underline{r},p,t)$ die differensiële deeltjiedigtheid as funksie van posisie, momentum en tyd is, is die vergelyking:

$$\frac{\partial U_p}{\partial t} + \underline{\nabla}.(\underline{V}U_p - \underline{\underline{\kappa}}.\underline{\nabla}U_p) - \frac{1}{3}(\underline{\nabla}.\underline{V})\frac{\partial}{\partial p}(pU_p) = 0$$

met $\underline{V}$ die sonwindsnelheid wat radiaal vanaf die son uit beweeg en

$$\underline{\underline{\kappa}} = \begin{bmatrix} \kappa_{11} & 0 & 0 \\ 0 & \kappa_{\perp} & \kappa_T \\ 0 & \kappa_T & \kappa_{\perp} \end{bmatrix}$$

die diffusietensor vir kosmiese strale in die interplanetêre magneetveld (IMV)

Die meganismes vir modulasie is basies 'n konveksie radiaal uitwaards weens die sonwind en dan (i) diffusie van deeltjies na binne parallel (κ_{11}) aan die magneetveld deur 'n proses van verstrooiing weens nie-homogeniteite in die veld; (ii) diffusie loodreg ($\kappa_{\perp}$) op die magneetveld en (iii) dryfbewegings van gelaaide deeltjies weens die anti-simmetriese diffusiekoëffisiënt κ_T.

Huidig word meestal slegs 'n sferies-simmetriese model ($\kappa_{\perp}=\kappa_T=0$) of eendimensionele model gebruik. Eksperimentele gegewens met satelliete wat verder as die Aarde vanaf die Son beweeg (>1AU) soos Pioneer 10 en 11 dui daarop dat so 'n eenvoudige model tekort skiet. Pioneer 10 het byvoorbeeld tot $\sim 16°$ bokant die ekliptiese vlak beweeg en insig oor die struktuur van die IMV verskaf wat sterk ondersteunend vir dryfeffekte is.

Die doel van hierdie projek is dus om 'n modulasiemodel wat dryf bevat, te ontwikkel en uitspraak te lewer of die invloed van κ_T van wesenlike belang vir die verklaring van waargenome modulasieverskynsels, anders as bloot op 'n ad hoc basis is. Die eerste mikpunt is dus om 'n kwantitatiewe beskrywing vir die 22-jarige modulasiesiklus te vind.

Die studie het tot dusver die volgende behels:

(i) 'n Oorsig van die sferies-simmetriese modulasiemodel wat afgehandel is met 'n publikasie in Astrophysics and Space Science, 1982.

(ii) Die verbetering en afronding van die numeriese differensiasie tegnieke waarop die gerekenariseerde oplossing van die transportvergelyking gebaseer is.

(iii) 'n Studie van die funksionele vorm van die diffusiekoëffisiënte wat die vertrekpunt vir die ontwikkeling van 'n kwantitatiewe dryfmodel vorm.

(iv) 'n Neutrale vlak bestaan in die heliosfeer aangesien die interplanetêre magneetveld (IMV) in die noordelike en suidelike halfrond teenoorgestelde polariteite het. Aangesien $\kappa_T \propto \frac{1}{B}$ waar B die grootte van die IMV is, moet besondere aandag aan die hantering van dryf in die neutrale vlak gegee word. Randwaardes eie aan die situasie is ontwikkel, bestudeer en in die rekenaarprogram geïmplimenteer.

(v) Die ontwikkeling van die dryfmodel tot 'n vlak waar uitspraak oor die rol en belang van dryfbeweging van gelaaide deeltjies, spesifiek gerig op eksperimentele gegewens onder andere verkry met neutronmonitors, gegee kan word. Die belangrikste eksperimentele getuienis is

(a) Intensiteit van met energie $\lesssim$ 1 GeV was hoër in 1976 as in 1965.

(b) Daarenteen het neutronmonitors in 1976 laer teltempo's as in 1965 gehad.

(c) Elektrone het die teenoorgestelde effek as in (a) hierbo getoon.

(d) Asimutale anisotropieë het in amplitude en fase tydens die ompoling van die IMV verander.

(e) Breedtegraadsopnames met neutronmonitors gee dat die differensiële intensiteitspektra vir 1954 en 1976 saamval, maar duidend verskil van 1965. Hieruit blyk dit dat die spektrum in 1976 en 1954 sagter as in 1965 was.

2.1.2 Studie van die beweging van gelaaide deeltjies in niehomogene magneetvelde
(R.A. Burger, J.J. Henning en H. Moraal)

Die transport van kosmiese strale in die interplanetêre ruimte word beïnvloed deur die teenwoordigheid van elektromagnetiese velde en verstrooiing in posisie- en momentumruimte deur onreëlmatighede in die magneetveld. Die sonwind voer deeltjies weg vanaf die son, en daar is dus twee inersiaalstelsels ter sprake, nl. die sonwind- of plasmastelsel en die waarnemerstelsel. Die magneetvelde ter sprake is hoofsaaklik die magneetveld van die son wat vasgevries is in die sonwind, en die elektriese velde hoofsaaklik dié wat geïnduseer word as gevolg van die beweging van die genoemde magneetvelde ten opsigte van die waarnemerstelsel.

Die transportvergelyking word verkry deur die eerste twee momente van die Boltzmannvergelyking te bereken. Dit verskil egter van die bestaande transportvergelyking, hoofsaaklik weens die hantering van die botsingsterm. Laasgenoemde term beskryf die verstrooiing van gelaaide deeltjies deur onreëlmatighede in die magneetveld.

'n Relativistiese behandeling van die probleem het aangetoon dat die botsingsterm se vorm dieselfde is as dié van die nie-relatiwistiese behandeling, en dat die verskille tussen die twee Transportvergelykings nie net Transformasieverskille is nie. 'n Belangrike punt is dat in die geval van swak verstrooiing beide vergelykings dieselfde vorm aanneem.

Die resultate van hierdie werk word tans saamgevat met die oog op 'n publikasie.

2.1.3 Modulasiestudies: Dagvariasies in die intensiteit van kosmiese strale
(M. Lemmer en H. Moraal)

Mev. M. Lemmer het gedurende 1982/1983 op die dagvariasie in die intensiteit van kosmiese strale gewerk. Dit is lank reeds bekend dat daar 'n skynbare 22-jaarvariasie in die amplitude en fase van dié dagvariasie bestaan. In die studie is data van die neutronmonitor te Hermanus gebruik. Daar is gevind dat met die ompoling van die interplanetêre magneetveld in 1969 tot 1971 die amplitude met ≈ 25% afneem en die tyd van maksimum intensiteit met ≈ 70 minute vervroeg. Die unieke aspek van dié studie was dat gepoog is om die resultaat in terme van standaard modulasieteorie te verklaar. Hierdie aanvanklike modelstudie was onsuksesvol omdat die modulasieteorie 'n asimutale onafhanklikheid aanvaar, en staatmaak op die identifikasie van een of ander simmetrievlak in heliobreedtegraad. Daar bestaan geen onafhanklike data om só 'n simmetrievlak - en die aarde se posisie ten opsigte daarvan - te identifiseer nie. Tweedens is gepoog om die amplitude en fase van die dagvariasie met uurlikse metings van die interplanetêre magneetveld te korreleer. Hieruit is aangetoon dat die fase in sterk korrelasie met die ekliptiese komponent van die veld verander. Daar kon geen duidende korrelasie tussen die amplitude en enigeen van die magneetveldkomponente gevind word nie. Een van die redes hiervoor was dat daar vir slegs sowat 2 jaar (in 1974/75/76) interplanetêre magneetvelddata beskikbaar was.

2.1.4 Stapgewyse en skokbepalende modulasie van kosmiese strale
(P.J. Ankiewicz, H. Moraal en P.H. Stoker)

Wanneer die teltempo's van neutronmonitors by hoë en lae afsnystyfhede grafies teen mekaar uitgesit word, blyk dit dat gedurende die oploopfase van sonaktiwiteit die teltempo van die neutronmonitor by hoë afsnystyfheid met periodes van 6 tot 18 maande op 'n gedeeltelike herstel van modulasie dui, terwyl kosmiese strale by laer afsnystyfhede geen of 'n relatief klein herstel toon. Die oorsaak van hierdie sogenaamde stapgewyse modulasie is gesoek in 'n moontlike versnelling van kosmiese strale deur skokgolwe wat vanaf sonuitbarstings die interplanetêre ruimte inbeweeg. Hierdie skokgolwe word deur satelliete en ruimtetuie tot diep in die interplanetêre ruimte waargeneem. Skokgolwe veroorsaak SSC's (skielike begin van magtetiese storms) in die aarde se magneetveld en Forbushafnames in teltempo's van kosmiese strale.

Uit die studies kon nie aangetoon word dat skokversnelling 'n bydrae lewer tot stapgewyse modulasie of tot Forbushafnames nie. Forbushafnames kan wel verklaar word deur 'n wegvee (konveksie) van kosmiese strale deur die verhoogde verstrooiingseffek van 'n skokgolf. Die studie het wel positiewe resultate m.b.t. Forbushafnames gelewer, wat gepubliseer sal word.

2.1.5 Skokversnelling van kosmiese strale in plofgolwe van supernova
(H. Moraal en W.I. Axford)

H. Moraal was gedurende 1982 met studieverlof aan die Max Planck Institut für Aeronansie, Lindau (Jan.-Junie) en aan die Max Planck Institut für Kernphysik (Julie-Des.) om versnelling van kosmiese strale in supernovaplofgolwe te bestudeer.

Daar is aangetoon hoe die teorie van versnelling in plat stasionêre skokke as 'n eerste stap uitgebou kan word om dit op sferiese, nie-stasionêre

plofgolwe toe te pas. Die resultaat van die studie was dat sulke plof=golwe die waargenome spektrum van kosmiese strale tot $\approx 10^{13}$eV kan ver=klaar. Vanweë 'n te groot interplanetêre diffusiekoëffisiënt en 'n te klein skokstraal kan die spektrum nie tot $\approx 10^{15}$ eV verleng word, waar daar 'n waargenome knak voorkom nie.

P.H. Stoker

Potchefstroom
29 Junie 1983

ANTARKTIESE NAVORSINGSVERSLAG AAN SANKGAR: 1982/3

Inrigting: POTCHEFSTROOMSE UNIVERSITEIT VIR CHO

1. Projek: Energiespektra van relatiwistiese sonprotone

Duur: 1971 - onbepaald

Projekleier: Prof. P.H. Stoker

Doelwit: Om die energiespektrum van relatiwistiese protone afkomstig van 'n sonvlam, te bestudeer.

Waarnemings: Vanaf Mei 1971 funksioneer 'n enkel neutrongemodureerde detektor (1NMD) tesame met die neutronmonitor (3 NM64) te Sanae. Vanaf Februarie 1974 is die 1NMD tot 'n 4NMD met 'n verbetering van 'n faktor 2 in die statistiek van die tellings, verander.

Resultate: Die protongebeurtenisse van 1-2 September 1971, 24 September 1977, 22 November 1977, 7 Mei 1978 en 23 September 1978 is bestudeer en die energiespektra en die verandering in die energiespektra tydens die aktiewe fase van die sonvlam is bepaal. 'n Vergelyking van die relatiwistiese spektra met die nie-relatiwistiese data soos bepaal met satelliete, toon 'n harder spektrum vir die relatiwistiese protone as vir die nie-relatiwistiese protone. Hierdie verskil in hardheid kon nog nie verklaar word nie.

Publikasies:

1. Stoker, P.H. en Louw P.A., The spectra of solar proton ground level events recorded at Sanae. Conference Papers, art. ST 5.2-17, 18e Internasionale Konferensie op Kosmiese Strale, Bangalore, 1983.

2. Louw, P.A., Die bepaling van die spektra van sonprotone uit grondwaarnemings met neutrondetektore te Sanae, PU vir CHO, Nov. 1982.

2. Projek: Bepaling van die energiespektrum van kosmiese strale by styfhede $\gtrsim$ 1 GV

Duur: 1962 - onbepaald

Projekleier: Prof. P.H. Stoker

Medeleiers: Dr. A.J. van der Walt, mnr. M.S. Potgieter

Doelwit: Om die energiespektrum van primêre kosmiese strale voortdurend te monitor.

Waarnemings:

1. Vanaf 1962 tot 1977 word breedtegraadsopnames van kosmiese strale met 'n neutronmonitor op die m.s. R.S.A. tydens aflosvaarte gedoen en vanaf 1977 word die breedtegraadsopnames met die S.A. Agulhas

tydens aflosreise en navorsingsvaarte gedoen.

2. Vanaf 1964 word intensiteitsveranderinge op die neutronmonitor (3 NM64) te Sanae waargeneem en ontleed in vergelyking met oor= eenkomstige veranderinge van teltempo's van neutronmonitors in Suid-Afrika en van oorsese neutronmonitors.

3. Vanaf 1971 word van die differensiële gevoeligheidseienskappe van die neutronmonitor (3 NM64) en die neutrongemodureerde detektor (NMD) gebruik gemaak om spektraalveranderinge in primêre kosmiese strale te monitor en te ontleed.

Resultate:

1. Funksiebepaling van breedtegraadverloop van kosmiese strale

Dr. A.J. van der Walt het 'n studie gemaak van die passing van 'n Dormanfunksie $N = N_o (1 - \text{eksp } (-\alpha P^{-k}))$ op die teltempo N van kos= miese strale as 'n funksie van die afsnystyfheid P vir 'n konstante diepte in die atmosfeer. Hierdie werk is in opvolging van die M.Sc.-studie van mnr. F. van Niekerk gedoen, om die standaard afwy= king van die passing op 'n statisties-verantwoordelike wyse te be= paal.

Dr. Van der Walt het 'n nuwe metode ontwikkel om die konstantes N_o, α en k van die funksie vir beste passings, tesame met hulle standaardfoute, te bepaal. Hy het sy metode toegepas op breedte= graaddata verkry op seevlak en op vliegtuigdata. Sy metode word op die breedtegraadopnames van die S.A. Agulhas tydens aflosreise vanaf Kaapstad na Sanae en subantarktiese eilande toegepas.

Hierdie werk is van wesenlike belang om primêre spektra van kos= miese strale te bepaal vir modulasiestudies.

2. Stapgewyse en skokbepalende modulasie van kosmiese strale

Wanneer die teltempo's van neutronmonitors by hoë en lae afsny= styfhede grafies teen mekaar uitgesit word, blyk dit dat gedurende die oploopfase van sonaktiwiteit die teltempo van die neutronmoni= tor by hoë afsnystyfheid met periodes van 6 tot 18 maande op 'n ge= deeltelike herstel van modulasie dui, terwyl kosmiese strale by laer afsnystyfhede geen of 'n relatief klein herstel toon. Die oorsaak van hierdie sogenaamde stapgewyse modulasie is gesoek in 'n moontlike versnelling van kosmiese strale deur skokgolwe wat van= af sonuitbarstings die interplanetêre ruimte inbeweeg. Hierdie skokgolwe word deur satelliete en ruimtetuie tot diep in die interplanetêre ruimte waargeneem. Skokgolwe veroorsaak SSC's (skielike begin van magnetiese storms) in die aarde se magneetveld en Forbushafnames in teltempo's van kosmiese strale.

Mnr. P.J. Ankiewicz bestudeer die effekte van verskillende geofi= siese en sonwindparameters om die oorsaak van stapgewyse modulasie te probeer bepaal. Uit die studie blyk dat skokversnelling nie Forbushafnames kan verklaar nie. Positiewe resultate met betrekking tot Forbushafnames is verkry, wat gepubliseer sal word. Mnr. Ankiewicz sal hierdie studie as 'n verhandeling vir 'n M.Sc.-graad voorlê.

Publikasies:

1. Ankiewicz, P.J., Moraal, H. en Stoker, P.H. Steplike and shock related changes in the longterm cosmic ray modulation, MG 4.21 18e Internasionale Konferensie op Kosmiese Strale, Bangalore, 1983.

2. Van der Walt, A.J. Calculation of cosmic-ray integral and differential response functions and their standard errors, MG 11-3, 18e Internasionale Konferensie op Kosmiese Strale, Bangalore, 1983.

3. Van der Walt, A.J., Stoker, P.H. en Raubenheimer, B.C. Comparison of the latitude distributions of cosmic rays for the periods of solar minimum during 1954, 1965 and 1976, MG 2.3-12, 18e Internasionale Konferensie op Kosmiese Strale, Bangalore, 1983.

3. Projek: Presipitasie van elektrone uit die magnetosfeer in die atmosfeer in die Suid-Atlantiese Anomaliegebied en te Sanae

Duur: 1964 - onbepaald

Projekleier: Prof. P.H. Stoker

Medeleiers: Dr. A.J. van der Walt, M.S. Potgieter

Doelwitte:

1. Om uit die relatiewe groottes van die absorpsies van 20, 30 en 50 MHz kosmiese ruis die verloop van die ionisasiedigtheid met hoogte te bereken en daaruit die spektrum van die presipiterende deeltjies.

2. Om presipitasie van elektrone uit die L-skil te Gough-eiland, wat binne die gebied om die Suid-Atlantiese Stralingsanomalie geleë is, te bestudeer.

Waarnemings:

1. Die waarnemings met behulp van riometers van 20, 30 en 50 MHz te Sanae word grafies en met syferregistrasie op magneetkasetteband opgeneem en ontleed, mede met die doel om 'n bydrae tot studies van magnetosferiese substorms deur die deelnemende groepe betrokke by bolugfisikaprogramme te Sanae te lewer.

2. 'n Riometer (30 MHz) sal tydens die Internasionale Suid-Atlantiese Anomaliekampanje (ISAAK) in Julie 1983 op Gough-eiland kosmiese radioruis registreer en die registrasie sal vir die res van 1983 en in 1984 voortgesit word. Die resultate sal met die data van 'n soortgelyke riometer by die Magnetiese Observatorium te Hermanus vergelyk word.

Resultate:

1. 'n M.Sc.-student:

Mnr. T.F.J. Steyn het uitgegaan van numeriese data van die intensiteit van kosmiese radioruis, soos geregistreer met die riometers

te Sanae. Hy het as doel gehad om die absorpsies van kosmiese radioruis soos geregistreer by frekwensies van 20, 30 en 50 MHz te bepaal. Daaruit moet dan volg die hoogteverloop van die elek= trondigtheid in die atmosfeer vanaf ongeveer 50 tot 130 kilometer. Uit hierdie verlope moet die spektrum van die presipiterende elektrone bepaal kan word. Hy het heelwat tyd moes spandeer om betroubare en realistiese stildagkrommes te bepaal, waarvandaan hy die aurora-absorpsies bereken. Die stildagkrommes het beson= dere wisselinge van dag tot dag getoon, wat 'n studie van die oor= sake daarvan nodig maak. Sy finale resultate is toegespits op absorpsies tydens dae 175 tot 178 van 1982, aangesien al drie riometers toe beste data gelewer het.

2. Toetsopstellings van die 30 MHz riometers naby Potchefstroom het temperatuur- en omgewingsprobleme aangetoon, wat die analise van die data bemoeilik. Maatreëls is getref om betroubare registrasie van die riometers te bevorder. 'n Absorpsiegebeurtenis is tydens hierdie toetstydperk te Potchefstroom gesien, wat verder ontleed moet word. Hierdie riometers word tydens ISAAK gebruik.

3. Die aurora-absorpsiegebeurtenis van 27 Julie 1979 is ontleed. Slegs die data van die 30 MHz riometer is vir die tydperk beskik= baar. Die resultate word met die berekeninge van Prof. J.A. Gled= hill op die grootte van die 30 MHz riometerabsorpsies, soos afge= lei uit ionosondata te Sanae en satellietdata, vergelyk. 'n Gesa= mentlike publikasie met Prof. Gledhill sal 'n deel vorm van 'n groepstudie van die magnetosferiese substorm, wat om 0040 UT op 27 Julie 1979 begin het, waarby ander waarnemings te Sanae inge= sluit is.

Publikasies:

1. Stoker, P.H. en Gledhill, J.A. Ionospheric Absorption during the magnetospheric substorm on 27 July 1979, voor te lê aan S.A. Tyd= skrif vir Fisika (1983).

2. Publikasies sal uit die M.Sc.-verhandeling van mnr. T.F.J. Steyn en die ISAAK-eksperiment te Gough-eiland voortspruit.

4. Verdere Projekte:

Hierdie projekte skakel aan by die werk wat in Suid-Afrika op kosmiese strale gedoen word en word ondersteun deur die teoretiese en numeriese modelstudiewerk van Prof. Moraal en mnre. M.S. Potgieter en R.A. Burger. Omgekeerd stimuleer bogenoemde antarktiese projekte weer hierdie verdere projekte, waaroor by die Loodskomitee van die WNNR se Navorsings eenheid vir Kosmiese Strale verslag gedoen word.

P.H. Stoker
Programdirekteur
POTCHEFSTROOM
28 Junie 1983

PROGRESS REPORT 1982/83

TITLE OF PROJECT: SANAE ELECTRONICIST (SUPPORT PROGRAMME)

NAME OF PROJECT LEADER: M B W ARLOW

ADDRESS OF PROJECT LEADER: MAGNETIC OBSERVATORY
P O BOX 32
HERMANUS 7200

All objectives as set out have been met. The time distribution system will be installed at Sanae during the 1983/84 relief voyage. Component stock taking and handover procedures were instituted at the Base to facilitate proper stock control by us.

MONITORING AND INVESTIGATION OF THE GEOMAGNETIC FIELD AND AURORA AT SANAE AND MARION ISLAND

PROGRAMME LEADER P R Sutcliffe
PROGRAMME RESEARCHERS P R Sutcliffe
D P Smits

ADDRESS Magnetic Observatory of the CSIR
P O Box 32
HERMANUS 7200

PROGRESS REPORT Annual Progress Report for 1982/83

OBJECTIVES OF PROJECTS

(i) To monitor and study variations in the geomagnetic field in the South Atlantic-Indian Ocean and adjacent Antarctic regions.

(ii) To monitor and study ULF pulsations in the vicinity of Sanae.

(iii) To monitor and study certain aspects of electron and proton aurora.

(iv) To improve our understanding of processes during magnetospheric substorms by making correlative studies of (i), (ii) and (iii).

(v) To provide geomagnetic absolute values and secular variation data for use in the compilation of regional and world magnetic charts (e.g. for MAGSAT programme).

(vi) To provide geomagnetic, pulsation and auroral data to other research groups.

HISTORY OF PROGRAMME

Variations in the geomagnetic field and aurora have been monitored at Sanae since 1960, while geomagnetic variations at Marion were monitored continuously from 1972-1983. During 1979 a geomagnetic secular variation station was established on Gough Island; it was re-occupied in 1981 and 1983. The Magnetic Observatory has taken the ULF Pulsation Project

over from the University of Natal, and commenced recording pulsations at Sanae in 1983. The geomagnetic data are published annually and distributed to approximately 80 institutions throughout the world including the World Data Centres in Britain, Japan, USA and USSR. Geomagnetic data for special intervals and aurora data are supplied upon request.

Previous research projects have been concerned with the study of pulsation phenomena associated with magnetospheric substorms. Studies have also been made of the secular, solar diurnal and lunar daily variations at Sanae and of the 'island effect' and solar and lunar daily variations at Marion. Recent research has concentrated on detailed studies of a particular magnetospheric substorm recorded at Sanae.

SCIENTIFIC PROGRESS

(i) Substorm of 27 July 1979

The detailed study of a magnetospheric substorm which occurred on 27 July 1979 was completed.

The various magnetic signatures suggest that the substorm onset occurred at 00h39 close to the meridian of Sanae. A large negative H bay indicates that Sanae came under the influence of a westward electrojet during the substorm. The Z component signature at Sanae suggests that the electrojet was nearly overhead at onset. Following onset, the electrojet moved rapidly polewards until 01h01 whereafter it gradually drifted equatorward until the next substorm onset at 02h22. These attempts to infer the location and movements of the electrojet have served to emphasize the limitations of having only a single magnetometer below the electrojet location. A second magnetometer, e.g. at Grunehogna, would be extremely useful and would enable more reliable determination of the electrojet location.

A study of the all-sky-camera photographs has revealed that a quiet arc was seen equatorward of Sanae before the substorm at 00h39 UT. At the start of the substorm the arc brightened and moved poleward. In the meridian plane the aurora was then seen to sweep equatorward

in two separate bands. By 02h22 UT the quiet arc had returned to its initial position on the equatorward horizon, at which time the next substorm started.

After digitisation and pre-processing (see 1980/81 Report) the proton aurora intensity was plotted as contours versus latitude and local time. An investigation of the contour plots shows that prior to the substorm onset at 00h39 most of the sky at Sanae was covered by diffuse proton aurora emission with a band of greater intensity located 30^{o} above the northern horizon. Following the onset, this band intensified and moved rapidly poleward to a point 30^{o} above the southern horizon within 10 minutes. The region of greatest intensity then drifted gradually equatorward until the onset of another substorm at 02h22.

Data for 22 other magnetic observatories distributed around the globe were obtained (some direct from the responsible organisation, other from the World Data Centre A, Boulder). We have used these data to compile AE and Dst indices for the duration of the substorm.

These findings have been written up and submitted to the South African Journal of Physics. Together with investigations of the same substorm by the other Upper Atmospheric Research groups, a paper for publication in an international journal is being prepared.

(ii) Magnetic Signature of an Auroral Surge

The expansion phase of a magnetospheric substorm involves the brightening of an auroral arc in the midnight sector, followed by a rapid poleward and westward expansion of auroral luminosity. It is generally accepted that the magnetic signature characteristic of an auroral westward travelling surge (WTS) is a positive spike in the geomagnetic D-component. Recently a number of researchers have proposed three dimensional model current systems to explain this magnetic signature. Although these models are very satisfactory

in explaining the positive D-spike in the northern auroral region, a discrepancy appears to arise when they are applied to auroral breakups and surges observed at Sanae.

Observations made during a number of substorms at Sanae indicate that the magnetic signature of a WTS is also a positive D-spike. However, when the model current systems proposed by e.g. Tighe and Rostoker (1981) or Inhester et al (1981) are mapped to the southern hemisphere, they suggest that the signature of a WTS should be a negative D-spike. We are presently looking through data recorded at Sanae since 1960 in an attempt to find more examples of WTS events. It is difficult to find suitable events, since the combination of correct magnetospheric conditions, cloudless and moonless sky, good magnetometer data, and all sky camera operational are not very common.

The next part of this study will be to determine whether the signature at Sanae is different to the northern hemisphere due to its being in the southern hemisphere, or due to its being at a lower L-value, or some other reason.

PUBLICATIONS

(i) Journals

Sutcliffe, P R, A D M Walker and D P Smits (1983), Magnetic signatures during the substorm of 27 July 1979, S. Afr. J. Phys. (submitted).

(ii) Conferences

Sutcliffe, P R (1983), The geomagnetic D-component signature of an auroral westward surge, Paper E15 presented at the 28th Annual Conference of the SAIP, Pretoria.

Smits, D P (1983), Pulsations at low latitudes, Paper E17 presented at the 28th Annual Conference of the SAIP, Pretoria.

(iii) Data Reports of the Magnetic Observatory
Magnetic Observations at Sanae 1981, (1982), CSIR Report MAG B21.

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ANNUAL PROGRESS REPORT TO SANCGASS : 1983

INSTITUTION: MAGNETIC OBSERVATORY of the CSIR

HEAD: Dr G J Kühn Deputy Head: Dr P R Sutcliffe

RESEARCH PROJECT LEADERS:

Magnetic ULF Variations and Substorm Phenomena:	Dr P R Sutcliffe
Magnetic Quiet Time Variations:	G L M Scheepers
Magneto-telluric Observations:	M Hattingh
Geomagnetic Field Modelling:	Dr G J Kühn

PROGRESS REPORT: for the period July 1982 to June 1983

OBJECTIVES:

Routine Services: To provide adequate spatial and temporal coverage of magnetic field observations to supply in the requirements of local and overseas users (geological exploration, global magnetic surveys, etc.) and to provide related geophysical data for research purposes as required.

Research: To improve our understanding of magnetospheric storms and substorms by studies of substorm associated phenomena such as magnetic pulsations and auroral displays, and of the relationship between these phenomena.

To investigate conditions of instability in the magnetosphere by studying characteristics of ULF pulsations such as Pi2 and Pc3 pulsations.

To study the quiet variations of the magnetic field for the purpose of understanding the cause of these variations and their effect on magnetic secular variation observations.

To establish a programme of telluric current observations with the twofold purpose of determining the effect of induced currents in the crust of the earth on surface magnetic field observations and to use this method to investigate electrical properties of the earth's crust.

To improve the quality of the model of the regional magnetic field in Southern Africa by comparing the Magnetic Observatory field survey results with MAGSAT data and by investigating alternative mathematical models.

BRIEF HISTORY: Previous research projects of the Magnetic Observatory were concerned primarily with the study of magnetic and auroral phenomena observed during magnetospheric substorms, and with the magnetic quiet solar (Sq) and lunar (L) variations. A variety of digital time series analysis methods have been used to study periodicities in magnetospheric and magnetic field phenomena.

A great deal of emphasis has recently been given to Pi2 magnetic pulsations and their relation to magnetospheric substorms. Morphological aspects such as the variation of Pi2 features like polarization characteristics with time, season, and latitude have already been studied and reported on.

SCIENTIFIC PROGRESS:

1. Routine Services: The following notable changes occurred in the past year:

   (a) The magnetic recording station at Marion Island was closed after eleven years of operation. The island will however still be visited regularly to do magnetic absolute observations so that it can continue to serve as a secular variation reference point.

   (b) A new 3-axis (H, D and Z) ULF pulsation magnetometer was put into operation at Sanae in the beginning of 1983.

   (c) A new La Jolla type riometer was put into operation at Hermanus in June 1983.

   (d) A new ionosonde was installed at Hermanus by the NITR in October 1982.

2. Research Programmes: Progress that relates specifically to the Antarctic activities of the Magnetic Observatory is reported on elsewhere and is not mentioned again in this section.

2.1 ULF Pulsation Research:

First Results from N-S Induction Magnetometer Chain

As reported in the 1981/82 SANCGASS Report, a chain of four induction magnetometers was operated along a magnetic meridian extending from George to Tsumeb during mid 1982. All the data was recorded on analogue charts which ran at 20cm/min during the day.

On one of the days studied there were different pulsations at each station. This is a typical example of independent toroidal mode oscillations where each magnetic shell oscillates at its own eigenfrequency, determined by the length of the field line and the plasma density along the line. By integrating the equation for the decoupled toroidal mode, a set of curves was obtained of eigenperiod versus equatorial plasma density. The observed eigenperiods were then used to determine the equatorial plasma density.

Although the model is simple it does provide reasonable estimates of equatorial plasma densities and by observing pulsations through the course of a day or at different seasons the changes in plasma density can be monitored in this region of the magnetosphere where satellite measurements are usually unreliable or lack resolution.

On some of the other days studied the data had a decidedly different character. Pulsations were observed which were coherent at all stations (D component) or at 3 stations (H component). It appears that magnetic shells oscillate independently up to some latitude beyond which the signal is propagated unaltered except for an attenuation in amplitude. Field line resonance theory in fact predicts that beyond the resonance region the signal should decay evanescently as is observed. Recently examples have also been

found of Pc5 events that are identical at Sanae and Hermanus which demonstrates that these waves can propagate over large distances.

Effect of Ground Conductivity on ULF Pulsations

ULF pulsations propagate from the ionosphere to the ground as electromagnetic waves. At the atmosphere/ground interface and at interfaces between ground layers of different electrical conductivity, these waves will be partially reflected and partially transmitted. Consequently spatial variations in ground conductivity can be expected to affect observations of pulsations from the same source. Since magnetospheric physicists are interested in using the pulsations as a diagnostic of magnetospheric parameters, it is important to know the effect of variations in ground conductivity on the pulsations. The characteristics of Pc3 pulsations recorded at two locations with a large difference in ground conductivity have been studied with a view to shedding more light on this problem.

Using Maxwell's curl equations and assuming a source which is periodic in the x-direction and uniform in the y-direction, expressions for the reflection coefficient were determined for a plane layered earth. Values of ground conductivity for the ground layers below Tsumeb and Otjiwarongo were obtained from the Geophysics Section of NPRL. Ground conductivity below Otjiwarongo is effectively about 1 000 times greater than below Tsumeb. These values were used to evaluate the reflection coefficients. From these results, predictions of the expected amplitude ratios and phase differences of Pc3 pulsations between Otjiwarongo and Tsumeb were made assuming similar source characteristics.

On 5 October 1982 Pc3 pulsations were recorded simultaneously at Otjiwarongo and Tsumeb. The FFT cross-spectral analysis technique was used to determine amplitude ratios and phase differences between these two locations. The predicted and observed amplitude ratios and phase differences for the H-component were found to agree reasonably well. However, major differences were found between the predicted and observed values for the D-component.

The main conclusion to be drawn from this study is that large differences in ground conductivity between observation sites can significantly affect observed pulsation characteristics. This should be taken into account when analysing data. The poor agreement between predicted and observed characteristics for the D-component is probably due to the over simplified assumption of an infinite plane layered earth.

2.2 Magnetic Quiet Time Variations: It is well known that the Sq variation varies with solar activity and season. Previously it was reported that refined statistical analyses showed a statistically significant dependence of the Sq variation on the intensity of the main field. It was furthermore also observed that this dependence varies with season.

Useful information on the character of other perturbation effects can be obtained from a study of the residuals derived during the abovementioned analyses. Group classification of the residuals indicated that the observed Sq field depends on the magnitude of the planetary magnetic activity index K_p used for selecting the quiet days. The residuals also show that the Sq field is modified by the direction of the Interplanetary Magnetic Field (IMF). These effects are statistically significant for the first three harmonics of the magnetic East component, for the first two harmonics of the North component and for the first harmonic of the Vertical component only.

Since there is a relationship between the direction of the IMF and the K_p level, further investigations are required to decide whether the observed IMF effects are independent of the K_p level, or are produced by fluctuations in the K_p level.

2.3 Geomagnetic Field Modelling: There are two questions that we want to resolve with this investigation, namely:

- is the quality of the South African field survey data acceptable or is the local model affected by field stations being in magnetically anomalous areas.

- has the most suitable mathematical model been used.

The MAGSAT model (MAGSAT 6/80) cannot really be used to resolve any of the above questions because its resolution is not sufficient. As the spherical harmonic coefficients of this model only goes to the 18th degree, it means that wavelengths smaller than about 2 000 km in extent cannot be resolved.

As a first step the local South African model was nevertheless compared with the MAGSAT model. Agreement was somewhat better than that obtained in similar analyses done for other parts of the world where similar field surveys are done. This good comparison however breaks down at, and outside, the boundaries of the area covered by the South African survey. The local model therefore extrapolates poorly which means that our magnetic field maps become unreliable over the ocean areas bordering on South Africa.

The second step was to compare the South African survey data and model with the actual MAGSAT data. For this purpose magnetic tapes with the satellite data and some programmes that read the data from the tapes and does some processing on them, were obtained from Dr Langel, the MAGSAT project scientist. Most of these programmes were successfully adapted for use on our local computer. Unfortunately problems have been experienced with the program that reduces the satellite data to ground level. Thus, although some comparisons have been made between the South African and MAGSAT data sets, the results are still inconclusive.

2.4 Magneto-Telluric Studies: Attention to this project was divided between the development and procurement of signal conditioning electronics and data logging equipment on the one hand, and the development of the computer software required for the processing of sounding data on the other hand.

Electronic equipment was developed to enable us to make trial observations. These observations showed up a very serious problem with artificial interference (50 Hz and its harmonics). The nature of this interference was investigated in detail and the design of the

electronic signal conditioning equipment was adapted according to the findings.

On the data processing side the problem areas are:

- the derivation of the field curve from sounding data, and
- the interpretation of the field curve in terms of geophysical properties of the earth's crust.

Programmes were consequently developed on the desktop computer being used as a data logger, to do digital filtering and power spectral density analysis on the sounding data in the field. The field curve then consists of a plot of amplitude versus frequency of the ratio of the magnetic and telluric electric field signals.

Interpretation of the field curve is usually based on the estimation of crustal parameters by a visual inspection of the curve. These parameters are then varied by computer until a curve is obtained which matches the field curve - at which point it is assumed that the parameters correctly describe the crustal features. A computer program which facilitates this interpretation method was finalized.

An alternative approach would be to derive the model parameters directly from the magneto-telluric sounding data - the so-called inverse method. This method is, however, complicated to use and in practice leads to a mathematical result which over-complicates the actual situation. This over-complication takes the form of a multitude of layers, each one differing marginally from the next. If this method is to be employed one needs to be able to interact with the computer to give it guidelines along which the result can be simplified into a geophysically meaningful model. A computer programme which deals with this method has at present reached an advanced stage of development.

PUBLICATIONS AND REPORTS: This list is supplementary to the one included in the separate reports on Antarctic Activities.

Papers presented at Conferences:

Smits, D P (1983), Low Latitude Pulsations, 28th Annual SAIP Conference, July 1983.

Sutcliffe, P R and D P Smits (1983), An investigation of the effect of ground conductivity on ULF pulsations, 28th Annual SAIP Conference, July 1983.

Theses:

Smits, D P (1983), Low latitude ULF pulsations, M.Sc thesis, University of Natal.

Scientific and Technical Reports of the Magnetic Observatory:

Sutcliffe, P R (1983), Introduction to magnetospheric substorms with examples from Sanae, Antarctica, Report No H MAG IR-83/1, 1983. (This work was also presented by invitation at a colloquium held at the NPRL, Sept 1982).

Sutcliffe, P R (1983), Design criteria for induction sensor calibration coils, Report No H MAG IR-83/2, 1983.

Smits, D P (1983), Low latitude eigenperiod determination, Report No H MAG IR-83/3, 1983.

Data Reports:

Magnetic Observations at Hermanus 1982	CSIR Report MAG A31
Magnetic Observations at Tsumeb 1982	CSIR Report MAG E10

SOLAR TERRESTRIAL PHYSICS

Scourfield, M., Walker, A.D.M. & Co-workers

PROGRESS REPORT

FROM 1/7/82 TO 31/6/83

See Annexures: 2a - 2d, 3a - 3n

Annexure 2a

D69.1 Broad-Band Ground Based VLF Data

Duration: 1979 - ongoing

Project Leaders: Prof M W J Scourfield
Mr P A Wakerley

Co-Workers: Prof A D M Walker
Dr A R W Hughes
Dr J S Rash
H Hansen
J Clarke
A Johnson

Description: A broad band (2-20 kHz) v.l.f. receiver is maintained in operation at Sanae. It is operated during all special periods specified in advance by consultation between scientists at Stanford University, British Antarctic Survey and University of Natal as well as at the discretion of observers during times of geophysical activity.

Rationale: VLF data provides information about whistlers, VLF emissions and noise. These data are used in many of the scientific projects undertaken by the group.

Data Processing and Storage:

Primary data is recorded in analogue form on 6.25 mm audio magnetic tape with NASA time code.
Data is routinely spectrum-analyzed, using a Ubiquitous Spectrum Analyzer, and recorded on 16 mm film.

Individual events are examined by spectrum analysis using a Kay Sonograph. Data can be digitised and processed on an HP 1000 minicomputer system.

Progress Report: Data were collected throughout 1982, often continuously by international arrangement. A new antenna was installed in 1983 which has improved matching between antenna and preamplifier. Its performance is up to specifications.

Annexure 2b

D74.1 Low Light Level TV Data

Duration: 1974 - ongoing

Project Leader: Prof M W J Scourfield

Co-workers:
Mr M D Barker
Mr P A Wakerley
Mr M J Coetzee
Mr H B Mostert
Mr S J Comfort
Mr J Clarke
Mr M Tibbenham

Description: Two low light level TV systems, incorporating SIT detectors, are operated at Sanae. These image auroral forms down to subvisual light levels through filters. One system is operated in the zenith with a large field of view (~120°), the other can be varied in azimuth and elevation (the field of view is typically about 30°). Operation is at the discretion of the observers, based on home instructions. The pulsation magnetometer has been retained as an early warning indicator of auroral activity.

Rationale: TV data provides information on the precipitating electrons that give rise to auroral light emissions.

Data Processing and Storage:
Primary data is recorded in analogue form on 3/4" casette U-matic format in the 625 lines and 50 Hz mode. A video generated time code is displayed on the TV monitor during playback. VLF data, with NASA time code, is recorded simultaneously on the audio channels of the cassette.

Progress Report: Two TV systems were operated in 1982 and will continue in use during 1983. Replacement TV systems incorporating Intensified Silicon Intensifier Tubes (ISIT) will be installed at Sanae in 1984 following laboratory evaluation of performance.

Annexure 2c

D77.1 Measurements of fair weather electric potential gradient at ground level

Duration: 1978 ongoing

Project Leaders: Mr P A Wakerley
Prof M W J Scourfield

Co-workers: J M Coetzee
H B Mostert
J Clarke
A Johnson

Description: A vertical field mill is maintained in operation at Sanae. It is a rotating dipole unit which operates by differential potential measurement. The field mill is operating continuously.

Rationale: The field mill data provides information about electric field variations which vary with the characteristic diurnal trend of the electrosphere potential. It is thought that the potential of the electrosphere is determined by thunderstorm generators and may also be subject to perturbations resulting from cosmic radiation modulation of the impedance above the thunder storm generators.

Data processing and storage:

Primary data is recorded in analogue form on Rustrak Chart paper. Data can be digitized and processed on an HP 1000 minicomputer system.

Progress Report: This data is being collected continuously.

Annexure 2d

D82.1 V.L.F. Goniometer system

Duration: 1983 ongoing

Project Leader: Dr A R W Hughes

Co-workers: Prof M W J Scourfield
Mr P A Wakerley

Description: A VLF goniometer is presently being constructed for the University of Natal by the University of Sheffield. The antennae will be constructed at the University of Natal, Durban.
The equipment was tested in Durban in 1983 and installed at SANAE in 1983.

Rationale: The direction finding capabilities of the VLF goniometer will enable us to make a precise determination of the whistler exit point from the ionosphere and enable us to study the drift of whistler ducts and the electric fields which produce the drifting. The data from this will be used in collaboration with the British base, Halley and the United States base, Siple. These bases are at approximately the same L-value but at different longitudes.

Data Processing and Storage:
Primary data is recorded on 6.35 mm audio magnetic tape. Data will be processed at the University of Sheffield using their semi-automated whistler analyser.

Progress Report: The VLF goniometer has been constructed and installed at SANAE. The instrument has been calibrated and observations began in March 1983.

Annexure 3a

S79.1 Methods of Whistler Data Analysis

Duration: 1979 - 1983

Project Leaders: Prof A D M Walker
Dr J P R Rash

Co-workers: K F Deane (1979 only)
M St Quintin (1980 - !983)

Description: Software will be developed to allow whistler data to be read in real time directly from audio tape, spectrum analyzed, and stored in digital form in the group's HP21MX computer. Methods of data analysis will be developed to process this digital data. In particular successive whistler groups will be integrated to see if it is feasible to suppress unwanted spherics and enhance the initiating spheric. Also methods will be devised to analyse the digital data directly so that the bottleneck of using a digitizing table to analyze sonagrams is removed.

Rationale: There is a major bottleneck in our whistler data analysis due to the long time required to scale sonagrams. This is an attempt to remove it.

Progress: This work was started by K F Deane in 1979 and continued by M St Quintin in 1980. It was temporarily halted by Mr St Quintin's term of duty in Antarctica during 1981 and his subsequent resignation. At present software has been developed to read spectrum analysed data to disc. There is a limitation to 3 s of data at a time because of the characteristics of the operating system. Improvements in hardware and operating systems are expected to remove this limitation. Dr Rash is now working on the project.

Annexure 3b

S80.1 Whistlers at low latitudes

Duration: 1980 - ongoing

Project Leader: Dr A R W Hughes

Description: ISIS 2 satellite VLF data have been acquired at Quito, Ecuador for the purpose of studying whistler dispersion of low latitudes of particular interest in the ionospheric contribution to whistler dispersion. The project requires the analysis of large numbers of whistlers and this is being done when the opportunity arises at the University of Sheffield, U.K. using their semi-automated whistler analyser.

Rationale: Whistlers have been studied in great detail at medium latitudes. This project extends satellite studies of whistlers to low latitudes where their propagation is greatly influenced by the equatorial arch in electron density and the associated horizontal gradients in electron density.

Key Questions: What are the effects of horizontal gradients on whistler dispersion and propagation paths?

Progress: More than 2000 whistlers have been analysed and their dispersion plotted as a function of latitude. An example of the results are shown in the diagram below. Preliminary results were presented at COSPAR, Budapest in 1980 and further progress at IAGA, Edinburgh 1981. A possible application of the results to the location of thunderstorms was presented in a paper to the Royal Astronomical Society meeting on Remote Sensing of Atmospherics in May 1980. Some results have been published in Adv. Space Res.

Reference: A R W Hughes, Satellite Measurements of whistler dispersion of low latitudes. Adv. Space Res. 1, 1980, p.377-380.

Annexure 3c

S80.2 Electric Fields and Auroral Forms

Duration: 1980 - 1983

Project Leader: Prof M W J Scourfield

Co-workers: Dr E Nielsen (Max Planck Institut, Lindau, Germany)
Dr J G Keys (D.S.I.R. Lauder, New Zealand)
Dr H Collin (Southampton University, U.K.)

Description: STARE (Scandinavian Twin Auroral Radar Experiment) gives two-dimensional maps of the electric field and plasma flow over a section of the auroral oval. In Nov 1979 and Jan 1980 the Durban TV system was operated simultaneously with STARE.

Rationale: This experiment offers a unique opportunity to compare plasma drift velocities (as measured by STARE) with auroral form drift velocities (as measured by the TV system). The relationship is vital in understanding the mechanism responsible for electron precipitation.

Key Question: Do auroral forms undergo $\vec{E} \times \vec{B}$ drift as is the case for the background plasma?

Progress: Work has been completed on the drift of pulsating auroras and measured electric fields.
Ref M W J Scourfield, Keys J G, Nielsen E, Goertz C K and Collin H, Evidence for the $\vec{E} \times \vec{B}$ drift of pulsating auroras (submitted to J. Geophys. Res, Jan 1983).
Further work has been started on a comparison of the drifts of auroral arcs and ionospheric electric fields.

Annexure 3d

S80.3 Storm Time Pc5 Pulsations

Duration: 1980 - 1984.

Project Leader: Prof A D M Walker

Co-workers:
Dr R A Greenwald (Johns Hopkins U. Applied Physics Lab. USA)
Dr A Korth (Max-Planck-Inst. für Aeronomie, W. Germany)
Dr H Junginger) (Max-Planck-Inst. für Physik und
) Astrophysik, D8046, Garching,
Dr O Bauer) Fed. Rep. of Germany)

Description: STARE and GEOS 2 data are compared in order to investigate the characteristics of storm time Pc5 pulsations. A theory of these pulsations is being developed.

Progress: This work was started during a visit by Prof Walker to the USA in December 1980. The data has been used to map magnetic field lines between the equatorial plane and the ground (Greenwald *et al* 1981a,b).
A theory has been developed to describe the phenomena (Walker *et al* 1981, 1982). Data from the Geos 2 electron beam experiment has been included in collaboration with H Junginger and O Bauer. This shows that the symmetry properties of the event are not consistent with theory.

References:

Greenwald R A*, A D M Walker and M Candidi* (1981a)
Use of hydromagnetic waves to map geomagnetic field lines.
American Geophysical Union, Spring Meeting.
Also presented at 4th IAGA General Assembly, Edinburgh (paper 3Q.25).

Greenwald R A*, A D M Walker and M Candidi* (1981b)
Use of hydromagnetic waves to map geomagnetic field lines.
J. Geophys. Res. 86, 11251-11257.

Walker A D M, R A Greenwald*, A Korth*, G Kremser*, G Haerendel* and M Candidi* (1981)
Geos 2 and Stare observations of Pc5 pulsations associated with the drift mirror instability.
4th IAGA General Assembly, Edinburgh (paper 3AP11).

Walker A D M, R A Greenwald*, A Korth*, G Kremser* (1982)
Stare and Geos 2 observations of a storm-time ULF pulsation.
Submitted to J.Geophys.Res.

Walker A D M. Interaction of drifting energetic particles with long period hydromagnetic waves (invited review)
AGU Chapman conference. Waves in magnetospheric plasmas, Hawaii, U.S.A. 1983.

*Not University of Natal

Annexure 3e

S80.4 Standing hydromagnetic waves

Duration: 1980 - 1983

Project Leader: Prof A D M Walker

Co-worker: J Taylor (1982-)

Description: Eigenvalues and eigenfunctions for standing hydromagnetic oscillations in the magnetosphere will be computed.

Rationale: These oscillations are important in the understanding of Pc5 pulsations.

Key Questions:
(i) Are there any good approximate methods for calculating eigenvalues and eigenfunctions?
(ii) What are the computed values of the eigenvalues and eigenfunctions for a wide range of conditions?

Progress: These functions arise in the theory of Pc5 pulsations (Walker, 1980). Perturbation methods have been developed to study toroidal oscillations and it has been shown that there is no good approximation for poloidal oscillations. Recently it has been shown that intermediate polarizations are possible. Programs are being developed to compute the eigenfunctions and eigenvalues for these intermediate modes. The perturbation methods have been extended to other density models.

References:
Walker A D M (1980)
Modelling of Pc5 pulsation structure in the magnetosphere.
Planet. Space Sci., 28, 213-223.

Annexure 3f

S81.1 Temperatures in the plasmasphere from VLF observations

Duration: 1981 ongoing

Project Leader: Dr A R W Hughes

Description: Electron densities are determined at two points on magnetic field lines in the plasmasphere from satellite observations of LHR noise and ground based measurements of whistler dispersion. Diffusive equilibrium models are fitted to the measured electron densities and scale heights, and hence electron temperatures, are determined.

Rationale: Temperatures in the plasmasphere have been determined mainly by using Langmuir probes or low altitude satellites. The method we are using enables us to determine temperatures at great altitudes where the plasma is tenuous. The method has not previously been used for determining temperatures in the magnetosphere. The errors in electron densities determined using whistlers arise largely because of an imprecise knowledge of plasma temperatures. The results of this project should lead to an improvement in the accuracy of equatorial electron densities determined from our ground based whistler station at SANAE.

Key Questions: To determine plasma temperatures as a function of L-value and magnetic local time and to compare these with measurements made by other methods on low altitude satellites.

Progress: Results have been published in two papers:
J McChesney and A R W Hughes, Temperatures in the plasmasphere determined from VLF observations. Jnl. Atmos. Terr. Phys. 45, (1) p.p. 33-39, 1983.
Hughes, A R W and Nugent, B. Temperature of the plasmasphere determined from VLF observations at SANAE.
Results will also be presented at IAGA Conference, Hamburg, Germany, Aug. 1983 in the paper:-
Hughes, A.R.W., The Temperature of the plasmasphere.

Annexure 3g

S81.2 Auroral Substorm Project

Duration: 1981 - 1983

Project Leader:) This project involves all groups operating
Co-workers:) at Sanae.

Description: An auroral substorm occurring at 0040, Day 208, 1979 has been isolated for study on the basis of a broad coverage of data sets. These include TV imaging and A S C imaging of auroral forms, magnetograms, H_β meridian scans, riometer data, ionospheric soundings and various satellite data.

Rationale: To obtain a detailed profile of an Auroral Substorm occurring in the vicinity of Sanae. The experience gained will be used as the basis for further co-laboration work by S. African groups based in Antarctica.

Key Questions:
(i) How accurately can the substorm onset time be identified in the various data sets?
(ii) Where is the substorm onset located with respect to Sanae?
(iii) What is the relationship between the current systems and the ground based observations?

Progress: Two Workshops have been held to date and we are now at the stage of preparing rough drafts of the work. Publication is set for 1983.

Annexure 3h

S81.3 Analysis of Pc 5 Pulsations

Duration: 1981-1983

Project Leader: Mr. M.D. Barker

Description: During the period November 6th-18th 1972, very clear dawn Pc 5 pulsation activity, with a period of nearly 300 seconds, was observed at SANAE from 0300-0900 UT with maximum amplitudes up to 15 nT. The variation of main pulsation periods and polarisation characteristics of these pulsations are to be studied.

Rationale: This period of Pc 5 pulsation activity is unique in that it continued for a number of days and has not been observed at any other time during the operation of the system at SANAE. Analysis of this data will be useful in understanding the interaction of the solar wind with the magnetosphere during quiet magnetic activity.

Key Question: Do the observed periods and polarisation characteristics of Pc 5 pulsations confirm the magneto-hydrodynamic resonance theories of Kelvin-Helmholtz instability in the low latitude magnetopause boundary layer? (See project S80.5).

Progress: Computer programs have been completed for the digitisation of analogue pulsation data, power spectral analysis for hourly periods and digital dynamic spectra for each day concerned. (See paper delivered at S.A.I.P. Conference, Port Elizabeth, 1981).

Current work is concerned with the development of programs to determine the polarisation characteristics of the pulsations.

References: Barker M.D. Dawn Pc 5 geomagnetic pulsations. Proceedings of the 26th Annual Conference of the South African Institute of Physics, Port Elizabeth, 1981, Paper E8.

Annexure 3i

S81.4 Satellite observations of whistler dispersion at low latitudes

Duration: 1981-82

Project Leader: Dr. A.R.W. Hughes

Co-worker.: Dr. J.P.S. Rash

Description: Whistlers recorded from the ISIS 2 satellite using the Durban based satellite tracker (Project D76.1) have been analysed for several passes showing a large number of whistlers. Computer programs were written to determine the dispersion D of the whistlers and a plot of D versus latitude made. These results were compared with others from Quito, Ecuador (Hughes 1980) and with theoretical values of D for a reasonable magnetospheric model.

Rationale: Comparison of measured dispersions with theoretical values and ground based measurements are used to determine whether the observed whistlers are ducted or non-ducted.

Key Questions: (i) Are the observed dispersions consistent with signals originating in both hemispheres?
(ii) Are the whistlers ducted or not?

Progress: Some results from two satellite passes were presented at the South African Institute of Physics Conference in July 1981 (Rash et al, 1981 - see Publication list). Simultaneous ground based recordings - difficult to observe in Durban - are now required for further progress.

References:

Hughes A.R.W.,
Satellite Measurements of Whistler Dispersion at low latitudes. Adv. Space Res., 1, p.377-380, 1981.

Rash J.P.S., Behrens M.A. and Hughes A.R.W.,
Satellite measurements of whistler dispersion.
Proceedings of 26th Annual Conference of South African Institute of Physics, Port Elizabeth, 1981.

Annexure 3j

S82.1 Plasmasphere Dynamics

Duration: 1981 - 1983

Project Leader: Prof M W J Scourfield

Co-workers: Dr J Rash
H Hansen

Description: The whistler method for tracking the movement of ducts of ionization has been of considerable use in the investigation of plasma convection in the plasmasphere. From continuous whistler data at Sanae the 24 hour period 0000 July 11 to 0000 UT July 12, 1976 has been selected for analysis.

Rationale: Plasmaspheric convection, studied under a range of geophysical conditions, is an important input to theoretical models of plasmapause formation. Work in this area has already been done by this group (see refs. below) which showed the existence of two plasmasphere bulges, the duct tracks conforming to the shape of the bulge.

Key Questions:
(i) Are the plasmasphere bulges a permanent feature under quiet conditions?
(ii) How does their time of occurrence depend on K_p?
(iii) To what extent does the magnetospheric electric field penetrate the plasmasphere?

Progress: The new results in this study have been compared with those of an earlier study (Rabe and Scourfield, 1977) under different magnetic conditions. A duskside plasmaspheric bulge is present at a similar time (17h00 UT) in both data sets. Westward electric fields are being evaluated in order to assess the role of changing ionospheric conditions in determining plasma motion.
From VLF data recorded simultaneously at Sanae and Halley we have shown that whistler duct lifetimes can be as short as 30 minutes which is of significance for current theories of whistler duct formation.
Papers on this work will be presented at IAGA (Hamburg) and will also be prepared for publication.

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Refs: Rabe E and Scourfield M W J.
Plasmasphere response to the onset of quiet magnetic conditions: plasma convection patterns.
Planet. Space Sci., 25, 1977, p303-308.

Woods A C, Scourfield M W J, Boynton D and Roach M A.
Plasmasphere convection patterns observed simultaneously from two ground stations.
Planet Space Sci., 27, 1979, p643-652.

Annexure 3k

S82.2 Subprotonospheric whistlers

Duration: 1982 ongoing

Project Leader: Dr A R W Hughes

A.

Co-worker: Dr H Strangeway, Sheffield University

Description: Subprotonospheric whistlers (SP) have been observed on ISIS 2 and we propose to conduct ray tracing studies to attempt to understand their occurrence. The project involves superimposing the equatorial arch in electron densities on existing plasma density models.

Rationale: SP whistlers have not previously been observed below a dipole latitude of 45°. It is interesting therefore to establish what factors give rise to their occurrence at latitudes between about 20° and the magnetic equator.

Key Questions: What factors govern the occurrence of SP whistlers?

Progress: 17 examples of SP whistlers have been obtained from ISIS 2 data. Preliminary calculations suggest that the horizontal gradients associated with the equatorial arch in electron density could make repeated reflections within the ionosphere possible.
Dr Strangeway is developing full wave programmes to do Low Latitude Ray Tracing.

Annexure 31

S82.3 Cooperative Direction Finding Studies of Whistlers

Duration: From 1982

Project Leader: Dr A R W Hughes

Description: Using a VLF goniometer observations will be made at SANAE and simultaneously at the British Antarctic Base at Halley and at the United States Base at Siple using identical equipment. The results at the 3 stations will enable us to study the function and drift of duct enhancements in the magnetoflux.

Rationale: The establishment of a chain of direction finding stations in the Antarctic at approximately the same L-value but at different longitudes.

At present, from nose whistler analysis we can determine the L-value at which a whistler propagates but the longitude of the path is unknown. Direction finding will enable us to make a precise determination of the whistler exit from the ionosphere and enable us to study the drift of whistler ducts and the electric fields which produce the drifting.

Key Questions: What factors determine the formation and movement of whistler ducts in the magnetosphere.

Progress: Calibration: Data has been sent to Sheffield and will be analysed during Dr Hughes' visit in July.

Annexure 3m

S83.1 Wave-Particle Interactions

Duration: 1983 - ongoing

Project Leader: Prof M W J Scourfield

Co-workers: Dr J Rash
Dr D Duthie
Mr M Barker
Mr M Tibbenham
Mr J Clarke

Description: The mechanisms and positions of Wave-Particle Interactions above Sanae can be best studied through observations of time varying parameters such as particle precipitation and the intensity of VLF hiss. The former can be monitored via the optical emissions recorded via a low light level TV system and the latter by recordings via the ground-based VLF system.

Rationale: The mechanisms whereby particles are precipitated in the atmosphere have always been of prime importance in upper atmosphere work. By studying the difference in arrival times of electrons and VLF hiss it is possible to establish whether the causal mechanism is a wave-particle interaction.

Key Question: Is the intensity modulation of electrons and VLF hiss observed at Sanae due to a gyroresonance or Cerenkov interaction on the Sanae field line?

Progress: Analysis of one data set has shown that the electrons (as revealed by the optical emissions) lead the VLF hiss by 0,2 s. This can be interpreted in terms of a gyroresonance interaction in the equatorial plane above Sanae.

Refs.: Scourfield M W J, Duthie D D and Rash J P S. Auroral Pulsations - TV image and VLF hiss correlation (Submitted to Planet Space Sci., Feb 1983).

One paper on this work will also be delivered at IAGA (Hamburg) in August and four papers at SAIP (Pretoria) in July.

Annexure 3n

S83.2 Auroral Image Processing

Duration: 1983 - 1985

Project Leader: Prof M W J Scourfield

Co-workers: Mr M D Barker
Mr C Handley
Mr S Comfort

Description: By means of a microcomputer coupled to a minicomputer the TV image of an auroral form can be digitized. The digitized array can then be processed to produce light intensity contours within an auroral form.

Rationale: Light intensity contours can be related to the intensities of electrons giving rise to the optical emission.

Key Question: Are the electron beams above auroral forms homogeneous?

Progress: A feasibility study should be completed by June 1983 and a paper submitted to the SAIP meeting in Pretoria.

ANNEXURE 4

Annexure (4)

(i)* VLF Programme Audio Tape Recorders.

For the past 10 years the recording of whistlers for any VLF programme has been on good quality Audio tape recorders. The machines are heavily used and are in need of replacement. Overall 10 machines will be involved, but initially it is proposed to replace six, and application for the sum of R6 600 has been made to the University Capital Loan fund for these items. The approximate figure to replace 6 machines is R8 400.

(ii)* Research Topics Related to Middle Atmosphere Programme (MAP)

A feasibility study.

1. Winds and Gravity Waves - 80 to 100 km.

Background. A group at Sheffield University has successfully employed a low light level TV system to image oxygen emissions (557,7 nm) and Sodium emissions (589 nm). They have observed drifting of these emissions and the presence of wave structure from which can be deduced wind speeds and gravity wave parameters.

The Durban Group has, for some years, used similar TV systems in Antarctica. We have made application to the University Capital Loan fund for assistance to purchase a low light level TV camera system to enable us to carry out a feasibility study to establish whether similar observations can be made from within South Africa. Non CSP funds available for low light level TV system R5 200.

Estimated balance of the cost for the low light level system without lens and filter system is R5 000.

*Items marked with an asterisk indicate that assistance from the University Capital Loan fund has been requested to purchase these items.

(iii) (a) Research related to Middle Atmosphere programme (MAP). Video Tape Recorder. In order to record oxygen emissions (557,7 nm) and sodium emissions (589 nm) a video tape recorder is required.

(b) The Auroral low light level TV system also requires a further video tape recorder to establish a maintenance rota and to allow one spare machine to be available at the Sanae base to replace a video tape recorder which might break down while in operation at Sanae.

Approximate cost for two machines - R6 800.

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Annexure 4 (contd)

(iv)** Research Related to Middle Atmosphere Programme (MAP).
For imaging the oxygen and sodium emissions mentioned above. A wide angle lens system is required. This is a special lens with a coverage of 170° and with appropriate filters. Approximate cost R8 000.

** Assistance to purchase this item has been made to CSP for Research Topics related to Middle Atmosphere Programme.

(v) Micro-processor System
A small micro-processor system is required for experimental work and for use on data analysis, initially the micro-processor will be used in Durban and when software has been developed this will be used directly at Sanae.

The approximate cost for this item which consists of
(a) The Micro-processor Unit
(b) Drive unit for floppy disc, Printer and software accessories is approximately R5 600.

(vi) Signal Analyser:Fast Fourier Transform Analyser

Preamble

The analysis and viewing of VLF and Goniometer data is a very time-consuming process in our VLF and Goniometer programme. The acquisition of a two channel Fast Fourier Transform Analyser could effectively cut viewing time of data by 60 times.
This enables all data gathered each year, to be viewed, with time available for viewing data previously collected and stored in the archives to be viewed; prompt exchange of information with International groups is facilitated.
The system is labour saving as manual work is reduced to a minimum with a vastly increased throughput.

The VLF and Goniometer Programme and Fast Fourier Transform Analyser

(a) The VLF programme at Sanae provides information on whistlers, VLF emissions and noise.
(b) In addition to the VLF programme we have recently installed a VLF goniometer system which enables us to make determinations of the whistler exit point from the ionosphere and will enable us to study the drift of whistler ducts and electric fields

which produce the drifting. This data will be used collaboratively with the British Antarctic Survey at Halley, and with the Stanford Group (USA) base at Siple.
A considerable amount of data are produced, and recorded on Audio Tape.

(c) The method of scaling the information is to produce it on Sonagrams using spectrum analysis. This is a major bottleneck, as it takes some 2½ minutes to analyse 2½ seconds of data thus requiring 180 hours to analyse one tape completely. Some 200 tapes have normally been produced per annum; this is now increased to 400 with the new system; this means it would take 8 years to analyse 1 year's real time V.L.F. and Goniometer data from Sanae.
Our method of scaling data is time consuming and out-of-date, and much valuable data is not looked at. A real time analysis system is thus required. This means 1 year's VLF and Goniometer data could be scanned in some 50 days. This would allow time to look at all data and analyse the items of interest in the year when the data is returned from Sanae. In addition we would be able to look at data from previous years currently stored in our Archives.

(d) A two channel FFT Analyser can cope with this volume of data and is essential for the following reasons:
   (i) To measure phase relationships between continuous or transient signals
   (ii) Correlate two variables
   (iii) Measure time delay between signals - establish directionality
   (iv) Carry out Power Spectral Density analysis
   (v) To measure frequency ranges of 1 Hz to 100 kHz with zoom facilities which can increase the frequency resolution by as much as 100 times. This also improves the signal to noise ratio of the measurement. The low frequency range is very important when studying ion whistlers where the Gyrofrequency is between 200 - 300 Hz. (In the case of He whistlers it is less than 250 Hz). This facility will thus easily allow the study of whistlers from electron to ion whistlers.

3. BIOLOGICAL SCIENCES

3. BIOLOGIESE WETENSKAPPE

SASCAR - Subcommittee for Biological Sciences

CHAIRMAN'S REPORT - 1983

The SASCAR - Subcommittee for Biological Sciences is a committee set up to plan and co-ordinate biological work of the Marion and Prince Edward Island System.

The objectives have been outlined in detail in the South African National Scientific Programmes Report No. 35, 1978.

The current research effort involves the activities of a number of University Departments and associated Research Institutes. These include:

1) University of Pretoria - Mammal Research Institute, Department of Entomology.

2) University of Orange Free State - Institute of Environmental Sciences

3) University of Cape Town - Percy FitzPatrick Institute for African Ornithology

- School of Environmental Studies

The policy of this Committee is to promote research on the island biology and the Committee are always willing to receive and consider applications for research into the areas of research outlined in the National Scientific Programmes Report No. 35.

Mammal Research

This work is currently being undertaken by the Mammal Research Institute under the direction of Professor J. Skinner.

The work being carried out at present centres around the alarming decrease in the population of the elephant seal Mirounga leonina currently estimated at 5 % per annum. This makes it all the more important to develop an effective technique to tag adults and to follow their movements once they leave the island.

It is encouraging to see that the population of the house cat Felis catus has been drastically reduced and it is hoped that the remaining cats will soon be eliminated or at least kept under control.

Ornithological Research

This work is being undertaken at the Percy FitzPatrick Institute for African Ornithology - under the direction of Professor R Siegfried.

This group has been primarily interested in the population dynamics of sea birds, the relationships between sea birds (chiefly penguins) and their prey, the feeding ecology of avian predators and the physiology and energetics of burrowing petrels and surface nesting birds and the small scale patterns of sea bird distribution.

Terrestrial Ecological Research

The Institute of Environmental Studies at the University of the Orange Free State has completed a study on the Plant Ecology of Marion Island and it is hoped that they will soon be able to provide workers with a habitat map of Marion Island.

Work on nitrogen cycling and decomposition studies on Marion Island has also been completed and the final reports on these two topics will be of considerable importance to other research workers on the island.

Entomological Research

This is a new area of research which was started in 1983. It was identified as an important area several years ago and is presently being undertaken by Dr C. Scholtz under the umbrella of the Terrestrial Ecological Research Programme.

Marine Research

This work was started at the School of Environmental Studies and the University of Cape Town. The current work on the energy flow and biological interaction in the littoral of Marion Island is in need of detailed investigation and it is hoped that work to this effect will commence in earnest in 1985.

Workshops

It is hoped that with the appointment of Antarctic Research Officers to help the Project leaders in the Marion Island Programme that workshops on selected topics will be held in an attempt to synthesize the existing information and identify certain areas for future research.

Conservation Policy for the Prince Edward Islands

A working document has been drawn up as a guide to a future conservation policy for the Prince Edwards Islands by Dr Condy and his committee. I am sure that this document will prove to be an important guideline.

I would like to conclude by congratulating the various research workers on the work accomplished during 1983 and a special word of thanks and congratulations to Prof. R. Siegfried and his committee for the excellent and efficient manner in which the Fourth SCAR Symposium on Antarctic Biology was organised.

The hard work of Dr Pat Condy and his team is gratefully acknowledged.

R N Pienaar
Professor & Head : Botany Department

Project Title: RELATIONSHIPS BETWEEN THE POPULATION DYNAMICS OF SELECTED SPECIES OF SEABIRDS (CHIEFLY PENGUINS) AND THEIR PREY AT PRINCE EDWARD AND GOUGH ISLANDS

Project Leaders: W R Siegfried & J Cooper,
Percy FitzPatrick Institute of African Ornithology,
University of Cape Town, Rondebosch 7700

Project Researchers: N J Adams & C R Brown,
Percy FitzPatrick Institute of African Ornithology,
University of Cape Town, Rondebosch 7700.

Date: Fourth interim progress report, July 1982 - June 1983, submitted in June 1983.

1. Objectives

a. To determine the numerical status, productivity and population structure of Macaroni and King Penguins at the Prince Edward Islands, and Wandering Albatross and Rockhopper Penguin at Gough and the Prince Edward Islands, and monitor longterm changes in their populations.
b. To determine the food requirements of these seabirds in relation to their population dynamics at the Prince Edward and Gough Islands.
c. To seek complementary approaches to the monitoring and theoretical modelling of interactions between seabirds and their prey at Marion Island.

2. History of Project

The SCAR/SCOR - BIOMASS research programme is aimed at obtaining a deeper understanding of the structure and functioning of the Southern Ocean ecosystem, as a basis for future management of the ecosystem and its living resources. Seabirds (chiefly penguins) are significant top consumers in the ecosystem, and changes in their trophodynamics should indicate changes in the abundance and distribution of their prey. Macaroni and King Penguins and Wandering Albatrosses were selected by the BIOMASS

Working Party on Bird Ecology, as candidates for base-line censuses, and feeding and breeding biology studies at the Prince Edward and Gough Islands.

The project began in 1979 when populations of Macaroni and King Penguins and Wandering Albatross at Marion Island were counted regularly during the period May 1979 - June 1980. The breeding success of these populations was monitored during the same period. Adults and chicks of Macaroni and Rockhopper Penguins were collected for their stomach contents.

During September 1980 - May 1981 censuses of subpopulations of Macaroni and King Penguins and Wandering Albatrosses continued at Marion Island. A manual describing monitoring techniques was prepared for eventual publication. Food samples from all four species were collected and partially analysed.

During the period July 1982 to June 1983 fieldwork concentrated on the continued monitoring of aspects of the population biology of Macaroni and King Penguins and Wandering Albatrosses at Marion, Prince Edward and Gough Islands. Laboratory work in Cape Town concentrated on the analysis of results and production of papers on aspects of the diet, energy requirements and physiology of King, Macaroni, and Rockhopper Penguins from field data collected previously at Marion Island.

3. Scientific Progress

Objective a.

Censuses of King Penguins, Macaroni Penguins and Wandering Albatrosses continued at Marion Island during the period under review. Breeding Wandering Albatrosses and King Penguins were counted at Prince Edward Island and Wandering Albatrosses were counted at Gough Island. Results are discussed for each species separately.

Macaroni Penguin Eudyptes chrysolophus

A provisional count of Macaroni Penguins at the Bullard beach colony at Marion Island was presented in the Third Interim Progress Report to SASCAR. In 1981 73 165 m^2 of the colony covered horizontal ground while 16 945 m^2 was on inclined ground. Thus, the colony covered a total area of 90 110 m^2, more than the estimated 88 393 m^2 covered in 1979. Density of breeding birds in 25 m^2 quadrats were 50,1 and 42,5 breeding pairs/quadrat for horizontal and inclined ground respectively. A revised estimate, based on these figures, gives a population of 175 516 breeding pairs, close to the 180 000 estimated during the 1976/77 breeding season.

Census of the subpopulations at Archway, Macaroni Bay and Van den Boogaard River at Marion Island gave estimates of 187, 707 and 39 breeding pairs respectively during the 1981/82 season. Breeding success was 59,5 % at Archway, 38,5 % at Macaroni Bay and 79,5 % at Van den Boogaard River. Counts of the same subpopulations during the 1982/83 season gave counts of 95, 961 and 40 breeding pairs at Archway, Macaroni Bay and Van den Boogaard's River respectively and a breeding success of 52,6, 10,9, and 65,0. In previous years there have been counts of Macaroni Penguins at Plover Pools, Marion Island. A landslide in 1979 resulted in failure of this small subpopulation to raise chicks. There is still no evidence of recolonization of the area and it is likely that the penguins have been absorbed into the Macaroni Bay Colony.

An aerial census of Macaroni Penguins was attempted at Bullard Beach and Kildalkey Bay in 1981 using 35 mm format and 80-200 mm zoom lenses from a helicopter. Results were disappointing and suggest that 35 mm format does not produce the high resolution necessary for aerial censuses. It is suggested that medium (120) format be used in future if aerial photographic equipment is unavailable.

Forty nests were marked at Macaroni Bay East to measure annual variation in chick growth rate. Of the marked nests, only 19 hatched. Chicks were weighed daily and culmen, tarsus and

flipper length were measured at five-day intervals until approximately 15 days of age when bad weather destroyed a large number of the nests and chicks low down on the shore. The study was then terminated due to the small sample size remaining.

During the April-May 1983 takeover the Bullard Beach colony was resurveyed and the colony marked out with permanent concrete bollards since the wooden stakes used previously proved unsatisfactory. The Kildalkey Bay Macaroni Penguins were also surveyed in a similar matter and 25 m^2 quadrats were laid out. Accurate censuses can now be made of approximately 90 % of the species' population at Marion Island.

Rockhopper Penguin E. chrysocome

In October/November 1982 a count (858 pairs) was made of incubating birds at Seal Beach, Gough Island. Birds in a small (26 pair) subcolony were experimentally banded to test for desertion effects. Desertion with loss of eggs occurred at at least three nests. In April/May 1983 several Rockhopper Penguin colonies at Marion Island were chosen and marked for monitoring in the 1983/84 breeding season.

King Penguin Aptenodytes patagonicus

An aerial census of the King Penguin population at Kildalkey Bay was attempted. Results proved disappointing (see above under Macaroni Penguins). Ground censuses continued during 1981/82 at Archway, Sealer's Beach and Bullard River. A census of Archway in October 1982 showed 1 551 adults and 618 chicks present. The corresponding count in 1981 was 748 adults and 441 chicks. Sealer's Beach had 4 967 adults and 1 493 chicks in October 1982 as opposed to 4 219 adults and 1 559 chicks in 1981.

The colony at Bullard River is thought to be at the threshold size for producing fledged chicks. Counts in 1981 gave 69 and 44 chicks in July and November respectively. In 1982 there were only 55 and 17 chicks in the corresponding months.

During May 1982 King Penguins were counted at Prince Edward Island. There was no evidence of King Penguins breeding on

the west coast of Prince Edward Island. Breeding colonies of King Penguins were observed at Penguin Beach, Cave Bay and Boggel. 232 chicks were counted at Cave Bay. The Boggel colony could not be counted because of deteriorating weather conditions and therefore a total count for King Penguins at Prince Edward Island has not yet been achieved. The King Penguin census at Prince Edward Island was repeated in April/May 1983 but results are not yet available. Six King Penguin eggs were collected within 24 h of hatching. These were sent to the National Institute for Water Research for pesticide analysis.

Wandering Albatross Diomedea exulans

The Wandering Albatross monitoring colonies at Macaroni Bay and Sealer's Beach at Marion Island have been mapped. All nest sites for the 1980/81, 1981/82 and 1982/83 breeding seasons have been plotted to determine internest distances and nest reuse in successive years.

In 1981/82 the Macaroni Bay colony contained 24 eggs from which 23 chicks were fledged, a breeding success of 96 %. Twenty eggs were present in 1982/83 from which 14 chicks fledged, a breeding success of only 70 %. Twentynine eggs were laid in this colony at the beginning of the 1983/84 season.

At the Sealer's Beach monitoring colony the number of eggs was underestimated in 1981/82 but 57 chicks fledged. During the 1982/83 78 eggs were counted and 71 chicks fledged, a breeding success of 91 %. Seventyeight eggs were laid in the 1983/84 season. Wandering Albatrosses appear to have a high breeding success at Marion Island and observation has shown that most chick mortality occurs within the first 14-28 days of hatching.

All chicks in monitoring colonies were ringed in October 1982 to assess natal nest site fidelity. Chicks will continue to be ringed each year. Numerous adults carrying both South African and foreign rings were recaptured breeding on Marion Island. These recaptures have been given in a paper on bird-ringing at Marion Island for the period 1978-1982.

A complete census of Wandering Albatrosses was carried out at the Prince Edward Islands between April and May 1982. Total numbers of breeding pairs, based on number of chicks present, were 1 207 for Marion Island and 957 for Prince Edward Island. Largest concentrations at Marion Island were found on Goney Plain and between La Grange Kop and Kaalkoppie while the largest concentrations at Prince Edward Island occurred in Albatross Valley and near Vaalkop.

A complete census of Wandering Albatrosses was conducted at Gough Island in October/November 1983. A total of 798 chicks was counted. 792 chicks were counted in 1979 (the only previous year when a full census was achieved) and it would seem that the population is stable. Seventyfour chicks were ringed in the study colony at Goneydale and nests were staked for plotting on a map during the 1983 takeover. Breeding success in this colony in the 1981/82 season was approximately 74 %, but no further data are available since data acquisition depends on the interest of a member of the Meteorological team.

Because of the dates that these complete censuses were carried out they do not take into account egg and chick mortality and are therefore underestimates. An estimated Wandering Albatross demi-population at the Prince Edward Islands is 2 452 pairs utilizing breeding success data from the study colony. Albatrosses breed every second year. Thus it can be estimated that the total breeding population of Wandering Albatrosses at the Prince Edward Islands is about 4 904 pairs or approximately 10 000 birds. The total breeding population of Wandering Albatrosses at Gough Island can likewise be estimated to be in the order of 2 000 pairs or 4 000 birds, when breeding failure prior to the censuses is taken into account.

The monitoring manual, detailing the aims, projects and methodology of monitoring at the Prince Edward and Gough Islands will be revised finally for publication after the April-May 1983 Marion Island takeover.

Objective b.

Analysis of diets of selected species continued during 1982/83. Approximately 100 Greyheaded Albatross D. chrysostoma casts were collected at Marion Island to assess the overlap, if any, in prey species with the Wandering Albatross. Although analysis is not yet completed, initial results suggest that the Greyheaded Albatross preys predominantly on the Onychoteuthid squid Kondakovia longimana whereas the Wandering Albatross appears to prey primarily on Moroteuthis knipovitchi. Examples of Gonatus, Discoteuthis and Chiroteuthis species were also found in Greyheaded Albatross casts, which are formed primarily of squid beaks.

Initial investigations into the diets of Macaroni and Rockhopper Penguins at Marion Island suggest that, although crustaceans form a major part of the diet with fish and squid forming only a minor part, the relative importance of the prey species may be subject to seasonal variation. For example, fish and cephalopods form a significantly greater part of the diet of Rockhopper Penguins in February than they do in March. Further diet samples from both species have been collected over the chick rearing period in 1982/83 in order to assess seasonal variation. It is intended to complete identification of all Macaroni and Rockhopper Penguin stomach contents collected over the period 1973-1983 on Marion Island for a combined analysis which will allow comparisons both within and between seasons, as well as between the two species.

Sizes of meals fed to chicks of Macaroni and Rockhopper Penguins were collected and representative samples analysed for energy content. Meal sizes fed to Macaroni Penguin chicks ranged from 150-890 g (mean 475 $\pm$ 197 g) and energy content was 21,1 kJg^{-1} dry weight. Mean water content was 78 %. Meal sizes fed to Rockhopper Penguin chicks ranged from 90 - 330 g (mean 181 $\pm$ 88 g), mean water content was 79 % and the energy content was 23,4 kJg^{-1} dry weight.

Thirtyeight King Penguin chicks were stomach pumped at intervals during the growth phase (August 1981 - May 1982). These samples are being analysed at present. Previous analyses suggest that squid forms the major proportion of the diet with fish contributing a small but important component. King Penguin food samples are characterized by their highly digested state making identification of the components difficult. The only conclusion that can be drawn at present is that King Penguins appear to prey mostly on immature squid.

Meal sizes fed to King Penguin chicks greater than two months old ranged from 150 - 3 100 g (mean = 1 421 $\pm$ 807 g). Smaller meal sizes recorded may represent instances where chicks were disturbed prior to completion of feeding. Representative samples are awaiting energetic analyses. The assimilation efficiency of adult King Penguins force fed exclusively on a diet of squid was 70 %. This figure is the lowest yet measured for a piscivorous seabird.

During August-September 1982 stomach contents were obtained from 67 Gentoo Penguins Pygoscelis papua at Marion Island. Samples contained fish as well as crustaceans but await detailed analysis.

During 1981/82, metabolic studies were initiated on King, Macaroni, Rockhopper and Gentoo Penguins, and on the Wandering Albatross at Marion Island, during the terrestrial phases of their life cycles. The aim of the study was to relate energy expenditure of adults during incubation and moult, and energy requirements of the chicks, to the food composition and requirement of the birds.

Basal Metabolic Rate (BMR) of the Wandering Albatross was 216 kJ kg^{-1} day^{-1} and energetic cost of incubation in the field was 305 kJ^{-1} kg^{-1} day^{-1}, or about 40 % greater than BMR. This is higher than has been previously estimated.

Basal Metabolic Rates of Macaroni and Rockhopper Penguins were 307 and 341 kJ kg^{-1} day^{-1} respectively. Energy costs of incubation were between 22 and 28 % lower. These results are surprising and

it is possible that handling birds during chick rearing may represent a significantly greater stress to adult birds than handling during incubation. Energy cost of moult, on the other hand, is 349 and 361 kJ kg^{-1} day^{-1} for Macaroni and Rockhopper Penguins respectively, slightly higher than BMR but lower than previous estimates for these species.

The BMR of the King and Gentoo Penguin were 168 and 256 kJ kg^{-1} day^{-1} respectively. The energy cost of moult for the King Penguin was 251 kJ kg^{-1} day^{-1}, 49 % greater than the measured BMR. Energy cost of moult based on rates of mass loss in King Penguins are 96 % greater than BMR.

Measurements of the dilution rates of Tritiated water (TOH) by metabolic water production was attempted to assess its suitability as a technique for measuring energy expenditure during incubation and moult in the field. Scintillation counts of blood plasma from treated birds show that dilution rates of TOH during fasting are very low and body water turnover rates could not be calculated with an acceptable degree of accuracy. The use of TOH as a measure of energy expenditure in the field is thus unsuitable, at least during periods of prolonged fasts.

Procellariiforms have lower body temperatures than other birds. This has led to the suggestion that they have lower metabolic rates, a feature that has been used to explain their long incubation periods, slow growth rates and longevity. Metabolic Rates were measured in 10 species of albatrosses and petrels to test this hypothesis. Results show that procellariiforms do in fact have similar metabolic rates to other birds.

Objective c.

A manuscript is being prepared for the Fourth Symposium on Antarctic Biology (Wilderness, South Africa, September 1983) with the title 'The role of surface-nesting seabirds as marine predators at the Prince Edward Islands. The abstract follows:

In recent years the role of seabirds as marine predators has received much attention, and has led to attempts to model the impact of seabird breeding colonies on the resources of the surrounding seas. Such attempts have been based on knowledge or estimates of seabird numbers, diets, foraging ranges and energetic requirements for existence, foraging, breeding and moulting. The Prince Edward Islands support large numbers of seabirds of 28 species. The 11 large surface-nesting species (penguins, albatrosses and giant petrels) total some 400 000 breeding pairs of which penguins form by far the greatest proportion. Their diets are made up of fish, crustaceans and cephalopods. Data collected at the Prince Edward Islands from 1973 to 1982 are used to construct a bio-energetic model of the energy and food consumption of these large surface-nesting seabirds. This model attempts to estimate the annual consumption of prey and attempts to answer inter alia the following questions: (1) What are the specific and total food requirements in energetic terms of large surface-nesting seabirds breeding at the Prince Edward Islands? (2) What are the types and amounts of prey consumed by the different species? (3) What species have the greatest impact on the resources of the surrounding seas? (4) What time of year does the greatest impact occur? (5) In what area of ocean does this impact occur? (6) Does this impact play a significant role in trophic cycling of resources in the surrounding seas? (7) Can the predatory roles of large surface-nesting seabirds at the Prince Edward Islands be used in a predictive way to assess the structure and dynamics of their prey?

5. Publications

(i) PUBLISHED

Berruti, A. 1982. A volcanic eruption at the site of a Macaroni Penguin colony at Marion Island. Ostrich 53: 118-119.

Berruti, A., Griffiths, A.M., Imber, M.J., Schramm, M. & Sinclair, J.C. 1981. The status of seabirds at Prince Edward Island. S. Afr. J. Antarct. Res. 10/11: 31-32.

Williams, A.J. 1982. Chick-feeding rates of Macaroni and Rockhopper Penguins at Marion Island. Ostrich 53: 129-134.

Williams, A.J. & Laycock, P.A. 1981. Euphausiids in the diet of so Sub-antarctic Eudyptes penguins. S. Afr. J. Antarct. Res. 10/11: 27-28.

(ii) IN PRESS

Adams, N.J. & Brown, C.R. Diving depths of the Gentoo Penguin, Pygoscelis papua. Condor.

Brown, C.R. & Adams, N.J. Basal metabolic rate and energetic cost of incubation in the Wandering Albatross, (Diomedea exulans).Condor.

Brown, C.R. & Oatley, T.B. Bird ringing at Marion and Prince Edward Islands, 1977-1982. S. Afr. J. Antarct. Res.

Cooper, J. Bird ringing at Gough Island,,1977-1982. S. Afr. J. Antarct. Res.

Siegfried, W.R. & Croxall, J.P. Progress and prospects of ornithological research within BIOMASS. Proc. BIOMASS Colloquium, Tokyo, Japan, May 1982.

(iii) INTERNAL REPORTS

Adams, N.J., Brown, C.R. & Enticott, J.W. 1982. Expedition report: S.A. Agulhas Voyage No. 24, April-May 1982. FitzPatrick Institute Unpubl. Rpt pp 6.

Cooper, J. (Ed.) 1982. Ornithological research at the Prince Edward and Gough Islands, May 1981 - May 1982. FitzPatrick Institute Unpubl. Rpt. pp 94.

Cooper, J., Enticott, J.W. & Watkins, B.P. 1983. Expedition Report: S.A. Agulhas Voyage No. 26 October-November 1983. FitzPatrick Institute Unpubl. Rpt. pp Ø.

La Cock, G. 1982. Expedition report: S.A. Agulhas Voyage No. 25, August-September 1982, FitzPatrick Institute Unpubl. Rpt. pp 3.

PROGRESS REPORT TO SASCAR

PROJECT TITLE: POPULATION ECOLOGY OF THE SOUTHERN ELEPHANT SEAL Mirounga leonina AT KERGUELEN

PROJECT LEADER: J D SKINNER, Mammal Research Institute, University of Pretoria, Pretoria 0002

PROJECT RESEARCHER: M N BESTER, Mammal Research Institute, University of Pretoria, Pretoria 0002

PROGRESS REPORT: First interim progress report, April 1983 - June 1983

OBJECTIVES: The primary aims are to determine the population statistics important in the evaluation of forces responsible for the change(s) in the breeding population size of the southern elephant seal at Kerguelen

HISTORY OF PROJECT: This project has been planned to follow on from the project titled "Spatial and temporal distribution of Pinnipeds", the final report of which was submitted to SASCAR in Janaury 1983 and has direct bearing on the understanding of population ecological processes of seals using island platforms in the Southern (Indian) Ocean, and therefore at the Prince Edward islands as well. It is also the result of an invitation by TAAF to resume the collaborative programme at Iles Kerguelen.

PROGRESS: The fieldwork period was supposed to commence during September 1983 and therefore initial preparations were done during the period April - June 1983. Due to logistical problems, the envisaged fieldwork period has been reduced to 45 days at Kerguelen during January/February 1984 (Appendix II, NP 10 for 1984/85). A further invitation for collaboration during 1984/85 has been received from TAAF which includes the aims originally envisaged for the current (1983/84) summer season.

PUBLICATIONS: None as yet from this particular project.

VORDERINGSVERSLAG.

PROJEKTITEL: MIGRASIE VAN DIE SUIDELIKE OLIFANTROB *Mirounga leonina* VANAF MARIONEILAND.

PROJEKLEIER: J.D. SKINNER, Soogdiernavorsingsinstituut, Universiteit van Pretoria, Pretoria 0002.

PROJEKNAVORSER: M.N. BESTER, Soogdiernavorsingsinstituut, Universiteit van Pretoria, Pretoria 0002.

VORDERINGSVERSLAG: Eerste tussentydse vorderingsverslag, April 1983 - Junie 1983.

DOELSTELLINGS: Met hierdie projek word beoog om met behulp van langafstand telemetrie die verspreiding van volwasse olifantrobbe *M. leonina* buite die teelseisoen en verharingseisoen vanaf Marioneiland na te volg.

GESKIEDENIS VAN PROJEK: Navorsing op die terrestriële fase van suidelike olifantrobbe het getoon dat die sub-bevolkings te Kerguelen, Marion en Possessioneilande 'n geskiedenis van konstante afname het, deels as gevolg van 'n geselekteerde vermindering van bulle gedurende die mariene fase. Te Marioneiland bestaan die verdere moontlikheid dat dié afnames volg op pelsrob-bevolkingstoenames. Aangesien olifantrobbe en pelsrobbe op land egter in ruimte en tyd van mekaar gedurende die teelseisoen geskei is, dui dit op interspesifiese mededinging om voedsel. As top predatore naby die bopunt van die voedselpiramide en algeheel afhanklik van mariene voedselbronne was 'n studie van die ruimtelike verspreiding van volwasse olifantrobbe tydens hul mariene (voeding) fase aangewese.

'n Voorlopige ondersoek gedurende 1981/82 het getoon dat (a) kundigheid in die sporing van platform-uitsaaiterminale met behulp van satelliete beskikbaar is, (b) biotelemetrie reeds met wisselende mate van sukses op soogdiere bv., dolfyne en walvisse uitgevoer is, en (c) die ontwikkeling van 'n sender volgens Service Argos vereistes, en toelating tot hierdie sisteem, die enigste onkoste-effektiewe metode sou wees om die verspreiding en beweging van olifantrobbe in die Suidelike Oseaan te bepaal.

Op grond hiervan is die huidige projek goedgekeur om as eerste stap, reeds bestaande kundigheid na te vors, probleme te identifiseer, die onkoste verbonde aan, en uitvoerbaarheid van so 'n program te bepaal, en as moontlike verbruiker indringende inligting aangaande die Argos dataversending- en funksioneringssisteem te bekom.

VORDERING:

Geen noemenswaardige vordering, hoofsaaklik as gevolg van die kort verloop van die verslagtydperk, is gemaak nie. (a) Die beplande besoek aan Marioneiland in verband met immobilisasie-eksperimente met die oog op die toetsing van harnasse vir die aanhegting van senders, het skipbreuk gelei (sien bylaag 1). Hierdie deel van die program moet dus noodgedwonge oorstaan tot die November 1983 aflosreis. (b) Die Service Argos Verbruikerskonferensie vind in September 1983 plaas (Londen, 27 - 28 September), in plaas van die gebruiklike Maart/April. Uitsluitsel oor die geskiktheid van harnas-toerusting en moontlike senders, sal eers hierna gegee kan word, en is as sulks deur die WKAN Sub-Komitee vir Biologiese Wetenskappe (Vergadering: Vrydag 22 April 1983 te Kaapstad) aanvaar.

Gedurende September 1982 is 'n ontmoeting met mnr. Alain Goasguen, hoof van die tegniese afdeling van Service Argos, Toulouse, gereël ten tye van sy besoek aan Suid-Afrika. Dit beloof om 'n waardevolle kontak te wees, en hy sal bystand kan verleen wanneer daar oor die tegniese aanvaarbaarheid/eienskappe van die senders, wat tentoongestel sal word by bogenoemde geleentheid, besin moet word.

Gedurende 1983 het 'n verdere tipe sender, die T2014 van die Japannese Toyocom maatskappy vir die sporing van dolfyne, op die mark gekom (Bylaag 2) wat met dié wat deur die Amerikaanse WISCO maatskappy vervaardig word, kompeteer. Laasgenoemde is reeds in klein hoeveelhede op aanvraag beskikbaar en teen 'n reeds vasgestelde prys (Bylaag 3).

PUBLIKASIES:

Geen publikasies is voorberei.

VORDERINGSVERSLAG

PROJEKTITEL: BEVOLKINGSEKOLOGIE VAN DIE SUIDELIKE OLIFANTROB Mirounga leonina TE MARIONEILAND.

PROJEKLEIER: J.D. SKINNER, Soogdiernavorsingsinstituut, Universiteit van Pretoria, Pretoria 0002.

PROJEKNAVORSER: M.N. BESTER, Soogdiernavorsingsinstituut, Universiteit van Pretoria, Pretoria 0002.

VORDERINGSVERSLAG: Eerste tussentydse vorderingsverslag, April 1983 - Junie 1983.

DOELSTELLINGS: In die lig van die afname in die bevolkingsgrootte van M. leonina te Marioneiland, word daar met hierdie program gepoog om bevolkingstatistieke belangrik in die uitpluising van die kragte verantwoordelik vir die veranderinge in bevolkingsgetalle, te bepaal.

GESKIEDENIS VAN PROJEK:

Hierdie projek is beplan om aansluiting te vind by die langtermyn kontrolering van die teelbevolkingsgrootte van die olifantrobbe te Marioneiland sedert 1973. Die merk van die robbe is sedertdien jaarliks aangepak terwyl herwaarneming hoofsaaklik by geleentheid uitgevoer is. Die finale projekverslag getiteld "Ruimtelike en tydelike verspreiding van Pinnipedia" het getoon dat waar die vasstelling van bevolkingsparameters van merk/herwaarnemingsprogramme afhanklik is, die data tans onvoldoende is as gevolg van 'n noodgedwonge gebrek aan 'n konstante poging om herwaarnemings in te win, en die relatief kort tydperk wat sedert die aanvang van die merkingsprogram verloop het. Dit was ook duidelik dat die kenplaatjies van monel-metaal minder geskik is vir herwaarnemings, en 'n nuwe meer toepaslike merker moes gevind word.

VORDERING:

Vier leidende maatskappye, nl., National Band & Tag Company (VSA), Dalton Supplies Ltd., (Engeland), Floy Tag & Manufacturing, Inc. (VSA) en Delta Plastics Ltd., (Nieu Zeeland) is genader betreffende geskikte merkers, asook wetenskaplikes wat aan die "Pinniped and Sea Otter Tagging Workshop", in Seattle, Washington (Januarie 1979) deelgeneem het. Op grond hiervan is op die Jumbo Rototag van Dalton besluit, en die bestelling is geplaas met die oog op die 1983/84 somerseisoen te Marioneiland.

Gedurende die oorname tydperk (April/Mei) is daar 'n herwaarnemingsveldtog geloods wat gerig is op die tweede piek in jaarlinggetalle, die merk van

die 1982 se pelsrobwelpies en herwaarnemings van veral volwasse pelsrobwyfies soos voorsien in die 1983/84 NP10 se voorgestelde werkplan. Dit word egter gekortwiek deur die verlies aan mannekrag as gevolg van die besnoeiing aan personeel wat die aflosreis kon meemaak. Die data sal eers na die aflosreis (Junie 1983) beskikbaar wees.

Tans word aan die plasing van merk/herwaarnemingsdata op die Universiteit van Pretoria se komper aandag gegee.

PUBLIKASIES: Geen.

PROJECT TITLE: BEHAVIOURAL ECOLOGY OF FUR SEALS *Arctocephalus tropicalis* AND *A. gazella* AT MARION ISLAND.

PROJECT LEADERS: J.D. SKINNER and M.N. BESTER, Mammal Research Institute, University of Pretoria, Pretoria 0002.

PROJECT RESEARCHER: A.N. Other.

PROGRESS REPORT: First interim progress report, April 1983 - June 1983.

OBJECTIVES: This project endeavours to define the behavioural ecology of two species of fur seals which enables adaptation to an environment where they coexist, with emphasis on behavioural variability, through comparison with data available for populations inhabiting islands within the area of the optimal distribution of each species.

HISTORY OF PROJECT: This project extends and supplements the project being concluded on the genetical and ecological separation of *A. tropicalis* and *A. gazella* at Marion Island, and the completed programme dealing with the spatial and temporal distribution of pinnipeds. The project was scheduled to last from April 1983 to November 1985, involving a scientist, Dr. T.S. McCann formerly employed by the British Antarctic Survey and experienced in studies on the behavioural ecology of *A. gazella* at South Georgia. He has, however, left us in an invidious position by taking up the post of Seal's Group Research Leader within an expanding British Antarctic Survey, and at the last possible moment. To date we have failed to locate a suitable replacement.

PROGRESS: As a result of the abovementioned no progress can be reported.

PUBLICATIONS: None.

ANNUAL PROJECT REPORT

PROJECT TITLE : Energy Flow and Biological interactions in the littoral of Marion Island.

PROJECT LEADER: Prof. John R Grindley and Prof. George R Branch
(Environmental Studies and Zoology Departments, University of Cape Town, Rondebosch 7700).

PROJECT RESEARCHES:

Mr W O Blankley and Mr P G Haxen
(Environmental Studies, University of Cape Town
Rondebosch 7700)

PROJECT DURATION:

April 1982 to March 1985.

PERIOD COVERED BY REPORT : April 1982 to June 1983.
(Submitted in June 1983)

1. OBJECTIVES

The prvevious marine biology project (1979 - 1982) outlined major trophic pathways and quantified standing stock biomass and community structure. The structural dynamics of the system now need to be investigated and described.

2. HISTORY OF THE PROJECT

The original proposals for this work were prepared by Mr W O Blankley with Prof. J R Grindley and Prof. G R Branch in 1981. Work was commenced by Mr Blankley but after his departure to a new post at the Oceanography Research Institute in Durban in 1982, the post was filled by Mr P G Haxen who had not yet finished his aspect of the work on the Marion Island littoral ecology programme. Mr Haxen was employed until the end of March 1983 when he submitted his 82 page report on the ecological role of Durvillaea antarctica. Mr Blankley obtained his M.Sc. with distinction on the basis of his thesis on the intertidal and shallow subtidal food web of Marion Island.

At that time no full-time research worker was available to be appointed to the post on Marion Island, but both an experienced Senior Scientist and a research assistant have now been appointed to go to Marion in November 1983.

3. SCIENTIFIC PROGRESS

September 1982 Visit to Island

Prof. G M Branch and two assistants, P Haxen and A McEwan visited Marion during the take-over. Substantial progress was made toward fulfilling the aims of the project during this visit. Respirometry studies on Nacella and Anasterias were completed. Fifteen dives were undertaken and the communities plotted from the 'intertidal to the outer fringe of the Macrocystis. Growth rates of Macrocystis were monitored and are astonishingly high. Predation of Nacella by gulls was quantified. Material from the collections made subtidally is still to be identified by taxonomic experts all over the world, but already it is obvious that the offshore benthic fauna is a very unusal one, dominated by 6 species of starfish, holothurians, a surprising diversity of nudibranchs, and largely lacking algae. Inshore of the Macrocystis beds is a zone of Desmarestia which houses very little animal life; and inshore of that are red algae and limpet-dominated zones. Monthly samples of Nacella have been collected during the period September 1982 to June 1983 and will be used to assess zoned output of limpets.

4. PUBLICATIONS AND REPORTS

Published:

Blankley, W O 1981. Marine food of kelp gulls, Lesser sheathbills and imperial cormorants at Marion Island (Subantarctic).

Cormorant 9 : 77-84

Blankley, W O 1982. Feeding ecology of three species of fish at Marion Island (Southern Ocean). S. Afr. J. Zool 17 (4) : 164-170

Blankley, W O and Grindley, J R 1983. Biomass and ecological interactions of the Marion Island Intertidal and subtidal fauna (abstract only). S.A. National Oceanographic Symposium, Rhodes University, Grahamstown, South Africa : Abstracts D 9

Haxen, P G and Grindley, J R 1983. Aspects of the ecology of the intertidal kelp, Durvillaea antarctica, on Marion Island. (Abstract only). S A National Oceanographic Symposium, Rhodes University, Grahamstown, South Africa ' Abstract D 10

Prepared and submitted for publication:

Blankley, W O. Ecology of the starfish Anasterias rupicola (Verrill) at Marion Island (Southern Ocean)

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REPORT ON ENTOMOLOGICAL ACTIVITIES ON MARION AND PRINCE EDWARD ISLANDS DURING THE TAKEOVER OF "MARION 40" (2-31 MAY 1983).

by J.E. CRAFFORD

INTRODUCTION

Besides various non-entomological activities such as loading and offloading the ship, various base duties and suchlike expected of a team member it was possible during the four week takeover-period to

(i) Undertake a survey of the terrestrial invertebrates
(ii) Establish laboratory cultures of the three dominant species
(iii) Sample qualitatively from sea level to the peaks of some of the high mountains
(iv) Make slide preparations of certain of the small insects for identification purposes - all of the above on Marion Island and
(v) Visit Prince Edward Island where a small quantitative survey was undertaken and specimens for comparative purposes were collected.

RESULTS AND DISCUSSION

(a) Marion Island

(i) A survey (in the same locality and using the same methods as those outlined by Scholtz & Crafford 1982) of the terrestrial invertebrates was undertaken. Two hundred samples were taken and hand sorted. The results were very similar to those recorded by Scholtz & Crafford (1982) and were within the limits recorded by Burger (1978) and Gleeson (1981). However, as this form of sampling is very time-consuming and, without an assistant, would take up far too much time it has been decided to change the approach somewhat.

Sampling will now be restricted to smaller plots within vege= tation types known to support large populations of invertebrates and the same area will be sampled regularly. More attention can then be paid to the importance of microhabitat, and fluctuations

of water level and pH, on population composition. Sampling will be undertaken monthly near the base as well as on the western side of the island.

(ii) Laboratory cultures of the three dominant species of insects involved in decomposition processes on the island were established.

It was suspected after analyzing gut contents of Pringleophaga marioni larvae and those of Ectemnorrhinus similis larvae and adults that these insects are probably polyphagous and that P. marioni at least is most likely omnivorous. Consequently adults and larvae of E. similis and larvae of P. marioni were placed in petri dishes and supplied with damp "Pro Nutro" for food.

Pringleophaga marioni larvae settled down immediately to this diet, E. similis adults appeared to tolerate it, and E. similis larvae were not seen to eat it at all. P. marioni has been reported feeding on moss cushions and grass roots (Vári 1970), small terrestrial invertebrates (Scholtz & Crafford 1982) and now for the first time it can be stated unequivocally that P. marioni larvae are omnivorous. The exact feeding preferences of E. similis adults and larvae remain to be determined.

Cultures of the larvae of the kelp fly Paractora mirabilis were also kept in the laboratory but it was found that the rotting kelp on which they feed ferments very rapidly when kept in the lab. This problem is being worked on.

(iii) A qualitative survey of insects was undertaken during a walk from the south of the island (Santa Rosa Valley), across the central highlands to Long Ridge (north). The material has not yet been processed.

(iv) Slide preparations of some of the smaller invertebrates e.g. collembolans and psocids were made for identification

purposes. The collembolans are particularly abundant and may prove to be important in various food chains.

(b) Prince Edward Island

Four days were spent on Prince Edward Island, two of which were spent on the east coast and the rest on the west coast.

At each of the localities 10 samples were taken in each of five different plant communities and handsorted. The species composition of the fauna was found to be similar to that on Marion Island but the insects were far more numerous than on Marion Island and the specimens collected on P.E. Island were much larger than their equivalents on Marion Island.

There are a few possible explanations for the larger and more numerous insects on P.E. Island.

(i) Birds are far more numerous on P.E. than on Marion Island with the result that all plant communities are biotically disturbed. As a consequence of the abundant birds the nutrient input into the soil is higher, resulting in more nutritous food for plant- and plant-associated feeders.

(ii) Predation of insects is probably lower on P.E. than on Marion Island because their main predator, the house mouse, does not occur on P.E. Also, because of the superabundance of birds on P.E. more bird carcases are available to scavengers such as the Lesser Sheathbill, (which prey heavily on insects on Marion Island), thus making the small, mobile insects less rewarding than carrion.

(iii) Curculionid beetles and Pringleophaga sp. (P. Kerguelenensis is the only species of Pringleophaga recorded from P.E. (Vári 1970). (It was recorded by Paulian, 1953 to feed on Pringlea and Acaena on Kerguelen). Larvae were also found to feed on bird carcases - a phenomenon not recorded on Marion Island (or anywhere else in the subantarctic?). Whether this implies different species (as indicated by Vári, 1970 for Pringleophaga), ecotypes, or in fact substantiates the assumption that many of the insect species

are omnivorous, is not known.

Whatever the reasons for the differences in the insect fauna of the two islands are it has become clear that in order to understand the underlying principles of the ecology of the insects of the Prince Edward group it will be necessary to establish unquivocally which species are in fact being studied, their relationship with other populations and how their basic ecology is affected by other biotic groups.

In conclusion, the importance of studies of the Prince Edward Island fauna should be emphasized and, wherever possible, live material should be collected on the island for detailed study. A study of the fauna and its comparison with that of Marion Island will tie in well with some of the long-term goals of the Entomological Programme, i.e. Confirmation of the taxanomic status of the dominant insects; and zoogeo= graphical relationships and the possible origins of the insects (points 2.e and 2.f in; Report on a meeting between Dr. C.H. Scholtz, Prof. D.F. Toerien, Prof. E.M. van Zinderen Bakker and Mr. V.R. Smith, held to discuss the Marion Island Entomological Project, typescript, February, 1983).

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Project Title: POPULATION DYNAMICS AND BIOLOGY OF SELECTED SEABIRDS AT MARION AND PRINCE EDWARD ISLANDS, WITH PARTICULAR REFERENCE TO THEIR MINERAL AND ENERGY CONTRIBUTIONS IN THE TERRESTRIAL ECOSYSTEM

Project Leaders: W.R. Siegfried & J. Cooper, FitzPatrick Institute, University of Cape Town.

Project Researcher: S.R. Fugler, FitzPatrick Institute, University of Cape Town.

Date: Fifth interim progress report, July 1982 - June 1983, submitted in June 1983.

1. Objectives

(a) To determine the mineral and energy contributions of nocturnal burrowing petrels, in the form of feathers, guano, carcasses and eggs, to the Marion Island ecosystem.

(b) To assess the effect of feral cat depredation on nocturnal burrowing petrels.

2. History of Project

Seabirds are an important source of mineral and energy inputs to the Marion Island ecosystem. The ornithological research carried out at Marion Island between 1973 and 1978 produced estimates of the energy and mineral element contributions of the large surface-nesting seabirds. The second phase of the research aims to achieve the same objectives for the burrowing petrels, which are inherently more difficult to study. A population of feral cats has become established at Marion Island and may drastically have altered the island's species composition and abundance of petrel populations. The study aims to provide quantitative information on the effects of cat predation on the petrels.

During the first three years of the project (July 1978 to June

1981) research at Marion Island concentrated on aspects of the breeding biology, feeding ecology, and habitat descriptions and requirements for breeding of five species of burrowing petrels: the Kerguelen Petrel, Greatwinged Petrel, Softplumaged Petrel, Whitechinned Petrel and Salvin's Prion. In addition, the effects of predation by Antarctic Skuas on burrowing petrels has been studied. Visits to nearby cat-free Prince Edward Island have allowed comparisons of the composition and density of the burrow-nesting petrel communities there with those of Marion Island, with a view to assessing the role of cats. Considerable material has been collected to determine mineral and energy contributions to Marion Island from feathers, guano, corpses and eggs (objective a). During 1981-82, research concentrated on a study of the breeding and feeding ecology of the Blue Petrel at Marion Island.

3. Scientific Progress

Objective a.

During the period July 1982 to May 1983 research continued to be concentrated on the Blue Petrel, the last abundant and/or readily accessible burrowing petrel awaiting study at Marion Island. Breeding biology data have been collected from 116 burrows from which 44 chicks fledged, giving a breeding success of 37,9%. Eighteen laying dates within 24-h, and incubation period for 10 nests have been recorded. Observations of nocturnal visits to burrows prior to egg-laying have been recorded.

During December 1982, rainfall at Marion was 30% above average and loss of eggs of Blue Petrels due to burrow flooding was recorded.

Growth rate of Blue Petrel chicks has been recorded on one occasion during the chick-rearing period, commencing with 21 chicks at hatching and finishing at fledging with 13 chicks.

All chicks had fledged by 6 February.
Some information (including guano samples) has been collected for the rare, winter-breeding Grey Petrel. This species has not been studied in detail previously at Marion Island.

Guano has been collected from chicks of four species of burrowing petrels at Marion Island over 24-h periods. A total of 68 samples has been analysed for volume, water content and soluble nitrogen in the form of ammonia, nitrates and nitrites. Guano samples have been kept for calorific analysis. Guano output and its chemical composition appears to vary greatly within a 24-h period and also between individuals. To investigate this aspect, guano has been collected at known times (e.g. directly after the chicks have been fed and 24 h after a meal). To measure the effects of burrowing petrels on the terrestial environment, in the form of mineral and energy contributions, soil cores have been taken in two areas where Blue Petrels breed, and in one where no burrowing petrels breed as a control. Soil cores have been taken every two weeks throughout the breeding season and analysed for water content, pH and nitrogen (ammonia, nitrates, nitrites) within 24 h of collection. Soil not used for nitrogen analysis has been stored for further analyses. The phenology of three species of plants, Blechnum penna-marina, Poa cookii and Cotula plumosa, has been followed in the same plots used for soil analyses. Monthly samples have been collected and live and dead mass of materials recorded. The effects of guano enrichment on soil chemistry and plant growth are thus being measured. No results are yet available since further analyses must be conducted at Cape Town.

Objective b.
In April-May 1983, a visit has been planned to Prince Edward Island to ascertain burrowing petrel, especially Blue Petrel, breeding densities. Results from this survey are not yet available but it is expected that the effects of cat predation on Marion Island will be shown up by the much higher breeding

densities of burrowing petrels breeding at cat-free Prince Edward Island.

Previously the effects of Subantarctic Skua predation on burrowing petrels at Marion Island has been studied (see 1982 Progress Report to SASCAR), to compare with the effect of cat predation. Skua predation at cat-free Prince Edward Island has now been investigated. Collections of prey remains were made in three areas at Prince Edward Island in May 1982. A total of 455 individual remains representing seven species were collected. Six species of burrowing petrels were identified. Blue Petrel was the most abundant at two sites (Boggel 73% of total collected; Kent Crater 76%). At the third site (McCall Kop area) the Keguelen Petrel was the most abundant species recorded (31%). Blue Petrels formed 65,3% of the combined sample. At Marion Island, Salvin's Prion formed the dominant prey and it may be assumed that the relatively higher proportion of Blue Petrels in the diet of the Subantarctic Skua at Prince Edward Island is related to their relatively greater breeding density. Such differences are probably related to the effects of cat predation at Marion Island. It is intended to repeat this survey at Prince Edward Island during April-May 1983. At the same time an attempt will be made to look for variations in Subantarctic Skua diet over the whole coastal region of Marion Island. Differences in burrowing petrel density and abundance at different parts of the island should be reflected in changes in the Skua's diet. Such differences can then be related to any regional changes in cat diet: thus putting cat predation on a regional basis in perspective. It has been confirmed that House Mice scavenge from dead Blue Petrel chicks and it is suspected, though not yet proven, that mice are able to kill chicks when they are first left alone in the burrow (end of brood stage). If this is true then the reduction of burrowing petrel numbers on Marion Island may not be solely due to cats. In particular, the assumed loss of breeding stormpetrels and

common divingpetrels at Marion Island could be mouse related. These birds are smaller than the Blue Petrel and, theoretically, would therefore be at greater risk. Prince Edward Island is also mouse-free and if the House Mouse is a predator of small burrowing petrel chicks then even greater responsibility exists to keep Prince Edward Island mouse-free. Prince Edward Island is one of the very few subantarctic islands without House Mice and it is pertinent to note that it is far more likely for mice to be accidentally introduced to it than feral cats.

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Project Title: THE FEEDING ECOLOGY OF FOUR SPECIES OF AVIAN PREDATORS AT MARION AND PRINCE EDWARD ISLANDS

Project Leaders: W R Siegfried & J Cooper
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Project Researcher: S A Hunter
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University of Cape Town, Rondebosch 7700.

Date: First Project Report: 1 April 1983 - 30 June 1983, submitted in June 1983.

1. Objectives and rationale

1. To assess the impact by predation of two species of giant petrels, the Subantarctic Skua and the Kelp Gull on eggs, chicks and adult birds at Marion and Prince Edward Islands.
2. To explain how these four species partition the available resources (prey) in terms of species, space and time at Marion and Prince Edward Islands.
3. To compare the predatory impact of skuas and gulls on burrow-nesting petrels with that of cats at Marion Island.
4. To increase understanding on the contribution of these four species to the mineral and energy inputs to the Marion Island ecosystem.

The breeding biology of nearly all the common seabirds breeding at Marion Island has been studied. Detailed feeding ecology studies to date have been restricted to those species of seabirds feeding at sea. Four further species: the Southern and Northern Giant Petrels, Subantarctic Skua and Kelp Gull feed by active predation or by scavenging either wholly or primarily terrestrially at Marion and Prince Edward Islands during their breeding seasons. Very little quantitative information is available on their diet. This information is required inter alia to a) contribute to knowledge of energy and mineral cycling, b) place the role of cats as predators in perspective and c) assess the effect of predation on breeding success of species already studied, especially those species being monitored for BIOMASS.

The approach to the research will be by answering the following questions:

1. What is the diet of the four predatory seabirds at Marion and Prince Edward Islands?
2. Do the four predatory seabirds compete for food at Marion and Prince Edward Islands?
3. To what extent do skuas and gulls compete for food with cats at Marion Island?
4. What is the rôle of the four species in recycling and redistributing nutrients at Marion and Prince Edward Islands?

Diet will be assessed by direct observations of predation, recording carcasses of depredated birds and by analysing regurgitated casts and stomach contents of the four species. The extent of competition will be assessed by comparing diets of the four species in space and time.

Censuses of gulls and skuas coupled with knowledge of their diet (Question 1) will allow a comparison to be made with the effects of cat predation on burrowing petrels. Knowledge on the type, quantity and quality (in terms of nutrients and energy) taken by the four seabirds will allow calculations to be made on their contribution to the major energy and nutrient fluxes in the Marion Island terrestrial ecosystem.

2. Manpower requirements

Anticipated manpower requirements are two persons: a biologist (Mr S A Hunter) and a field assistant (Mr B W Stead) for the duration of the project. Temporary assistance may be employed to help with laboratory analyses in 1985 after field work has been completed.

3. Fieldwork schedule

a. April-June 1983

Preliminary assessment of Marion Island during takeover period for the planned research, choosing of study sites, ring sizes and practicing various capture techniques. Preliminary censuses of avian predators at both Marion and Prince Edward Islands. Collection of prey remains of Subantarctic Skuas at Marion and Prince Edward Islands.

b. October 1983 - May 1985.
Setting up of study colonies of four species of avian predators at Marion Island, colour marking and ringing of breeding individuals at marked nests. Collection of mensural and moult information and on breeding biology (e.g. laying dates, incubation periods, growth rates, breeding success) by regular nest checks. Collection of diet samples from all four species. Observation of foraging behaviour of marked birds by day and by night (using an image-intensifier).

c. April - May 1984 and 1985
Visits to Prince Edward Island to undertake censuses of four species of avian predators and to collect comparative data on diet so that cat-free Prince Edward Island may be compared with Marion Island.

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PROJECT TITLE: PALYNOLOGY OF MARION ISLAND
(PALYNOLOGY AND LONG DISTANCE DISPERSAL - SOUTHERN ISLANDS)

PROJECT LEADER: Prof D F Toerien, Institute for Environmental Sciences, U O F S, P.O. Box 339, Bloemfontein 9300

PROJECT RESEARCHER: Dr L Scott, Institute for Environmental Sciences, U O F S, P.O. Box 339, Bloemfontein 9300

DATE: Interim progress report, May 1983

OBJECTIVES

The aim of the project is to study the age, origin and evolution of the biota on Marion Island. Fossil pollen and spore assemblages provide evidence for early plant communities while recent pollen spectra provide evidence for the present production and foreign input on the island. The investigation is necessary to improve our background understanding of the island ecosystems.

HISTORY

The research was previously conducted by Prof E M van Zinderen Bakker under the title 'Palynology and Long Distance Dispersal - Southern Islands'. Since April 1981 the research has been done by Scott. Miss S Beneke was appointed as research assistant to the project since 1982. Prof van Zinderen Bakker studied a number of pollen trap samples from Marion Island and from five other sub-antarctic areas such as S. Georgia and Kerguelen in order to assess the long distance dispersal of small particles to the Island. He also analysed the pollen of two peat profiles collected by K J Hall and H J Lindeboom. Scott visited the Island during April/May 1981 and collected pollen samples from a series of peat profiles, recent surface materials and some interglacial deposits. A paper (Scott and Hall, 1983) has been published on the pollen analyses of the interglacial deposits and the present report describes new results of the analyses of pollen extracted from the peat and surface samples as well as those of peat profiles collected during April/May 1981 by V R Smith and J M de Villiers. A sample (supplied by K J Hall) from a peat profile overlying glacial deposits from Kerguelen was also analysed in

order to obtain some correlation over a wider area.

SCIENTIFIC PROGRESS

Interglacial samples

Pollen of a possible extinct plant type found in five peat deposits of Pleistocene age which formed before a series of glacial events (Scott and Hall, 1983) has now tentatively been identified as that of *Cardamine* (Cruciferae). Species of this genus presently occur widespread in temperate and cooler regions. Examples are *C. glacialis* and *C. africana* which are found on Gough Island and in South Africa respectively. SEM photographs of the pollen type which is thought to belong to this group has been produced and they may help to confirm the identification.

Surface pollen spectra

A detailed pollen percentage diagram of twenty-three superficial soils have been produced. The samples represent different altitudes and vegetation types and the diagram can be applied in the interpretation of the fossil pollen profiles. It is shown that the pollen of *Cotula plumosa* is very prominent (± 75%) in a spectrum of a low altitude site (± 10 m) near the ocean shore, where this plant is common. Pollen of *Callitriche antarctica* is relatively important (up to 13%) in samples below 30 m but generally the pollen of Gramineae is the most important element (28-80%) at the studied sites below ± 150 m. In most cases above this level the pollen of *Azorella selago* is dominant often reaching 80% or more. Two high altitude samples from areas free of vegetation above ± 650 m, contain high percentages of Gramineae, *Cotula* and foreign (long-distance) pollen. This probably implies that Gramineae and *Cotula* are well dispersed pollen types. It can be assumed that a certain proportion of these taxa, especially in the case of the Gramineae, are also long distance types. *Acaena magellanica* pollen and *Blechnum*-type spores occur regularly especially in samples of altitudes below ± 300 m and in two cases the former attain high values (47 and 69%). The pollen of *Uncinia compacta* occur regularly in relatively low numbers at altitudes below about 250 m while that of *Ranunculus* spp is in some cases important (up to 20%) at altitudes as high as ± 500 m. The spores of *Lycopodium* species are distributed in relatively low numbers at altitudes below ± 550 m while spores and pollen of *Hymenophyllum peltatum*, *Pringlea*

antiscorbutica, Caryophyllaceae and *Montia fontana* were occasionally recorded in smaller numbers below ± 150 m.

Radiocarbon dating

Altogether 14 ^{14}C age determinations have been completed by the National Physical Research Laboratory (C S I R) and they are listed in Table 1. The peat profiles from Skua Ridge and Albatross Lakes were sampled behind moraine deposits described by Hall (1978) in the hope of finding the earliest peat which accumulated after the last glacial episode. Unfortunately none of the sampled peat profiles were found to be older than the Holocene period or the dates recorded by Schalke and van Zinderen Bakker (1971). The oldest sample of ca. 7300 yr B P came from Kildalkey Bay. Apart from the dates in Table 1 two peat samples for ^{14}C dating from soil profiles near Junior's Kop were submitted to the N P R L by J M de Villiers.

Pollen analyses of the peat profiles

The pollen contents of the following peat profiles from Marion Island were analysed and detailed pollen diagrams have been produced:

1. First boring, Skua Ridge: This profile of 145 cm, behind the moraine nearest to the shore, indicate that fjaeldmark with *Azorella selago* was more important in the surroundings just after 7 000 yr B P and that it was gradually replaced by vegetation with more grasses.

2. Second boring, Skua Ridge: In view of the profile's relatively young age (1680 ± 50 yr B P) and its closeness to the first boring of Skua Ridge, the pollen was not studied in detail. The young age may be as ascribed to the infilling with peat of a previous drainage line or the nearby lake which could have covered a greater area.

3. Landslide section, Skua Ridge: This profile of 32 cm was exposed by a landslide on the steep south slope of Skua Ridge. The ^{14}C date shows that the peat along the slope grew to its present thickness during roughly the last 500 years and the pollen spectra suggest that succession from fjaeldmark to a vegetation dominated by grasses and *Acaena magellanica* took place during this period.

4. Third boring, Albatross Lakes: This 4 m profile was sampled immediately next to the lake, behind a moraine close to the shore. The pollen profile suggests the presence of fjaeldmark vegetation in the basin around 6000 yr B P. By 5900 yr B P it was replaced by a vegetation with a high proportion of Ranunculaceae. This is probably an indication of aquatic conditions and lake development. Succession to a vegetation with more grasses, *Acaena magellanica* and *Blechnum* followed. The material above 280 cm could not be sampled because it was not compact enough.

5. Fourth boring, Albatross Lakes: This profile of 165 cm was sampled behind an inland moraine to the west of the third boring. The pollen spectra suggests that a vegetation type with a relatively high proportion of grasses and some fjaeldmark, remained fairly constant in the area during the last 4140 ± 70 yr B P.

6. Kildalkey Bay peat section: The peat profile of 6 m covers the last 7300 yr B P. According to the five ^{14}C dates and those reported by Lindeboom (1979) the accumulation rate was constant. The deepest peat samples represent fjaeldmark which was replaced by a vegetation with more grasses and *Acaena magellanica* *Ranunculus* spp. and *Callitriche antarctica* around 6000 yr B P. The pollen of these components as well as those of others such as *Montia fontana* which occur in smaller numbers, appear alternately in sharp irregular peaks throughout the profile. However, the pollen of *Acaena* remained relatively scarce during roughly the last 1500 yr B P. The persistence of *Callitriche antarctica* and *Montia fontana* in fairly high numbers suggests that enrichment by animals, probably birds, already occurred since ca. 6000 yr B P. The peaks of the different pollen components may be a reflection of succession which occurred at different stages following local disturbance by animal activity. The eventual expansion of the penguin rookery caused erosion of the peat which exposed the 6 m section.

7. Sites 24 and 25 near Junior's Kop: These profiles of 110 and 90 cm respectively are analysed in collaboration with V R Smith and J M de Villiers in order to aid the interpretation of some buried soil horizons. In view of ^{14}C dates in the area (Schalke & van Zinderen Bakker, 1971) these sites are not expected to be older than ± 3000 yr B P. In the early stages of accumulation in site 24 *Azorella* was probably slightly less prominent that at present while *Uncinia* and *Blechnum* was perhaps slightly more important. *Callitriche* in the

upper sample suggests more animal activity. The lower peat between 70 and 90 cm in site 25 was probably formed by *Azorella* cushions although grasses and other vegetation also contributed. Grasses and *Uncinia* were relatively more important during the formation of the interval between 52 and 60 cm but *Azorella* again became relatively more important in the upper section of the profile (3 - 35 cm).

8. Moraine matrix sample, Albatross Lakes: A pollen spectrum was found in a matrix sample of a moraine between the third and fourth borings at Albatross Lakes. The deposit represents the glacial episode which probably ended before 10 000 yr B P (Schalke and van Zinderen Bakker, 1971; Hall, 1978). The pollen is dominated by that of *Azorella selago* and suggests fjaeldmark conditons corresponding those implied for the Late Glacial period in this area (Schalke and van Zinderen Bakker, 1971).

9. Kerguelen peat: A sample of peat from Kerguelen, which directly overlies a tillite sequence comparable to that found at Kilkalkey Bay was supplied by K J Hall. The sample is only 3 160 ± 60 yr B P old suggesting that peat development started relatively late. The pollen spectrum includes high numbers of *Acaena, Azorella,* Gramineae and *Callitriche* pollen. The latter indicates animal activity.

Papers describing these palynological results in detail are being prepared. They support the suggestion by Schalke and van Zinderen Bakker (1971) that fairly constant climatic conditions prevailed during the last 10 000 years and that oscillations in the pollen diagrams only reflects local succession. *Azorella* fjaeldmark can be expected to have prevailed at lower altitudes during the cooler period before 10 000 yr B P as is proposed by Schalke and van Zinderen Bakker (1971). However, the high percentages of *Azorella selago* in some basal levels of the studied peat units which belong to the relatively warm Holocene period, suggests that increased numbers of this pollen type do not provide proof of cooler conditions. It is suggested that succession of barren fjaeldmark to peat-forming vegetation with Gramineae and other species occured at different stages at various sites. It is not clear whether fjaeldmark persisted until relatively late in some areas or whether possible older peats, which formed during earlier cycles of succession, were removed by erosion.

Airborne diaspora and long-distance dispersal

A paper entitled "Exotic pollen and long-distance wind dispersal at a sub-antarctic island" by L Scott and E M van Zinderen Bakker has been submitted to the palynological journal "Grana". The abstract reads as follows:

Exotic pollen grains on Marion Island (southern Indian Ocean) make up ± 1.2% of the spectra recorded in samples of various surface soils, peat profiles and a moraine matrix. They consist mainly of elements transported over long distances across the circum-Antarctic ocean by the prevailing westerly winds. The majority of forms originate from the southern tip of Africa while others come mainly from the more distant South-American region. The results imply that there is a regular transport of small particles to Marion Island by wind but that wind dispersal has probably not played a major role in the establishment of the present biota on the island.

ACKNOWLEDGEMENTS

The ^{14}C age determinations were proformed by J C Vogel (C S I R).

PUBLICATIONS

Scott, L. and Hall, K.J. 1983. Palynological evidence for interglacial vegetation cover on Marion Island, Subantarctic. *Palaeogeogr., Palaeoclimatol., Palaeoecol.* 41: 35-43.

D. J. Toerien
PROJECT LEADER

L. Scott
PROJECT RESEARCHER

TABLE 1. ^{14}C age determinations of sub-antarctic peat samples

Profile	Depth (cm)	^{14}C age (yr B P)	Lab. no.
1st boring, Skua Ridge	20-35	470 ± 70	Pta-3351
	90-100	2380 ± 70	Pta-3352
	130-140	6930 ± 90	Pta-3214
2nd boring, Skua Ridge	110-125	1680 ± 50	Pta-3378
Landslide section, Skua Ridge	23-32	460 ± 50	Pta-3378
3rd boring, Albatros lakes	288-295	too little peat left	-
	340-350	5900 ± 70	Pta-3384
	353-363	5990 ± 70	Pta-3232
4th boring, Albatros lakes	35-55	too little peat left	-
	165-180	4140 ± 70	Pta-3231
Kildalkey bay peat section	80-90	490 ± 40	Pta-3373
	300-310	2970 ± 60	Pta-3381
	505-515	5220 ± 70	Pta-3452
	575-585	6180 ± 70	Pta-3382
	600	7300 ± 70	Pta-3208
Kerguelen profile	300	3610 ± 60	Pta-3372

PROJECT TITLE : NITROGEN CYCLING ON MARION ISLAND

Project leader : Prof D F Toerien
Institute for Environmental Sciences
University of the O F S, Bloemfontein

Project Researcher : V R Smith
Institute for Environmental Sciences
University of the O F S, Bloemfontein

Date : Fourth interim report, June 1983

Objectives

Identification and quantification of inputs of N to, and losses from, the island ecosystem.
Identification of the important soil N transformations and the assessment of the role of microorganisms in these transformations.

History of project

The project was initiated in April 1979 as a continuation of earlier work on cyanobacterial nitrogen fixation (Croome 1973), the role of microorganisms in uric acid breakdown (Lindeboom 1978) and the nitrogen status of the island plants and soils (Smith 1977).

Scientific progress, April 1982 - March 1983

1. Gas chromatographic analysis of C_2H_2 reduction samples (field investigation of heterotrophic acetylene reduction)

   Approx. 600 incubation atmosphere samples were analysed by GC in order to assess the importance of heterotrophic bacteria in fixing N under field conditions. The field work involved incubating peat samples aerobically and anaerobically at fortnightly intervals over a year period.

2. Laboratory investigation of heterotrophic N fixation

   A study of the conditions favourable toward N fixation by heterotrophic bacteria was carried out. GC analysis of the incubation atmospheres

is complete. The results of this, and the field study reported above, have been written up as a paper to be presented at the SCAR biology symposium in September 1983.

3. Gas chromatographic investigation of denitrification in the field

Funds for a column and accessory apparatus needed for the gas chromatograph in order to measure N_2O were only made available at the end of March 1983 and no progress in this study was made.

4. Mineralization and nitrification rates in the island peats

This study, intended for the period 1983/84, was initiated in the period reported on here. Two techniques have been employed :
(i) in situ investigation of the transformations
(ii) soil column investigations under laboratory conditions

Preliminary results indicate rapid rates of mineralization, especially if an energy source (glucose) is supplied. No comments on the rate of nitrification can be made at this tage.

5. Acetylene reduction by bryophyte/cyanobacteria associations

This investigation represented the major activity carried out within the nitrogen cycling project during the period under consideration. Its continuation also forms the main emphasis of the project during 1983/84. Cyanobacterial/bryophyte associations have been shown to be the important "fixers" of N on Marion Island. Two publications on this phenomenon appeared during the period reported on.

6. MPN analysis of denitrifying bacteria at selected island sites

The results of this study were reported in a paper by Steyn and Smith (1981) which resulted mainly from work done within the "Decomposition on Marion Island" project.

Publications appearing in 1982/83

Smith V R and Ashton P J 1981. Bryophyte-cyanobacteria associations on sub-Antarctic Marion Island : are they important in nitrogen fixation? S.Afr. J. Antarct. Res. 10/11: 24-26.

Smith V R and Russell S 1982. Acetylene reduction by bryophyte-cyanobacteria associations on a sub-Antarctic island. Polar Biol. 1: 153-157.

Steyn M G and Smith V R 1981. Microbial populations in Marion Island soils. S. Afr. J. Antarct. Res. 10/11: 14-18.

Manuscript to be presented at SCAR Biology Symposium, September 1983

Smith V R. Heterotrophic acetylene reduction in Marion Island soils.

PROJECT TITLE : DECOMPOSITION STUDIES ON MARION ISLAND

Project leaders : V R Smith and D F Toerien

Date : Second interim report, June 1983.

Objectives

This project aims at understanding aspects of the decomposer subsystem of the island ecosystem.

History of the project

This project commenced in April 1981 when limited funds were made available to initiate decomposition studies on the island. Early work included the quantification of nutrient inputs to the island ecosystem, the rate of disappearance of material from "litter bags" and a preliminary study of the relationship of soil microflora to site characteristics. These topics were reported on in the first interim report.

Scientific Progress, April 1982-March 1983

1. Spatial distribution of soil microflora and its relationship to site characteristics

   The initial study yielded interesting results which were published in 1982. A follow-up, more intensive investigation was initiated in 1981 and the fieldwork completed during the period reported on here. Much of the laboratory analysis (bacteria and fungi counts, inorganic forms of N, available P, pH) was also completed, as was a botanical survey of the 126 sites investigated. Funding has been awarded during 1983/84 for further analyses (CEC, exchangeable cations, Total N, organic C, soluble cations). The study will, therefore, only be reported on in the final project report due in 1984.

2. Midwinter and midsummer populations of soil microorganisms at 20 sites distribution with depth and strain isolation

   The field work was completed during the period being reported on.

Strain isolation and physiological characterization was initiated and will be completed during 1983/84.

3. Collection of standing dead material for studies of the factors influencing decomposition rates of plant material

Standing dead material of several vascular and bryophyte species was collected in order to initiate a study, under controlled conditions, of the factors influencing decomposition of plant matter in the island peats. However, funding for the soxhlet apparatus needed for this study has not been awarded and it is unlikely that this study will be initiated in 1983/84.

Publications

Steyn, M G and Smith, V R (1981) Microbial populations in Marion Island soils. S. Afr. J. Antarct. Res. 10/11: 14-18.

Smith, V R and Steyn, M G (1982) Soil microbial counts in relation to site characteristics at a Subantarctic island. Microb. Ecol. 8: 253-266.

PROJECT TITLE : MULTIVARIATE SYNOPSIS OF MARION ISLAND SOIL, CLIMATIC AND BOTANIC DATA

Project leader and researcher : V R Smith
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Date : First Project Report, June 1983

INTRODUCTION

The proposal for this project was submitted to SASCAR in June 1982. It was considered and accepted by the management panel of the SASCAR Biological Sciences subcommittee in September 1982 and funds made available in April 1983. The duration of the project is expected to be one year, viz. April 1983 to March 1984.

MOTIVATION AND RATIONALE OF THE PROJECT

The various ecological projects on Marion Island since 1956 have yielded a large body of data which, although published within the context and frame of reference of each project, have never been synthesized in a comprehensive format which would enable a comprehensive understanding of the patterns occurring within the island ecosystem or which would allow for a meaningful comparison of this ecosystem (and those of other sub-Antarctic terrestrial regions) with those of other (mainly northern subpolar) sites.

A meaningful comparison between these sites requires that the complex of environmental factors operative at them be examined. In many cases one or a few variables (e.g. temperature, moisture, soil nutrients) may be recognizable as the important factors. However, many variables (and populations and ecosystem processes) vary across the spectrum of sites in a more complex way, dependent on a series of factors, often themselves interacting. A convenient way of reducing the abundance of variability to manageable proportions is by some form of multivariate analysis. This reduces a large number of simple variables to a smaller number of more complex gradients and may be used to ordinate or classify sites on the basis of their mutual differences and similarities in any set of factors.

Two main sets of factors may be used to define the major patterns of variation within and between southern and northern subpolar areas; the climatic/soil complex and the vegetation composition. To some extent, of course, the two sets are interrelated. Multivariate anayses of the variation in both of these 2 sets of factors will not only provide interesting and meaningful descriptions of inter (and intra) site variations but will also establish a framework within which data from future projects on Marion Island can be evaluated and compared with other subpolar sites.

LITERATURE REVIEW

A literature review was presented with the original project proposal and is not repeated here.

SCIENTIFIC PROGRESS

In the 3 months since the inception of this project much progress has been made regarding the original objectives, key questions and proposed work plan listed under sections 8 and 9 of the NP10 proposal (SASCAR Biological Sciences subcommittee meeting 15/9/82, document 4.16).

1. Main sets of factors defining the major patterns of variation within and between island sites.

The original proposal (point 1, section 8 NP10) envisaged using the raw data collected by Niek Gremmen during the phytosociological survey. However, the body of data involved has proved far too large to handle conveniently or within the time limits of this project. Approximately 10 200 individual measurements were made during the survey. It was therefore decided to extract the data from the synthesis published by Gremmen (1981). The information was transformed into a relative cover index table of life forms (Table 1) similar to the life-form classification adopted by the IBP Tundra Biome working groups. The use of the synthesis, rather than the raw data had decided advantages and an important disadvantage. The main advantage was that the vegetation information could conveniently be transformed into a format compatible with information from other subpolar sites. Another advantage was speed of synthesis of the vegetation data. An important advantage was that the vegetation information could be supplemented by other data not collected as part of the phytosociologi-

cal survey (e.g. that collected separately by Huntley and Smith and published elsewhere). Since much of the soil chemistry and microclimate data used in the multivariate analyses pertain to vegetation communities studied by these latter two authors, the benefit of including this "non-Gremmen" data is apparent.

An important (in terms of the project proposal) disadvantage of the procedure used in handling the botanical data is that a large part of the objective listed under point 1 of section 8 of the NP10 cannot be realized i.e. a definition of the main sets of factors defining the patterns of variation between sites on Marion Island i.e. the phytosociological classification presented by Gremmen (1981) cannot be tested since this classification has been accepted *a priori* in the approach. However, the "noda" of the complexes proposed by Gremmen (and by Huntley 1971) can be tested, and compared with vegetation units at other subpolar sites.

For reasons stated above the last sentence of point 1, section 8 of the original NP10 form: "The results from both multivariate techniques will be compared with the phytosociological classification of Gremmen (1981)" is inappropriate. However, it has recently become apparent from comments in the literature that such a comparison would be exceedingly profitable in terms of understanding the distribution and classification of sub-Antarctic plant communities. It is hoped that the Biological subcommittee will view favourably any future proposals to carry out such a comparison, which would have to be considered a more ambitious project (i.e. needing at least one person's time for 1 year, full-time basis).

A data bank on the macro and microclimatic variables which have been measured on the island as part of other projects has also been established as well as one containing soil chemistry data for the various "noda" identified. A resume of the information is provided in Tables 2 and 3. This also accords with the proposed approach listed under point 1, section 8 of the NP10 proposal. Chemical analysis of the additional soil samples (point 1, section 9) is also underway.

Points 2 and 3, section 8 of the NP10 proposal involved the establishment of a data bank containing similar information from other subpolar (both southern and northern hemisphere). This has been initiated and the sites for which information is being collected are provided in Table 4.

PROPOSED WORK-PLAN JULY 1983 - MARCH 1984

The work-plan envisaged in the original proposed appears to be realistic and is summarized below:

July to August 1983

1. Continuation of chemical analysis of approximately 40 soil samples needed to complete the Marion Island data set. These samples were collected as part of previous investigations but never analysed for the elements required in this project.

August-December 1983

2. Update of Marion data bank and establishment of data banks for other southern and northern sites.

3. Multivariate analysis of data.

4. Interpretation of vector structures.

January-March 1984

5. Synthesis and publication of results.

TABLE 11 FLORISTIC DATA FOR HARTON ISLAND SITES

1	Evergreen shrub <3 cm 2	Deciduous shrub <3 cm 3	Evergreen shrub >3 cm 4	Deciduous shrub >3 cm 5	Single-shoot Graminoid 6	Caespitose Graminoid 7	Cushion Dicots 8	Mat Dicots 9	Rosette Dicots 10	Erect Dicots 11	* Pteridophytes 12	Bryophytes 13	Lichens 14	Total cover index 15
Slope Fernbrakes	0	0	0	4	13	0	15	0	0	0	55	9	4	100
Flush/drainage line	0	0	0	41	4	0	1	4	0	1	3	46	0	100
Mire	0	0	0	1	20	3	3	11	0	0	5	57	1	100
Med/low altitude feldmark	0	0	0	0	7	0	34	0	0	0	0	39	20	33
"Inland tussock grasslands"	0	0	0	2	79	0	1	5	1	0	0	12	0	100
Grossly Biotically influenced sites	0	0	0	0	40	0	0	41	18	0	0	1	0	100
"Salt-Spray	0	0	0	0	1	0	12	9	28	** 46	0	2	2	100/67

* This comprises *Blechnum penna-marina*, a carpet forming pteridophyte which, phenologically, is similar to category 5 and may be considered as part of that category.

** Due to *Crassula moschata* which often forms a mat and may therefore considered under category 9.

TABLE 7: FLORISTIC DATA FOR MARION ISLAND SITES

1	Evergreen shrub <3 cm 2	Deciduous shrub <3 cm 3	Evergreen shrub >3 cm 4	Deciduous shrub >3 cm 5	Single-shoot Graminoid 6	Caespitose Graminoid 7	Cushion Dicots 8	Mat Dicots 9	Rosette Dicots 10	Erect Dicots 11	* Pteridophytes 12	Bryophytes 13	Lichens 14	Total cover index 15
Slope Fernbrakes	0	0	0	4	13	0	15	0	0	0	55	9	4	100
Flush/drainage line	0	0	0	41	4	0	1	4	0	1	3	46	0	100
Mire	0	0	0	1	20	3	3	11	0	0	5	57	1	100
Med/low altitude feldmark	0	0	0	0	7	0	34	0	0	0	0	39	20	33
"Inland tussock grasslands"	0	0	0	2	79	0	1	5	1	0	0	12	0	100
Grossly Biotically influenced sites	0	0	0	0	40	0	0	41	18	0	0	1	0	100
"Salt-Spray	0	0	0	0	1	0	12	9	28	** 46	0	2	2	100/67

* This comprises *Blechnum penna-marina*, a carpet forming pteridophyte which, phenologically, is similar to category 5 and may be considered as part of that category.

** Due to *Crassula moschata* which often forms a mat and may therefore considered under category 9.

TABLE 2: CLIMATIC DATA FOR MARION ISLAND SITES

	WAT	CAT	FFA	TSA	WST	CST	FFS	TSS	PPTN	EVAP	DS
Slope fernbrakes	7.3	3.2	310	1860	8.6	4.7	[273]	2197	2576	536	[70]
Flush/Drainage line	7.3	3.2	310	1860	(9.9)	(4.6)	[273]	2394	2576	536	80
Mire	7.3	3.2	310	1860	9.9	4.6	[273]	2394	2576	536	80
Med/Low altitude feldmark	7.3	3.2	310	1860	8.6	4.7	[273]	2299	2576	536	[90]
"Inland tussock grassland"	7.3	3.2	310	1860	10.1	5.4	[273]	2737	2576	536	[70]
Grossly biotically influenced sites	7.3	3.2	310	1860	9.7	4.5	[273]	2439	2576	536	80
"Salt spray"	7.3	3.2	310	1860	9.0	4.5	[273]	2355	2576	536	80

		H_2O % D.WT	pH	L.O.I %D.WT	Org. C %D.WT	TOTAL N %D.WT	C/N	P ppm D.WT	K ppm D.WT	Ca ppm D.WT	Mg ppm D.WT
Slope fernbrakes	$\bar{X}$ ±SD	551±152	4,3±0,4	83,6±14,6	28,2±14,0	1,82±0,68	15,7	25±22	547±587	1120±740	1118±868
	range	269-1041	3,7-5,0	59-95	-	-	-	4-88	-	-	-
	N	67	12	7	20	20	-	29	20	20	20
Flush/Drainage Line	$\bar{X}$ ±SD	759±358	4,7±0,3	70,3±15,7	42,9±10,7	2,50±0,44	17,2	19±37	391±203	2700±114	2005±565
	range	210-2000	4,2-5,4	35-93	29,1-46,0	-	-	11-45	-	-	-
	N	29	20	16	6	6	-	· 5	6	6	6
Mire	$\bar{X}$ ±SD	1506±651	4,8±0,4	79,9±16,7	43,7±8,0	2,25±0,39	19,0	27±31	273±149	320±86	377±143
	range	290-3180	3,8-6,4	30-99	-	-	-	2-161	-	-	-
	N	190	281	126	15	15	-	40	15	15	15
Med/Low Altitude feldmark	$\bar{X}$ ±SD	214±119	5,4±0,4	31.6±14.6	11.3±5.0	0.69±0.45	25.2±17.24	11±6	156±258	120±84	219±83
	range	10-380	4,8-6,2	-	4-20	0,2-2.4	9-66	4-20	-	-	-
	N	17	16	25	22	22	15	8	10	10	10
"Inland Tussock Grasslands"	$\bar{X}$ ±SD	446±145	4,1±0,2	70,7±11,1	22,5±6,0	1,60±0,36	14,1	74±44	117±39	540±320	377±243
	range	201-750	3,8-4,4	50-82	-	-	-	10-149	-	-	-
	N	32	13	8	13	13	-	15	13	13	13
Grossly Biotically Influenced Sites	$\bar{X}$ ±SD	859±389	4,5±0,7	88,8±12,6	44,8	3,41±0,54	12,9	179±179	619±590	933±632	681±306
	range	120-2140	3,5-7,6	50-99	-	2,72-4,73	-	33-625	156-2195	296-2441	292-1206
	N	68	34	34	1	13	-	40	11	11	11
"Salt-Spray"	$\bar{X}$ ±SD	679±200	5,0±0,4	81,5±14,3	42,9±1,8	2,49±0,40	17,2	27±31	508±117	1640±800	3086±1445
	range	280-1225	4,4-5,7	43-94	-	-	-	2-161	-	-	-
	N	40	31	31	4	4	-	40	5	5	5

TABLE 4

Main Study Area (see Fig. 1 for location)	Site (name and main vegetation)		Used in PCA of:			Published Site Descriptions
Devon Island	Beach ridge, Crest (Saxifrage, Salix, Lichens)	DBC	+	+	+	Bliss (1985, 1981)
	Beach ridge, Slope (Dryas, Saxifrega, Lichens)	DBS		+	+	
	Beach ridge, Transition zone (Cassiope, Dryas, Carex)	DBT			+	
	'Dry' Meadow (Eriophorum, Carex)	DDM	+	+	+	
	Mesic Meadow (Carex, Salix arctica, bryophytes)	DMM	+	+	+	
	Wet Meadow (Carex, bryophytes)	DWM			+	
Jareya	'Spotted tundra' (spot crust)	TSSC	+	+		Chernov et al. (1985) Tikhomirov (ed.) (1971, 1973)
	'Spotted tundra' (troughs) (Carex, Dryas, bryophytes)	TSF		+	+	
	River Bank (heath) (Dryas, Cassiope, Salix)	TRB			+	
	Astragalus-Dryas Tundra	TAT		+		
	Polygon Centre (Carex, bryophytes)	TPC		+	+	
	Polygon Border (misc. graminoids)	TPB		+	+	
Barrow	Moist Meadow (Carex, bryophytes)	B2	+	+	+	Bunnell et al. (1985), Brown (1981)
	Mesic Meadow (Carex, Poa arctica, bryophytes)	BMM			+	
	Polygon Trough (Dupontia, Eriophorum, bryophytes)	B4T		+	+	
	Polygon Ridge (Salix, bryophytes)	B4T		+	+	
	Polygon Basin (wet) (Carex, bryophytes)	B4L			+	
	Polygon Basin (dry) (lichens)	B4B		+		
	Polygon High Centre (Luzula confusa, bryophytes)	B4H		+	+	
Disko Island	Alchemilla meadow	DKA	+	+	+	Callaghan (1981a)
	Salix glauca meadow	DKS		+		
	Fellfield (Dryas)	DKF	+	+	+	
	Snowbed (Salix herbacea)	DKSB	+	+	+	
Kevo	Pine (Pinus sylvestris, Vaccimium vitis-idaea, lichens)	KP	+	+	+	Kallico (1985, 1981)
	Birch (Betula tortuosa, Empetrum)	KB	+	+	+	
	Heath (Empetrum, lichens)	KM	+	+	+	
	Palsa (shrubs, Sphagnum)	KPa	+	+		
Abisko (Storadalen)	Elevated bogs (shrubs, Eriophorum vaginatum, Sphagnum)	AH	+	+	+	Rosswall et al. (1985), Sonesson & & Jonsson (1981)
	Wet depressions (Carex rotunda, Sphagnum)	AP		+	+	
Hardangervidda	Lichen Heath (lichen, Empetrum)	HLH	+	+	+	Dabye et al. (1985), Wielgolaski (1981)
	Dry Meadow (Salix reticulata, Dryas)	HDM	+	+	+	
	Wet Meadow (Carex nigra, bryophytes)	HWSM	+	+	+	
	Birch Forest (Betula tortuosa, Vaccinium myrtillus)	HBF	+	+	+	
	Snowbed (Salix herbacea)	HSB	+	+		
Moor House	'Dry' Bog (Calluna, Eriophorum vaginatum, lichens)	MHC	+	+	+	Heal et al. (1975(, Heal & Smith (1978), Heal (1981)
	Mesic Bog (Calluna, E. vaginatum, Sphagnum)	MGF			+	
	Mesic Bog (Calluna, Vaccinium myrtillus, E. vaginatum, lichens)	MBE			+	
	Wet Bog (Calluna, Erica tetralix, Eriophorum angustifolium, Sphagnum)	MIE		+	+	
	Wet Bog (Calluna, E. vaginatum, Rubus chamaemorus, bryophytes)	MSH			+	
	Wet Bog (Calluna, E. tetralix, Oxycoccus, Sphagnum)	MGB			+	
	Wet Bog (Sphagnum, Calluna)	MHS		+	+	
	Juncus Moor, (Juncus squarrosus)	MHJ		+	+	
	Limestone Grassland (misc. grasses and herbs)	MHC		+		
Glanamoy	Heathy Bog (Calluna, Hypnum, Molinia)	GHB			+	Moore et al. (1975), Moore (1981
	'Typical' Bo (Schoenus, Sphagnum, Calluna)	GB	+	+	+	
	Flushed Bog (Calluna, Sphagnum, Molinia)	GM			+	
	Flushed Bog (Juncus, Sphagnum)	GJ			+	
	Grassland (Festuca arundinacea meadow)	GG		+		
	Forest (Pinus contorta)	GF		+		
Patscherkofel	Vaccinium heath	PV			+	Larcher et al. (1985)
	Loiseleurietum	PL			+	
	Loiseleuria heath	PLH			+	
Hohe Nebelkogel	Herb snowbed	HNH			+	Moser (1971)
	Moss snowbed	HNM			+	
	Lee snowbed	HNL			+	

Projektitel: Die invloed van die wilde huiskat Felis catus op die terrestriële ekosisteem van Marioneiland en die effektiwiteit van jag as 'n bykomstige beheermaatreël.

Programleier: J.D. Skinner, SNI, Universiteit van Pretoria.

Mede-leiers: P.G. Howell, Dept. Infeksiesiektes, Fakulteit Veeartsenykunde, Universiteit van Pretoria.

G.A. Robinson, Nasionale Parkeraad, Pretoria.

Navorser: P.J.J. van Rensburg, SNI, Universiteit van Pretoria

Vorderingsverslag: Derde tussentydse vorderingsverslag Junie 1983.

Doelstellings:

(1) Om die huidige predasiedruk op die prooispesies te definieer.
(2) Om vas te stel hoe 'n kunsmatige vermindering in predasiedruk die prooispesies sal beïnvloed.
(3) Om te bepaal tot watter mate feline panleukopaenia (FPL) en ander siektes die katbevolking beïnvloed.
(4) Om die ruimteverbruik, jageffektiwiteit en sosiale organisasie van katte in die bevolking te bepaal.
(5) Om vas te stel of jag gedurende die somerseisoen 'n koste-effektiewe beheermaatreël kan wees.

Geskiedenis van die projek:

Die projek het in Maart 1981 'n aanvang geneem in ooreenstemming met die Spesiale Evalueringsgroep se voorstelle (Ongepubliseerde verslag van die Spesiale Evalueringsgroep van die Marioneilandse katte, Augustus 1980). Die projek is gevolglik volgens die voorstelle beplan en volg op projekte wat sedert 1974 onder toesig van die Direkteur van die Soogdiernavorsingsinstituut op aanbeveling van die Biologiese Komitee van WKAN uitgevoer is. Die tweede fase van die huidige projek is vanaf Junie 1982 tot Mei 1983 uitgevoer, waarmee die veldwerk wat

oor twee seisoene gestrek het, afgesluit is.

Wetenskaplike vordering:
Predasiedruk:

Prooioorblyfsels en maaginhoude van katte is versamel en ontleed soos beskryf deur Van Aarde (1980).

'n Ontleding van kat-prooioorblyfsels van die huidige steekproef en die van 1974/75 oor dieselfde tydperk, toon 'n betekenisvolle verandering aan (χ_3^2 = 11,314; 0,025 > P > 0,01). 'n Betekenisvolle verandering in die prooisamestelling van roofmeeue Catharacta skua is ook waargeneem (χ_4^2 = 66,931; P < 0,005). Die afwesigheid van Pterodroma brevirostris in die dieët van katte en roofmeeue is by uitstek hiervoor verantwoordelik.

'n Vergelyking van maaginhoude tussen die twee katbevolkings dui ook op 'n betekenisvolle verandering. Dit word weerspieël deur 'n toename in muise (Mus musculus) (χ_1^2 = 12,153; P < 0,005) en 'n afname in stormvoëls (Familie Procellariidae) (χ_1^2 = 18,252; P < 0,005) in die dieët van katte. Die gegewens dui op 'n afname in die beskikbaarheid van voëls as prooi van katte.

Die invloed van 'n vermindering van predasiedruk op die prooibevolkings.

Pterodroma macroptera, Procellaria aequinoctialis en Pachyptila salvini is vir broeisukses binne die katvrye- en kontrolegebiede te Skua's Ridge, Juniorskop en Nellie's Hump nagevolg. Broeisukses word in Tabel 1 aangegee.

Broeisukses te Nellie's Hump het nie betekenisvol verskil nie. Dit kan toegeskryf word aan 'n te klein steekproef vir die gebied weens die lae digtheid van sowel katte as grawende stormvoëls. Die effek van katpredasie te Skua's Ridge en Juniorskop word duidelik vertoon.

Die effek van FPL op die katbevolking.

Die versameling van materiaal en inligting vir die bepaling van

FPL infeksie en bevolkingsparameters is voortgesit. Versamelde materiaal word tans ondersoek.

Voorlopige resultate van hemaglutinasie inhibisie toetse op 50 serum-monsters word in Tabel 2 gegee.

Volgens Tabel 2 het al die katte teenliggaampies teen FPL. 'n Neutralisasie antiliggaamtiter van 1:10 kan as 'n drumpelwaarde van immuniteit teen FPL beskou word (Fastier 1968). Hiervolgens is 98% van die katte immuun. Die resultate toon verder dat FPL deur die bevolking versprei het.

Die katbevolking het na die vrylating van FPL met 42,5% per jaar afgeneem. Gepaardgaande hiermee het die ouderdomsamestelling ook betekenisvol verander weens 'n afname in onvolwasse katte (Van Rensburg 1982). Dit is toegeskryf aan 'n moontlike toename in die mortaliteit van jongeling katte wat aanleiding gee tot die afname in onvolwasse katte weens 'n verlies van immuniteit wat volgens O"Reilly, Paterson en Harris (1969), van die moeder oorgedra word. Die huidige bevolking het nie noemenswaardig verander oor die afgelope twee veldwerkseisoene nie ($N_1 = 407 \pm 79$; $N_2 = 376 \pm 75$). Die ouderdomsamestelling het betekenisvol verander ($\chi_2^2 = 7,045$; $0,05 > P > P,025$) as gevolg van 'n afname in jongeling katte. Die verhouding van onvolwasse katte het egter konstant gebly. Dit kom tans voor dat die bevolking besig is om af te plat, maar dat FPL steeds die jongeling/onvolwasse katte affekteer.

Ruimteverbruik, jageffektiwiteit en sosiale organisasie van katte

Drie mannetjies (twee volwassenes, een onvolwassene) is gevang en toegerus met radiohalsbande.

Aktiwiteit en tuisgebiedgrootte is soos vir die wyfiekatte tydens die vorige veldwerkseisoen bepaal (Van Rensburg 1982).

Die aktiwiteit van die volwasse mannetjies volg dieselfde patroon van naglewendheid as die van die wyfiekatte. Die onvolwasse kat het 'n groter mate van aktiwiteit gedurende die dag as volwasse katte

getoon. Die verskil kan moontlik aan 'n hoër sosiale en/of ekologiese druk op 'n onvolwasse dier toegeskryf word.

Berekening van tuisgebiedoppervlaktes word tans voorberei vir rekenaarontleding. Tuisgebiede van die twee volwasse mannetjies dui egter op 'n groter en 'n kleiner tuisgebied onderskeidelik, as die van wyfiekatte. Die groot tuisgebied kan toegeskryf word aan emigrasie van 'n ongevestigde mannetjie (Dards 1978). Dit is die diere wat van belang is by die verspreiding van FPL. Die kleiner tuisgebied is klaarblyklik die van 'n gevestigde mannetjie. Die waargenome tuisgebied verteenwoordig waarskynlik slegs die kerngebied van die kat, aangesien hy dikwels buite opvanggafstand was. Die onvolwasse mannetjie se tuisgebied dui op ongeveer dieselfde grootte as die van wyfies, maar met 'n meer eweredig gebruik van die gebied. Die gegewens stem ooreen met die bevindinge van Dards (1978).

Eksperimentele jag

Nagjagekspedisies is tydens die veldwerkseisoen voortgesit.

Die uitvoerbaarheid van jag op moeilik begaanbare terrein is rondom die eiland ondersoek. In al die gebiede is jag praktiès moontlik.

'n Regressieanalise toon dat in 'n gebied wat intensief en herhaaldelik oor 'n relatiewe kort tydperk (sewe ekspedisies oor 22 dae) aan jag blootgestel word, daar 'n reglynige verband tussen die afname in katwaarnemings (y) met opeenvolgende jagekspedisies (x) bestaan en dat dit betekenisvol is ($r = 0,059$; $P<0,001$).

In ander gebiede waar opvolging van jag ongereeld was is sodanige effek nie waargeneem nie. Dit was hoofsaaklik as gevolg van immigrasie van katte uit ander gebiede, maar wyfie katte is egter meer kwesbaar vir jag weens gebiedsgebondenheid (Van Rensburg 1982). Dit is dus duidelik dat daar met enige jagpoging, aaneenlopend en gedurende rondom die eiland met minstens dieselfde intensiteit gejag sal moet word. So 'n poging sal 'n minimum van agt jagspanne van twee persone elk vereis om die nodige areas te kan dek. Dit wil voorkom dat 'n

uitroeiingspoging oor minstens twee tot drie somerseisoene sal moet geskied om te verseker dat die laaste kat verwyder is, alhoewel die meerderheid van wyfie katte moontlik reeds tydens die eerste seisoen verwyder sal kan word.

Meganiese beheer is tans nie net 'n praktiese moontlikheid nie, maar ook 'n noodsaaklikheid, as gevolg van die katte se steeds vernietigende effek op die voëlbevolking en ook dat immuniteit teen FPL nou ingetree het.

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Verslae:

VAN RENSBURG, P.J. 1981a & b, 1982 a & b. Die invloed van die wilde huiskat, Felis catus op die terrestriële ekosisteem van Marioneiland en die effektiwiteit van jag as 'n bykomstige beheermaatreël. Vorderingsverslag. Soogdiernavorsingsinstituut, Universiteit van Pretoria.

Tabel 1: Broeisukses (%) van drie Procellariidae spesies binne katvrye- en kontrolegebiede.

Spesies	Skua's Ridge			Juniorskop			Nellie's Humps		
	Katvry	Kontrole	χ^2	Katvry	Kontrole	χ^2	Katvry	Kontrole	χ^2
erodroma macroptera									
ktober 1982)	59,4	5,6	20,54(P<0,005)	57,1	16,7	0,85(0,5>P>0,1)			
macroptera									
lovember 1982, nesverlaat periode)	50,0	0	20,84(P<0,005)	57,1	16,7	0,85(0,5>P>0,1)			
n	32	36		7	6				
ocellaria aequinoctialis									
laart 1983)				100	46,2	7,57	71,4	64,3	0,10
n				14	13	(0,01>P>0,005)	14	14	(0,9>P>0,5)
chyptila salvini									
ebruarie 1983)				59,5	28,0	5,93	72,3	65,7	0,42
n				37	25	(0,025>P>0,01)	47	35	(0,9>P>0,5)

Tabel 2: Feline panleukopaenia teenliggaamtiters van 50 katte.

Neutralisasie antiliggaamtiters	1:8	1:16	1:32	1:64	1:128	1:256	1:512
Persentasie voorkoms	2	2	22	24	38	10	2

4. EARTH SCIENCES

4. AARDWETENSKAPPE

SASCAR SUBCOMMITTEE ON EARTH SCIENCES - CHAIRMAN'S REPORT

Two Earth Science parties from the Universities of Natal (Pietermaritzburg) and Stellenbosch spent a total of 35 days in the field from 4 January to 7 February 1983. The Natal party consisted of two members who initiated a major project involving the study of the Precambrian basement rocks to the south and east of the Jutulstraumen Glacier and Penck Trough. All of the nunataks of the H.U. Sverdrupfjella flanking the Jutulstraumen Glacier were mapped. The two members of the Stellenbosch party completed sedimentological studies in the Borgmassivet and started similar work in the Ahlmannryggen. Because of bad weather conditions, the objectives of an airborne geophysical feasibility study by the fifth member of the Earth Science team from the BPI University of the Witwatersrand, could not be met entirely.

The project on the fission track dating method (BPI) will be commenced during the second half of 1983. The project on geochronological and isotopic investigations progressed well and it is possible to construct a tentative tectonic history of the rocks of Western Dronning Maud Land based on the data collected during this study, which terminates early in 1985.

Significant marine geophysical data were obtained during cruises in connection with the Africa-Antarctica plate boundary project.

Good progress has been made with the analysis of samples and the writing up of the results of the Southern Ocean lithosphere project.

Two test flights undertaken in the Grunehogna area proved that photographs of good quality can be produced by the helicopter-mounted camera for the project on the production of large-scale orthophoto maps. Some small-scale (1 : 250 000) maps based on LANDSAT imagery will become available in 1986.

Field work, including sampling, was done for four weeks on Marion Island during the April-May 1983 relief voyage and a reconnaissance was made of Prince Edward Island. A geologist will be spending the 1983/84 season on Marion Island studying the volcanology of the island.

Three members of the geology working party attended the Fourth SCAR Symposium on Antarctic Earth Sciences in Adelaide, Australia, during August 1982.

Recommendations were made as to the future development of the South African Antarctic earth sciences research programme by an ad hoc working group created at the request of the Inderdepartmental Antarctic Committee.

The draft of a document describing the South African Antarctic Earth Sciences research programme was finalized for publication by CSP.

The following is a summary of research projects funded by SASCAR during the period July 1982 to June 1983:

Department of Geology, University of Natal, Pietermaritzburg

- Geochemistry and petrology of the Ahlmannryggen, ending March 1985.
- Study of the metamorphic and plutonic rocks of the Sverdrupfjella, ending March 1986.

Department of Geology, University of Stellenbosch

- Sedimentologic-stratigraphical investigation of the Högfonna, Raudberget and Fassettfjellet formations in the Borgmassivet, ending December 1984.
- The Pleistocene stratigraphy and volcanology of Marion Island, ending March 1985.
- Sedimentologic and stratigraphical investigation of the sedimentary formations in the Ahlmannyrggen, ending December 1985.

Department of Mineralogy and Geology, University of Cape Town, Cape Town

- Southern Ocean lithosphere project, ending March 1985.

Bernard Price Institute of Geophysical Research (BPI), University of the Witwatersrand, Johannesburg

- Investigation, by fission track dating method, of Gondwanaland break-up and the spreading of Antarctica from southern Africa, ending March 1986.
- Geochronological and isotopic investigations of crust-mantle evolution in Queen Maud Land, Antarctica and in subantarctic islands, ending March 1984.
- Africa-Antarctica plate boundary, ending March 1986.
- The Palaeomagnetic and aeromagnetic interpretation of the areas surrounding the Jutulstraumen, Queen Maud Land, Antarctica - a feasibility study, ending March 1984.

Surveys and Mapping Branch, Office of the Chief Director of Surveys and Mapping, Cape Town

- Large-scale orthophoto maps.
- Small-scale LANDSAT maps.

L N J ENGELBRECHT
Chairman: SASCAR Subcommittee for Earth Sciences

NATIONAL PROGRAMME: S.A.S.C.A.R. ANTARCTIC RESEARCH PROGRAMME

SECTION: EARTH SCIENCES

PROJECT TITLE: GEOCHRONOLOGIC AND ISOTOPIC INVESTIGATIONS OF CRUST-MANTLE EVOLUTION IN QUEEN MAUD LAND, ANTARCTICA, AND IN THE SUB-ANTARCTIC ISLANDS.

PROJECT LEADERS: Dr. J. M. BARTON Jr. AND PROFESSOR H. L. ALLSOPP
PROJECT RESEARCHER: Mrs. Y. E. COPPERTHWAITE
BERNARD PRICE INSTITUTE OF GEOPHYSICAL RESEARCH
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THIRD ANNUAL PROGRESS REPORT, SUBMITTED JUNE 30, 1983

KEY WORDS: Western Dronning Maud Land, mafic rocks, crust-mantle evolution, initial 87Sr/86Sr ratio, emplacement age

OBJECTIVES:

1. To detail the isotopic and trace element character of the mafic rocks in the Ahlmann- and Giaeverriggen, Gjelsvic- and Sverdrupfjella, Borgmassivet, and Kirwanveggen of western Queen Maud Land, Antarctica, and the Sub-Antarctic Islands in order to investigate the pattern of crust-mantle evolution in the area.

2. To provide geochronologic and isotopic data where possible to complement geological studies of metamorphic, sedimentary and granitic rocks in the areas mentioned above.

HISTORY OF THE PROJECT:

The early history of this project was outlined in last year's Progress Report. Since that report was submitted, no further field work was undertaken by the project leaders for this project although during the 1982/83 Field Season, a suite of samples of gabbroic and sedimentary rocks from the Borgmassivet was collected for us by Kobus Swanepoel and a second suite of volcanic rocks from Bouvet Island was collected for us by Steve Auret. At the moment these samples are being processed for analysis.

This project will be terminated at the end of March, 1984, and a new project entitled: "Crust-mantle evolution studies in western Dronning Maud Land: mantle heterogeneity versus crustal contamination in mafic rocks" has been proposed in its place. A final report for the present project will be submitted at the end of March, 1984.

SCIENTIFIC PROGRESS AND FUTURE RESEARCH:

During the past year, research has been concentrated on documenting the Sr-isotopic characteristics of the mafic rocks exposed in western Dronning Maud Land. In addition, sialic rocks were studied from Annandagstoppane and the Sverdrupfjella. Within the time remaining for this project, the Sr-isotopic analyses will be completed on the samples available and some Pb-isotopic analyses will be undertaken on selected representative samples.

1. Sub-Antarctic Islands:

During this past year, work on samples from the Sub-Antarctic Islands has not progressed very far. To a large degree, this is because Professor Verwoerd was looking for a person to study the geology and geochemistry of the volcanic rocks on Marian and Prince Edward Islands. Now that Luc Chevallier is actively engaged in research for this project, we will be working closely with him, studying the isotopic compositions of samples he collects.

This past year, we analyzed a further eight samples from Bouvet Island for their Rb-Sr elemental and isotopic compositions. Our data confirm those of O'Nions and Pankhurst (1974). These authors obtained an average 87Sr/86Sr ratio of 0.70368 $\pm$ 0.00002 for seven samples and we obtained an average ratio of 0.70364 $\pm$ 0.00011 for ten samples. Our results cover a wider range of 87Sr/86Sr ratios than theirs do from about 0.7035 to about 0.7038. We found, as did O'Nions and Pankhurst (1974), that two major types of rocks are present: trachyte with 87Rb/86Sr ratios of about 0.5 and basalt with 87Rb/86Sr ratios of about less than about 0.1. We also observed an indication of slight differences in 87Sr/86S ratio between these rock types with the trachytes having a mean value of 0.70357 and the basalts of 0.70364.

It has been suggested that the hot-spot presently under Bouvet Island was responsible for many Cretaceous kimberlite eruptions in southern Africa (Crough et al., 1980). To test this hypothesis it would be valuable to compare the distinctive isotopic signatures of the kimberlites (Smith, 1983) with that of the Bouvet volcanic rocks. To this end, it is expected that Craig Smith at the B.P.I. will analyze some of the Bouvet Island samples for their Pb-isotopic compositions in conjunction with his kimberlite studies.

2. Borgmassivet:

The samples of gabbro collected during the 1981/82 Field Season have been analyzed for their Rb and Sr elemental and isotopic compositions. These data scatter on an isochron diagram (Fig. 1) but cluster according to sampling locality. Nevertheless, data from one suite of samples from a sill yield a trend corresponding to an errorchron age of about 1200 Ma with an initial 87Sr/86Sr ratio of about 0.708. As these samples have unaltered igneous textures, it is felt that this errorchron may reflect conditions at the time of emplacement of the sill. During the coming year, the samples of gabbro collected during the 1982/83 Field Season will be analyzed for their Rb and Sr elemental and isotopic compositions in hopes of substantiating the possible 1200 Ma age. It is to be hoped that the new samples will provide a larger range of Rb/Sr ratios and permit the age and initial ratio of the gabbros to be better constrained. In addition, we intend to analyze samples of sandstone from the Borgmassivet for their Sm and Nd elemental and isotopic compositions in an effort to ascertain the age of their provenance rocks.

3. Grunehogna Mafic Dyke:

A gabbroic dyke intruding the sills and sedimentary rocks at Grunehogna was sampled during the 1981/82 Field Season. The samples have fresh igneous textures in marked contrast with many igneous rocks in the area. Thus far, only one Rb-Sr whole rock elemental and isotopic analysis has been carried out on samples of this unit and these results are plotted as the star on Fig. 2. These data plot on the extension of the Rb-Sr whole rock isochron published previously by Barton and Copperthwaite (1983) for a suite

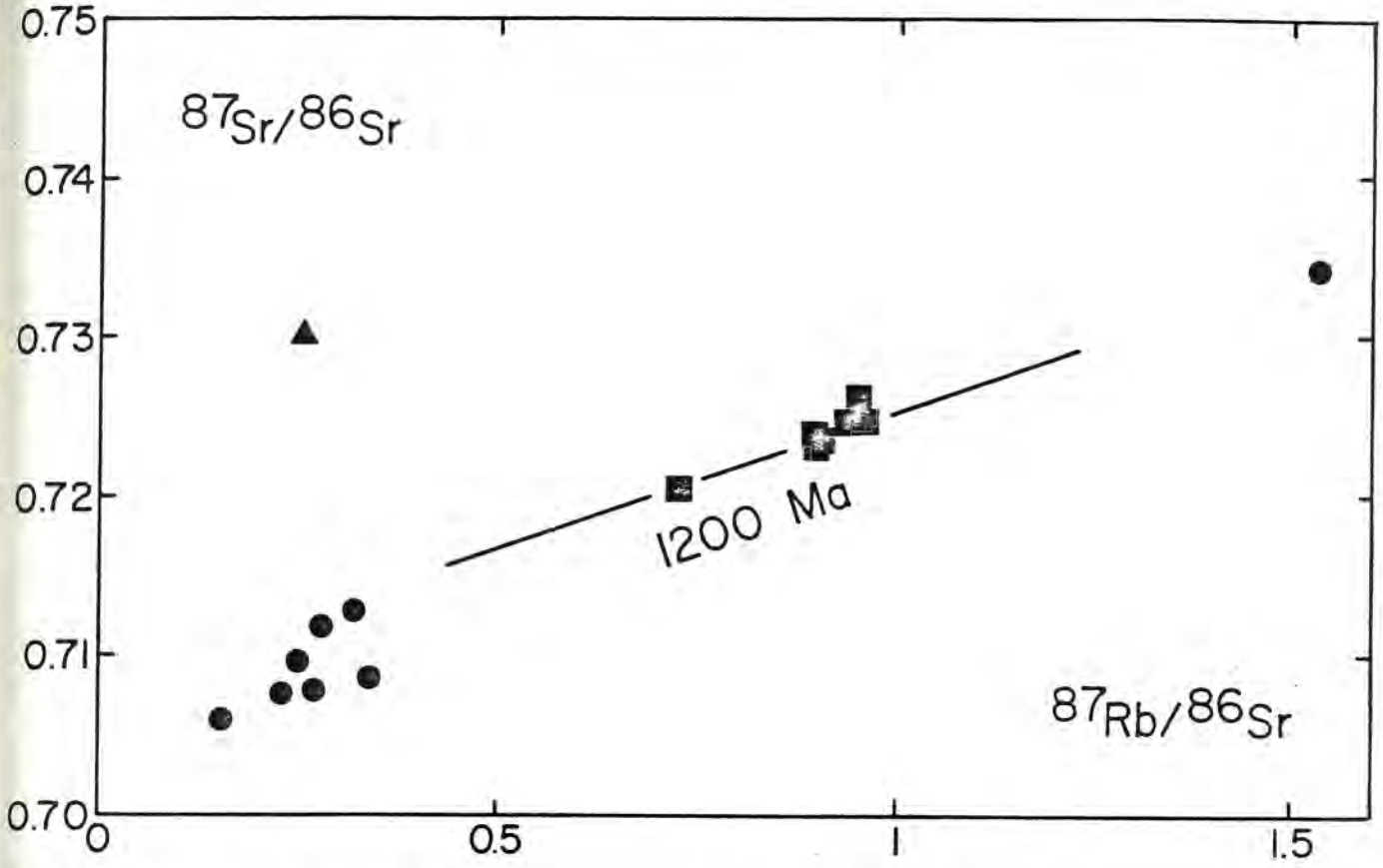

Fig. 1: Rb-Sr isochron diagram showing the data from the Borgmassivet. The different symbols represent different suites of samples.

of samples of a sill at Grunehogna. Including the dyke data with the sill data yields an isochron of 1404 ± 66 Ma (2 sigma) with an initial 87Sr/8Sr ratio of 0.7054 ± 0.0010 (2 sigma). We feel that the dyke therefore is genetically related to the sill and may well be the feeder. More samples from the dyke will be analyzed to try to confirm this possibility. In this case too, the combined data may be characterized by a wider range of Rb/Sr ratios and permit closer constraints on the age and initial 87Sr/86Sr ratio.

4. Robertskollen Igneous Complex:

Two suites of samples were collected from the layered igneous complex at Robertskollen, one of peridotite and the other of the overlying gabbro. The gabbro is unaltered and the olivine in the peridotite is only slightly altered. Results of Rb-Sr whole rock analyses of the gabbro yield an isochron of 1215 ± 128 Ma (2 sigma) with an initial 87Sr/86Sr ratio of 0.7065 ± 0.0005 (2 sigma) (Fig. 3). Similar results from the peridotite yield an isochron of 1181 ± 53 Ma (2 sigma) with an initial 87Sr/86Sr ratio of 0.7057 ± 0.0003 (2 sigma). In addition, analyses of phlogopite separated from the peridotite yield Rb-Sr phlogopite-whole rock ages of about 1100 Ma. These data are believed to indicate that the Robertskollen Igneous Complex was emplaced about 1200 Ma age and cooled to below 250° C by about 1100 Ma. The initial 87Sr/86Sr ratio differences indicate that the Robertskollen Igneous Complex, rather than differentiating from a single magma, formed from at least two magmas, one yielding the peridotite and the other yielding the gabbro. In this respect, the Complex is similar to the Bushveld Complex.

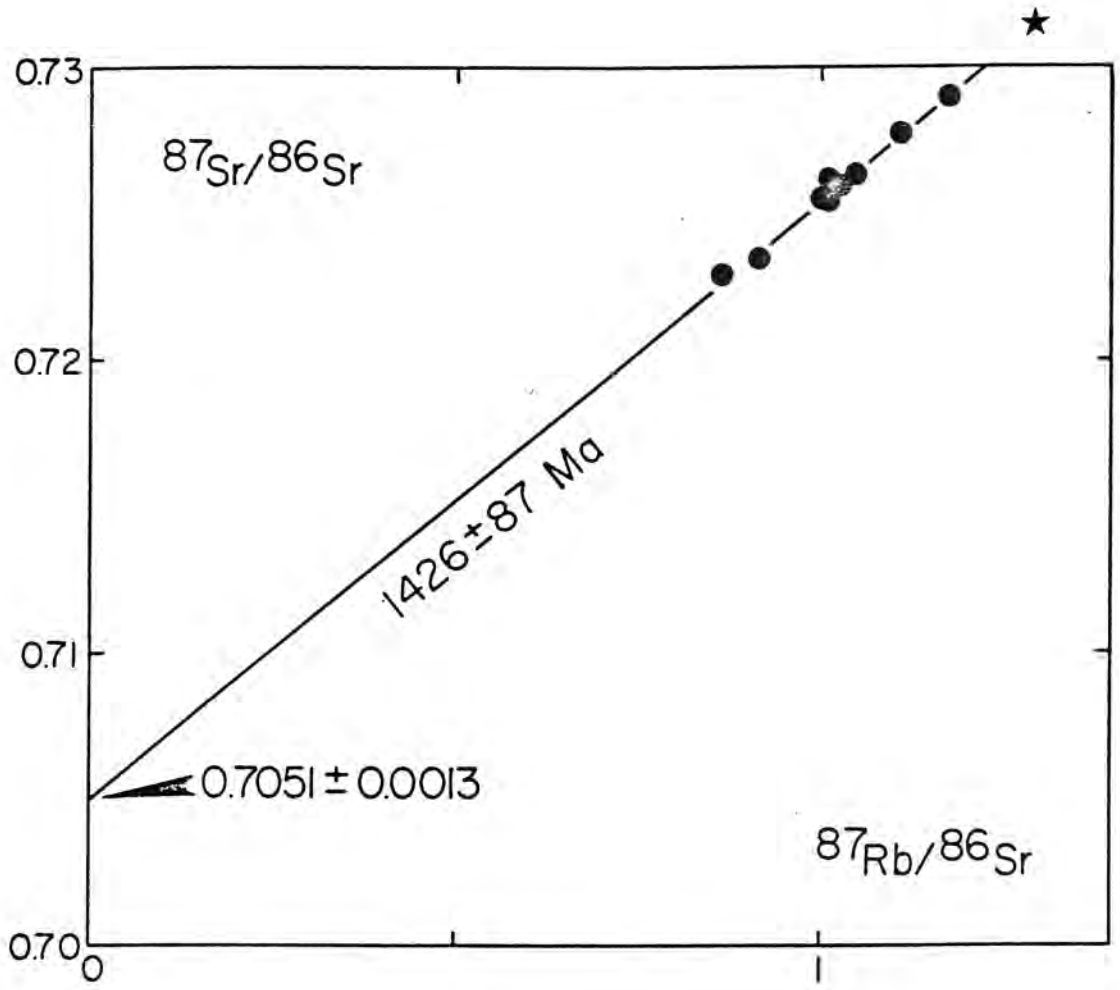

Fig. 2: Rb-Sr isochron diagram of the data from Grunehogna. The solid dots represent the Grunehogna Gabbro published previously by Barton and Copperthwaite (1983). The star represents the data from the mafic dyke.

Suites of samples from two separate dykes intruding the Robertskollen Igneous Complex were sampled during the 1981/82 Field Season. Analyses will be undertaken on these samples during the coming year.

5. Juletoppane Igneous Complex:

The Juletoppane Igneous Complex is composed of two sill-like layers of gabbro here termed the "upper sill" and the "lower sill". The "upper sill" is a medium to coarse grained gabbro while the "lower sill" is a fine grained gabbro. The contact between the sills is intruded by a pegmatitic plagioclase-hornblende rock. The older relative age of the "upper sill" is shown by the fact that the "lower sill" gabbro contains xenoliths of the "upper sill" gabbro. Suites of samples were collected from both these layers during the 1981/82 Field Season. These samples are unaltered and preserved their original igneous textures although some of the "upper sill" samples contain myrmekite which may indicate that the magma of this body has assimilated sialic material. Results of Rb and Sr elemental and isotopic analyses of samples of the Juletoppane Igneous Complex are plotted on Fig.

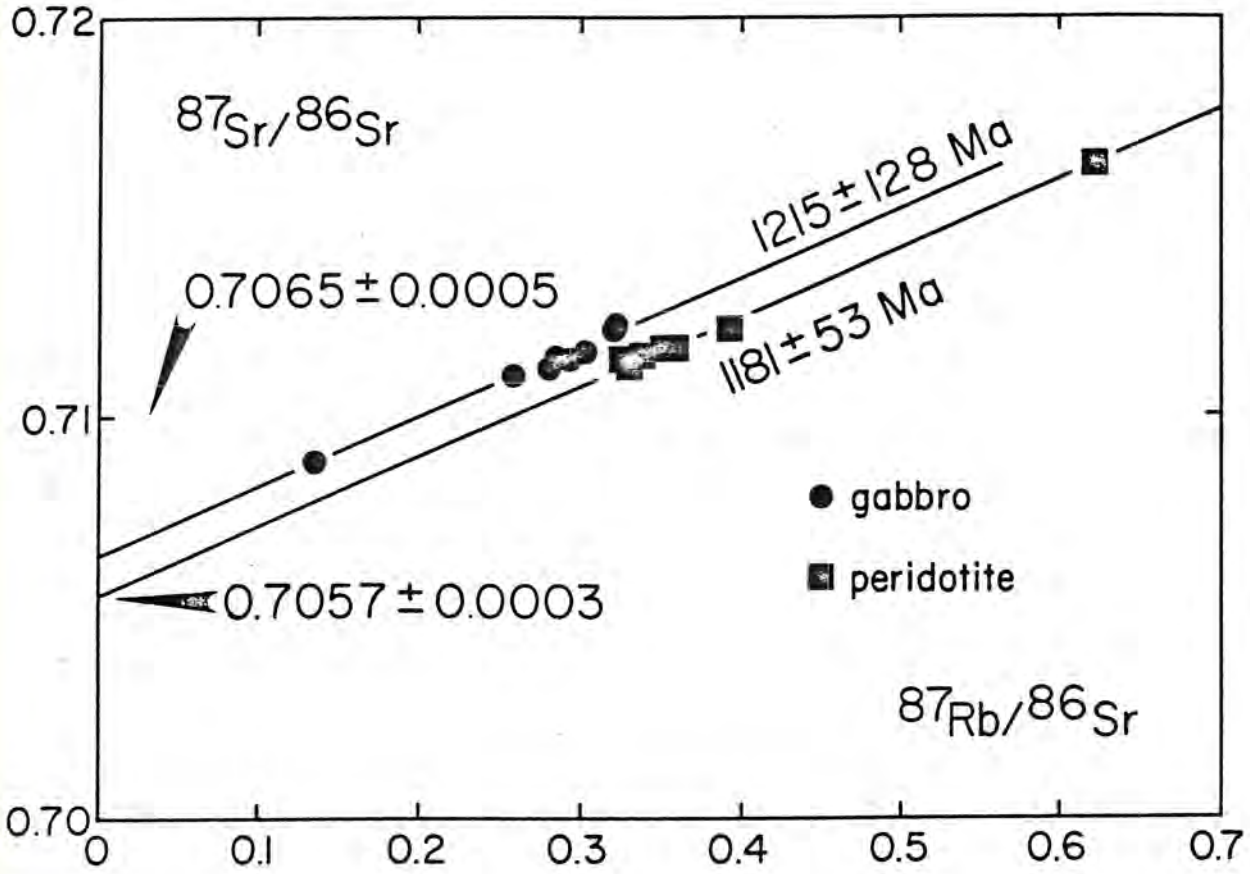

Fig. 3: Rb-Sr whole rock isochron of the data from the Robertskollen Igneous Complex.

4. The data from the "upper sill" scatter but cluster away from those of the "lower sill". The data from the lower sill define parallel isochron trends corresponding to an age of about 1200 Ma with initial 87Sr/86Sr ratios ranging from about 0.709 to 0.710. The trends are defined by consecutively numbered samples collected in stratigraphic order and may indicate that the "lower sill" is composed of several magmas. In an attempt to justify sub-division of the samples into discrete units, and thereby give credence to an age of about 1200 Ma for the "lower sill", evidence from trace element studies and other isotopic systems will be expanded. The scatter in the data from the "upper sill" may reflect magma contamination.

Johan Krynauw has suggested on compositional evidence that the Juletoppane Igneous Complex and the massive gabbroic rocks exposed at Annandagstoppane are part of a single body. The whole rock data from the Annandagstoppane gabbro published previously by Barton and Copperthwaite (1983) are also plotted on Fig. 4. While some of these data do plot in the field of the "lower sill" analyses of the Juletoppane Igneous Complex, they define steeper trends. One of these trends corresponds to a whole rock isochron age of about 1800 Ma, the presumed emplacement age of the Annandagstoppane gabbro. None of the Juletoppane "upper sill" data plot near the Annandagstoppane data. The Rb-Sr whole rock data, therefore, do not appear to support Johan Krynauw's hypothesis. They do suggest, however, that the Juletoppane Igneous Complex is coeval with the Robertskollen Igneous Complex and some gabbroic sills in the Borgmassivet. The Annandagstoppane gabbro may be older.

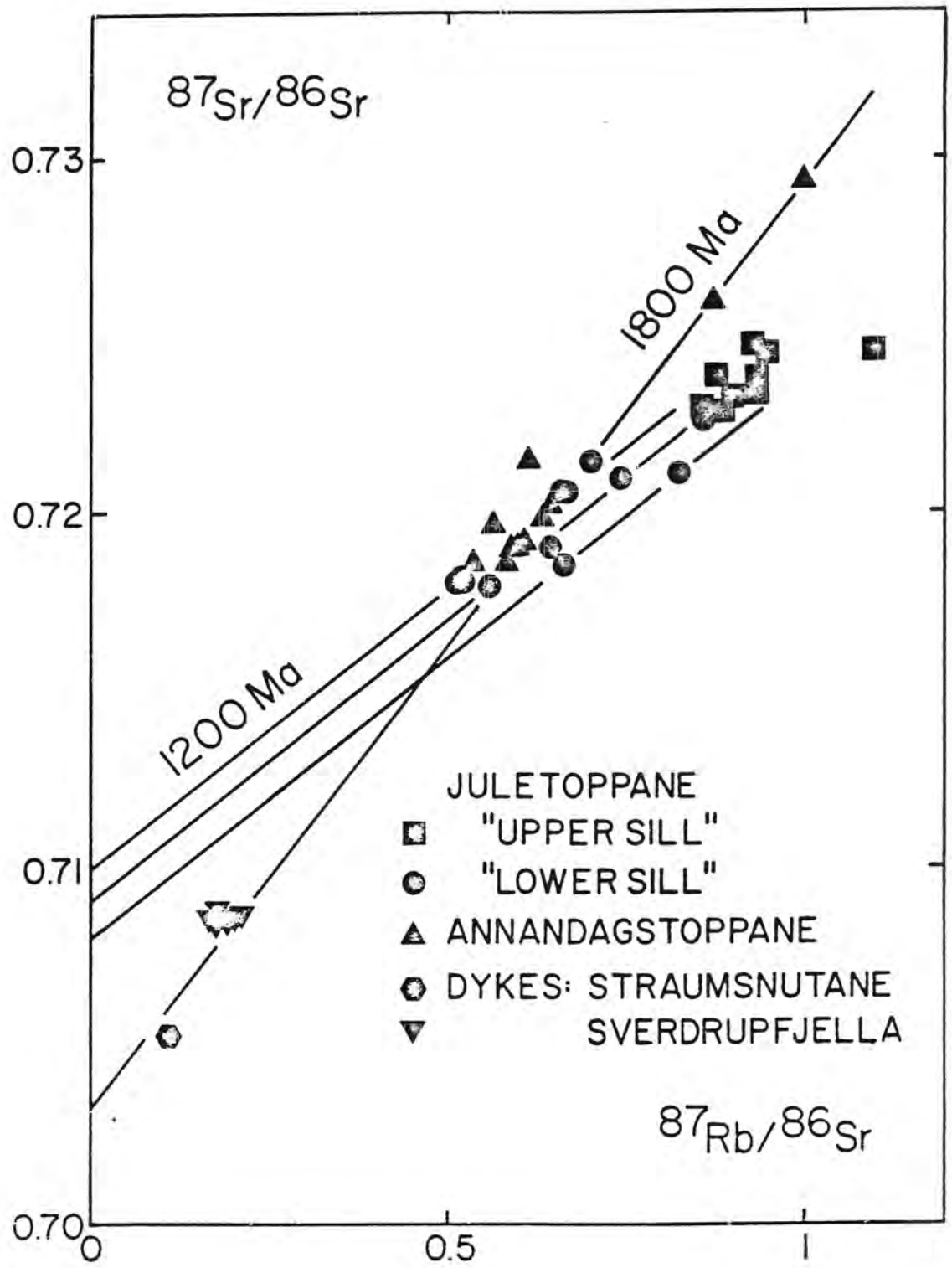

Fig. 4: Rb-Sr isochron diagram for the data from the Juletoppane Igneous Complex, Annandagstoppane gabbro and mafic dykes from the Straumsnutane and Sverdrupfjella.

6. Annandagstoppane Granite:

A suite of samples of Annandagstoppane Granite was collected during the 1981/82 Field Season. These samples were analyzed by Steve Auret as his Honours Project in the Department of Geophysics at the University of the Witwatersrand. His findings indicate that the granite was emplaced about 2800 Ma ago with a rather high initial 87Sr/86Sr ratio of about 0.707. The Annandagstoppane Granite has nearly a minimum melting composition. This fact, combined with the relatively high initial 87Sr/86Sr ratio suggests that the Annandagstoppane Granite formed by partial melting of some significantly older Archaean crustal source. What this source was is unknown. Analyses of biotite from the granite yield biotite-whole rock ages of about 1100 Ma, indicating that the last cooling of this rock below 250° C occurred about that time.

The granite is intruded by pegmatite and graphic granite veins. These veins are believed to be about 1100 Ma old and their emplacement was probably responsible for the heating indicated by the biotite-whole rock age of the granite.

Bodies of granophyre occur in the Annandagstoppane Gabbro. These are believed, on compositional evidence, to be partially digested xenoliths of Annandagstoppane Granite.

The major and trace element compositions of the Annandagstoppane Granite, the intrusive pegmatite and graphic granite veins and the granophyre are presently being redetermined so that more precise magma models can be made.

7. Annandagstoppane Mafic Dykes:

Suites of samples from two gabbroic dykes were collected at Annandagstoppane. One suite came from a dyke intruding the granite, pegmatite and graphic granite veins. The other suite came from a dyke intruding the Annandagstoppane Gabbro. These samples have unaltered igneous textures. Results of analyses of the whole rock elemental and isotopic compositions of these samples are plotted on Fig. 5. The data from the dyke in granite yield a nearly horizontal array. Ignoring the single analysis with a low 87Rb/86Sr composition, this array defines a trend corresponding to an age of about 200 Ma but with very large uncertainty limits. We tentatively suggest that this dyke is of Mesozoic age and related to the break-up of Gondwanaland. The data from the dyke in gabbro scatter a great deal but they too define a nearly horizontal trend. We suggest that this dyke is of Mesozoic age too. The indicated initial 87Sr/86Sr ratio of the dyke magmas are anomalously high. The data from the Annandagstoppane gabbro are also plotted on Fig. 5. They clearly have a quite different Rb-Sr composition and history.

8. Sverdrupfjella Biotite-Whole Rock Ages:

Biotite was separated from three samples of paragneisses from the Sverdrupfjella. These minerals and their corresponding whole rock sources were analyzed for their Rb and Sr elemental and isotopic compositions. The whole rock data do not define a linear array but these analyses yield remarkably constant biotite-whole rock ages of about 455 Ma (middle Ordovician). Similar ages have been reported by Ravich and Solov'ev (1966) for the Sverdrupfjella and by Elworthy (1983) for the Kirwanweggen. The constant and wide spread nature of these biotite-whole rock ages indicates that the Sverdrupfjella and Kirwanweggen are characterized by a mineral age veil which may be

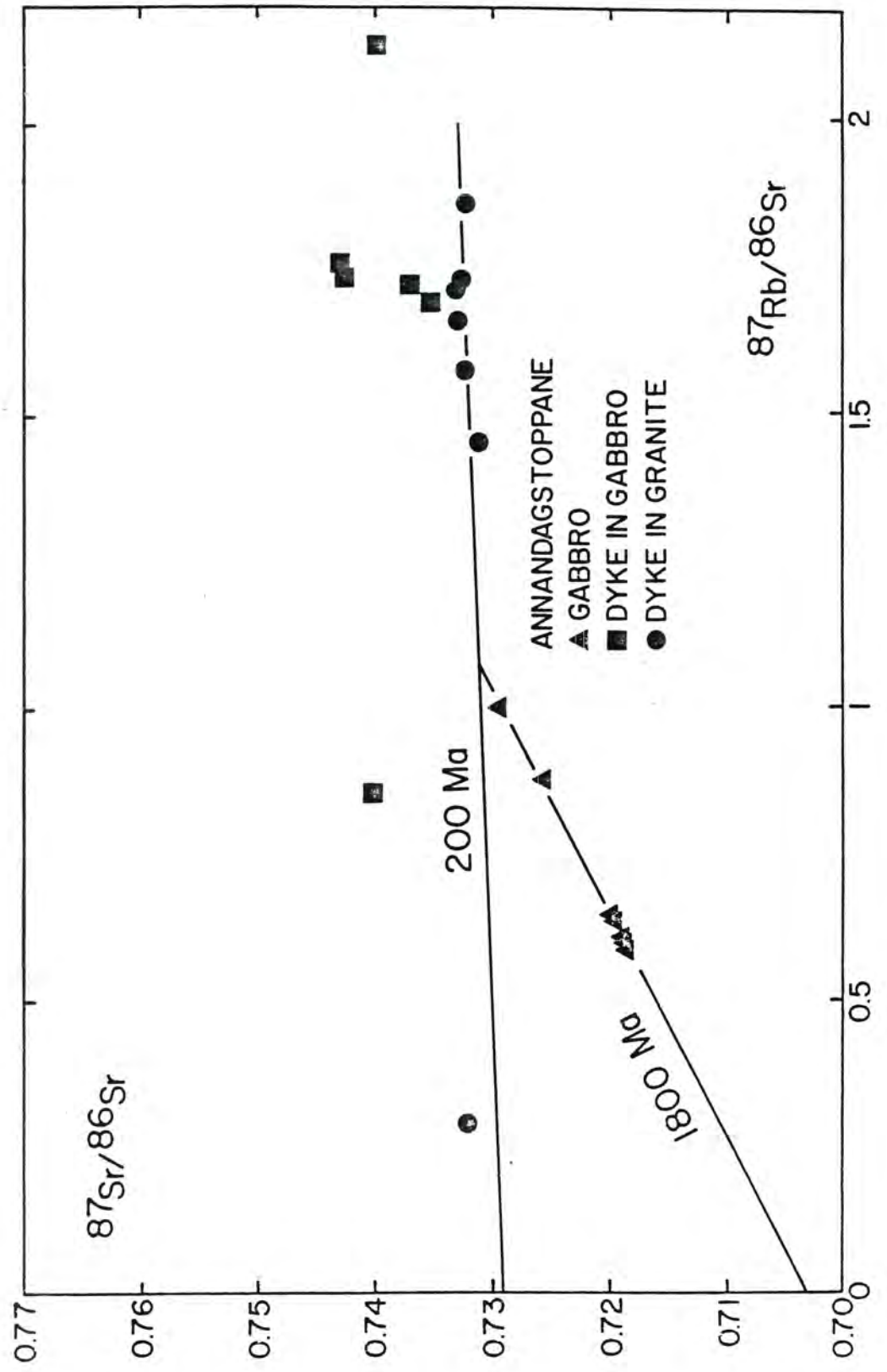

Fig. 5: Rb-Sr isochron diagram for the data from the Annandagstoppane Dykes. The data from the Annandagstoppane Gabbro is shown for comparison.

interpreted to reflect the late stages of regional uplift in these two adjacent areas. A more detailed discussion of the significance of this mineral age veil is presented in Barton et al. (1983).

9. Sverdrupfjella Mafic Dyke:

A suite of samples from a single gabbroic dyke was collected from the Sverdrupfjella during the 1981/82 Field Season. The samples have fresh unaltered igneous textures. This dyke is probably less than about 450 Ma old because conditions responsible for the middle Ordovician mineral age veil affecting the country rocks of this area would probably have altered the minerals comprising the dyke. Rb and Sr elemental and isotopic analyses have been carried out on these samples and the results are plotted on Fig. 4. The data have a very small compositional spread but appear to define a roughly horizontal trend on an isochron diagram. While no age may be calculated from these data, this dyke may have been emplaced during the Mesozoic.

10. Straumsnutane Mafic Dyke:

A suite of samples was collected during the 1981/82 Field Season of a gabbroic dyke intruding the altered volcanic rocks of the Straumesnutane. This dyke has an unaltered igneous texture. Only one Rb and Sr elemental and isotopic analysis has been determined for these samples and the results are plotted on Fig. 4. At this point, no emplacement age may be assigned to this dyke but it has a markedly different composition than does the dyke studied from the Sverdrupfjella. The remaining samples of this dyke will be analyzed during the coming year.

11. Tectonic History Of Western Dronning Maud Land:

It is possible to construct a tentative tectonic history of the rocks of western Dronning Maud Land based on the data collected during this study and those published previously by Ravich and Solov'ev (1966) and Elworthy (1983). This tectonic history is summarized in Table I. For reasons discussed in more detail by Barton et al. (1983), western Dronning Maud Land may be divided into two domains with contrasting tectonic histories separated by the Penck-Jutulstraumen Trough System. One domain contains the metamorphic rocks of the Sverdrupfjella and Kirwanweggen and is part of the East Antarctic Shield. The other domain contains the sedimentary and intrusive and extrusive mafic rocks of the Ahlmannryggen and Borgmassivet and the granitic and gabbroic rocks of Annandagstoppane. This second domain has been tentatively assigned the name of Grunehogna Microplate. On a Gondwanaland reconstruction, it is possible that the rocks of the Sverdrupfjella and Kirwanweggen are part of the Mozambique Belt but it is difficult to correlate rocks of the Grunehogna Microplate with those of the Kaapvaal Craton of southern Africa. Among the reasons is the lack of widespread 1200 Ma mafic magmatism in the Kaapvaal Craton. Barton et al. (1983) have suggested, therefore, that the Grunehogna Mircoplate is a piece of continental crust brought into its present position relative to the East Antarctic Shield during formation of Gondwanaland. Where this piece of crust was previously located is uncertain.

12. Initial $^{87}Sr/^{86}Sr$ Versus Age:

Initial $^{87}Sr/^{86}Sr$ ratios versus emplacement ages for various mafic igneous rock studied in this project are plotted on Fig. 6. The data display a positive correlation of increasing initial $^{87}Sr/^{86}Sr$ with decreasing time. All of the initial $^{87}Sr/^{86}Sr$ ratios plot above those postulated for

TABLE I

TENTATIVE SUMMARY OF TECTONIC EVENTS IN WESTERN DRONNING MAUD LAND

EAST ANTARCTIC CRATON (west of 4° E)	TIME (Ma)	GRUNEHOGNA MICROPLATE
Mafic dykes and alkaline intrusives	200	Mafic dykes at Annandagstoppane and in the Sverdrupfjella
M_2 Regional uplift creating a mineral age veil .	400	
	600	
	800	Krylen Diorite?
M_1 Regional metamorphism to amphibolite grade .	1000	Grunehogna Granodiorite and Jekselen Diorite
	.....	Pegmatite and graphic granite at Annandagstoppane
Emplacement of sedimentary sequences and mafic igneous rocks (stratigraphic positions uncertain	1200	Robertskollen and Juletoppane Igneous Complexes and Borgmassivet mafic sills
	1400	Grunehogna Diorite
	1600	
	1800	Annandagstoppane Gabbro
	2000	
	2200	Emplacement of sedimentary sequences (exact stratiposition uncertain but being red beds, these rocks are younger than about 2200 Ma
	2400	
	2600	
		----- ?? unconformity ?? -----
	2800	Annandagstoppane Granite
	3000	
Gneissic basement ???? (present further east) .	.....	Gneissic basement ??
	3200	
	3400	

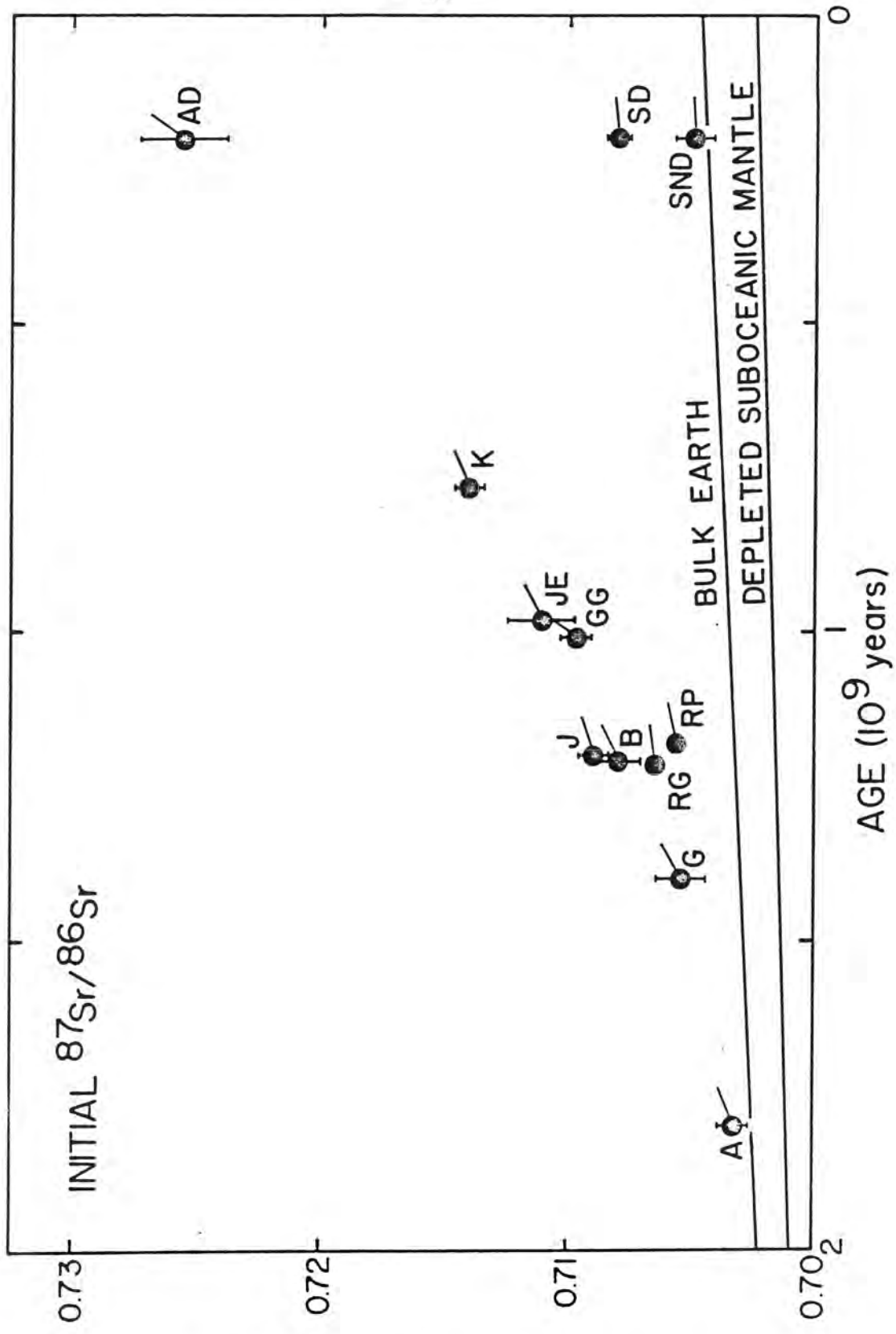

Fig. 6: A plot of initial 87Sr/86Sr versus emplacement age for the mafic rock units studied in western Dronning Maud Land. A = Annandagstoppane Gabbro. G = Grunehogna Gabbro. RG = Robertskollen Igneous Complex gabbro. RP = Robertskollen Igneous Complex peridotite. B = Borgmassivet sill. J = Juletoppane Igneous Complex. GG = Grunehogna Granodiorite. JE = Jekselen diorite. K = Krylen diorite. AD = Mafic dyke in Annandagstoppane Granite. SD = Sverdrupfjella mafic dyke. SND = Straumsnutane mafic dyke. The error bars are at 2 sigma. Where not shown, they fit within the symbol.

bulk earth or depleted suboceanic mantle development curves for respective emplacement ages. This relationship indicates three possible scenarios for magma generation. One is that the magmas were derived from a mantle source with an anomalously large Rb/Sr ratios. The second is that the magmas were derived from a lower crustal source of older mafic igneous rocks, e.g. underplated gabbro. The third is that the magmas were derived from conventional asthenosphere sources but have been contaminated with crustal strontium. We can not choose among these possibilities at the moment. But it is important that what ever mechanism has been responsible for the high initial 87Sr/86Sr ratios in these mafic igneous rocks, it has operated in western Dronning Maud Land since the middle Proterozoic. Extension of this approach will comprise the main thrust of our proposed new project.

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THE PALAEOMAGNETIC AND AEROMAGNETIC INTERPRETATION OF THE AREAS SURROUNDING THE JUTULSTRAUMEN GLACIER, QUEEN MAUD LAND, ANTARCTICA

H Bergh & B Corner

REPORT

ON THE 1982/1983 FEASIBILITY STUDY

FOR AEROMAGNETIC SURVEYING

IN QUEEN MAUD LAND, ANTARCTICA.

1. INTRODUCTION:

In October 1982 a "Geological working party "* meeting of the South African Antarctic Earth Science Program (S.A.A.E.S.P.) concluded that the 1982/1983 South African Antarctic field-season schedule should include practical aeromagnetic tests conducted during routine helicopter operations. The data and experience obtained during these reconnaissance flights were to firstly form the basis of a detailed feasibility study on South African aeromagnetic surveys in Queen Maud Land, Antarctica, and secondly provide essential information on the magnetic responses of the various geological terranes. Subsequent to this meeting, it was decided that the aeromagnetic work would be conducted over a ten day period during the offloading of the "S.A. Agulhas" Antarctic supply ship.

On arrival at Sanae, poor weather conditions throughout the ten day offloading period permitted only two aeromagnetic test-flights before the departure of the "S.A. Agulhas". Requests for the extension of the ten day period were refused on logistic grounds. An analysis of the minimal data and experience obtained from the two "test" flights that were completed, is incorporated in this report.

2. SURVEY PLAN:

The Queen Maud Land areas of particular interest to South African Antarctic Earth Scientist's may be subdivided into four geological terranes (the Ahlmann Ridge, Borg Massif, Kirwan Escarpment, and Svendrup Mountains), each comprising a unique combination of geological parameters and each anticipated to produce distinct magnetic responses. Since a knowledge of these responses from all areas under investigation is essential to meaningful assessment of survey objectives and the efficient planning of a detailed aeromagnetic survey, several flights traversing each area were planned. None of this reconnaissance work came to fruition since the permitted test flights were both flown along the edge of the ice shelf to the new West German base "Georg von Neumayer Station".

3. SURVEY OPERATIONS:

Due to helicopter flying-time restrictions, test flights were to have been undertaken during routine flights to the Grunehogna base construction site and the geological field camps. To maximize the utility of these logistic helicopter flights and ensure representative reconnaissance coverage of each of the geologic terranes a number of different flight paths were planned for each destination. Straight line reconnaissance flights to ensure valid navigation checks, in addition to altitude, velocity and heading tests were also planned.

*Working Party on Geology. Held at University of Natal, Pietermaritzburg on the 29th October 1982.

4. INSTRUMENTATION:

A Geometrics Magnetometer (G803)* and Data Acquisition System (G714)* comprising the heart of the aeromagnetic system were mounted in a Puma helicopter modified for Antarctic flying conditions. A proton precession sensor* was housed in a fibreglass "bird" trailed from a 35 m weighted cable** attached to the helicopter cargo sling. Data were recorded in analogue form on a Hewlett-Packard Chart Recorder**.

All the above equipment belonged to either GENCOR or Anglo American Corp. and was kindly loaned to the Bernard Price Institute of Geophysical Research (BPI) on a cost free basis, as a contribution to the S.A.A.E.S.P.

5. INSTRUMENT INSTALLATION, TESTING AND CALIBRATION:

No structural modifications to the helicopters were necessary. The magnetometer and data acquisition system were housed in a shock insulated aluminium frame strapped to the helicopter floor, whilst the sensor bird was simply raised or lowered through the cargo sling inspection hatch. No provision for camera or radar altimeter equipment was deemed neccessary for the 1982/1983 reconnaissance work.

Test flying and calibration were performed in the Ysterfontein and Langebaan areas north of Cape Town immediately prior to departure for the Antarctic.

6. OPERATIONAL PROCEDURES:

Since less than 10% of the geology in Queen Maud Land actually outcrops, navigation was performed primarily by means of the "Doppler-Tans" (Model G) navigation system used in each of the helicopters. Position, velocity, altitude and heading were simply verbally relayed to the data acquisition system operator at appropriate intervals. Raising or lowering of the sensor-bird was accomplished by hand whilst the helicopter maintained a hovering position.

7. RESULTS AND DISCUSSION:

7.1) Instrument Performance.

All instrumentation comprising the aeromagnetic system performed satisfactorily under Antarctic conditions with no apparent manifestation of temperature related or other malfunctions.

Geomagnetic field strength in the SANAE environs varied between 40 000 and 41 000 nT, providing a strong clear signal. At altitudes of 800 feet, mean system noise levels of 8 and 10nT were exhibited at velocities of

*Geophysical equipment loaned by GENCOR
**Geophysical equipment loaned by Anglo American

70 and 125 knots, respectively. These signal to noise ratios compare with those experienced during test trials in the Western Cape where, at a signal strength of between 27 000 and 28 000 nT, noise levels at 80 knots averaged 1,7 nT.

Excerpts of characteristic signal from the analogue aeromagnetic records of two test-flights (one in Queen Maud Land and one in the Ysterfontein area, Western Cape) are included in Appendix I. The analogue and digital records obtained during all aeromagnetic test-flights are on file at the Bernard Price Institute of Geophysical Research and are available for inspection on request.

7.2) Qualitative discussion

Since aeromagnetic survey conditions were far from favourable during both completed flights, it is extremely difficult to evaluate the variation in survey parameters which could be expected during more normal conditions and under standard survey specifications.

It is, however, apparent from the experience gained, that with respect to future aeromagnetic surveys in Queen Maud Land, several improvements are prerequisite, namely; -

i) Navigational positioning methods:

The helicopter navigation system exhibited off-target errors of up to 5% of the flight distance. i.e. Far in excess of the 300 m wide flight path corridor quoted* for the Doppler-Tans (Model G) navigation system. Clearly an improved method of flight path recovery should be instituted in any major aeromagnetic survey where this navigation system is used.

ii) Altitude monitoring:

Frequent altitude variation was a feature of both test-flights completed in Queen Maud Land. The frequency with which altitude data were verbally relayed from helicopter cockpit to data acquisition system operator proved inadequate. Although more normal flying conditions could undoubtedly increase the efficiency of this type of data recording, a continuous record of altitude variation is considered prerequisite, particularly in view of the relative simplicity and low cost of installation of additional radar altimeter equipment. (According to the analysis of flight technicalities referred to above, under "navigational positioning methods", it is not possible to tap the aircraft's central data system, including the helicopter radar altimeter).

iii) Monitoring of velocity and heading.

Again, the rate of variation in these parameters exceeded the frequency of their verbal communication. However, in this case, the greater efficiency anticipated in more normal flying conditions should be sufficient to ensure valid monitoring of these data, particularly where an improved method of flight path recovery has been instituted.

*G. duToit (Acting Commandant, 30 Squadron) October 1982. An analysis of the flight technicalities and logistics associated with the use of Puma helicopters in Antarctic aeromagnetic surveys.

iv) Allocation of real-time aeromagnetic survey period:

Production losses resulting from periods of either poor flying-weather conditions, or of unstable magnetic field strength (magnetic storms) are an integral part of aeromagnetic surveys. Sufficient allowances with respect to these delays must be incorporated into survey time allocations.

Inclement weather conditions in Queen Maud Land may be expected over up to 30% of the Antarctic summer season. Evidently, ten days of continuous poor weather can occur. (Ironically, from the end of the allocated aeromagnetic survey period until the close of the South African Antarctic field season some 5 weeks later, clear weather conditions prevailed).

Magnetic storm activity is independent of weather conditions. A brief examination of the records of magnetic field strength monitored at SANAE indicate magnetic storm activity over approximately 20% of the Antarctic summer, with periods of storm activity lasting two or three days. A more detailed examination of past records is planned.

It is clear that the allocation of the quantity and timing of aeromagnetic flying time should be as flexible as possible, and extend over as long a period as is feasible.

8. CONCLUSIONS:

From the limited data obtained during the two flights accomplished in the 1982/1983 field season it is not possible to draw meaningful conclusions regarding the detailed planning of a major aeromagnetic survey. It is, however, apparent that any further South African attempts at aeromagnetic work in Antarctica will require substantially more time allocation, commitment and flexibility than that demonstrated in the 1982/1983 field season. I must stress that a great deal of work and preparation on the part of several members of the BPI and at a cost of some R 4 700 went into ensuring every chance of success of this feasibility study. Its failure with respect to the most important objectives of reconnaissance work in Queen Maud Land could in the first instance be attributed to inclement weather conditions.

In the second instance, however, it is my opinion that the real failure of the 1982/1983 South African aeromagnetic effort may be attributed to a lack of flexibility in the South African Antarctic field season program. With minor alteration and logistic innovation (perhaps involving the early return of one member of the SANAE 1982 team on the first SANAE Relief Voyage) the aeromagnetic survey time allocation could have been extended by five weeks thus ensuring a real possibility of achieving all the desired objectives. We are thus a further year behind in providing the much needed geophysical input into the South African Earth Science Research program.

9. ACKNOWLEDGEMENTS:

The BPI is indebted to GENCOR and Anglo American Corp. for the cost-free loan of a significant amount of expensive geophysical equipment.

S. Auret, March 1983

PROJECT TITLE:	SOUTHWEST INDIAN RIDGE - PRESENT ACTIVITY AND HISTORY OF OCEAN FLOOR GENERATION SINCE MESOZOIC
PROJECT LEADER:	DR. H.W. BERGH BPI GEOPHYSICS UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG
PROJECT RESEARCHER:	MRS. B. HORROCKS BPI GEOPHYSICS UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG
DATE:	FIRST INTERIM PROGRESS REPORT JUNE 1983

OBJECTIVES:

1) Understanding the manner in which the margin between the African and Antarctic plates is being rifted apart with the accretion of new sea floor.

2) Working out the separation history of these two plates and thereby the development of the ocean basins between Africa and Antarctica.

3) Using Objective (2) to establish the original configuration of Africa, South America, Antarctica and Madagascar within the super-continent of Gondwana.

HISTORY OF PROJECT:

The Project, under several names, has been continuously funded by SANCOR since 1970. Use was made firstly of m.v. RSA and then m.v. SA Agulhas on their relief voyages to SANAE and the islands. The Marion Island relief was especially suited to Objective (1) and detailed mapping of ridge segments and fracture zones led to the first clear understanding of present-day motion between Africa and Antarctica. Surveys in the deep basins north and south of the Southwest Indian Ridge have clarified their development since the Cretaceous.

/ Careful study .....

HISTORY OF PROJECT (cont.)

Careful study of magnetic anomaly lineations has revealed amplitude variations which might be related to flow processes along the ridge-transform system. Our dredging programme was initiated to find out whether the anomaly variations are mirrored in variations of magnetic properties of recently formed basalts at the spreading ridge. This has led to collaboration with geochemistry departments at UCT and Woods Hole Oceanographic Institution.

SCIENTIFIC PROGRESS : JULY 1982 - JUNE 1983

1) Northern Weddell Sea (Jan. 1983)

Survey lines were run from known magnetic anomaly 33 - 34 (80 m.y. old) lineations southward as far as the packice permitted (about 69°S). The broken-up nature of the lineations found is indicative of numerous fracture zone offsets. Some anomalies could be traced continously for 40 - 50 km, but modelling attempts have not produced unique identification. Our data is being combined with all other data-sets available for the region, from British Antarctic Survey supply cruises to Halley Bay and USA Surveys aboard the Argentinian vessel Islas Orcadas.

Data obtained on the homeward leg from the South Sandwich Islands across the Mid-Atlantic Ridge will help in the planning of our proposed dredging cruise in September 1983.

2) Marion - Crozet Area (May 1983)

We have extended the French magnetic and bathymetric coverage southward as far as the northern flank of the Del Cano Rise. Clear magnetic limitations found in this area constrain the presently conflicting ideas on the origin of the aseismic rise. Our data is still being processed - preliminary analysis is being made of a possible relationship between development of the Del Cano Rise and mantle plume activity. In addition, the mapping of fracture zones north and northwest of the Crozet Islands can be used to outline

/the evolution .....

2) Marion - Crozet Area (May 1983) (Cont.)

the evolution of the fossil triple junction between the Southwest and Southeast Indian Ridges.

3) U.S. Navy Meeting in New York (March 1983)

Dr. Bergh attended this Office of Naval Research sponsored meeting at Lamont Doherty Geological Observatory. The renewed U.S. interest in the Southern Oceans is related to determining energy propagation in the upper crust and generally obtaining more detailed information about the sea bottom. In particular, they are interested in unusual shoals or deeps, and in this regard the recent SEASAT radar altimetry data was most impressive.

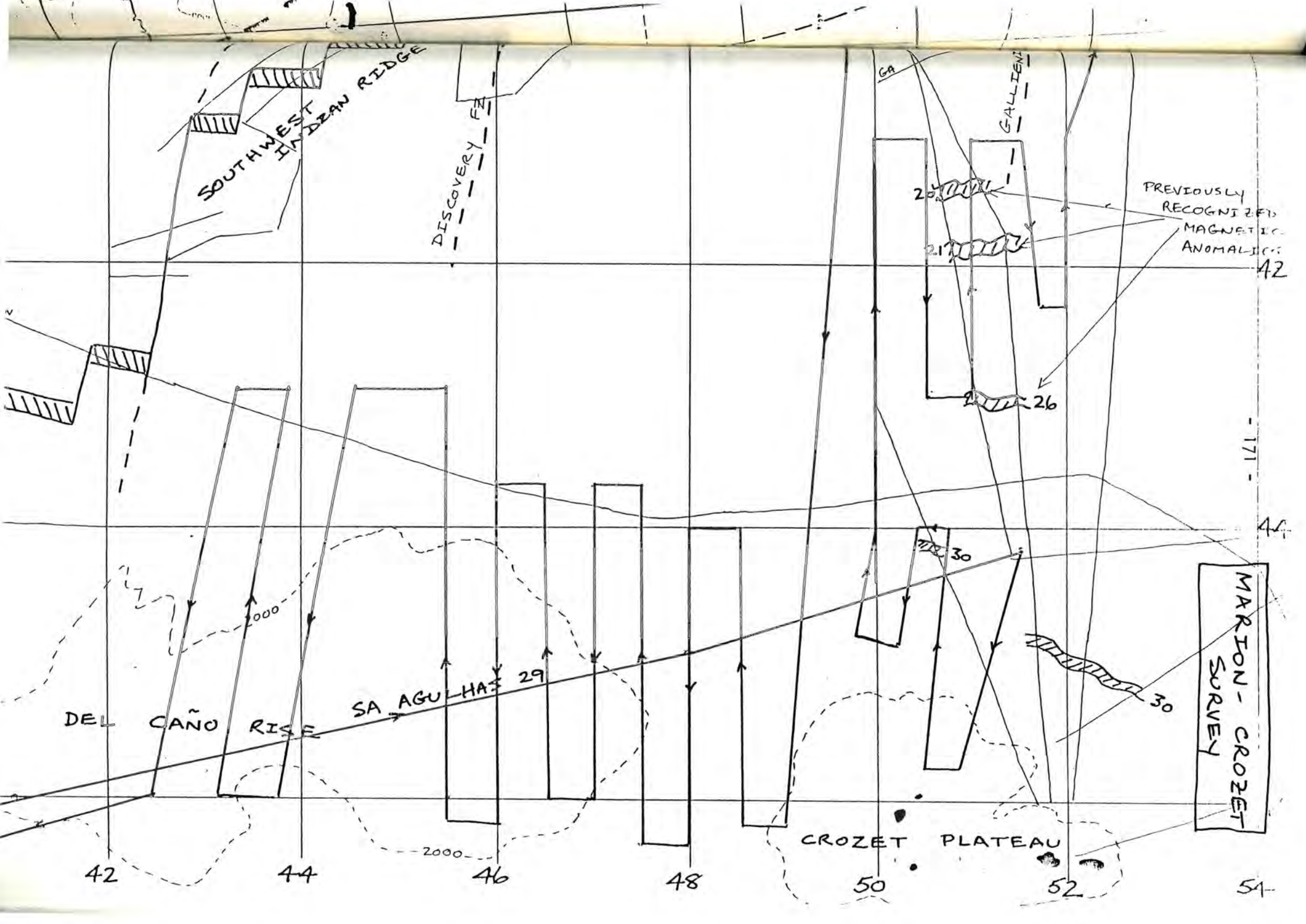
New side-scan and bathymetric mapping systems discussed at this meeting provide facilities for high-speed production of ocean floor images up to 10km wide. Much interest was expressed in whether Southern Ocean nations (Brazil, Argentina and South Africa) would be willing to provide ship's time for joint programmes with U.S. workers using these sophisticated and very expensive systems.

4) Magnetic Study of Dredged Basalts

A newly appointed research assistant (Mrs. B. Horrocks), is being trained to carry out this study. She has created data files of all results so far available and written programmes to handle the files. Sample preparation is nearly complete for the Vulcan and Agulhas 22 dredge hauls. Measurements will be carried out at the Geological Survey paleomagnetic laboratory in Pretoria.

HWB/SC

WEDDELL SEA SURVEY


SOUTHWEST INDIAN RIDGE
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GALLIENI
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SA AGULHAS
MARION-CROZET SURVEY
CROZET PLATEAU
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- 171 -

Project title : Large scale orthophoto maps

Project leader : R Wonnacott

Date : Second annual report covering the period July 1982 to June 1983

Objectives

This project was initiated to produce large scale (1:10 000) orthophoto maps of selected ice free portions of Dronning Maud Land which are of particular interest to geological and geophysical researchers. The mapping of the islands of the South Atlantic Ocean such as the Prince Edward group and Gough Island, and in which South Africa has a interest, is also to be included in this project at a much later date.

History of Project

Towards the end of 1982 the design, construction and fitting of aerial camera mountings for the Puma helicopters was completed. During February 1983 two test flights were made in the Grunehogna area. The result of these two test flights is a set of photographs covering two seperate areas about 10 km by 20 km each. The photographs which were taken during these test flights were good.

Scientific Progress

This is a supportive programme and scientific results, as such, are not expected.

Project title : Small scale LANDSAT maps

Project leader : R Wonnacott

Date : Second annual report covering the period July 1982 to July 1983

Objectives

The aim of this project is to produce small scale (1:250 000) maps of portions of Dronning Maud Land based on LANDSAT imagery and using the techniques of remote sensing and cartography.

History of Project

For various reasons no field work was carried out at SANAE during the period under review.

A visit was made to the Satellite Remote Sensing Centre at Hartebeeshoek to liaise with personnel at the centre.

Scientific Progress

This is a supportive programme and no scientific results, as such, are expected.

PROJECT TITLE: STUDY OF THE METAMORPHIC AND PLUTONIC ROCKS OF THE SVERDRUPFJELLA

PROJECT LEADER: Professor D.R. Hunter, Department of Geology, University of Natal, Pietermaritzburg.

PROJECT RESEARCHER: Dr A.R. Allen, Department of Geology, University of Natal, Pietermaritzburg.

Second Interim Progress Report - May 1983

1. OBJECTIVES

The project is a contribution to objectives (ii) and (iii) contained in NSP Report No. 35. These are:

(a) 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;

(b) 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 Ahlmannryggen and Borgmassivet.

The objectives during the 1982/83 austral summer season were to study those nunataks adjacent to the Jutulstraumen glacier. The most westerly nunataks of the H.U. Sverdrupfjella include east and west Jutulrora, Brekkerista, Straumsvola, Tvora, Storjoen and Little Storgeon, north and south Joungane, Roerkulten and outliers, Skimten and various other small unnamed nunataks. All the above nunataks were mapped.

2. HISTORY OF PROJECT

The project was approved for commencement in 1982/83. In order to provide researchers with some experience of terrain conditions, Dr A.R. Allen accompanied the 1981/82 geological party when he assisted other projects. He was able to spend a brief period during the 1981/82 season in the Sverdrupfjella.

Although funds were available for the appointment of an additional researcher in 1982/83 no appointment was made. Wide publicity was given to the availability of this post, and an applicant was selected. However, this applicant withdrew after selection as did a second applicant. A suitable candidate was subsequently recruited, too late however to participate in the 1982/83 season.

Original proposals requested the appointment of a second researcher, but in view of the difficulties experienced in appointing suitable persons, the second post was withdrawn from the 1983/84 application.

3. SCIENTIFIC PROGRESS

A total period of five weeks was spent in the field and all the nunataks named under section 1 above were mapped. The accompanying sketch map shows the positions of these nunataks and the nunataks visited during the 1981/82 reconnaissance. The sketch map also shows the extent of other nunataks which have not yet been visited. These have not been named on the sketch.

The oldest rocks identified are a layered grey granodioritic gneiss complex and a metasedimentary sequence consisting primarily of psammitic and mafic lithologies with rare pelitic and calc-silicate interlayers. Age relations between these two units are uncertain as intense isoclinal interfolding of the two units obscures their contact relations. Both units appear to have undergone the same deformational history, but nevertheless, contact relationships between the two units are still unclear and require further work.

The granodioritic gneiss complex occupies the northern half of east and west Jutulrora, the souther tip of Brekkerista and the southern tip of the northwestern ridge of Straumsvola. A similar layered grey gneiss complex occupies most of Roerkulten 15 km to the east, and the two are provisionally correlated. The complex is layered on a coarse (50 m) scale, but is homogeneous on a finer scale and is dominated by a strong S_1 foliation axial planar to isoclinal F_1 folds

defined by folded pegmatoid veins. The gneiss contains much pegmatoid material parallel to S_1, suggestive of partial melting or metamorphic differentiation. The S_1 foliation is crenulated on a fine scale and folded on a coarse scale, and locally (i.e. in coarser-grained rocks) a distinct S_2 cleavage is developed. F_2 folds are the most obvious folds seen in the field. The rocks are composed predominantly of quartz, feldspar, hornblende and biotite, and the layering is manifested by variations in grain size and mode. Metasediments are found on the southern half of east and west Jutulrora, most Brekkerista, north and south Joungane, the northeastern tip of Tvora, the northwest and southeast ridges of Straumsvola, Skimten and various outlying nunataks between Tvora and Roerkulten. Although the character of these metasediments varies somewhat from nunatak to nunatak, they all exhibit the same deformational and metamorphic history, so they are all provisionally correlated into the same unit. They are characterized by a strong S_1 foliation parallel or subparallel to layering (S_0), and axial planar to isoclinal F_1 folds. Abundant F_2 folds are well developed. S_1 is typically crenulated and locally an S_2 foliation axial planar to the F_2 folds is developed, particularly in pelitic or mafic layers. Locally possible sedimentary cross-bedding was observed in quartzose rock types. The metasediments are composed mainly of quartz, feldspar, hornblende, biotite, rare garnet and possibly other index minerals. Much of the biotite is of lat-stage origin, developed in S_1 cleavages.

In Brekkerista and east Jutulrora, the metasediments are intruded by minor granitic sheets of porphyritic character, now porphyroclastic gneiss, which have undergone a deformational history similar to the metasediments. These granitic sheets are pinkish in colour and ominated by porphyroclasts of alkali feldspar. The granitis sheets are cut by dykes of basic and intermediate compositions, which also display S_1. Abundant mafic dykes of at least one other generation also cut these older rock types.

At Roerkulten a small body of foliated pink granite is found from which emanate abundant pink pegmatite-aplite veins. These criss-cross the grey granodiorite gneiss complex of Roerkulten and Jutulrora, the metasediments, the porphyroclastis granitic gneiss on Brekkerista, and the bolder basic and intermediate dykes. The foliation in this small granitic body is undeformed and may be equivalent to S_2 in older rock types. Grey undeformed aplite veins are also found cutting the grey granodioritic gneiss and metasediments on Brekkerista.

The Straumsvola, Tvora, Storjoen, Joungane group of nunataks is dominated by the Straumsvola monzo-syenite complex which occupies much of the first three nunataks. This complex, which is undeformed, is intruded into the metasedimentary sequence and contacts are seen on the southeastern ridge and western peak of Straumsvola and on the northeastern ridge of Tvora. The complex displays prominent lensoid layering dipping gently northwards around the main summit of Straumsvola, whereas on Storjoen and Tvora no layering is observed. The most spectacular feature of this layering is a 30 - 40 m thick hornblendite layer near the summit. On Storjoen a prominent flow-banded layer in a coarse alkaline phase of the complex can be traced for over 1 km, whereas on Tvora a homogeneous dark brown, highly weathered phase occupies most of the nunatak. The syenite is criss-crossed by numerous dykes of monzonite, microsyenite, trachyte and syenite pegmatite displaying all manner of mineralogical, compositional and textural characteristics. Numerous pegmatoid patches and partially assimilated inclusions are present, particularly on Storjoen. The contact phase is pegmatitic and is particularly rich in included country rock fragments.

The whole terrain is criss-crossed by undeformed dolerite dykes which range up to 2 m in thickness, and vary widely in mineralogical, chemical and textural

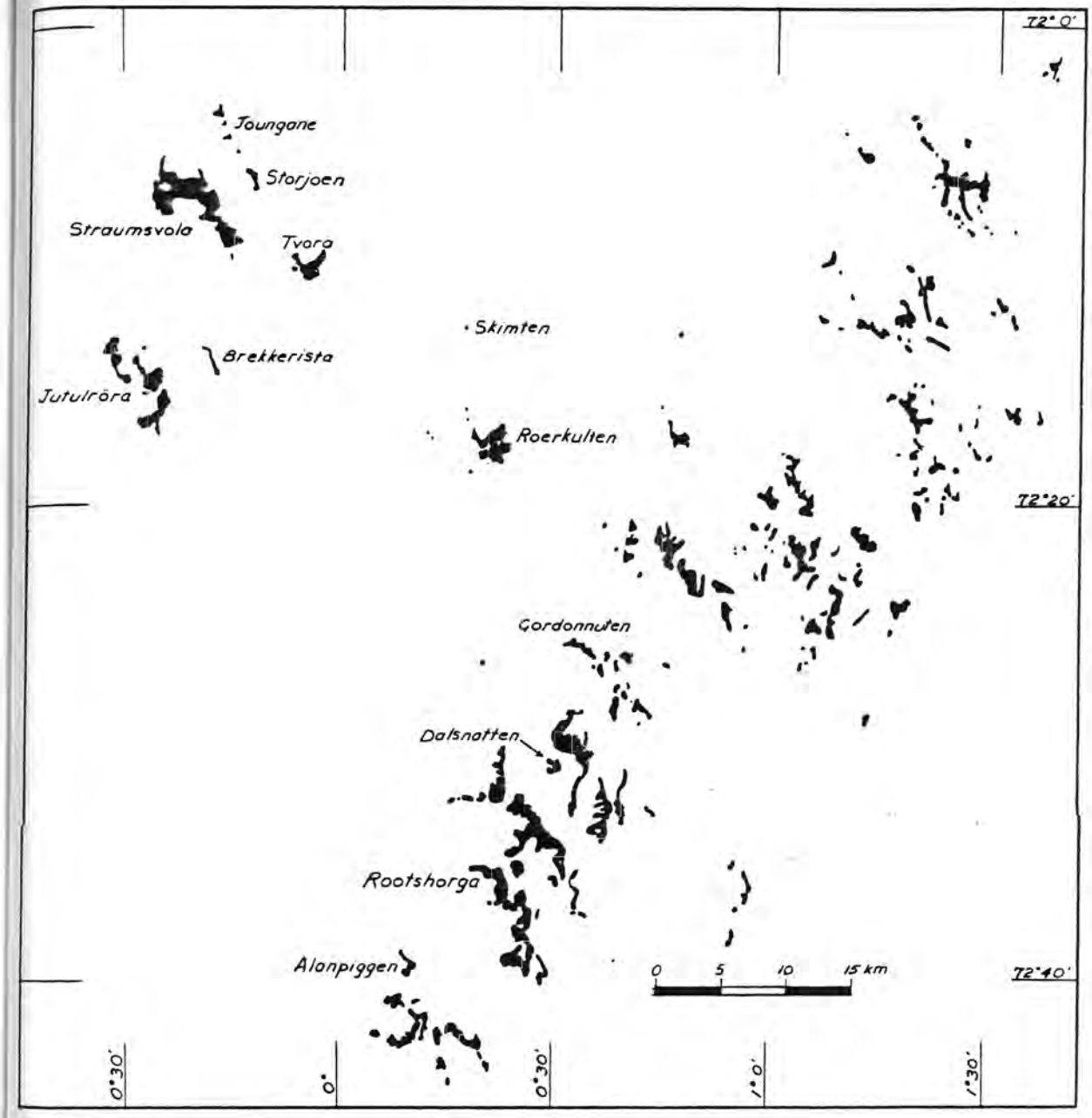
characteristics. These decrease in abundance eastwards away from the Jutulstraumen Glacier, and are relatively rare in the main range of H.U. Sverdrupfjella. They are of more than one age, as indicated by cross-cutting relationships and appear to be contemporaneous with the Straumsvola Complex, as they generally display no chilled margins against the latter and are themselves cut by dyke phases of the Straumsvola Complex.

The youngest rock type in the area is a recent debris flow covering a small area on the northeast ridge of Straumsvola and overlying the Straumsvola Complex and its cross-cutting dykes.

Examination of thin sections and plotting of structural data on stereograms have been started.

ALASTAIR R. ALLEN

23 May 1983


72°0'
Joungane
Storjoen
Straumsvola
Tvora
Skimten
Brekkerista
Jutulrora
Roerkulten
72°20'
Gordonnuten
Dalsnatten
Rootshorga
Alanpiggen
0 5 10 15 km
72°40'
0°30'
0°
0°30'
1°0'
1°30'

PROJECT TITLE: GEOCHEMISTRY AND PETROLOGY OF THE AHLMANNRYGGEN

PROJECT LEADER: Professor D.R. Hunter, Department of Geology, University of Natal, Pietermaritzburg.

PROJECT RESEARCHER: Mr J.R. Krynauw, Department of Geology, University of Natal, Pietermaritzburg.

Third Interim Progress Report - May 1983

1. OBJECTIVES

See Second Interim Report.

2. HISTORY OF PROJECT

The project was approved for commencement in 1981/82. However, it was possible to make a brief sampling trip during the previous austral summer. Preliminary visits were made to Krylen, Annandagstoppane, Jekselen and Grunehogna. More detailed sampling was undertaken during 1981/82 at Annandagstoppane, Juletoppane, Robertskollen, and Grunehogna. Krylen and Jekselen had been visited during the 1980/81 season. A total of 200 samples were collected during the 1981/82 season. The chemical analysis of these samples began in April 1982. It became evident that the analysis of these samples should be completed (for major and trace elements) before embarking on further sample collection. No field work was therefore undertaken during 1982/83.

3. SCIENTIFIC PROGRESS

Geological descriptions of nunataks under investigation were given in the second interim progress report of 1982. Only those aspects that need further clarification will be mentioned below. Since the previous report more than 3 400 XRF analyses on 163 samples have been completed. The trace elements analysed are Nb, Zr, Y, Sr, U, Rb, Th, Zn, Cu, Ni and Cr. Analyses for Sc, Ba, V, La, Ce, Pb and possibly Co will be completed by early July before more samples from the present collection will be selected for further work. It is also planned to concentrate ortho- and clinopyroxenes from the Annandagstoppane/Juletoppane and Robertskollen areas for analyses. Microprobe analyses should be completed within the next two years. Results from different areas are discussed below.

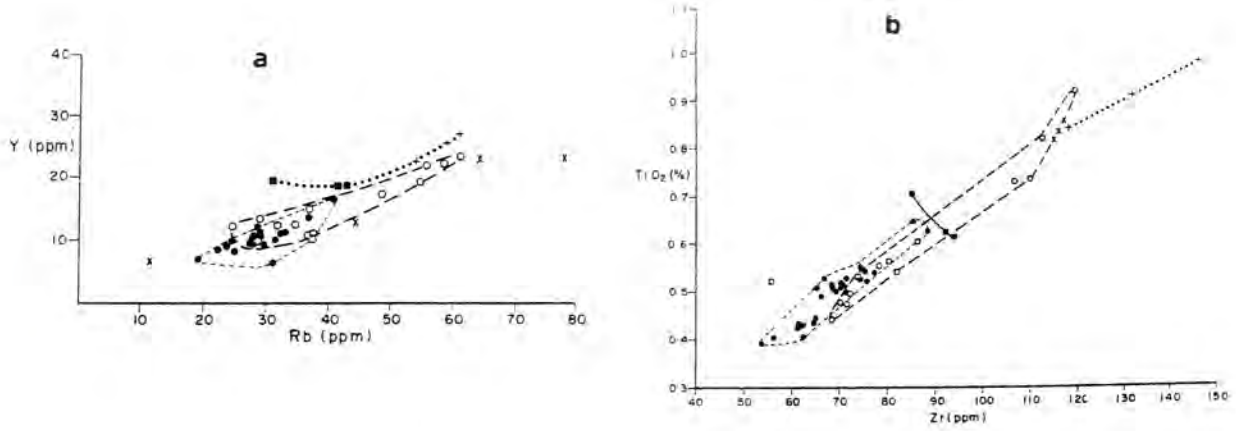


Fig. 1a Y-Rb chemical variation diagram of the Annandagstoppane/ Juletoppane intrusions. Solid circles: Annandagstoppane; Open circles: Juletoppane; squares: Juletoppane fine-grained sill; diagonal crosses: Annandagstoppane dykes; upright crosses: Juletoppane fine-grained phases.

1b TiO_2-Zr variation diagram of the Annandagstoppane/Juletoppane intrusion. Symbols as for Fig. 1a.

(a) Annandagstoppane and Juletoppane

Three different sets of rocks from Annandagstoppane and Juletoppane will be discussed, namely (1) the gabbronorites; (2) the fine-grained sill from Juletoppane and (3) the dykes from Annandagstoppane.

1. The gabbronorites may be part of a single layered complex. The layered nature of these rocks has been shown through the use of Pearce diagrams (Pearce, 1970). In these ratio diagrams three variables are used of which one, the divisor, is common to both ratios, and is assumed to be concentrated perfectly into the residual liquid during fractionation. Pearce used Al_2O_3 as the divisor, but petrographic evidence suggests that plagioclase may be one of the fractionating phases in the present study.

Zirconium was therefore used as the divisor, and it can be shown that plagioclase, orthopyroxene and possibly clinopyroxene are the fractionating phases. Variations in the slopes of the trends suggest that rhythmic and cryptic layering exist in these rocks. An important aspect is that the range of compositions of the Annandagstoppane and Juletoppane rocks overlap considerably on both major and trace element variation diagrams (Figs. 1a and 1b). Petrographic features in both areas are identical. These features include the presence of ophitic clino- and orthopyroxenes in the same thin section, mantling of inverted pigeonite by primary orthopyroxene and vice versa, small amounts of primary biotite, and interstitial micrographic intergrowths of quartz and K-feldspar. The geochemical and petrographic overlap between Annandagstoppane and Juletoppane suggests that the gabbronorites may be part of the same layered complex, and it may be worthwhile to follow up the present study with geophysical investigations in order to establish the size and shape of such a large layered body.

2. The major element chemistry of the lower, fine-grained mafic sill at Juletoppane is very similar to the coarser gabbronorites. However, Figures 1a and 1b show that trace element geochemistry of the two rocks may define different trends. In thin section, the lower sill shows a very marked preferred orientation of plagioclase, clinopyroxene and orthopyroxene. No micrographic intergrowths are present. Examination of the overlying gabbronorites at the central nunatak where the lower sill outcrops showed that the plagioclase is more sericitized than in other parts of Juletoppane, and some of the pyroxenes have been altered to amphibole. This alteration may be related to intrusion of the lower sill.

Irregular patches of fine-grained rocks are present in the coarser gabbronorites overlying the lower sill. These fine-grained patches contain micrographic intergrowths of quartz and K-feldspar, and may be a deuteric product of the intrusive fine-grained sill. It is possible that this fine-grained deuteric rock intruded the overlying gabbronorite. In some chemical variation diagrams they appear to define a fractionation trend with the lower sill, but these relationships are not consistent (e.g. Figs. 1a and 1b). However, more data are needed on the fine-grained phases before final conclusions can be reached.

3. Chemical variation diagrams show that the fine-grained dykes intruding the gabbronorites and the 2800 Ma granites at Annandagstoppane are probably not related to the gabbronorites and define trends indicating that they may be part of a different chemical system (e.g. Rb-Sr, Rb-Zr and Th-Zr).

(b) Robertskollen

Gabbronorites, gabbros and diorites overlie ultramafic rocks at Robertskollen. The ultramafic outcrops have been found at two nunataks in the northwest of the area, and at the main Robertskollen nunatak in the southeast. The northwestern outcrops are 1,5 km apart, and the southeastern outcrop is about 5 km from the northern area. Chemical variation diagrams have shown that the ultramafic to mafic sequence defines coherent fractionation trends, and that the Robertskollen area has a distinct geochemical character when compared with the Annandagstoppane/Juletoppane layered rocks. The ultramafic rocks tend to show some scatter on the diagrams. This scatter is probably the result of variations in the amount of post-cumulus crystallization of plagioclase and clinopyroxene in the ultramafic rocks. The southern outcrop may define a separate trend, parallel to the trend defined by the northern outcrops, but this possibility has to be studied further. A norite layer at the top of the southeastern Robertskollen peak seems to belong to a separate chemical system or may represent a new magma pulse. However, it is possible that the norite displays anomalous behaviour owing to cumulus processes taking place during crystallization. More data on these rocks are required before definite conclusions can be reached.

(c) Grunehogna

The sequence on the Grunehogna north face comprises, from the base upwards, a lower medium- to fine-grained diorite sill (referred to as the Lower Sill), of which 55 m is exposed, a 55 m thick pegmatoid layer, a 20 m dark, fine- to medium-grained diorite, and a 50 m coarse-grained, altered diorite (the Upper Sill) with a chill zone at the contact with the overlying sediments of the Högfonna Formation. At the northern windscoop of Nunatak 1285 a sill, probably part of the Lower Sill, cuts across part of the Grunehogna Formation, which has been folded along the contact. The sequence at the north face of Grunehogna is ideal to study the mafic intrusions in detail. The intrusive contacts at 1285 have been very useful to study sill/

sediment relationships and processes that took place in the sediments during intrusion. These two aspects are discussed separately.

1. Major element variation diagrams show that the Lower and Upper sills may not be related to one another. This suggestion has been confirmed on all the trace element variation diagrams. An example is shown in Fig. 2, where Rb has been plotted against Zr. The Upper Sill has virtually no change in its Zr content, but has a wide variation in Rb. The Lower Sill and the granites from the southern side of Grunehogna show trends markedly different from the trend in the Upper Sill, and also from one another. It is clear that the Lower Sill, the Upper Sill, and the granites represent three separate episodes of igneous intrusion.

Although it is difficult to obtain representative samples of the pegmatoid sill, the available evidence is that it is a fractionation product of the Lower Sill.

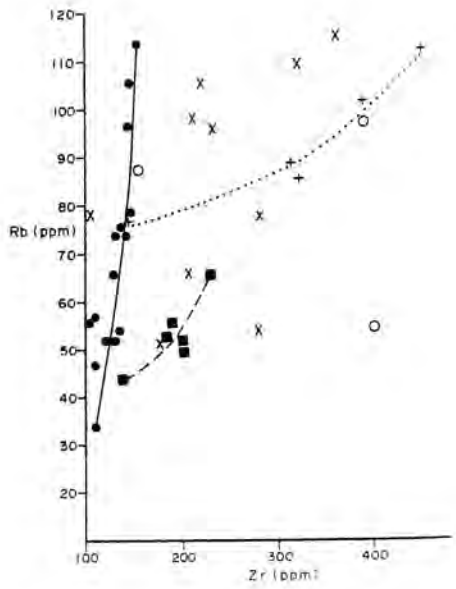


Fig. 2 Rb-Zr chemical variation diagram for the Grunehogna intrusions and sediments. Solid circles: Upper Sill; squares: Lower Sill, upright crosses: granites; diagonal crosses: sediments; open circles: granitic products derived from local melting of sediments.

2. Field evidence that the Lower Sill intruded wet, unconsolidated sediments is the following:

(i) The plastic deformation along the sill/sediment contact at 1285 is thought to be related to the intrusive event. Although heat from the intrusion might render sediments plastic, the large scale of the folding suggests that unconsolidated sediment was deformed during intrusion.

(ii) Small vugs in the sediments adjacent to the intrusion indicate that volatile action was involved and that intrusion took place at shallow levels.

(iii) Contorted sedimentary xenoliths, indicative of soft sediment deformation, are present in the sill. However, no similar structures were observed in sediments, constituting the country rocks, in the area. Deformation of the xenoliths probably took place when they were caught up in the magma.

Petrographic studies have shown that during intrusion the sediments were affected in a variety of ways. In parts a progressive degree of recrystallization can be identified, and melting along intergrain boundaries took place closer to the heat source. The melt formed in this way did not move very far, and in most cases crystallized virtually in situ. It was identified by its granitic composition and the presence of micrographic intergrowths. Occasionally a large enough volume of melt was formed to be mobilized and to intrude the surrounding sediments as small granitic bodies. The scatter of plots on variation diagrams of the granitic melts reflects the original chemical inhomogeneity of the parent sediment (Fig. 2). Further investigations on melting relationships and partitioning of trace elements into the melt promise to be a very fruitful field of study.

J.R. KRYNAUW
Antarctic Research Officer

27 May 1983

PROJEKTITEL: 'n SEDIMENTOLOGIES -STRATIGRAFIESE ONDERSOEK VAN DIE SEDIMENTÊRE GESTEENTES IN DIE AHLMANNRYGGEN

PROJEKLEIER: C D Potgieter
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DATUM: Die tweede jaarlikse vorderingsverslag, Junie 1983.

1. DOELSTELLINGS

Die projek is gerig op die paleogeografiese ontsyfering van die sedimentêre en klimatologiese toestande gedurende die afsetting van die gesteenteformasies in die Ahlmannryggen. Daar word ook gepoog om 'n korrekte idee te kry van die totale dikte van die sedimentêre opeenvolging in hierdie gebied om sodoende aflei= dings aangaande die geologiese evolusie van hierdie gedeelte van die Antarktiese-kraton te postuleer. Dit sal ook inligting ver= skaf oor die ouderdom van die gesteentes in hierdie gebied en of dit werklik in tyd met die Waterberg-Groep en korrelate in die R.S.A. korreleerbaar is. Korrelasie probleme tussen die 2
verskillende nunatakte moet oorbrug word, om sodoende 'n vereen= voudigde stratigrafiese indeling vir die Ahlmannryggen, sowel as vir die Borgmassivet te bewerkstellig. Daar moet vasgestel word wat die posisie van die Antarktiese-kraton t.o.v. die Kaap= vaalkraton was, voor kontinentale drywing aan die einde van die Mesosoïkum. Bykomstige inligting sal verkry word aangaande die lokalisasie en karakter van die provenans, terwyl die metamorfe en teksturele veranderings van die gesteenteformasies ook onder= 3.
soek sal word.

Sleutelvrae wat beskou moet word is:

..... 2/

(a) Wat is die petrografiese samestelling van die verskillende litologiese tipes, en hoe skakel die resultate in by die algemene opvatting van sekere petrografiese assosiasies wat betref sekere fasiesmodelle?

(b) Wat is die afsettingsomgewings van die verskillende gesteenteformasies?

(c) Wat was die paleotektoniese, paleobiologiese en paleoklimatologiese toestande, en hoe het dit die afsettingstoestande beïnvloed?

(d) Waar was en uit watter litologiese tipes het die provenans bestaan?

(e) Wat is die ouderdomme van die sedimentêre gesteentes?

(f) Wat is die ouderdomme van die intrusiewe gesteentes?

(g) Tot watter mate is die sedimentêre gesteentes deur metamorfose en metasamatose beïnvloed.

(h) Hou die metamorfose en metasomatose verband met die indringing van groot volumes intrusiewe gesteentes, of staan dit in verband met die ontwikkeling van die Pencktrog?

2. GESKIEDENIS VAN PROJEK

Die projek is geïnisieer gedurende die 1982/83 veldseisoen in Antarktika, hoewel grootliks beperk tot 'n verkenningsopname. Globaal gesien vorm hierdie projek die tweede fase van die oorspronklike projek soos geformuleer in die 1981/82 projekvoorstel.

3. WETENSKAPLIKE VORDERING

Vier dae is gedurende die 1982/83 veldseisoen in die Sentrale Ahlmannryggen deurgebring en veldwerk is gedoen vanaf die nuwe

..... 3/

Grunehogna-basis (sien aangehegte kaart).

'n Stratigrafiese profiel is by 1285 (Grunehogna) en 1285-wes ('n klein nunatak net wes van 1285) opgemeet oor gedeeltes van die Högfonna- en Schumachersfjellet-Formasies.

Jekselen is besoek en daar is bepaal dat dit 'n "drywende" blok sedimentêre gesteentes is, m.a.w. die stratigrafiese posisie is problematies a.g.v. versteuring deur die indringing van diori= tiese stollingsaktiwiteit. Die sedimentêre opeenvolging by Jekselen is tentatief korreleerbaar met die Högfonna-Formasie by 1285 (Grunehogna).

Die suidelike gedeelte van Schumachersfjellet is ook verken. Dagsome is egter uiters swak blootgestel.

Die nunatakte tussen Nupshamrane en Flårjuvnutane is ook besoek en 'n stratigrafiese profiel is by lg. nunatak oor gesteentes, wat moontlik met die Framryggen-Formasie korreleerbaar is, opgemeet.

Verkenning is ook by die Tindeklypa en Istind gedoen.

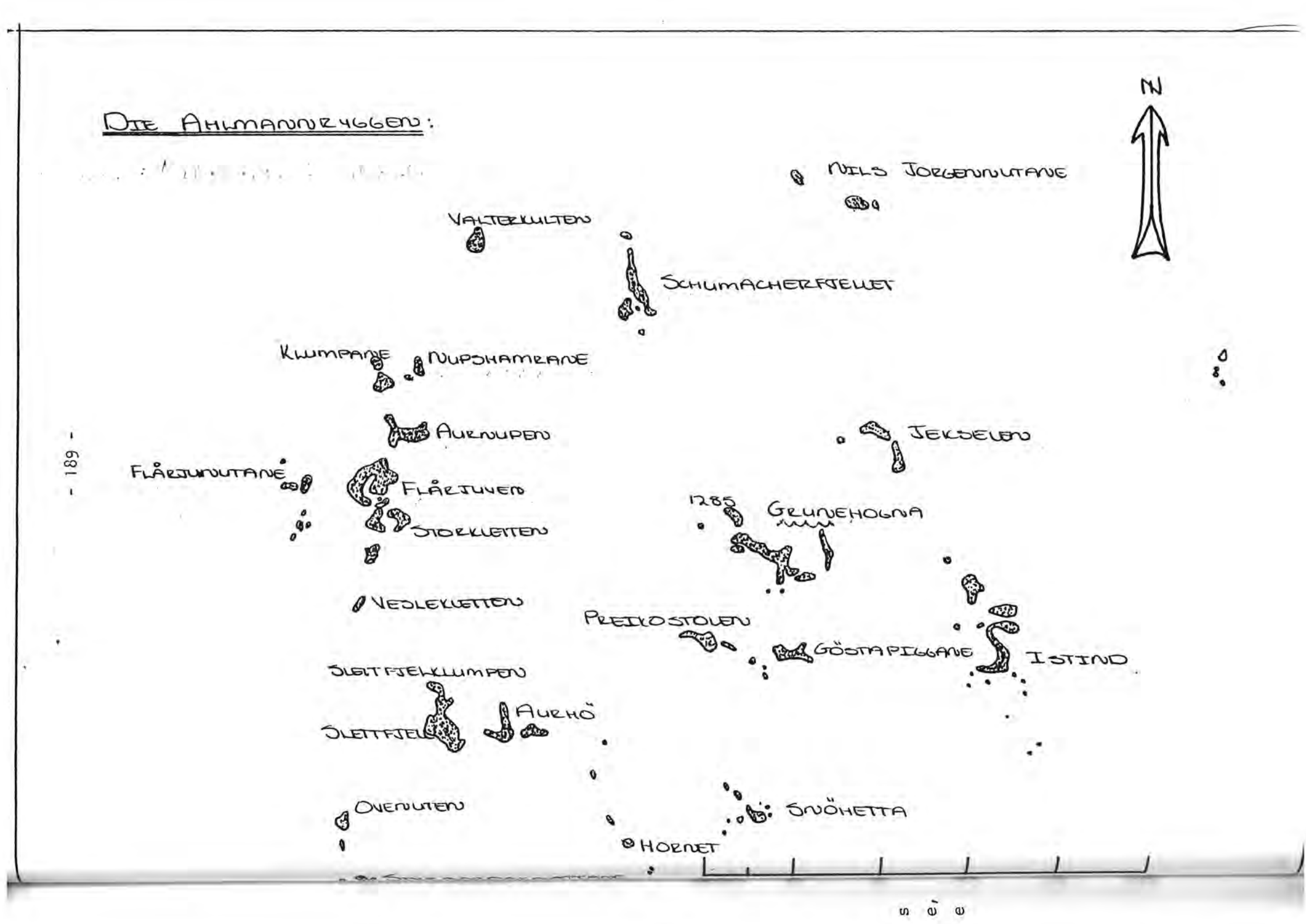
Voorlopige fasieanalise van die Högfonna-Formasie dui op soort= gelyke paleogeografiese toestande soos afgelei vir Framryggen-Formasie in die Borgmassivet. Paleostroom gegewens het ook dieselfde resultate gelewer m.a.w. aanvoer vanuit die noordweste na die suidooste tot ooste. Dit wil dus voorkom dat die provenans wat aktief was gedurende die afsetting van die Framryggen-Formasie, nog steeds materiaal verskaf het ten tye van die afsetting van die Högfonna-Formasie.

Uit die verkenningstogte het dit ook geblyk dat die gesteente= formasies in die Ahlmannryggen 'n regionale helling van $< 10°$ in die rigting van die Pencktrog besit. Afwykings kom egter nader aan die Pencktrog voor, (die hellings word steiler) soos wat ook in die Borgmassivet gevind is. Petrografiese ondersoek dui daarop dat die gesteentes onderwerp was aan die groenkis= fasies van metamorfose.

C D Potgieter

C D POTGIETER 26 Mei 1983

DIE AHLMANNBERGEN:



PROJEKTITEL: 'n SEDIMENTOLOGIES-STRATISGRAFIESE ONDERSOEK VAN DIE HÖGFONNA-, RAUDBERGET- EN FASETTEFJELLET-FORMASIES IN DIE BORGMASSIVET

PROJEKLEIER: C D Potgieter
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DATUM: Die derde jaarlikse vorderingsverslag, Junie 1983

1. DOELSTELLINGS

Die projek is grootliks gerig op die paleogeografiese ontsyfering van die sedimentologiese en klimatologiese toestande gedurende die afsetting van die sedimentêre gesteenteformasies in die Borgmassivet. Die totale dikte van die sedimentêre opeenvolging, sowel as die volumes van litologiese tipes kan gebruik word as 'n aanduiding van die mate en tipe geologiese evolusie wat hierdie gedeelte van die Antarktiese-kraton ondergaan het. Daar word gepoog om 'n verbeterde algemene voorstelling van die paleostroomdata te verkry, wat afgesien van die belang daarvan in paleogeografiese rekonstruksie, ook gebruik sal word in die oplossing van die brongebiedprobleem vir hierdie gebied.

Die inherente stratigrafiese probleme wat daar bestaan a.g.v. swak blootstelling en afstandkorrelasie kan moontlik opgelos of vereenvoudig word, deur soveel nunatakte as moontlik te besoek en stratigrafies op te meet. Met behulp van paleostroom-, geochronologiese en paleomagnetiese inligting sal daar ook gepoog word om 'n idee te verkry van die oorsponklike posisie van die Antarktiese-kraton t.o.v. die Kaapvaalkraton aan die einde van die Mesosoïkum. Bykomstige stratigrafiese inligting sal ook verskaf word vir die geochronologiese projekte in Antarktika.

2. GESKIEDENIS VAN DIE PROJEK

Hierdie projek is gedurende die 1981/82 veldseisoen geïnisieer waartydens die sentrale en noordwestelike gedeeltes van die Borgmassivet ondersoek is. Gedurende die 1982/83 veldseisoen is die res van die nunatakte in die Borgmassivet besoek (sien aangehegte kaart).

3. WETENSKAPLIKE VORDERING

Net soos gedurende die 1981/81 veldseisoen is sekere sleutelnunatakte besoek. Hierdie nunatakte is m.b.v. stratigrafiese metodes opgemeet, litofasies en sedimentêre strukture is genoteer, en is ook sistematies gemonster.

(a) Petrografie

Die sedimentêre gesteentes in die Borgmassivet bestaan uit silisiklastiese sedimentêre gesteentes wat wissel deur die hele spektrum van korrelgroottes, en dus energie-toestande, d.w.s. van konglomerate tot modderrotse. Die modderrotse maak egter volumetries die grootste persentasie van die litologiese tipes uit, gevolg deur die areniete. Ekstraformasionele polimikte konglomerate kom ondergeskik voor, maar dien egter as belangrike merkerhorisone in sekere areas.

Die areniete het oor die algemeen 'n gemiddelde teksturele en mineralogiese karakter, en is dus tipies van areniete wat onder fluviale toestande afgeset is. Tipes soos arkose, subarkose, litiese areniete en sublitiese areniete is ontwikkel. Kleure wissel van ligbruin tot grys.

Die modderrotse het rooibruin kleur en sliksteenlense kom gewoonlik tussengelaagd daarin voor. Simmetriese riffelmerke is veral met hierdie litologiese tipe geassosieer en aanduiding van die lae energie-toestande gedurende afsetting daarvan.

Rolsteentipes, rotsfragmente in die areniete en swaarmineraal-analises dui op 'n granitiese, suurvulkaniese en sedi-

..... 3/

mentêre brongebied.

(b) Sedimentologie

(i) Geometrie

Die konglomerate alhoewel dun, neig om ekstensief voor te kom. Die areniete is egter geneig om lensvormig te wees en daar bestaan gewoonlik erosiewe kontakte met die onderliggende areniet en/of moddersteen/sliksteen-eenhede. Die modderrotse kom ekstensief voor.

(ii) Sedimentêre strukture

Tafel- en trogvormige kruisgelaagdheid is die belangrikste rigtingduidende sedimentêre strukture, alhoewel asimmetriese riffelmerke ook voorkom. Stroomlineasies en simmetriese riffels is ook gebruik in die opstelling van paleostroom gegewens. Die kruisgelaagdheid is grootliks geassosieer met die areniete, alhoewel riffelkruislaminasie in die slikstene aanwesig is. Graderingsgelaagdheid kom in sekere lokaliteite voor (bv. 1910-nunatak), en Bouma-eenhede is ontwikkel.

(iii) Paleostroomanalise

Die rigtingduidende sedimentêre strukture dui op 'n algemene aanvoerrigting na die suidooste d.w.s. die bronbied(e) was in die noordweste of weste geleë. Die enkelmodale verspreidings van hierdie strukture pas ook goed in by die algemene paleostroommodelle van fluviale afsettingsomgewings. Die graderingsgelaagdheid in sekere fynkorrelrige silisiklastiese sedimentêre gesteentes dui moontlik op die aanwesigheid van lakustrine omgewings, waarin sedimentasie a.g.v. gravitasieprosesse plaasgevind het.

..... 4/

(iv) Paleontologie

Die tentatiewe Middel-Proterosoïese ouderdom van die silisiklastiese sedimentêre gesteentes in die Borg= massivet maak dit 'n onwaarskynlike teiken vir enige paleontologiese fondse. Geen aanduiding van skellet-, sowel as spoorfossiele is gevind nie.

(v) Samevatting

Die algemene geometrie, paleostroomanalises en fasies= analises dui daarop dat die grootste gedeelte van die sedimentêre gesteentes in die Borgmassivet onder flu= viale toestande afgeset is. Die konglomeraatfasies word geïnterpreteer as verliggende gedeeltes van alluviale waaiers en as kanaalafsettings. Die areniete is hoofsaaklik afgeset as kanaalopvullings (puntwalaf= settings), terwyl die modderstene en slikstene op die vloedvlaktes rondom die meanderende fluviale sisteem afgeset is. Gegradeerde slikstene en modderstene dui daarop dat daar ook mere op die breë alluviale vlakte teenwoordig was.

(c) Stratigrafie

Die sedimentêre gesteentes in die Borgmassivet vorm deel van die Ahlmannryggen-Groep, wat die basale groep van die Rit= scherflya-Supergroep verteenwoordig. Die Ahlmannryggen-Groep is hier opgebou uit die Framryggen-Formasie (onder), Högfonna-Formasie en Raudberget-Formasie.

Die Framryggen-Formasie bestaan hoofsaaklik uit fynkorrel= rige arkosiese areniete, slikstene en rooibruin skalies. Hierdie formasie dagsoom in die westelike gedeelte van die Borgmassivet, ten weste van die Raudbergdalen. 'n Moontlike tentatiewe korrelaat nl. die opeenvolging by Friis-Baastad= nuten, kom suidoos van die Frostlendet voor en dui op breër verspreiding van die Framryggen-Formasie, as wat aanvanklik voorgestel is.

Konkordant op die Framryggen-Formasie volg die Veten-Lid

..... 5/

(Högfonna-Formasie) en word opgebou uit 'n dun basale konglo=meraat, arkosiese areniete en hoofsaaklik rooibruin skalies. Hierdie lid dagsoom ook hoofsaaklik in die gedeelte van die Borgmassivet wes van die Raudbergdalen, alhoewel die boonste gedeelte van Friis-Baastadnuten ook tentatief met die Veten-Lid korreleerbaar is. Die bokant van die Veten-Lid is nie in die Borgmassivet blootgestel nie, sodat die kontak met die oorliggende Högfonaksla-Lid (Högona-Formasie) problematies is.

Die Högfonaksla-Lid bestaan hoofsaaklik uit subarkosiese en arkosiese areniete. Die bokant word gekenmerk deur 'n dik konglomeratiese sone by Högfonaksla (gedeelte van Högfonna).

Tentatief volg die Rauberget-Formasie konkordant op die Högfonaksla-Lid, maar het egter 'n minimale ontwikkeling by lg. nunatak. Die bestaansreg van die Raudberget-Formasie in die Raudberget word op hierdie stadium betwyfel, en word die sedimentêre opeenvolging aldaar tentatief met die Veten-Lid gekorreleer.

(d) Struktuur

Die regionale helling van die Ahlmannryggen-Groep is minder as 10° na die suidooste, m.a.w. in die rigting van die Penck=trog. Afwykings vanaf hierdie algemene hellingsrigting kom voor in die gebied tussen die Frostlendet en Pencktrog. Die algemene geologiese struktuur van die gebied word voorgestel in figuur 1. Uit veldwerk en korrelasie van sekere merker=sones blyk dit dat die algemene struktuur 'n trapverskuiwings=karakter het, en dat die valkante van die verskuiwings na die noordweste geleë is. Die teenwoordigheid van hierdie normale verskuiwings dui dus op die aanwesigheid van rekspanning in hierdie gedeelte van die Antarktiese-kraton en staan moontlik in verband met die indringing van dioritiese intrusies.

(e) Diagenese en metamorfose

Die petrografiese ondersoek toon dat die gesteentes en veral die areniete, tot 'n groot mate gesilisifiseer is, tot so 'n mate dat die korrelbuitelynne in die meeste gevalle moeilik

sigbaar is. Alhoewel geen of baie min klastiese matriks huidiglik tussen die korrels in die areniete voorkom, en dus die karakter van 'n mineralogies volwasse gesteente skep, is die matriks moontlik gedurende diagenese vervang of verwyder. Die veldspate is grootliks geserisitiseer, alhoewel vertweelinging van die Ca-veldspate wel nog waarneembaar is. Ander minerale wat in die areniete voorkom is epidoot, chloriet en ondergeskikte kalsiet. Die teenwoordigheid van veral epidoot en chloriet dui daarop dat die gesteentes aan die groenkisfasies van metamorfose onderwerp was. Die moontlike metasomatiese invloed van die dioritiese plate en gange is moeilik bepaalbaar. Die konsentrasie van epidoot in nate en krake, (d.w.s. die herverspreiding daarvan) kan moontlik die gevolg van hierdie metasomatiese effekte wees.

(f) Geochemie

Geochemiese-analises van slikstene en skalies dui op 'n verryking van hoofsaaklik silika, soos ook deur die petrografiese metodes vasgestel is.

(g) Paleomagnetisme

Vyftien georiënteerde fynkorrelrige areniete is gemonster en sal deur die B P I (U W W R) ondersoek word.

(h) Ekonomiese geologie

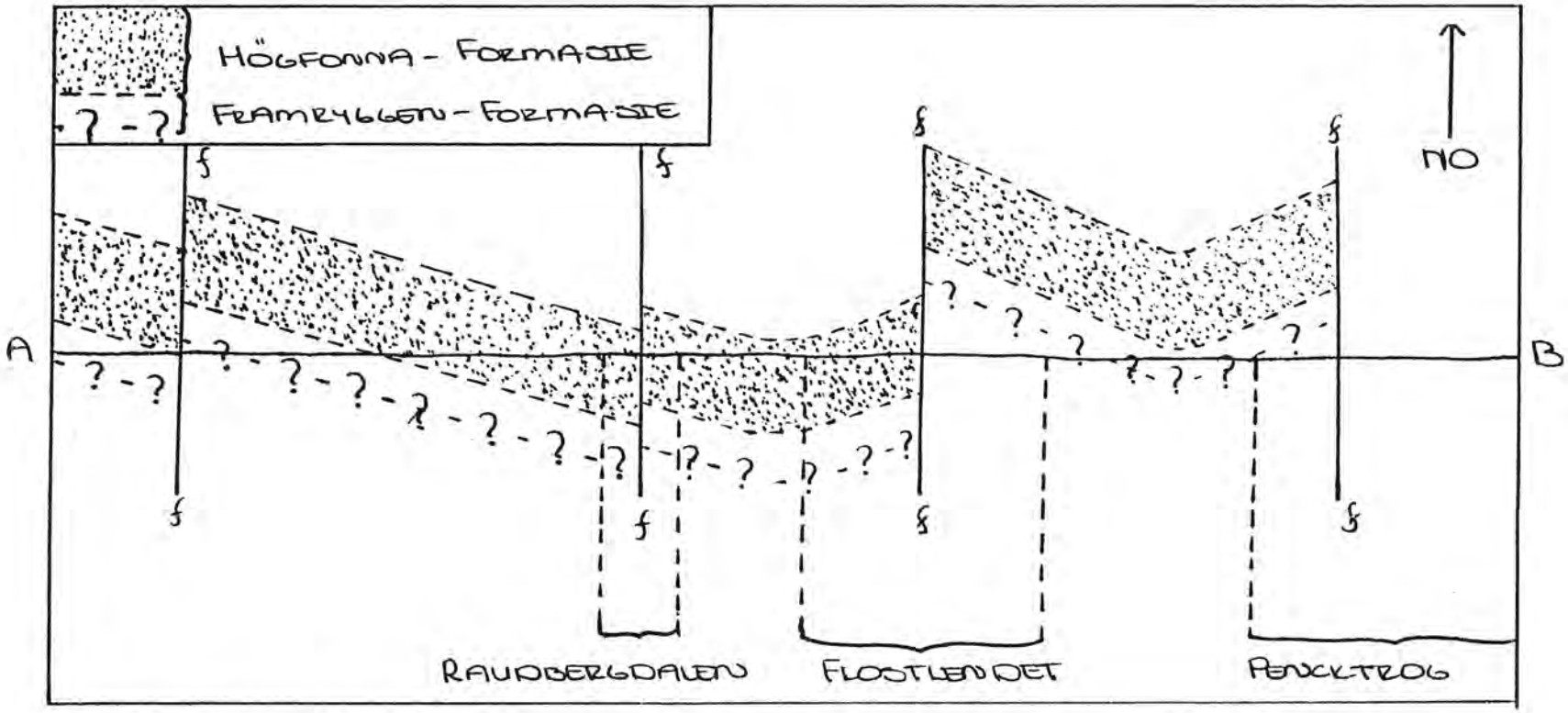
Geen noemenswaardige ertsvoorkomste is in die gebied gevind nie. Ondergeskikte mineralisasie van atakamiet kom in nate en krake voor, terwyl spekulariet met die konglomerate aan die basis van die Veten-Lid geassosieer is.

C D POTGIETER

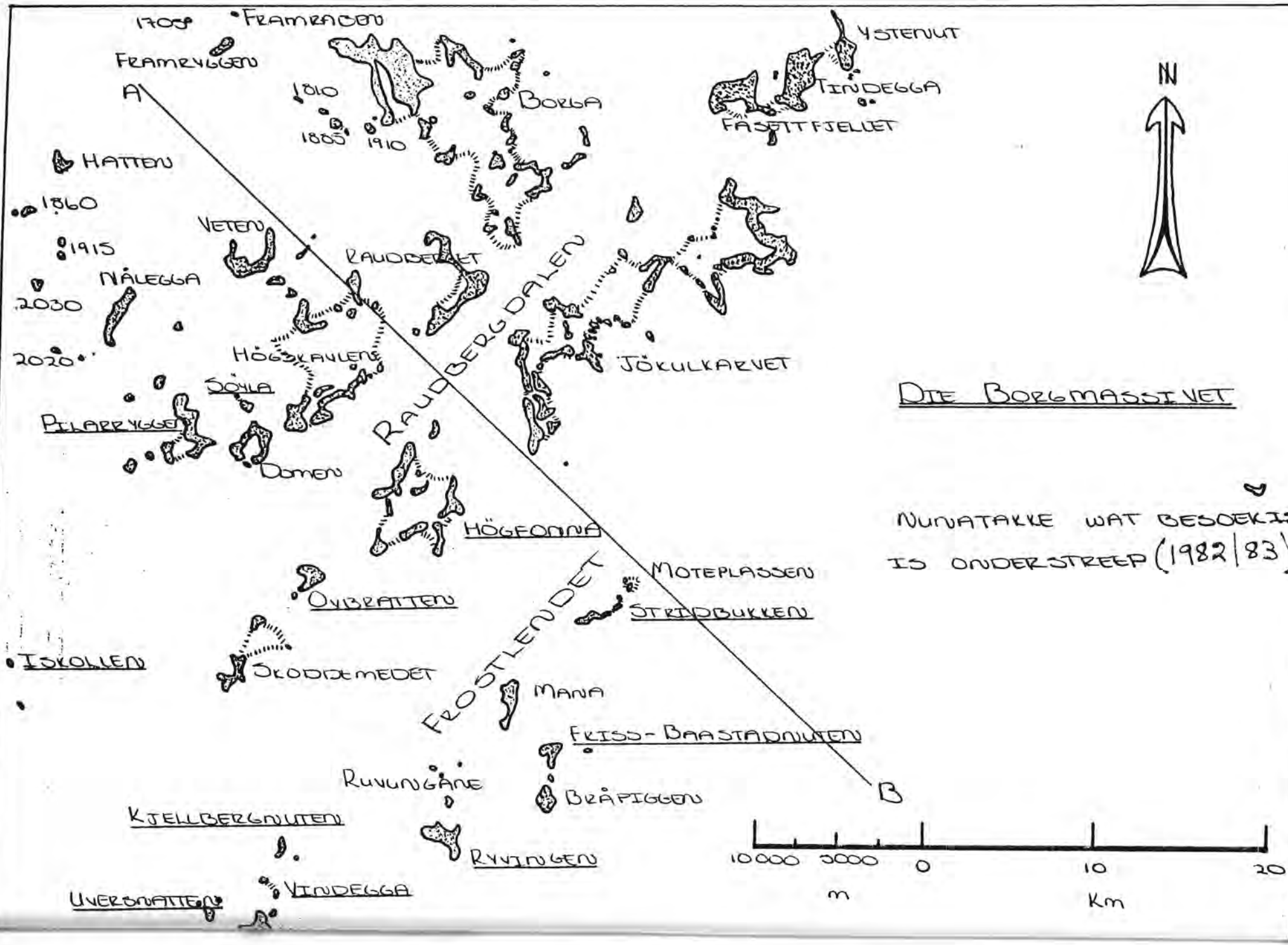
26 Mei 1983

J J P SWANEPOEL

FIGUUR 1:



'N VEREENVOUDIGDE, SKEMATIESE VOORSTELLING VAN DIE STRUKTUUR IN DIE BORGMASSIVET.



DIE BORGMASSIVET

NUNATAKKE WAT BESOEK IS IS ONDERSTREEP (1982|83)

SOUTHERN OCEANS LITHOSPHERE PROJECT

Project Leaders: A.M. Reid[1], A.J. Erlank[2], A.P. le Roex[1]

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(2) Department of Geochemistry, University of Cape Town, Rondebosch, 7700

Project Researcher: A.P. le Roex

Date: 8 June, 1983

Period of Report: June 1982 to June 1983

Objectives

(a) Identification, analysis and description of igneous rocks from fracture zones and ridge systems in the South Atlantic and Indian Oceans and from associated oceanic islands.

(b) Formulation and testing of models for the formation of these rocks, for the relationship of rock type to tectonic setting and for the evolution of the lithosphere in the Southern Oceans.

History of the Project

When the project was initiated, our knowledge of the nature of the igneous lithosphere in the Southern Oceans was limited to studies of sample suites from oceanic islands and from a few samples dredged from the South Atlantic. The highly successful Islas Orcadas cruise in 1976 produced a number of samples from the ridge and fracture zones of circum-Antarctic ridge system. The Islas Orcadas samples, on which the SOLP project began, and samples from successive cruises have greatly expanded our knowledge of what was previously a little known segment of the oceanic lithosphere. The project is a collaborative one with

Woods Hole Oceanographic Institution, where Dr. H.J.B. Dick has been instumental in organising several highly successful cruises to dredge the Southern Oceans, and with Dr. H. W. Bergh and others at the Bernard Price Institute in Johannesburg.
Since the initiation of the project, three dredging cruises have taken place: ATLANTIS II to the Southwest Indian ridge (1°W-11°E), VULCAN 5 to the America-Antarctica Ridge (4°W-18°W) and AGULHAS 22 to the Southwest Indian Ridge (17°E-25°E). A large set of samples are now available from the circum-Antarctic ridge systems and these samples form the basis of our studies.

Scientific Progress

A. Sr and Nd Isotopic analyses

One of us, A.P. le Roex, spent 6 weeks at the Massachusetts Institute of Technology during August-September, 1982, to complete Sr and Nd isotope analyses on basalts from the Southwest Indian Ridge (1°W-11°E and 17°E-25°E) and from the America-Antarctica Ridge (4°W-18°W). The visit was highly productive and it was possible to complete analyses on all the selected samples.

B. Southwest Indian Ridge (1°W-11°E)

The analytical program (major and trace elements by XRF; rare earth elements by neutron activation analysis; Sr and Nd isotopes by mass spectometry) for this portion of the circum-Antarctic ridge system has been completed. The analytical data and our interpretations resulting from this study have been written up in two articles, one of which appeared in October, 1982 (Earth and Planetary Science Letters), the other of which is in press and will be published in Journal of Petrology in August, 1983. A significant part of the year was dedicated to the preparation of the latter article which summarizes data and interpretation for a large segment of the Southwest Indian Ridge (see appendix to this report). In addition, a summary of the trace element and isotopic results was presented at the IAVCEI meeting on 'The

Generation of Major Basalt Types' which was held in Iceland during August, 1982. Some of the results from this study were also presented at the 5th National Oceanographic Symposium, held in Grahamstown during January, 1983.

C. America-Antarctica Ridge (4°W-11°W)

Detailed major and trace element analyses by XRF of 62 samples from the America-Antarctica Ridge have been completed. On the basis of these results, 10 samples were selected for Sr and Nd isotopic analysis and 16 were selected for rare earth element (REE) analyis. The isotope analyses have been completed and the neutron activation analyses (INAA) for the REE are currently underway.

One significant result to emerge from this dataset is that there appears to be a distinct difference in the nature of the sub-oceanic mantle beneath the America-Antarctica Ridge compared to that below the western end of the Southwest Indian Ridge. This difference is specifically evident in incompatible element and isotopic variations and we attribute the difference to the lack of influence of the Bouvet 'mantle plume' on the source region of the America-Antarctica Ridge basalts in comparison to the source regions for the basalts on the Southwest Indian Ridge which show pronounced 'plume' influence.

D. Southwest Indian Ridge (17°E-25°E)

Selected basalts, dredged from the Southwest Indian Ridge during cruise 22 of the S.A. AGULHAS, have been chosen for detailed major and trace element analysis. Microprobe polished sections for the analysis of mineral phases have been prepared for a representative suite of samples. Sr and Nd isotope analyses have been completed on selected samples and INAA analyses for the REE are currently underway.

Preliminary XRF results indicate that the samples are fairly uniform in composition and that a 'mantle plume' influence is not evident in these samples. This conclusion is supported by the isotopic data and these results enable us to place an eastern limit of between 11°E and 17°E on the region of influence of the Bouvet 'mantle plume' .

E. Oceanic Islands

The analytical program (XRF and microprobe analyses) on the Gough Island lavas has been completed. Interpretation and writing up of the results are currently underway, but one observation that can be made at this stage is that the Gough Island lavas are both chemically and mineralogically more complex than the Bouvet Island lavas. This feature is attributed to a more complex magmatic evolution of the lavas, incorporating greater degrees of magma mixing coupled with a more heterogeneous source region. Another important aspect to arise from the study is that the island is significantly younger in age than previously thought. K-Ar ages indicate that the oldest sub-aerial lavas are ~1.Ø m.y. old rather than the previously estimated age of 2-6 m.y. (Miller, 1962).

The results of our study on Bouvet Island appeared in press during late 1982.

Publications

Le Roex, A.P. and Erlank, A.J. (1982). Quantitative evaluation of fractional crystallisation in Bouvet Island lavas. J. Volc. and Geotherm. Res. 13, 309-338.

Le Roex, A.P., Dick, H.J.B., Reid, A.M. and Erlank, A.J. (1982). Ferrobasalts from the Spiess Ridge segment of the Southwest Indian Ridge. Earth Planet. Sci. Lett. 6Ø, 437-451.

Abstracts

Le Roex, A.P., Erlank, A.J., Reid, A.M. and Dick, H.J.B. (1983). Influence of tectonic setting on the chemical composition of ocean floor basalts: evidence from the Southwest Indian Ridge. Fifth National Oceanographic Symposium, Grahamstown, South Africa, January 1983.

Erlank, A.J., le Roex, A.P. and Reid, A.M. (1983). Is the sub-oceanic mantle different from the sub-continental mantle? Fifth National Oceanographic Symposium, Grahamstown, South Africa, January 1983.

Reid, A.M., le Roex, A.P., Erlank, A.J. and Dick, H.J.B. (1983). Nature and diversity of volcanic rocks from the Southern Oceans. Fifth National Oceanographic Symposium, Grahamstown, South Africa, January 1983.

Publication in Press

Le Roex, A.P., Dick, H.J.B., Erlank, A.J., Reid, A.M., Frey, F.A. and Hart, S.R. (1983) Geochemistry, mineralogy and petrogenesis of lavas erupted along the Southwest Indian Ridge between the Bouvet triple junction and 11 degrees East. J. Petrol. 24(3),

PROJECT TITLE: THE PLEISTOCENE STRATIGRAPHY AND VOLCANOLOGY OF MARION AND PRINCE EDWARD ISLANDS

PROJECT LEADER: Professor W.J. Verwoerd, Department of Geology, University of Stellenbosch, Stellenbosch 7600.

PROJECT RESEARCHER: Dr. L. Chevallier, Department of Geology, University of Stellenbosch.

First Interim Progress Report, February - June 1983

1. OBJECTIVES

The purpose of the project is to reconstruct the geological history of the two neighbouring volcanic islands during the Pleistocene epoch, i.e. from the time they first appeared above the surface of the ocean until the beginning of the Holocene. In order to achieve this, detailed stratigraphic profiles of vertical exposures at different localities will be recorded and correlated on the basis of field observations, petrology, geochemistry of lavas and K-Ar dating. It is intended that the results will be compared with those of other islands in the Southern Indian Ocean and thus contribute to a better understanding of plate tectonics between Africa and Antarctica.

Key questions include the following:

(1) Did the grey lavas flow out on the surface or were they submarine, subglacial or intrusive in stead of extrusive?
(2) Are the interbedded sedimentary layers pyroclastic, glacial, fluvioglacial or colluvial in origin?
(3) What is the number of lava flows, what are their ages and what is the rate of extrusion?
(4) What petrological and geochemical differences exist between different lava flows in vertical succession?
(5) What inferences can be drawn from the composition of the lavas regarding magmatic evolution and mantle conditions?
(6) Did glacial and volcanic episodes alternate or were they contemporaneous?
(7) Is the Pleistocene succession divided into tectonic blocks and if so, what are the absolute and relative displacements along the faults?

(8) What structural control (local or regional) is revealed by the orientation of dykes and faults?

(9) What relationship exists between the two neighbouring islands and what can be inferred about the magmatic chambers that existed at depth?

(10) What effects did the world-wide climatic changes during the Upper Pleistocene have on deposition, erosion, height of sea level and loading of the crust at Marion and Prince Edward?

2. HISTORY OF THE PROJECT

The project was approved for commencement in April 1982 but could only be started after the appointment of Dr. Chevallier in February 1983.

It may be considered a continuation of the pioneering studies by the 1965/66 Van Zinderen Bakker expedition in which Verwoerd and Langenegger provided the topographic and volcanologic base for all later geological work on the islands. They recognised a clear distinction between the products of two main periods of volcanism called the Older and Younger successions respectively. Geochronological (K-Ar) work by McDougall categorized the former as Upper Pleistocene and the latter as Holocene. Subsequently Hall studied aspects of the glacial geology on Marion in considerable detail. After an interval of 15 years, renewed interest in the volcanology of Marion was stimulated by the discovery of an unexpected volcanic eruption at Kaalkoppie between February and September 1980.

This event was investigated ad hoc at the request of the C.S.I.R. by a six-man team of geologists led by Prof. Verwoerd during April 1981, and created sufficient enthusiasm for the formulation of a new set of research proposals of which the present project is the first.

3. SCIENTIFIC PROGRESS

This report summarizes approximately four weeks of field work by by Prof. Verwoerd and dr. Chevallier during the April - May 1983 relief expedition. The reasonably favourable weather and excellent helicopter support enabled an ambitious sampling programme on Marion

and an instructive reconnaissance of Prince Edward Island to be carried out. Scientific photography was unfortunately less successful. During February - March and June 1983 Dr. Chevallier was fully occupied at Stellenbosch with project-related studies.

Conclusions that are presented below and in the accompanying text figures are subject to revision pending the results of further field observations and geochronology.

3.1 Stratigraphy

Important cliff sections along the west and south coasts of Marion island (Triegaardt Bay, Swartkop, Goodhope Bay) and in the Santa Rosa Valley were studied, as well as on Prince Edward Island. Tentative correlations are shown on Fig. 1. Two angular unconformities within the older (Pleistocene) succession are interpreted as former coastal escarpments. They enable a threefold subdivision to be made, in descending stratigraphic order as follows:

Unit 3 is composed of thick (4 - 15 m) grey flows constituting a lava cap that covered the two islands before the onset of the Würm glaciation. This also caps the exposures on the north coast of Marion (Macaroni Bay, Ship's Cove and Long Ridge). Ages ranging from 276 000 to 105 000 years have been documented for these lavas. The top surface is striated and overlain by Würm age tills and moraines.

Unit 2 consists of numerous thin (1 - 3m) flows interbedded with phreatomagmatic pyroclastites resulting from the proximity of the palaeo-coastline, and occurring mainly at the base of the succession. Sills are intruded into this unit but it is uncertain whether they belong to Unit 2 or Unit 3 in time.

Unit 1 is composed of massive lava flows (4 - 5 m) but at the south end of Triegaardt Bay a detrital deposit 10 m thick leads to the recognition of a very old erosive period. This deposit is made of 6 similar units of unsorted material, sometimes coarsely bedded, separated by thin layers of fine-grained sediment, locally folded. There is no striated pavement underneath. These characteristics may point to a fluvioglacial wash-out origin, belonging to an early(?)

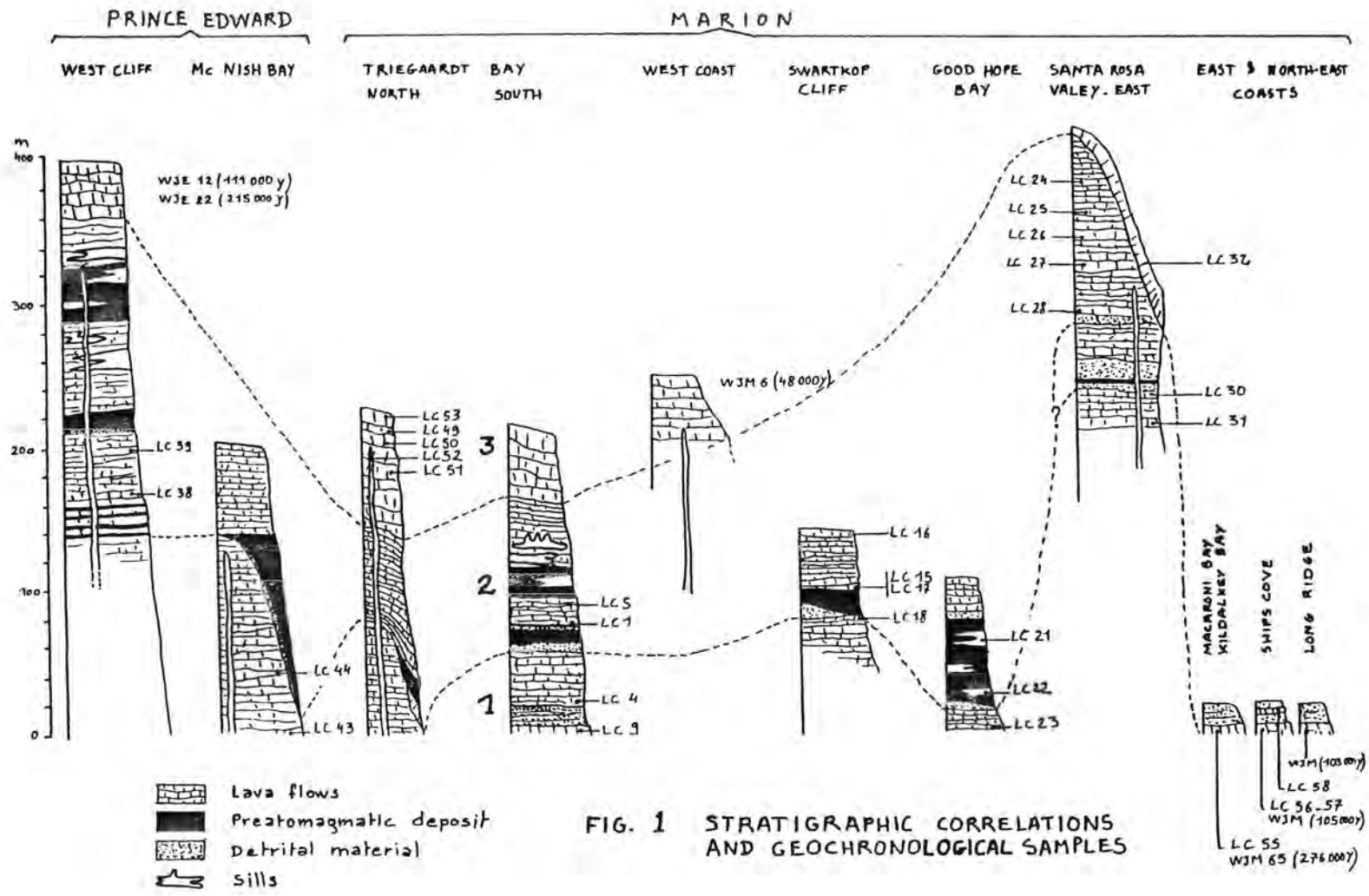

FIG. 1 STRATIGRAPHIC CORRELATIONS AND GEOCHRONOLOGICAL SAMPLES

Pleistocene glacial period.

There are also detrital deposits at higher stratigraphic levels at Swartkop Cliff, Good Hope Bay and Santa Rosa Valley. The latter has torrential (fan?) characteristics and is connected with a palaeocliff, a palaeo-coastal plain and phreatomagmatic deposits. A glacial origin appears doubtful in these cases. They can not be correlated with the Würm-age tills of the east and north-east coast.

3.2 Geochronology

Much effort was expended in obtaining unaltered samples of lava from the base, the middle and the top of the three units at each locality and it is hoped that a total of 32 samples will be suitable for K-Ar dating, including a few dykes and sills. Preliminary arrangements have been made with Dr. I. McDougall of Australian National University to undertake the geochronological work on a collaborative basis as in the past.

Unfortunately it was not possible to collect a geochronological sample near sea level at the base of the southern escarpment on Prince Edward Island, which may well represent the oldest stratigraphic level.

3.3 Tectonics

By measuring the orientations of dykes, a radial fracture system has been recognised for the first time on Prince Edward Island. The dykes converge towards the geometric centre of the volcano which appears to be situated northwest of the island, so that 5/6 of the edifice is postulated to be missing (Fig.2).

Collapse in addition to marine erosion must be invoked to explain such a feature. The dykes acted as feeders to the Pleistocene as well as the younger lavas (clearly seen at McNish Bay).

On Marion Island radial fracturing is well established, but preliminary measurements of dyke directions and detailed photo interpretation point towards further refinements of the pattern.

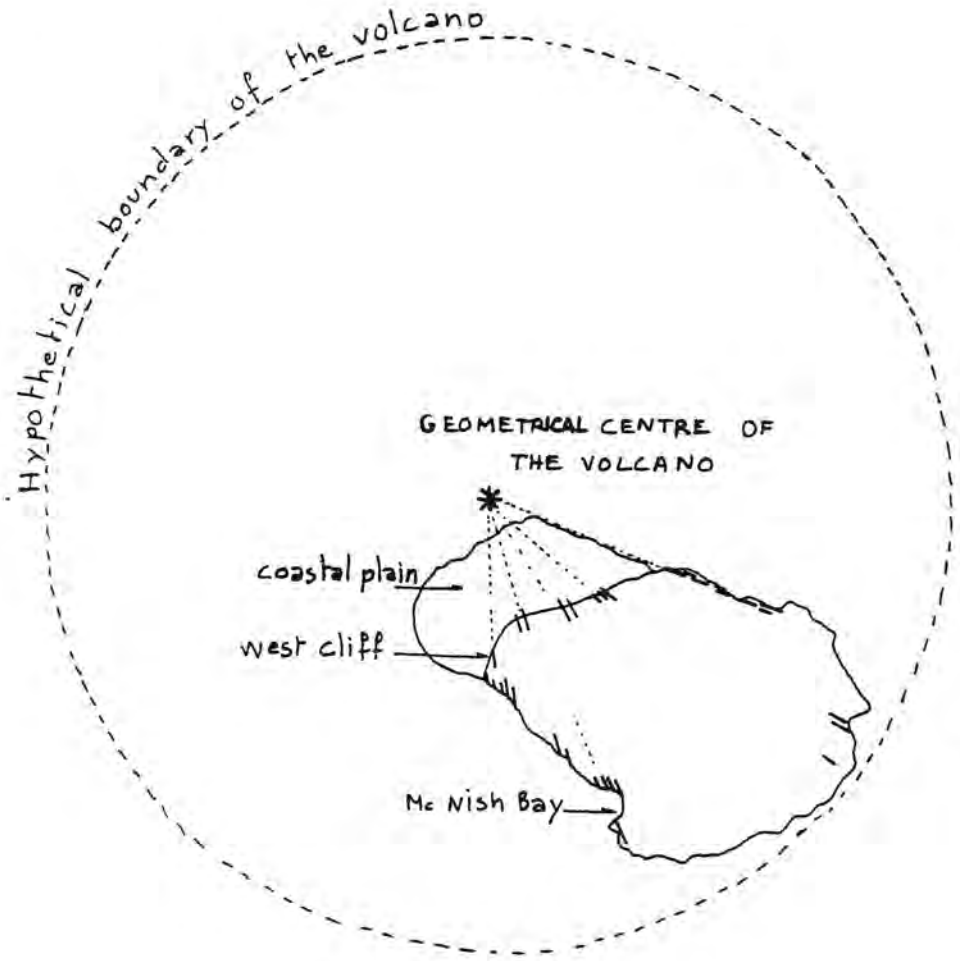

FIG. 2

RADIAL DYKE SYSTEM OF PRINCE EDWARD ISLAND

3.4 Petrology and Geochemistry

This aspect of the lavas was only briefly dealt with in 1965/66. From a preliminary study of the existing collection before departure to Marion it appears that:

1. The lavas belong to an alkalic trend olivine basalt - feldspar= phyric basalt - aphyric basalt - hawaiite.
2. The trend is characterised by a decrease of olivine and pyroxene and an increase of plagioclase.
3. All the lavas have high content (10 - 30%) of opaques (magnetite and ilmenite)
4. Biotite (5 - 10%) is present in the final differentiate (hawaiite).
5. The trend is confirmed by available analyses of major and trace elements, but the feldspar-phyric basalt may be a cumulative phase.

Field observations point towards geographical variations in the Pleistocene lavas (as in the younger ones). This will have implications

for the internal structure of the volcano and location of magmatic chambers. There are also vertical variations reflecting changes of magma composition in time.

New thin sections are in preparation. It is hoped that microprobe analyses will not only reveal compositional variations but will allow estimates of temperature and fO_2.

3.5 Other Observations

1. The relief expedition afforded the opportunity of investigating the spectacular younger phreatomagmatic rings and cones of the two islands in some detail (i.e. Kaalkoppie, Kent Crater, Vaalkop and several newly discovered ones). Sedimentary features like impact structures were found to be exceptionally clear in some instances. An understanding of the relationship between subaquous and aerial volcanic activity on the present-day coastal plains where these pyroclastic landforms occur will contribute greatly to elucidating the origin of similar deposits interbedded with the Pleistocene succession. A separate publication dealing with the phreatomagmatic deposits of Marion and Prince Edward islands is contemplated.

2. The unscheduled stop-over on Gough island enabled one of us (L.C.) to study a linear dyke-swarm, arcuate structures and other features of volcanotectonic significance that have been overlooked in the past. This was followed by photo-interpre= tation and comparison with other oceanic interplate shield volcanoes and may result in a short paper indirectly related to the Marion island project.

   Sampling of the Mt. Rowett cross section was also done for reference purposes.

W.J. VERWOERD
L. CHEVALLIER
30 June 1983

5. OCEANOGRAPHIC SCIENCES

5. OSEANOGRAFIESE WETENSKAPPE

STATUS REPORT, SASCAR OCEANOGRAPHY PROGRAMME

BACKGROUND

The programme had its origins in two developments namely:

- a decision by SANCOR (South African National Committee for Oceanographic Research) in November 1976 that a sub-committee should investigate South African involvement in Southern Ocean research in the light of the fast developing international interest in the region and formulate a suitable research programme;

- an appreciation at the Marion Island symposium in 1978 that the Prince Edward islands' ecosystems could only be studied in full if the research, which until then had largely been limited to onshore work, was extended to include the ocean areas around the islands.

The SANCOR initiative led to the formulation of the SANCOR Southern Ocean Programme, published in 1979 as No 38 in the SANSPR (South African National Scientific Programmes Report) series. The programme was closely linked to the BIOMASS programme, which was being developed internationally by the Group of Specialists on Southern Ocean Ecosystems and their Living Resources (SCAR, SCOR, IABO, ACMRR). In the meantime, SFRI had undertaken a cruise to the Bransfield Strait area on the **SAS Protea** . The result of this cruise, and of a further one **SA Agulhas** in 1980 in which scientists from a number of SCAR countries participated, were very positive and showed that acoustic estimation of krill densities was feasible. This finding was largely instrumental in the adoption of acoustic krill estimation as the major emphasis of FIBEX (First International BIOMASS Experiment) in 1981 in which 13 ships, including **SA Agulhas,** from 10 countries participated.

Other aspects of the SANCOR Southern Ocean Programme included marine chemistry, primary productivity, physical oceanography, detailed studies of the Ross Seal populations off SANAE and studies aimed at establishing the feasibility of using seabirds as indicators of krill abundance. In addition it included a large geoscience component.

The Marion Island developments led to the provisional formulation within SASCAR of a programme of research into the physics, chemistry and productivity of waters around the Prince Edward Islands. Apart from exploratory work on the biology and hydrology of the waters around the islands in 1981 and 1982, and ongoing work on the primary productivity and chemistry of these waters and detailed work in the subtidal and intertidal zones of Marion Island, this programme has, however, not yet been fully implemented.

Concurrent with these developments the Convention of the Conservation of Antarctic Marine Living Resources (CCAMLR) was negotiated within the framework of the Antractic Treaty System and came into force in 1982, bringing with it certain responsibilities for member countries, including South Africa. Finally, within the BIOMASS programme, plans were developed for SIBEX (Second International BIOMASS Experiment) to take place in 1984 and 1985.

Status

Due to organizational difficulties related to the use, for oceanographic purposes, of the **SA Agulhas** it was agreed in 1981 that the Southern Ocean Programme should in future be managed as part of the Antarctic Programme, and the funds which were available for it on the SANCOR budget were transferred to that of SASCAR. In SASCAR the geoscience component was incorporated in the Earth Sciences Programme and it was decided that a new Oceanography Programme would be developed. Subsequently, additional funds for the latter programme have been obtained by SASCAR which means that for 1984/5 an amount of approximately R240 000 should be available.

Those proposing projects for 1984/5 found themselves somewhat at a disadvantage, because as a result of the reorganizations mentioned, no clearly defined South African Southern Ocean programme now exists. This matter was addressed at the meeting of the new SASCAR Subcommittee on Oceanography and it was agreed that such a programme has to be formulated early in 1984 and that it should probably be based on two major components initially:

- work related to BIOMASS
- work in waters around the Prince Edward Islands (Marion Offshore Ecological Study - MOES).

Further components for consideration include studies off the Fimbul Ice Shelf, at frontal zones between Africa and Antarctica, and flowing from CCAMLR membership.

In spite of the lack of an agreed overall programme, South African participation in SIBEX I has been well planned. It will be undertaken off **SA Agulhas** in the Prydz Bay area in March/April 1984 as part of a joint expedition with French, Japanese and Australian vessels. Plans for participation in SIBEX II in early 1985, using **RV Africana** in the same area are also making progress.

Sixteen projects were considered by the SASCAR Subcommittee on Oceanography. Of these, one will be concluded in March 1984, five were ongoing projects and nine were new project proposals. Continued support of the ongoing projects was recommended, as was support of seven of the nine new projects.

Highlights and Findings

A highlight of the year was the Fourth SCAR Symposium on Antarctic Biology, held in Wilderness in Septemner 1983. About 150 delegates from 13 nations, 11 of them being SCAR nations, attended. The theme - "Nutrient Cycles and Food Chains" - allowed for a strong BIOMASS related participation. All participants and prospective participants in the SASCAR Oceanography programme attended and, by all reports, benefited greatly from the contact with their counterparts and colleagues from overseas. The BIOMASS Executive and SIBEX Chief Scientists held business meetings during the symposium, while in the week beforehand a BIOMASS Workshop on Bird Ecology and the SCAR Group of Specialists on Seals held meetings in Wilderness and Pretoria respectively. The Conservation Subcommittee of the SCAR Working Group on Biology also met at Wilderness during the symposium.

The year under review saw the crystallization of South African plans for participation in SIBEX, both nationally at various discussions dealing with the issue and finally internationally at Wilderness as reported above. Our community should be able to maintain the excellent reputation built up in FIBEX.

The prey identification service which has been a requirement for many years, has now been launched by the Port Elizabeth Museum and should soon be geared to providing identification of stomach contents of predators on a routine basis. The service's first priority is to work on material provided by Antarctic bird and seal projects, but it is envisaged that as it develops it will also be able to provide assistance nearer home, to the Benguela Ecology Programme for example.

The project "Species Diversity and Trophic Relationships of the Marine Avifauna in Prescribed Sectors of the Southern Ocean" finishes in March 1984 when a final report will be submitted. The results would seem to lend weight to the value of seabirds as indicators of the presence and abundance of potential prey in the areas studied.

The other project which was completed at the end of 1982 and for which a final report was available is that on "Marine Chemistry of the Southern Ocean". It has demonstrated that trace elements can be used as tracers in the study of both physical and geochemical processes and has set the scene for a follow-up project which is more specifically aimed at chemical processes at the sediment-bottom water interface in the Weddell-Enderby basin.

Shortcomings and Prospects

The most serious shortcoming at this stage is the lack of an agreed framework for a South African Southern Ocean programme. The matter is receiving attention but I am not convinced that it can be produced as easily as was foreseen at the meeting of the SASCAR Subcommittee. The reason for my doubts is that there are currently so many imponderables associated with Southern Ocean research. Firstly, the future development of the BIOMASS programme internationally is not clear. Nominally, the programme is scheduled to end in 1986 - after SIBEX I & II. At this stage it is unclear whether the research requirements flowing from CCAMLR will be managed directly by the CCAMLR Scientific Committee, or whether a non-governmental arrangement like BIOMASS will be preferred. There does seem to be a feeling in CCAMLR that it should not itself try to arrange the kind of multi-ship exercises which BIOMASS has so successfully undertaken.

The second uncertainty results from CCAMLR itself. The Commission and Scientific Committee have no clear thoughts yet on how they should go about managing the marine resources of Antarctica on an ecosystems basis, as prescribed by the Convention. It can be expected that as their thinking develops specific research requirements will be identified, which CCAMLR members will have to consider addressing. The issue also has to be resolved as to how South African scientific effort is to be mobilized to take care of our CCAMLR responsibilities (for which the SFRI is the responsible technical body), and our SCAR responsibilities (with SASCAR responsible for advice to the Department of Transport).

Thirdly, the position of whale research (within the Antarctic programme) has to be resolved and finally it is still unclear what work may have to be done should South Africa become a party to the Law of the Sea and the Prince Edward Islands thus acquire an Exclusive Economic Zone.

Only when the decisions on the above questions are available can a meaningful programme be developed.

Another major problem facing our research in the Southern Ocean is the provision and maintenance of multi-user research equipment on the **SA Agulhas.** Various alternatives have been tried to date but none really successfully. The required equipment is becoming more and more sophisticated and expensive, and a satisfactory arrangement will have to be found.

Finally, more attention has to be paid to the working up of results. Good progress was made recently as evidenced by the twelve papers presented at the Wilderness Symposium. However, the FIBEX data for example have not been fully analysed and interpreted. I accept that this is tied up with uncertainties in BIOMASS internationally, and that these uncertainties also hold up decisions on how SIBEX data will be presented and worked up. At least for our own purposes we should, however, agree on how we are going to present, work up and publish our SIBEX (and FIBEX) findings. Some discussion in this regard re the SIBEX data have taken place and these need to be carried further, initially in the form of local, South African SIBEX workshops.

The above may create a somewhat sombre or at least unclear picture. I am convinced that we have the will and resources to make very important contributions to knowledge about the Southern Ocean. We are very well situated geographically, we have two good research vessels and we have the necessary scientific expertise and enthusiasm. Finally, we have very good relations with most of the countries researching the Southern Ocean and opportunities for collaborative research are excellent.

O A VAN DER WESTHUYSEN
November 1983

PROJECT TITLE: SPECIES DIVERSITY AND TROPHIC RELATIONSHIPS OF THE MARINE AVIFAUNA IN PRESCRIBED SECTORS OF THE SOUTHERN OCEAN

Project Leaders W.R. Siegfried & J. Cooper.
FitzPatrick Institute, University of Cape Town.

Project Researchers: R.W. Abrams, J.W. Enticott and A.M. Griffiths, FitzPatrick Institute, University of Cape Town.

Date: Fifth interim progress report, July 1982 - June 1983, submitted in June 1982. The first four interim progress reports were submitted to SANCOR and appear in "Progress Reports to SANCOR" for the years 1979-1982.

1. Objectives

(a) To determine the taxonomic, numerical and trophic make-up of seabird communities in prescribed sectors of the Southern Ocean.

(b) To relate community structure and seabird abundance in the Southern Ocean to biotic and physical parameters, and so to attempt to correlate seabird communities with peculiar oceanic biotopes.

(c) To determine the food requirements of selected seabirds in the Southern Ocean, and their impact on prey populations.

2. History of Project

The SCAR/SCOR BIOMASS research programme is aimed at obtaining a deeper understanding of the structure and functioning of the Southern Ocean ecosystem, as a basis for future management of living resources. Seabirds are top consumers in the ecosystem. This project deals mainly with petrels and albatrosses at sea, primarily in the area 30° to 70° and 10° W to 40° E. By dovetailing this project with land-based studies at Marion Island and elsewhere, it is intended to investigate the suitability of using petrels and albatrosses as indicators of

ecological conditions (including potential changes) in the Southern Ocean. Project planning began in January 1979. The first phase of data collecting commenced in April 1979 and ended in April 1980. The second phase (May 1980 - April 1981) of data collecting included an expansion into the southeast Atlantic, to test theories and methods which could be useful in the Southern Ocean proper.

During the period April 1979 to April 1981, 865 hours of observations were made on 12 cruises of the M.V. S.A. Agulhas in the Southern Ocean. From May 1980 to April 1981, 132 hours of observations were made in the southeast Atlantic from trawlers and other boats. During July 1981 to June 1982, a total of 174 hours of observations was made on four cruises of the M.V. S.A. Agulhas

3. Scientific Progress

Data from three cruises of the M.V. S.A. Agulhas and one cruise of the R.V. Africana in the Southern Ocean representing 275 hours of observations using the BIOMASS 10-minute card system have been added to those of 16 cruises conducted prior to April 1982. The combined data set now represents 1 314 hours of systematic observations of seabirds at sea from a total of 20 cruises over four years.

Objective a.

The combined data set, spanning four years, has now been coded for computer analysis and the four years are being compared to assess consistency of the seabird community structure. Preliminary analyses suggest that patterns of variation have remained reasonably consistent, with some year-to-year variation in seabird abundance. Plankton-eaters, the most abundant birds in all years, contributed less to total biomass than the larger cephalopod-eaters (such as albatrosses).

Preliminary data collected on ship-following by wandering albatrosses suggest that the duration of following can be used to estimate population size. This technique is restricted to

the large and less abundant species which can be individually recognized.

Data collected on the distribution and abundance of Southern Ocean species of seabirds in the southeast Atlantic, particularly on the southern African trawling grounds, strongly suggest that certain species, especially the larger species which scavenge from demersal trawlers, have increased in abundance over the last 30 years. There has been an increase in the proportion of squid- and plankton-eating species, relative to primarily fish-eating southern African breeding species (chiefly cormorants and the Cape gannet). Current stimates of seabird biomass in the southeast Atlantic between Cape Point and St. Helena Bay give $1,9X10^{6}$ and $1,0X10^{6}$ kg of squid- and fish-eating birds, respectively. This represents an eight-fold increase in biomass over 30 years.

Thus, while the African sector of the Southern Ocean has shown little variation in the taxonomy of seabird communities and in their numerical, biomass and trophic make-up, the southeast Atlantic region has historically shown large changes in these attributes due to the presence of a demersal trawling industry which has increased (in terms of landed catches) approximately five-fold since the 1950's.

Objective b.

The lack of variation over four years in the distribution of seabirds in the African sector of the Southern Ocean suggests that seabirds are correlated broadly with particular oceanic biotopes. The use of non-linear regression techniques indicates that relatively small-scale oceanographic events (both in space and time) are important influences on the spatial structure of the seabird community. Seasonal variation in the proportion of Southern Ocean seabirds attending trawlers in the southeast Atlantic suggests that when natural prey is available the birds are dispersed more than at times of low prey availability when the birds are clumped at trawlers. This variation appears to

be related to seasonal changes in the intensity of upwelling with which, in turn, natural prey availability is strongly correlated.

Previous efforts to model seabird-abiotic factor associations have met with difficulty in resolving the scatio-temporal scale at which seabirds function at sea. Non-linear regression techniques and data from the southeast Atlantic now strongly suggest the need for finer-scale studies of seabird distribution in the African sector of the Southern Ocean than has so far been attempted. The SOPS computer program developed earlier (see the 1982 SANCOR Progress Report on this project) is being used to resolve these finer scale patterns of seabird-habitat assocations. Water-mass characteristics and weather patterns significantly influence seabird distribution. The presence of newly discovered additional oceanic fronts and zones of surface-water mixing in the African sector of the Southern Ocean means that the influence of fine-scale oceanographic events on seabirds may be more important than macroscale features. Wind stress over the sea surface also creates small-scale events with which seabirds associate.

Analyses are now concentrating on converting a descriptive model of seabird habitat associations into a deterministic model which may be used to predict prey concentrations, on a basis of seabird-oceanic front associations.

Objective c.

During four cruises in the Southern Ocean during 1982-83 much effort was put into observing foraging behaviour of seabirds at sea. As in previous years, few data were gathered on cruises beween Marion and Gough Islands. However, on the SANAE cruise (December 1982-January 1983; V27) active feeding of seabirds was observed on numerous occasions for a total of 27 species, especially in the Weddell Sea region. Preliminary analyses of the results show that surface-seizing (recorded in 13 species) was the most frequently observed foraging technique. Pattering

was observed in four species of stormpetrels, and plunge-diving and pursuit-diving in five and four species, respectively.

Feeding associations with whales have been recorded for Antarctic petrels and Wilson's stormpetrels. The collection of data on the foraging behaviour of Southern Ocean seabirds is being expanded to include dive-time, depth, distance travelled under water, and number of prey captures per dive. This aspect of the project commenced in April 1983 and results are not yet available.

Diets of four species of penguins at Marion Island and that of the chinstrap penguin at Bouvet Island have been studied by non-destructive techniques, using a modified enema pump. Breeding chinstrap penguins at Bouvet Island were eating mainly krill Euphausia superba with fish forming a minor proportion of the diet, in December 1982. Preliminary analyses of penguin diets at Marion Island show that crustaceans, squid and fish are all taken, but in different proportions for each species. The diets of Antarctic and snow petrels are very variable, consisting of fish, crustaceans and cephalopods. The presence of a large proportion of single prey items in the stomachs of these birds suggests opportunistic feeding strategies and a lack of diet specialization.

An attempt has been made to relate group-size of seabirds at sea to methods of food location. It was found that the smallest and largest species occurred in the smallest groups, whilst medium-sized species formed the largest groups. The abundant prions and blue petrels showed the greatest seasonal differences, occurring in much larger groups during their breeding phases. Excepting prions, group-size variation with time of day did not show distinctly interpretable trends. Study of the impact of seabirds on prey populations in the African Sector of the Southern Ocean has concentrated on data collected in the African sector of FIBEX (first international BIOMASS experiment). Approximately 400t (representing 4 birds km^{-2}) of seabirds were planktivores and 87t (0,3 birds km^{-2}) were mixed-feeders.

Assuming that krill comprised 100% of the diet of planktivores and 50% of the diet of mixed-feeders within the FIBEX sector, the daily energy requirements are 396kJ $bird^{-1}$ day^{-1} and 806kJ $bird^{-1}$ day^{-1}, respectively. With a food assimilation efficiency of 80%, daily krill consumption (based on an energetic content of 4,51kJ g^{-1}) is estimated to be 488,6g km^{-2}. This corresponds to $3X10^{2}$ t d^{-1} or $3X10^{4}$ t yr^{-1}, assuming a 100-day feeding period for all krill-eaters over the whole 620 000 km^{2} of the FIBEX sector. These calculations do not include penguins, which were not censused during FIBEX. This level of prey consumption is small, given a standing stock of $1X10^{6}$ t krill and an annual production of $1,8X10^{6}$ t. However, pelagic seabirds are episodic feeders and their distribution was not uniform in the FIBEX sector. Large flocks of planktivorous birds occurred in a narrow latitudinal band. Thus, their impact on prey poplations (in this case krill) could be much more significant in specific areas. This lends weight to the value of seabirds as indicators of the presence and abundance of potential prey in the African sector of the Southern Ocean.

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PROGRESS REPORT TO SASCAR FOR 1983

Title:

An investigation of the distribution and production of plankton in the seas around the Prince Edward Islands.

Professor B R Allanson and Mr L D Parker
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6140 Grahamstown.

Since the last progress report to SANCOR, two voyages to the Prince Edward Islands were undertaken by this group, these were;

(i) V003 of R.S. Africana (September, 1982)

(ii) V20 of S.A. Agulhas (April/May, 1983).

Unfortunately the cruise of R.S.Africanawas dogged by bad weather but a grid of stations was occupied the results of which are to be published later this year.

The Voyage of S.A. Agulhas was very successful and though the results have not been fully anlysed yet, like the April/May (1982) cruise, the effect of run-off from the islands was demonstrated. In addition, a stable thermocline was observed on both these voyages and it was absent during the Africana survey. These seemingly conflictive data sets could be due to the influence of external forces, namely eddies from either the Subantarctic or Antarctic points passing close to and/or decyaing in the vicinity of the islands.

It has also been suggested that the low zooplankton biomass observed in this area is indictative not of an unproductive ecosystem but of a productive system that is suffering from severe grazing pressures. This is indicated by the predator based zooplankton community. If this is the case, then it is expected that the herbivore biomass would be very low. This suggestion is partially substantiated by the chlorophyll a concentrations which are more similar to those of the productive frontal regions (0.9 mg pigment/m^3) than the open sea (0.3 mg pigment/m^3).

Professor Allanson has obtained funds from the Anglo-American Chairman's Fund to appoint Dr Brian Boden for a year beginning July 1 to the team to provide the all important input of specialised knowledge of zooplankton structure. This association will go a long way towards providing training in the area of zooplankton taxonomy which is so essential in this investigation.

Presentations arising from this project thus far are:

(i) A poster presented at the Joint Oceanographic Assembly in Halifax (Parker, L D & B R Allanson, August, 1982).

(ii) A poster presented at the 5th National Oceanographic Symposium in Grahamstown (Parker, L D & B R Allanson, January, 1983).

(iii) A paper to be published in Polar Biology later this year (Miller, D, B Boden and L D Parker).

In addition, a paper was presented at the 5th National Oceanographic Symposium based on ancillary cruises of S A Agulhas (Allanson, B R & L D Parker, January 1983).

CENTRAL DATA BANK (CDB) FOR CO-ORDINATION OF ANTARCTIC BIRD BANDING

PROGRESS REPORT JANUARY 1983 - MAY 1983

The only progress which can be reported at this stage is that letters requesting submission of primary banding data for the 1982/1983 Antarctic summer season have been sent to all participating schemes. To date, replies and schedules have been received from Australia and Great Britain. The U.S.A. has acknowledged receipt of the request and indicated that a tape copy of their data will probably be ready in August. It may be much longer before data from some other schemes is submitted because they seem to be running years late with assembling all schedules for a particular season, and the logistics of Antarctic Research tend to aggravate delays.

From schedules already received it is evident that there is considerable diversity in the nature of complementary data collected, and data capture needs to be delayed until a reasonable cross-section of national scheme schedules have been received and the range of data to be captured becomes evident.

W R SIEGFRIED &
T B OATLEY

FINAL REPORT - DECEMBER 1982

SOUTHERN OCEAN MARINE CHEMISTRY PROJECT

Project Leaders: Assoc. Prof. M.J. Orren
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University of Cape Town

Mr. P.M.S. Monteiro
Department of Oceanography
University of Cape Town

Keywords: Southern Ocean, chemistry, trace metals

Background:

The project began in December, 1978. Preparations for sampling were completed by June, 1979, and a trial cruise undertaken aboard "SA Agulhas" later in the year. The first deep-sea cruise was Cruise 12 (Feb/April 1980) followed by cruise 14 (May/June 1980, Marion Relief) and cruise 18 (Feb./March, 1981, FIBEX).

The objectives of the project were:

(1) To study the distribution of selected elements (mainly trace elements) in the Southern Ocean by means of the analysis of seawater, particulate matter, plankton and sediments.

(2) To provide limited support for other projects undertaken in the Antarctic area, which are generally not concerned with chemistry but which on occasions call for specialized knowledge of geochemical/oceanographic techniques of sampling, analysis and interpretation.

Mr (now Dr.) J.W. Marchant resigned in February 1981 and the project was severely set back since he had then reached the stage where he could provide a competent and adequate scientific input. Since Dr. Orren had moved from NRIO to the University in mid-1980, he could not devote as much time to the project as formerly. Mr. Monteiro joined in January, 1981, and training at sea and in the laboratory was necessary before he was able to make significant contributions to the project. The provision of an assistant post in 1982 has greatly accelerated the working-up of the data. Further details of the background to this project appears in the SANCOR Annual Report series. One major difficulty has been that the main thrust of all the cruises so far was directed to priorities other than chemistry and the siting of stations had to fit in with other projects, such as the biologically dominated krill and FIBEX programmes. This led to a compromise situation and the station pattern was far from ideal from a purely chemical viewpoint, giving rise to difficulties in interpretation. Cruise 18 was further disrupted by a problem on Marion Island which led to the

diversion of the vessel from its original cruise plan. The conflict between the transport and supply functions of the "SA Agulhas" and the scientific work aboard causes difficulties, but these are common to most nations operating in the Southern Ocean.

Methods:

Standard oceanographic methods were used for the determination of temperature, salinity, (discrete sampling and the use of CTD), dissolved oxygen, phosphate, nitrate and silicate in the water column. Procedures for the trace metals copper, zinc and cadmium have been published (P.M.S. Monteiro, MSc thesis, University of Cape Town, 1982) and similar methods were used to determine iron, manganese, cobalt and nickel. In summary, solvent-extraction pre-concentration followed by graphite furnace atomic absorption determination was used. The problem of trace metal contamination was very serious and considerable precautions were taken both at sea and in the laboratory to minimise contamination. (For fuller details, see Monteiro, 1982, op. cit.)

Findings:

Overall, the project has achieved its objectives in that baseline distributions of T, S, O, nutrients and trace metals have been established in the water column in the sector of the Southern Ocean south of South Africa. Station and laboratory time did not permit extension to sampling and analysis of particulates and sediment. The second objective was achieved in that extensive support was given to the biological oceanographers by assisting with CTD, XBT, submerged fluorimetry and primary production studies. In our belief, this input has led to a greater emphasis being placed on physical/chemical studies in SIBEX, the follow-up to the two FIBEX/BIOMASS cruises. In Cruise 14, support was given to Dr. Lutjeharm's project in the Marion Island Area. A brief summary of the findings follows.

Physical observations from cruise 12 were outlined in the 1980 SANCOR Annual Report. Dissolved oxygen sections clearly showed the sinking of well-oxygenated water north of the Antarctic Convergence and the uplift of Deep Water with levels of 4,0 to 4,5 ml O_2 dm^{-3},

The Circumpolar Water had rather uniform oxygen concentrations (4.25 to 4.50 ml $O_2 dm^{-3}$) below the well-oxygenated (about 7 ml $O_2 dm^{-3}$) surface layers. The similar nitrate and phosphate sections showed the expected distributions, except that phosphate-rich (over 3.4 µmol dm^{-3}) water lay just below the surface water (100 to 300 m) at about 58°S. Salinity and oxygen were very constant with depth in this region. Silicate sections showed a dramatic increase in concentration southwards. An enriched layer (over 100 µmol Si dm^{-3}) was at 500-1000 m in the 58°S region, laying just below the P maximum mentioned above. Preliminary investigation suggests the observed distribution may be caused by the effect of the eastern extension of the Weddell Gyre.

Since almost no trace element data was available from this region, interpretation of the data has proved unexpectedly difficult and is continuing. Some high values obtained may be due to contamination but at present, insufficient evidence exists to reject these on a rational basis. Comparison with Cruise 18 data is being used to assist interpretation.

Cruise 12 was the first in which "SA Agulhas" had been used for extended deep-sea physical /chemical oceanographic sampling, and since it was thus to some extent a "shake-down" cruise, the results were considered satisfactory, demonstrating the ability of the vessel to operate successfully on scientific missions.

Cruise 18 data have been worked up to the stage of final preparation of manuscripts for publication. Some summarized findings follow, emphasizing trace metal distribution.

The results show that the distribution of trace metals cannot be viewed in terms of a simple one dimensional input - output model since both physical and chemical processes interact closely to regulate the observed distribution. Horizontal advection of water masses and, directly, input from the abyssal siliceous sediments were the most important processes affecting the distribution. The physical data confirmed current ideas on the hydrodynamics of the Southern Ocean and were useful as a tool providing a framework for the interpretation of the trace metal distribution.

The following conclusions were established for the geochemistry of copper, zinc and cadmium:

1. Both zinc and cadmium showed a meridional enrichment in surface waters towards the south compared to subtropical waters.

2. Copper showed a variability in the water column that could be related to a given stratum. Thus, it was found that Circumpolar Deep Water was relatively depleted in Cu (1.5-2.0 nmol kg^{-1}) contrary to the expectation that copper follows nutrient systematics. This creates the potential of water mass typeing using their copper content provided the analytical accuracy and precision index is high.

3. Even though the concentration ranges are within the accepted limits for oceanic waters, there is little indication of the metal systematics being the same as those of the nutrients. This may be a result of the low production levels in this region whereby the vertical biogenous particulate flux is of secondary importance.

4. The Cu/Si ratio was found to be a very useful parameter to infer the input of copper from interstitial water into bottom water. It was found that the siliceous sediments of the Enderby Basin are a source of Cu from the observed increase of the Cu/Si ratio with an increase in silicate content of Antarctic Bottom Water.

5. The vertical distribution of zinc and cadmium in deep water showed little variation, thus it is unlikely that the bottom sediments are a significant source of these elements. The upper part of the water column at the main subsurface metal gradient, showed that advection played an important role in determining

Publications

Monteiro, P.M.S. (1982) The distribution of Cu, Zn and Cd in the Southern Ocean south of South Africa. (MSc thesis, University of Cape Town).

Data are on file in the UCT Computer Centre and will be transferred to SADCO as soon as certain corrections are incorporated in Cruise 12 data.

Project Staff.

Assoc. Prof. M.J. Orren, Department of Analytical Science, UCT (1978 to date)
Dr. J.W. Marchant, Department of Oceanography, UCT (1978-1981)
Mr P.M.S. Monteiro, Department of Oceanography, UCT (1981 to date)
Mrs H. Salmon, Department of Oceanography, UCT (1982)

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Department of Geochemistry and Analytical Science, UCT, for making laboratory space and analytical instrumentation available.

The South African National Committee for Oceanographic Research for support and generous funding of the project.

PROJECT TITLE: Prey Identification Service

PROJECT LEADER: G.J.B. Ross,
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P.O. Box 13147,
Humewood 6013.

DATE: First interim report, June 1982

PROJECT RESEARCHER: N. Klages,
Port Elizabeth Museum
(from September 1983)

OBJECTIVES

(a) To assemble reference collections of potential prey species (or parts thereof) of top predators in selected sectors of the Southern Ocean, and use these collections.

(b) To identify stomach contents of predators to the lowest possible taxon, with particular reference to the prey of seals and seabirds in the seas around the Prince Edward Islands and SANAE.

PROJECT BACKGROUND

The need for such an identification service arose from two SASCAR programmes presently underway. They are "Species diversity and trophic relationships of the marine avifauna in prescribed sectors of the Southern Ocean" (PFIAO) and "Population biology and feeding ecology of the Ross Seal Ommatophoca rossi" (MRI), which require prey identifications to fulfil their objectives.

The functions of the Prey Identification Service reflect primarily the objectives of its users, that is to identify and where possible quantify the prey organisms of selected top predators in order to gain a better understanding of food web structure and ultimately energy flow through these ecosystems.

PROGRESS

In its initial stage, the project has progressed very little, owing to difficulties in appointing a suitable researcher to the project. However, the appointment of Dr. Norbert Klages from September 1983 should put the project into motion properly.

In the interim, contact has been maintained with workers locally and overseas who had indicated they could supply or loan reference material to the project. Material received to date includes myctophid otoliths (ex Dr. Hulley, S.A. Museum) and squids from Amsterdam Island (ex Dr. Bester, MRI). The collections of otoliths being assembled by Dr. Hecht (JLB Smith Institute) for production of an otolith atlas will also be a valuable addition to the available reference material.

6. ATMOSPHERIC SCIENCES BIBLIOGRAPHY

6. ATMOSFERIESE WETENSKAPPE-BIBLIOGRAFIE

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GUIDELINES FOR THE PREPARATION OF

PROGRESS REPORTS

TO

SASCAR COMMITTEES

GUIDELINES FOR THE PREPARATION OF INTERIM PROGRESS REPORTS AND FINAL PROJECT REPORTS TO SASCAR AND ITS SUB-COMMITTEES

Reports to be included in the Volumes of PROGRESS REPORTS TO SASCAR will be photocopied directly from those submitted to CSP. These guidelines have therefore been drawn up in the hope of introducing a degree of standardization to the format of reports contained in these volumes.

SASCAR has approved a system which has a direct bearing on the submission of NP 10 forms and Progress Reports. It is as follows:

1. Project Proposals - all on the CSP NP 10 form, to reach CSP by 30 June each year through normal routes.

2. First Project Report - in the case of new projects being funded for the first time from 1 April, the first report which is due by 30 June the same year will take the form of a full description of the project, its rationale (also indicating how the project fits into the objectives of the relevant component of the National Antarctic Programme), the anticipated manpower requirements and fieldwork schedule over the entire duration of the project and the review of literature. Authors will be able to use this report to expand on what could be accommodated in the original NP 10 form. For guidance, this report can be divided into sections similar to those on the NP 10 form, but the layout is generally flexible and authors may exercise their own discretion. The report should, however, be confined to 10 pages or less and on the front page, authors must include the project details as indicated in the guidelines for Interim Progress Reports below.

3. Final Project Report - not later than two months before the cessation of funds (e.g. by 31 January for 31 March) for a project, a Final Project Report will be required.

   Please limit your Final Project Report to:

   - an introduction (1-2 pages)
   - the key questions and a summary of the answers to them (about 1-2 pages per key question), making reference to publications that have come out or are coming out of the study where relevant (i.e. an overall synthesis)
   - a conclusion which focuses on the directions in which future research should be aimed (2-3 pages)
   - a list of all publications (published, in press and in preparation) arising from the project (do not attach copies of the actual publications).

   Theses are not acceptable as Final Project Reports. The general policy in this respect is that a project is not completed until the results are in press or published, and theses and internal reports do not meet these requirements.

4. Interim and Final Interim Progress Reports - interim progress reports are to be submitted along with annual follow-up project proposals (NP 10 forms), throughout the duration of the project. In the case of a project in its last year of funding, a final interim progress report is required by 30 June of the last year, even though a follow-up NP 10 form for the project is not being submitted.

The guidelines for the preparation of Interim Progress Reports are given below.

The Report should be first identified as follows:

Project Title (in capitals)	-	as given on the NP 10 forms
Project Leader(s)	-	name(s) and address(es)
Project Researcher(s)	-	name(s) and address(es)
Date	-	the report should be dated (e.g. third interim progress report, July 1982 - June 1983)

and then continued on the front page under the following headings:

1.	Objectives	-	referring to the objectives as stated in the previous NP 10 form. Changes in original objectives and/or key questions should be stated and the reasons for this given.
2.	History of Project	-	referring briefly to scientific progress made in the project since its implementation, so that section 3 below can be read in context with the First Project Report.
3.	Scientific Progress	-	made during the year under consideration, with particular emphasis on specific scientific findings and/or achievements, such as answers to key questions given in the previous or original NP 10 form. This section should be confined to approximately four typed pages.
4.	Acknowledgements	-	only if necessary and should then be made only for assistance outside the normal duties of the parties concerned.
5.	Publications	-	list separately: (i) those published, (ii) those accepted (i.e. in press and not in preparation) for publication, and (iii) relevant internal reports which are likely to remain unpublished. Listings under these sub-headings should include only those published or in press since the previous Interim Progress Report was submitted, and only those which have originated directly from the work being funded by SASCAR

Please type in 1½ spacing on one side of A4 pages. As these reports will not be edited or retyped, please make sure that clean original copy is submitted, so that it can be photocopied as is. Reports may be submitted in English or Afrikaans.

Although we have requested the body of the Interim Progress Report (i.e. scientific progress made during the year under consideration) to be limited usually to four typed pages, researchers may if they wish increase this to not more than 10 pages. However, in this event please note that the emphasis throughout must be placed on scientific progress and not matters related to logistical aspects.

Attention is drawn to the fact that progress reports are key documents in support of the continued funding of a project. Proper care and attention should be given to their production.

If, for reasons beyond the researchers control, logistical and/or equipment problems prevented any scientific progress from being made in the year under review, an "Activity" Report explaining these matters and what was done about them may be added as an addendum to the Progress Report. Please take care that such a report does not degenerate into a protracted enumeration of general complaints. The main purpose of this publication is the recording of annual scientific progress in the National Antarctic Programme.

Thank you for your cooperation.

RIGLYNE BY DIE VOORBEREIDING VAN

VORDERINGSVERSLAE

AAN

WKAN-KOMITEES

RIGLYNE BY DIE VOORBEREIDING VAN TUSSENTYDSE VORDERINGSVERSLAE EN FINALE PROJEKVERSLAE AAN WKAN EN DIE SUBKOMITEES

Verslae wat in die bundel VORDERINGSVERSLAE AAN WKAN ingesluit word, sal direkte fotostatiese afdrukke wees van verslae wat aan KWP gestuur word. Hierdie riglyne is dus saamgestel met die oog op standaardisering van die formaat van verslae wat in hierdie volumes gebind word.

'n Sisteem, wat direkte betrekking het op die indiening van NP 10-vorms en vorderingsverslae, is deur WKAN goedgekeur. Dit is as volg:

1. Projekvoorstelle - elk op die KWP NP 10-vorm, om KWP deur die normale kanale teen 30 Junie elke jaar te bereik.

2. Eerste Projekverslag - in die geval van nuwe projekte wat vir die eerste keer vanaf 1 April fondse ontvang, moet die eerste verslag wat teen 30 Junie van die betrokke jaar ingedien moet word, die volgende behels: 'n Volledige beskrywing van die projek; logiese motivering (waarin ook aangedui word hoe die projek inpas by die doelstellings van die betrokke komponent van die Nasionale Antarktiese Program); die verwagte mannekragbehoeftes en veldwerkskedule gesien oor die algehele duur van die projek en 'n literatuuroorsig. Opstellers kan in hierdie verslag uitbrei op punte wat in die oorspronklike NP 10-vorm ingesluit kon word. Die verslag kan ingedeel word om ooreen te stem met die afdelings van die NP 10-vorm alhoewel die formaat oor die algemeen buigbaar is en aan die opsteller se diskressie oorgelaat word. Hierdie verslag moet egter beperk word tot 'n maksimum van 10 bladsye en op die voorblad moet projekbesonderhede verskyn soon hieronder voorgeskryf vir tussentydse vorderingsverslae.

3. Finale Projekverslag - moet ingedien word ten minste twee maande voordat fondse aan 'n projek gestaak word (bv. 31 Januarie vir 31 Maart).

   Beperk u Finale Projekverslag asseblief tot:

   - 'n inleiding (1-2 bladsye)
   - die sleutelvrae en 'n opsomming van die antwoorde daarop (ongeveer 1-2 bladsye per sleutelvraag) asook verwysings na publikasies wat, waar van toepassing, uit die studie voorgespruit het of nog in 'n embriostadium verkeer (= 'n oorsigtelike uittreksel)
   - 'n afsluiting wat die rigting waarin toekomstige navorsing moet gaan, aandui (2-3 bladsye)
   - 'n lys van alle publikasies (reeds gepubliseer, in druk en in voorbereiding) wat uit die projek voortspruit (die publikasies moet nie aangeheg word nie).

   Tesisse is nie aanvaarbaar as finale projekverslae nie. Die algemene beleid wat hier geld, is dat 'n projek nie afgehandel is voordat resultate of in druk of gepubliseer is nie en derhalwe voldoen tesisse en interne verslae nie aan die vereistes nie.

4. Tussentydse en Finale Tussentydse Vorderingsverslae - tussentydse vorderingsverslae word ingedien saam met jaarlikse projekopvolgvoorstelle (NP 10-vorms) vir solank as wat die projek duur. 'n Finale tussentydse vorderingsverslag word op 30 Junie van die laaste jaar van befondsing van 'n projek verlang al word geen opvolg NP 10-vorm vir die projek ingedien nie.

Die riglyne by die voorbereiding van tussentydse vorderingsverslae word hieronder verskaf.

Die verslag moet eerstens geïdentifiseer word:

Naam van Projek (in hoofletters) - soos dit op die NP 10-vorm voorkom

Programleier(s) - naam (name) en adres(se)

Programnavorser(s) - naam (name) en addres(se)

Datum - die verslag moet gedateer word (b.v. derde tussentydse vorderingsverslag, Julie 1982-Junie 1983)

en dan op die voorblad voortgesit word onder die volgende hoofde:

1. Doelstellings - verwys na die doelstellings soos uiteengesit in die vorige NP 10-vorm. Veranderings in die oorspronklike doelstellings en/of sleutelvrae moet aangedui en die redes daarvoor aangegee word.

2. Geskiedenis van Projek - verwys kortliks na wetenskaplike vordering sedert begin van program, sodat punt 3 (volgende) in verhouding tot die eerste projekverslag gesien kan word.

3. Wetenskaplike Vordering - vordering soos gemaak in die betrokke jaar met besondere klem op spesifieke wetenskaplike uitvindings en/of prestasies soos bv. antwoorde op die sleutelvrae wat op die vorige of oorspronklike NP 10-vorm voorkom. Hierdie gedeelte moet tot ± vier getikte bladsye beperk word.

4. Erkennings - slegs waar nodig en dan ook net vir buitengewone betrokkenheid wat nie onder normale werksverpligtinge sorteer nie.

5. Publikasies - lys afsonderlik:

   (i) gepubliseerde werke,
   (ii) werke wat vir publikasie aanvaar is (in druk en nie in voorbereiding nie) en
   (iii) toepaslike interne verslae wat waarskynlik nie gepubliseer sal word nie.

   Slegs werke wat sedert die vorige tussentydse vorderingsverslag gepubliseer is, of aanvaar is vir publikasie en werke wat 'n direkte uitvloeisel is van die WKAN-programnavorsing, word onder die bogenoemde subhoofde gelys.

Verslae moet asseblief in 1½-spasiëring op een kant van A4-velle getik word. Maak asseblief seker dat ons 'n skoon, oorspronklike afskrif van die verslag ontvang waarvan foto-afdrukke gemaak kan word, aangesien die verslae nie nagesien of oorgetik gaan word nie. Vorderingsverslae mag in Engels of Afrikaans ingedien word.

Alhoewel daar onder punt 3 gespesifiseer word dat die gedeelte oor "Wetenskaplike Vordering" tot vier getikte bladsye beperk moet word, mag hierdie gedeelte vermeerder word tot 'n maksimum van tien bladsye indien die navorser dit nodig ag. In so 'n geval moet egter daarop gelet word dat die klem regdeur op wetenskaplike navorsing val en nie op sake wat betrekking het op die logistiese aspek nie.

U aandag word daarop gevestig dat wetenskaplike vorderingsverslae sleuteldokumente is vir die motivering van verdere befondsing van 'n projek. Die nodige sorg en aandag moet dus aan die voorbereiding van sulke verslae spandeer word.

Indien omstandighede buite die navorser se beheer, logistiese en/of toerustingprobleme veroorsaak het dat geen wetenskaplike vordering in 'n betrokke jaar gemaak is nie, mag 'n "Aktiwiteitsverslag" waarin hierdie omstandighede of probleme (asook wat daaromtrent gedoen is) omskryf en as 'n addendum by die vorderingsverslag ingesluit word. So 'n verslag moet asseblief nie in 'n algemene klagbrief ontaard nie. Die hoofrede vir die daarstelling van hierdie publikasie is die behoorlike optekening van jaarlikse wetenskaplike vooruitgang in die Nasionale Antarktiese Program.

Dankie vir u samewerking.