K015B
1999/2000

LOGISTICS REPORT

K 015 B Holocene Climate History from Coastal Ice
ANTARCTICA NEW ZEALAND 1999/2000

Event Personnel :

Ms. Nancy Bertler	(Antarctic Research Centre, Victoria University of Wellington)
Dr. Warren Dickinson	(Antarctic Research Centre, Victoria University of Wellington)
Prof. Peter Barrett	(Antarctic Research Centre, Victoria University of Wellington)
Mr. Alex Pyne	(Antarctic Research Centre, Victoria University of Wellington)
Mr. Nick Jackson	(Cape Roberts Project Team Member, Victoria University of Wellington)
Mr. Mike Avey	(Cape Roberts Project Team Member)
Mr. Richard Stutters	(Cape Roberts Project Team Member)

Holocene Climate History from Coastal Ice (K015B)

1. Aims of this Project

This study investigates the regional Holocene climate of the South Victoria Land coast, using the snow and ice of the Wilson Piedmont Glacier as an archive. Ice cores are being recovered and will be analysed to obtain a detailed, continuous record of past climate. The principal idea behind ice core analyses is, that as snow accumulates, it preserves information about climate, by trapping atmospheric gas, dust particles, and freezing the isotopic composition of water and air molecules. Analysis of these parameters can be used as proxies to quantify past temperature, precipitation, sea ice extent, wind direction, and storm frequency.

The purpose of this year's study was to test the quality of the paleoclimatic signal, recorded in the WPG and to establish transfer functions between meteorological data, satellite images and the ice core parameters. For this reason six shallow ice cores (varying from 7 to 33m) were recovered from Lower Victoria and Baldwin Glacier (Fig.:1). Due to their different characteristics in catchment, altitude, and topography, a comparison between the cores from the two areas will allow the effect of local influences to be separated from the regional climatic signal. To help interpret the ice core record, a mass balance measurement device has been installed, borehole temperature measured and snow profiles investigated and sampled. The area has been surveyed using differential GPS.

The results of this year's investigations are two-fold: firstly, they enable us to judge the quality of an ice record retrieved from that area and hence are the basis for the decision to drill a deeper 200m core during the coming season. Secondly, they will enable us to establish transfer functions for the deeper core, to calculate absolute values for paleoproxies, such as temperature, precipitation and sea ice extent, beyond the time covered by meteorological measurements and into the geological past.

2. Planing

i) With the application process

The application procedure is very well organised resulting in a smooth process. However, the two year application mode seems somewhat too long and unflexible to plan PhD or Postdoctoral projects, limiting significantly the contribution of young researcher to Antarctic science.

ii) With Antarctica New Zealand staff

Antarctica New Zealand staff appeared very helpful and competent

iii) Provision of maps and aerial photographs

The provision of maps was poor and badly organised. Consequently maps and aerial photographs have been ordered directly from USGS.

iv) To Pre-season Information

The information received was valuable and timely. However, it would have been helpful to receive a blank copy of this report and the field manual significantly before leaving into the field.

v) To Medicals, documentation and flights to Antarctica

All this was well explained and organised.

3. Cargo

All the cargo handling, including transport to and from Scott Base and the storage at Scott Base and Christchurch, has been carried out with great care and professionalism.

Our cargo included a weather station, repair kit for the drilling system, mass balance measurement device, general equipment for ice core handling, and laboratory items for the work at Crary Laboratory (such as a microtome, camera, tripot, knives, tapes etc.)

4. Personnel

Nancy Bertler, Principal Investigator
Antarctic Research Centre
Victoria University

Dr. Warren Dickinson, Scientific Supervisor and Drilling Expert
Antarctic Research Centre
Victoria University

Nick Jackson, Drilling Assistant
Cape Roberts Project Team Member

Mike Avey, Drilling Expert
Cape Roberts Project Team Member

Richard Stutters, Field Guide
Cape Roberts Project Team Member

5. Preparations for the field

i) Reception
The reception was well organised, efficient and productive. The main issues of transport and time tables were discussed and determined.

ii) Equipment
The equipment requested from Scott Base was supplied in time and fully functional. This included a chain saw and a fuel pump. The Scott Base staff was very supportive and competent. In addition, equipment not available at Scott Base has been requested from McMurdo Station, including a generator (with American plug system and voltages), and a snow density kit.

iii) Field training
The field training was helpful and appropriate. The exercises seemed carefully chosen and were presented and taught with great professionalism

iv) Delays at Scott Base
NA

6. Field Transport

i) Aircraft Operations

Date	Point of Departure	Destination	Personnel moved	General Comments (*all Helicopter used are Cape Roberts shift change or cargo transport shuttles)
19 Nov 1999	Scott Base	Cape Roberts Camp	Bertler, Dickinson	no incidents, total weight contribution ~1000 lbs, (212)
23 Nov 1999	Cape Roberts Camp	Victoria Lower Glacier and Baldwin Valley	Bertler, Dickinson, Stutters	no incidents, two landings, ground time 30 min, total weight contribution ~600 lbs (A-Star)
24 Nov 1999	Cape Roberts Camp	Victoria Lower Glacier	Bertler, Dickinson, Stutters	no incidents, 2 shuttles, sling load for fuel, generator and ice core boxes, total weight contribution ~ 3000 lbs, (Kiwi 212)
25 Nov 1999	Victoria Lower Glacier	Cape Roberts Camp	Stutters	no incidents, total weight contribution 200 lbs (A-Star)

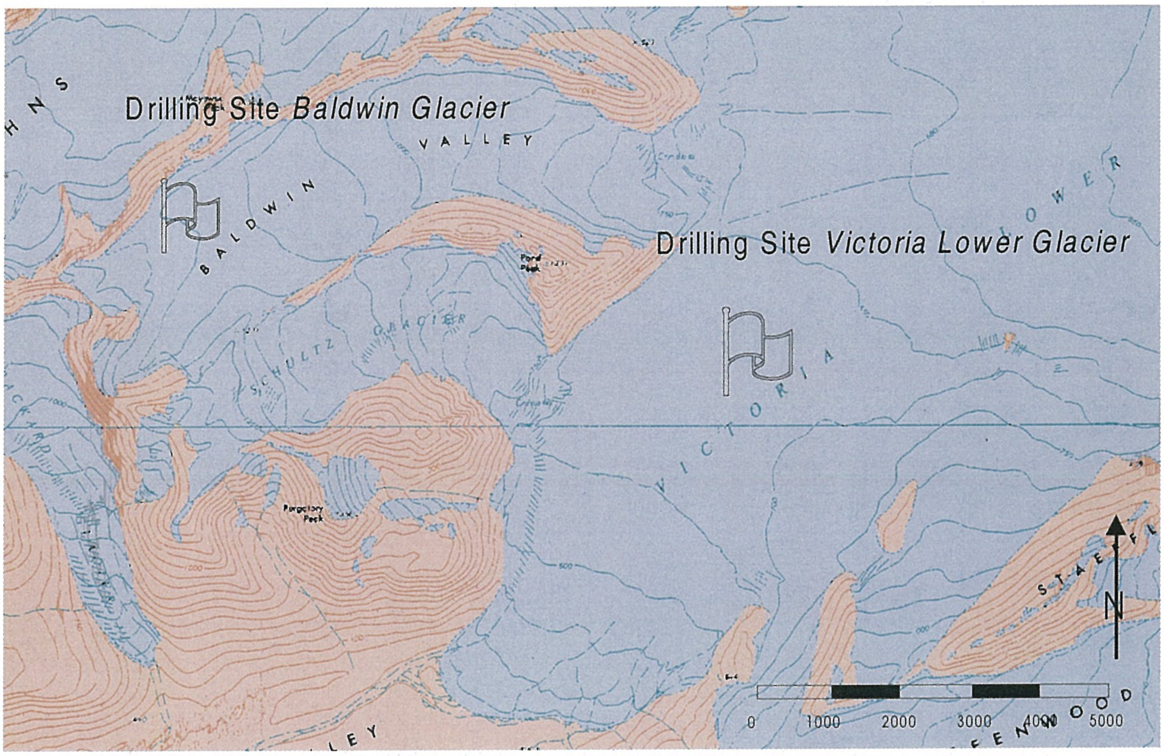
25 Nov 1999	Cape Roberts Camp	Victoria Lower Glacier	Avey	no incidents, total weight contribution 250 lbs (A-Star)
27 Nov 1999	Victoria Lower Glacier	Cape Roberts Camp	Avey	no incidents, total weight contribution 200 lbs (A-Star)
28 Nov 1999	Cape Roberts Camp	Victoria Lower Glacier	Avey, Jackson	no incidents, total weight contribution ~500lbs (Kiwi 212)
30 Nov 1999	Victoria Lower Glacier	Scott Base	Avey	no incidents, total weight contribution ~300lbs (A-Star)
03 Dec 1999	Victoria Lower Glacier	Baldwin Valley	Bertler, Dickinson, Jackson	no incidents, 2 shuttles with sling loads for fuel, generator and ice core boxes, total weight contribution ~2200 lbs; 1000 lbs have been left at Victoria Lower Glacier (212)
07 Dec 1999	Baldwin Valley	Scott Base	Bertler, Dickinson, Jackson	no incidents, 2 shuttles with sling loads for fuel, generator, and ice core boxes, stop over at Victoria Lower Glacier, between first and second shuttle for Bertler and Dickinson, ground time 2 hours, total weight contribution ~3600lbs. (212)

7. Event Diary

Date of Movement	Personnel moved	Destinations	Personnel at site, working tasks, and general comments
14 Nov 1999	Bertler, Dickinson	Arrival at Scott Base	(Bertler) AFT, (Bertler & Dickinson) • preparation for fieldwork
19 Nov 1999	Bertler, Dickinson	Transfer to Cape Roberts Camp (CRC)	(Bertler, Dickinson) • Modifications on drilling equipment with help of Cape Roberts Team Members
23 Nov 1999	Bertler, Dickinson, Stutters	Reconnaissance Flight to Victoria Lower Glacier and Baldwin Valley Glacier	(Bertler, Dickinson & Stutters) • Reconnaissance and flagging of the proposed drilling sites and evaluation of safety issues on-site, such as crevasses
24 Nov 1999	Bertler, Dickinson, Stutters	Put in to Victoria Lower Glacier Camp (LVGC), S77°19.810'/ E162°31.991'	(Bertler, Dickinson, Stutters) • Establishment of the camp • Crevasse detection in the vicinity of the camp • Installation of weather station

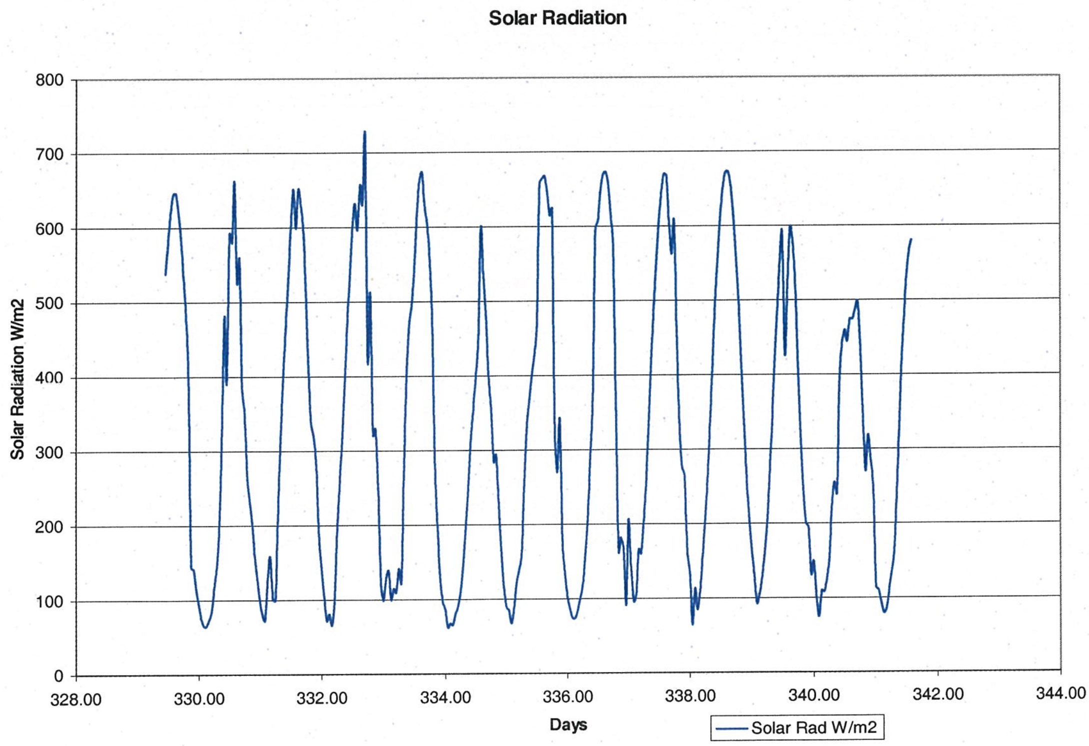
25 Nov 1999	Stutters Avey	Transfer from LVGC to CRPC Transfer from CRC to VLGC	(Bertler, Dickinson & Avey) • Set-up of the drilling rig, preparing ice core storage • Start of ice core drilling
27 Nov 1999	Avey	Transfer from LVGC to CRC	(Bertler & Dickinson) • Cutting and logging of snow profiles • Snow sampling
28 Nov 1999	Avey, Jackson	Transfer from CRC to VLGC	(Bertler, Dickinson, Avey & Jackson) • Ice core drilling (four cores of 7, 10, 12 and 34m)
30 Nov 1999	Avey	Transfer from VLGC to CRC	(Bertler, Dickinson & Jackson) • Borehole temperature measurements • Set-up of glacier mass balance device • Site survey using differential GPS • Glacio-geomorphological investigation of the vicinity of Victoria Lower Glacier • Break down of camp
03 Dec 1999	Bertler, Dickinson, Jackson	Transfer from VLGC to Baldwin Valley Glacier Camp (BVGC) S77°19.836'/ E162°32.019'	(Bertler, Dickinson & Jackson) • Camp set up • Preparation of drilling rig and ice core storage, • Drilling of 2 cores (12 and 31m) • Measurements of borehole temperatures • Cutting and logging of snow profiles • Sampling of snow
06 Dec 1999	Bertler, Dickinson, Jackson	Transfer from BVGC to Scott Base	(Bertler, Dickinson & Jackson) • Preparation for work at Crary Laboratory • Organisation of cargo sent to NZ
14 Dec 1999	Dickinson, Jackson	Transfer to Christchurch	(Bertler at Crary Laboratory) • Logging of the cores using a light table • Splitting the ice core into halves using a band saw • Subsampling for β-activity measurement • Packing for transport to NZ and USA) • Organisation of cargo sent to NZ and USA
11 Jan 2000	Bertler	Transfer to K015	

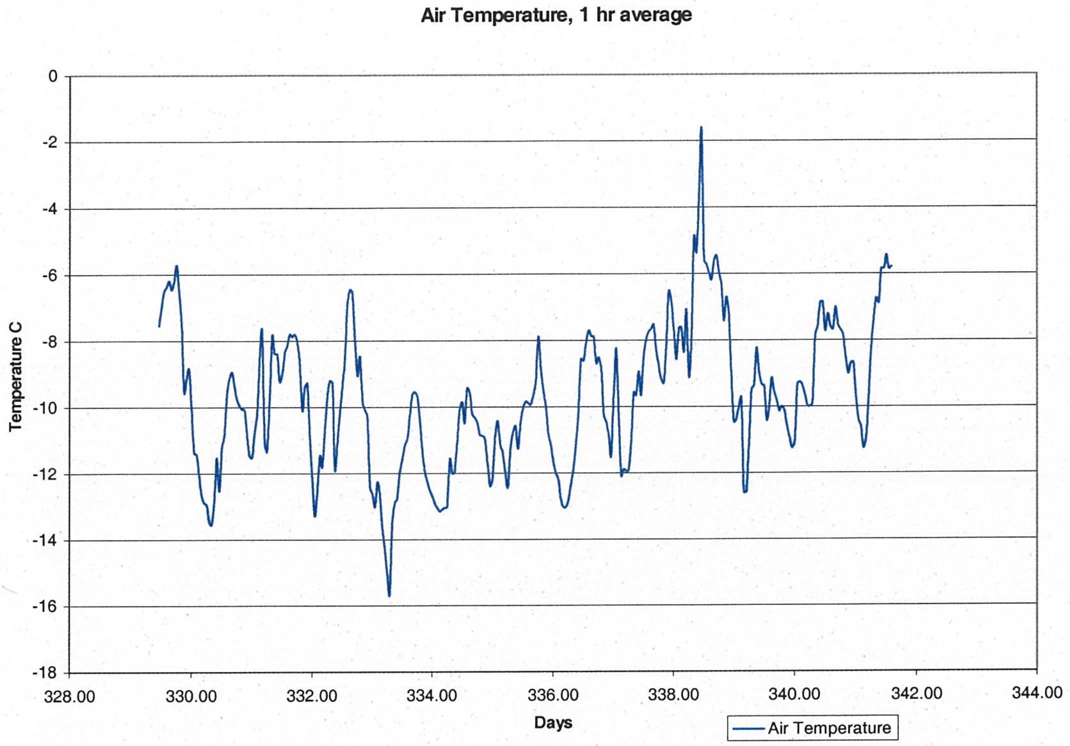
8. Event Map

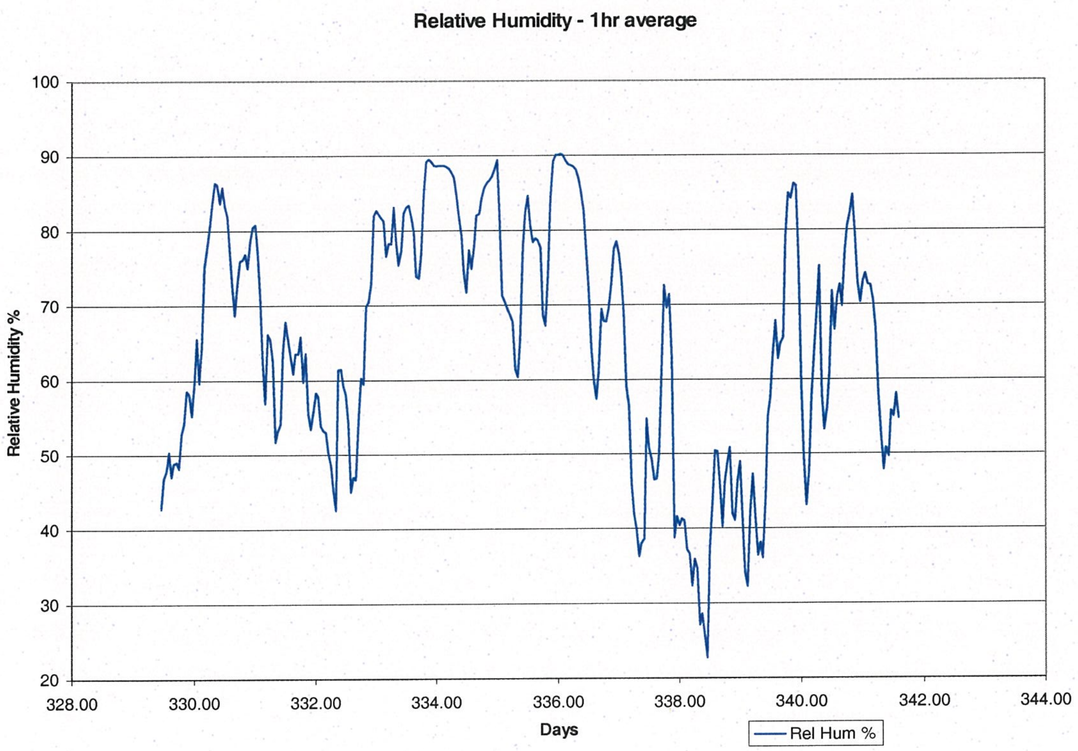


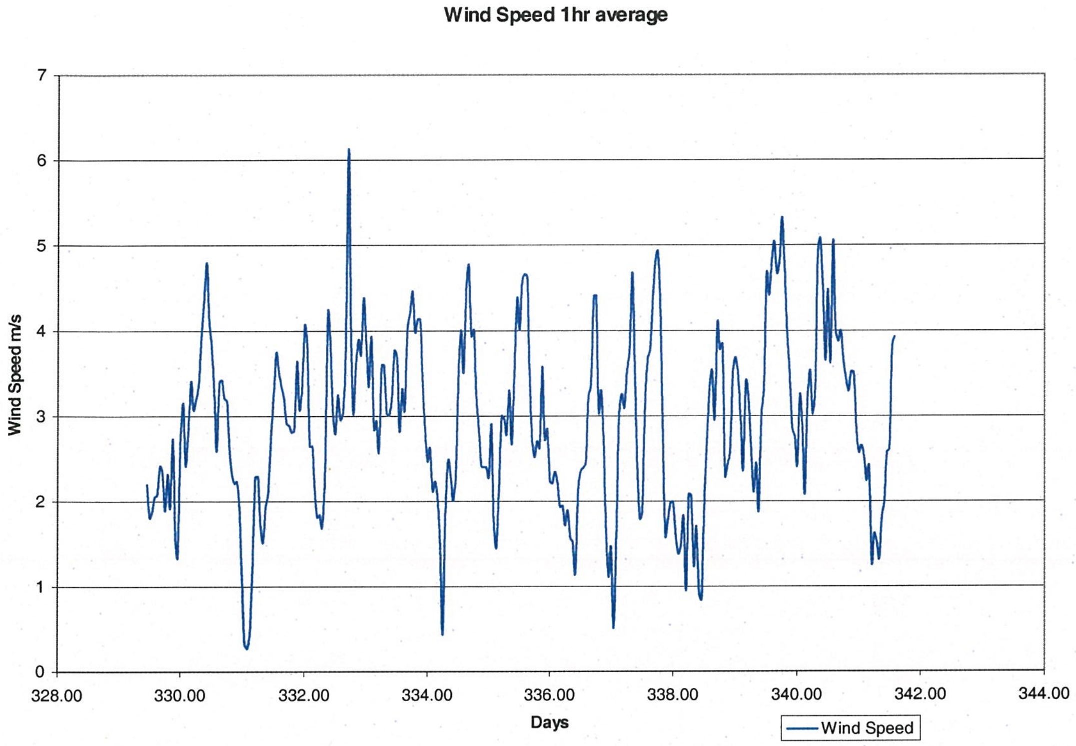
9. Weather

A weather station had been installed at Victoria Lower Glacier, S77°19.810'/ E162°31.991'




Air Temperature, 1 hr average
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
Temperature C
328.00
330.00
332.00
334.00
336.00
338.00
340.00
342.00
344.00
Days
Air Temperature


Relative Humidity - 1hr average
100
90
80
70
60
50
40
30
20
Relative Humidity %
328.00
330.00
332.00
334.00
336.00
338.00
340.00
342.00
344.00
Days
Rel Hum %



10. Accidents, incidents or hazards

There have been no accidents, incidents or hazards.

11. Field Equipment

i) Field Clothing

The issued field clothing proved to be appropriate and satisfied greatly our requirements. However, a supply of more sustainable, warm working gloves would have been appreciated.

ii) Field Equipment

The supplied field equipment was in good shape and very reliable. Tents (polar tent and macpac, type Olympus) and sleeping kits were comfortable and appropriate for the field conditions. The repair kits for tents and kitchen gear were sufficient. The safety and rescue gear was well chosen and in good condition.

iii) Food in the field and at Scott Base

The 20 person day ration boxes were in general well packed in terms of nutrition and quantity. Nonetheless a greater variety would have been appreciated, especially for quick lunch meals. Some of the sweet energy suppliers, such as cookies and muesli bars, and some of the soup sachets might be well replaced by 'sandwich spreads'. The calculated quantities for breakfast cereals seem somewhat low. In contrast the allocated amount of frozen meat and vegetables appeared to be rather high. Some of the box ingredients appeared to be unsuitable, such as lasagne and sponge cakes in tins for example.

The food offered at Scott Base was both: delicious and nutritious.

iv) Specific Field equipment

The requested chain saw and fuel pump were in reasonable condition and worked reliably, The PICO hand auger, generator, and snow density kit lent from the Berg Field Center performed well. A few modifications have been carried out on the drilling system: the drilling platform has been supplied with a chicken-wire coat for safety, the core barrels have been strengthened around the extension joints and the tripot has been fitted with snow anchor feet

12. Radio Communication

i) Radio equipment
The radio kit issued (one VHF radio, two batteries, one external aerial and one solar panel) worked reliably, with only minor communication problems. The capacity of the batteries appeared relatively low and had to be charged constantly, effecting the recharge capacity. A second VHF radio would have been highly appreciated in case of failure and to communicate between group members working at different locations on-site.

ii) Reception and Transmission
The reception and transmission was in general satisfying. The external aerial was helpful, repeater stations were used during the whole time. The sked timing was suitable.

iii) Information during skeds
The radio communication with Scott Base was very efficient, professional and highly appreciated.

13. Scott Base and Arrival Heights Laboratory Facilities

NA

14. Refuge and Research Hut

NA

15. Environmental Impact

i) Event Diary:

Victoria Lower Glacier
- Location S 77° 19.810' / E 162°31.991'
- Dates: 24 Nov 1999 to 03 Dec 1999
- Total days: 10
- Maximum number of people at site: 4
- Total person-days spent at site: 29
- Main activity undertaken: ice coring

Baldwin Glacier
- Location S 77° 19.836' / E 162°32.019'
- Dates: 03 Dec 1999 to 06 Dec 1999
- Total days: 4
- Maximum number of people at site: 3
- Total person-days spent at site: 12
- Main activity undertaken: ice coring

ii) Protected areas
N.A.

iii) Interference with terrestrial, freshwater or marine plants or animals
N.A.

iv) Collection of geological material
A total amount of 940lbs of ice has been sampled

Victoria Lower Glacier:	~ 540lbs
Baldwin Glacier:	~ 400lbs

v) Chemicals taken to the field
N.A.

vi) Use of explosives
N.A

vii) Importation to Antarctica
N.A.

viii) Equipment left in the field
Two mass balance systems (in form of 25m of wire and two 2.40m metal rods) have been installed in to two of the drilling holes at Victoria Lower Glacier (S 77° 19.810' / E 162°31.991'). Once further mass balance measurements are not required, it will be tried to recover as much as possible from the device.

ix) Environmental impacts
The environmental impact of our work has been less than minor. The only observed source of pollution were exhaust fumes of the generator, the chain saw and helicopters. All the work has been carried out on snow and ice surfaces.

x) Occurrence of incidents
N.A.

xi) Changes from the PEE
N.A.

16. Historic Sites

NA

17. Management of Science in the Ross Dependency

The support from Scott Base was very helpful and highly appreciated. The study of glacial ice cores for reconstructing paleoclimatic variability presents new ground within NZ science and hence there are a few issues, which are yet to be developed to cover all the demands. For this reason few additional requests have been undertaken to McMurdo Station, where such facilities already exist. As a result the freezer facilities at Crary Laboratory were used to log and split the ice cores. Furthermore ice core storage space has been dedicated to our project to store the cores until they have been shipped back to NZ.

18. Antarctic Geographic Place Names

NA

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IMMEDIATE SCIENCE REPORT

K 015 B Holocene Climate History from Coastal Ice
ANTARCTICA NEW ZEALAND 1999/2000

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Mr. Richard Stutters	(Cape Roberts Project Team Member)

Holocene Climate History from Coastal Ice - K015B

1. Popular Summery of Scientific Work Achieved

This study investigates the regional Holocene climate of the South Victoria Land coast, using the snow and ice of the Wilson Piedmont Glacier as an archive. Ice cores are being recovered and will be analysed to obtain a detailed, continuous record of past climate. The principal idea behind ice core analyses is, that as snow accumulates, it preserves information about climate, by trapping atmospheric gas, dust particles, and freezing the isotopic composition of water and air molecules. Analysis of these parameters can be used as proxies to quantify past temperature, precipitation, sea ice extent, wind direction, and storm frequency.

The purpose of this year's study was to test the quality of the paleoclimatic signal, recorded in the WPG and to establish transfer functions between meteorological data, satellite images and the ice core parameters. For this reason six shallow ice cores (varying from 7 to 33m) were recovered from Lower Victoria and Baldwin Glacier (Fig.:1). Due to their different characteristics in catchment, altitude, and topography, a comparison between the cores from the two areas will allow the effect of local influences to be separated from the regional climatic signal. To help interpret the ice core record, a mass balance measurement device has been installed, borehole temperature measured and snow profiles investigated and sampled. The area has been surveyed using differential GPS.

The results of this year's investigations are two-fold: firstly, they enable us to judge the quality of an ice record retrieved from that area and hence are the basis for the decision to drill a deeper 200m core during the coming season. Secondly, they will enable us to establish transfer functions for the deeper core, to calculate absolute values for paleoproxies, such as temperature, precipitation and sea ice extent, beyond the time covered by meteorological measurements and into the geological past.

2. Proposed Programme

The principal questions we sought to answer with our work during the season 1999/2000 were:

- *Is the Wilson Piedmont Glacier suitable for reconstructing Holocene Climate of the Dry Valley area?*

  The study of aerial photographs and satellite images enabled us to identify suitable drilling sites to answer such a question at Victoria Lower Glacier and Baldwin Glacier. Due to their different characteristics in catchment, altitude, and topography, a comparison between the cores from the two areas will allow the effect of local influences to be separated from the regional climatic signal.

In help interpret the ice core record, we installed a mass balance measurement device (Hamilton & Whillans, 1995), measured borehole temperature and sampled snow profiles. The glacier topography in the vicinity of the drilling sites has been surveyed using differential GPS. The mass balance device will record from next year on the actual state of mass balance of the Victoria Lower Glacier. The borehole temperature will be used to calculate mean annual air temperature and the investigations of the snow samples will help to understand the acting processes during snow – firn – ice metamorphism.

- *What are the transfer functions between meteorological data, satellite images and the ice core proxies?*

In order to calculate absolute temperature, precipitation and sea ice values, it is necessary to calibrate the ice core record with the measured climatic parameters of the area. For that reason meteorological data and satellite images, quantifying sea ice extent in the McMurdo Sound area, will be used to convert isotopic ratios and methane sulphuric acid percentages into temperature, precipitation and sea ice extent values. Once these transfer functions have been established, they can be used to convert ice core data beyond such records.

Fig.:1 Map of Drilling Sites at Victoria Lower Glacier and Baldwin Valey

3. Scientific Endeavours and Achievements

Victoria Lower Glacier S77°19.810', E162°31.991'

During the season 1999/2000 four shallow cores have recovered from the glacier (7.0m, 9.9m, 12.5m, 33.6m). While the 7.0m and 9.9m cores have been used to measure density profiles in the field, the 12.5 and 33.6m cores have been taken for further analyses to New Zealand and USA. All four cores have been logged to test for intrasite variability. The topography of the glacier surface in the vicinity of the drilling site has been surveyed applying differential GPS, with the base station employed at the Cape Roberts tide gauge.

To accomplish the ice/firn core record, snow profiles from 0 – 3m depth have been cut and investigated. The analyses include visual logging, density measurement and sampling for determining isotopic and chemistry characteristics. A mean annual temperature of –22.3°C has been calculated by recording the borehole temperatures of the 9.9 and 33.6m drilling holes (fig.).

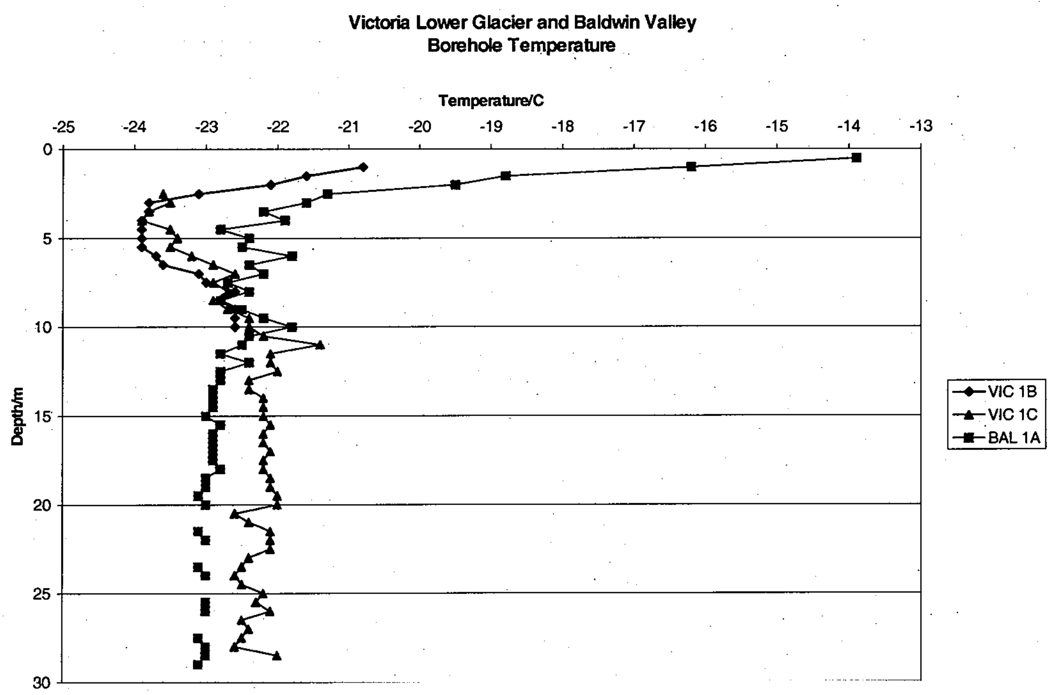

Fig.2: Borehole temperature records from Victoria Lower Glacier and Baldwin Glacier

Continuous meteorological data, such as temperature, wind speed and direction and insolation, have been recorded and will help to correlate between longterm weather records from Marble Point and the actual weather systems at Victoria Lower Glacier, where no such records are available.

In order to determine the present-day state of mass balance, a 'coffee can' device has been installed, following the instructions of Hamilton & Whillans (1995). The first readings can be expected from the coming season onwards.

Investigations of the Lower Victoria Glacier snout indicated an overall positive mass balance and led to a better understanding of the general ice flow directions and catchment characteristics. The sand dunes, west of the glacier snout, have been studied as a possible source for the dust found in the cores.

Baldwin Valley Glacier S77°19.836', E162°32.019'

Two firn cores have been recovered from Baldwin Glacier (12.2m and 31.1m). While the 12.2m core has been used to establish a density record, the longer core has been taken to NZ and USA for further analyses. A snow profile from 0 – 1.8m has been cut, visually logged and the density measured. Samples for isotopic measurements and chemistry have been taken.

The mean annual air temperature was calculated to be -23°C by measuring borehole temperatures. Investigations of the vicinity of the drilling site gave insides of the ice flow structures and catchment characteristics.

Crary Laboratory

All cores chosen to be taken back for further analyses have been logged in more detail at Crary laboratory, using a light table. The 12.5m core from Victoria Lower Glacier has been prepared for β-activity measurements and sent off. All cores have been split and packed for the transport to NZ and USA.

Methodology

- Ice Core Drilling
  For the ice core drilling the PICO (Polar Ice Coring Office) Hand Auger has been used. Despite the loss of one drilling bit, the coring went smoothly with only minor problems. A few modifications have been carried out for safety and convenience.

- Borehole Temperature Measurement
  Coupled conductivity wire were used to read temperature. The meter displayed a high sensitivity to the air temperature and had to be keptabove 0°C.

- Snow Profiling and Sampling

A hand saw and in places a chain saw were used to cut the snow profiles. No modifications were necessary.

- Meteorological Measurements
  The weather station used was hired from NIWA. Since it had been employed in Antarctica before, no modifications were necessary.

- Differential GPS Measurements
  The GPS system used (Trimble X PRO) has been employed in Antarctica before so that no modifications were necessary. In order to derive differential data, the measurements have been linked with the data from the base station located at the Cape Roberts tide gauge.

4. Publications

The results will be published in peer reviewed papers in co-authorship with Warren Dickinson, Peter Barrett, Alex Pyne, Paul Mayewski, Eric Saltzman, Gordon Hamilton, and Ian Whillans.

5. Acknowledgements

- Scott Base Staff
- CR Team, especially:
  - Peter Barrett
  - Alex Pyne
  - John Alexander
  - Jim Cowie
  - Nick Jackson
  - Mike Avey
  - Richard Stutters
- PICO, especially:
  - Dave Giles
- Crary Laboratory, especially:
  - Robbie Score
- Berg Field Center, especially:
  - Mimi Fujinomi
- NSF, especially
  - Julie Palais
- Prof. Paul Mayewski
- Dr. Mark Twickler
- Dr. Gordon Hamilton
- Prof. Ian Whillans
- Dr. Tim Haskell
- NIWA, especially

- Tony Bromley
- Errol Lewthwaite
- Scripps Institution of Oceanography, especially
  - Dan Lubin
  - Bob Whritner
  - Steve Hart
- and I acknowledge Victoria University for funding this project.

K042
1999/2000

LOGISTICS REPORT

Event K042 Glacial History of the East Antarctic Ice Sheet at Allan Hills

ANTARCTICA NEW ZEALAND 1999/2000

Event Personnel :

Prof. Peter Barrett	(Victoria University of Wellington)
Dr. Stephen Hicock	(University of Western Ontario)
Philip Holme	(Victoria University of Wellington)
Jeremy Mitchell	(Victoria University of Wellington)
Cliff Atkins	(Victoria University of Wellington)
Prof. Jaap van der Meer	(University of Amsterdam)
Mark Lloyd-Davies	(University of Amsterdam)

ANTARCTICA NEW ZEALAND REPORT NO 2:
LOGISTIC REPORT

Note: this document reports on the activities of two coincident studies conducted under the K042 event. Where necessary for clarity, details and comments for the two studies will be presented separately.

1 Aims

VUW

This project is a detailed study of ancient glacial deposits termed the Sirius Group at Allan Hills, Southern Victoria Land, Antarctica. The Sirius Group is a collection of Neogene deposits that crop out at high elevations (mostly >1500 m) throughout the Transantarctic Mountains (TAM). Allan Hills occupies a low point in the TAM, making the site more susceptible to overriding by the EAIS during minor ice volume fluctuations. The aim of this project is to show whether the Sirius Group was deposited by valley glacier or continental ice sheet, by wet- or dry-based glacial ice, by a single depositional event or several overriding events and to determine paleoflow direction.

This past field season ran from mid-November 1999 to mid-January 2000 at Allan Hills during which time field mapping of early glacial deposits was continued from last season. The Sirius Group takes the form of seven patches of thin debris with a total area of 2 km^2. From these, eight outcrops were selected for detailed description and sampling. The collected data include: orientations of 300 stones, 270 linear glacial abrasions and 90 planar deformational structures. In addition, 37 rock samples were collected for laboratory analysis. Sample processing has not yet begun but evidence indicates wet-based glacial deposition. Although the number of advances is not yet known, the work thus far suggests flow from the southwest and west. The presence of a cirque incised into a surface capped with Sirius deposits on the south side of Trudge Valley reveals a later phase of local temperate ice before the present cold ice sheet formed.

Univ. of Amsterdam

1) Build upon research carried out by Hiemstra and van der Meer (1999) in their field report for the Netherlands Centre for Geo-ecological research titled: *Neogene Glacial History of the Allan Hills, South Victoria Land, Antarctica*. This would include quantification of Sirius related glacio-tectonic bedrock deformation structures and further descriptions and sketches.
2) Collect spatially and stratigraphically variable Sirius diamict samples for analyses by micromorphology. Wherever these micromorphology samples are taken, a small sample will also be taken for bulk texture analysis. Determine whether this is possible with a University of Amsterdam hand held drill or by simply removing a block of diamict using a chisel and geological hammer.
3) Describe, sketch and quantify glacio-tectonic deformation of bedrock related to a recent advance of the Manhaul glacier. Collect spatially variable samples of Manhaul glacial diamict associated with the glacio-tectonic deformed bedrock for analysis by micromorphology. Wherever these micromorphology samples are taken, a small sample will also be taken for bulk texture analysis.
4) Collect samples of 'sublimation till' from the snout of Taylor glacier and Suess glacier, Taylor Valley for analysis by micromorphology.
5) Collect samples from the debris-laden basal layer of Taylor glacier itself for micromorphology analysis.
6) Determine the practicality of undertaking pre-impregnation of unconsolidated sediments in the Antarctic field, with daily temperatures considerably below zero.

2 Planning

Discuss the New Zealand pre-Antarctic planning phase of your expedition, detailing any suggestions for improvements:

i ***With the application process;***

No suggestions for improvements.

ii ***With Antarctica New Zealand staff;***

The efforts of Paul Woodgate in helping us during the preparatory stages of our expedition are greatly appreciated.

iii ***Provision of maps and aerial photographs;***

All maps and aerial photographs were obtained the previous season from outside sources. However, the material obtained is rather lacking. Given the increase in activity in and around Allan Hills we feel that there should be good quality maps of all of Allan Hills at a scale of 1:10 000.

iv ***To the Pre-season Information.***

No suggestions for improvements.

v ***To Medicals, documentation and flights to Antarctica.***

Medicals were conducted at an on-campus clinic by a general practitioner. No suggestions for improvements. Our flight south from Christchurch was delayed two days because of poor weather at McMurdo. We were nicely looked after at the Rusley Inn and enjoyed our stay there. The three hour delay notices for the flights were frustrating but that can't be helped. We were grateful to receive the use of a van for an afternoon to allow us to explore the outer environs of Christchurch.

3 **Cargo**

VUW

We transported one kerosene heater and one large wooden box containing: four empty wooden rock boxes and one 10 kg box of paper readings, maps and airphotos.

Univ. of Amsterdam

A hand held drill and handle bars were transported by air to Antarctica New Zealand, Christchurch from the University of Amsterdam. They were labelled for the attention of Paul Woodgate. There were no problems transporting the cargo and it arrived at Scott Base in ample time for the field season.

Excellent support provided by 'Cargo Chris' in shipping field samples from Scott Base to Christchurch, New Zealand.

We did not experience any problems related to packaging, transport of chemicals, compressed gases, excess hand baggage etc.

4 **Personnel**

Prof. Peter Barrett	(supervisor for Holme and Atkins - Victoria University of Wellington)
Philip Holme	(PhD student, principal investigator (for P. Barrett) - Victoria University of Wellington)
Jeremy Mitchell	(MSc student, field assistant to Holme - Victoria University of Wellington)
Cliff Atkins	(PhD student - Victoria University of Wellington)
Dr. Stephen Hicock	(co-supervisor for Holme - University of Western Ontario)
Prof. Jaap van der Meer	(supervisor to Lloyd-Davies - University of Amsterdam)
Mark Lloyd-Davies	(PhD student - University of Amsterdam)

5 **Preparations for the Field**

As applicable discuss your initial period at Scott Base relating to:

i ***Reception, planning for your event and liaison where appropriate;***

When we first got off the plane upon arriving in Antarctica we were quickly rushed into vehicles and not permitted more than two minutes to look around and absorb the environment. This was regrettable because for three of us it was our first time and it is a significant moment for any new arrival. Other than that everything was acceptable.

ii ***Availability and condition of equipment received by your event. Any work required by your party to make the equipment serviceable should be noted;***

All equipment supplied by Antarctica New Zealand was received in good working order.

iii ***Field training and field party equipment 'shakedown' journey (if applicable);***

Field training (AFT) was very applicable to our event and most members benefited considerably from the training. One of our members was highly skilled in outdoor survival craft so the training was nothing new to him. No equipment 'shakedown' was required.

iv ***Delays at Scott Base, whatever the cause.***

There were no delays at Scott Base prior to our being transported to the field. Our flight south from Christchurch was delayed two days due to poor weather at McMurdo.

If you feel that any service was poorly carried out by support staff at Scott Base, please make a note but include a positive recommendation for improvement of this service.

Services carried out by support staff at Scott Base were fully satisfactory. The staff at Scott Base were always helpful and would often work beyond the scope of their job to see us right.

6 **Field Transport**

As applicable report on the following:

i **Vehicles**

No vehicles were used.

ii **Aircraft Operations**

Discuss the success or otherwise of all aircraft, helicopter or other operations supporting your event.

VUW

Most helicopter operations conducted in support of our event were completely satisfactory. The only exception to this was the delay caused by the crash of the 3-Squadron helicopter. This unfortunate event resulted in a one week delay in transporting two event members to our field site and the relocation of another member to a different event.

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The helicopter crash which took place nearly jeopardised my field season at Taylor Valley, which, if that had been the case, would have been both frustrating and potentially detrimental to my PhD. Regardless the crash had it's hidden benefits, as I needed to work very hard for three days so to produce a week's worth of research (as I originally planned to do). Having achieved this in three days, I had an unexpected two days in Taylor Valley owed to poor weather. This provided me the opportunity to visit and sample from Suess glacier.

All other helicopter operations were fine. I would like Antarctica New Zealand to encourage pilots who are dropping off events at a field site for the first time to shut down whilst the members orientate themselves and test the radio equipment. K042 were fine, but I hear it is not always consistent practise.

Describe the containerisation of cargo, total flight weights, special handling of dangerous cargo, (eg motor toboggan, fuel tanks) and pre-planning meetings.

Cargo for our helo flights was largely contained in individual boxes and packs. No special handling of cargo was necessary because the only dangerous cargo we had was fuel which was stored in the tail section of the helo except for 60 L drums. Total flight weights (estimated from weights given in the ANZ field manual and probably accurate to within 150 lbs.) are as follows: (Note: this list does not include a flight which came in after Helo 4 to supply cargo which was mistakenly not included on Helo 4.)

Helo 1 (20/11/99 - insertion), aircraft - Bell 212, approx. weight 1600 lbs.
Helo 2 (06/12/99 - resupply 1), aircraft - Bell 212, approx. weight 1300 lbs.
Helo 3 (14/12/99 - resupply 2), aircraft - Bell 212, approx. weight 1470 lbs.
Helo 4 (18/12/99 - resupply 3), aircraft - Bell 212, approx. weight 1200 lbs.
Helo 5 (20/01/00 - partial pullout), aircraft - Bell 212, approx. weight 1600 lbs.
Helo 6 (21/01/00 - final pullout), aircraft - Bell 212, approx. weight 1600 lbs.

As appropriate, detail the suitability of any skiways used. Clearly mark these on your report map and provide GPS coordinates where possible.

No skiways were used.

iii Ship Operations.

No ships were used except to transport rock samples to New Zealand at the close of the season.

7 Event Diary

Describe your field activities and movements in a concise day-by-day diary form, including main activities, where the party stayed (hut, description of camp site) and if members are at different locations. (Note this and numbers at each location) Record general comments relating to weather, route finding problems, dangerous icefalls or crevasse fields (mark on map also), suitable camp sites, surface conditions encountered etc. Briefly outline your efforts to accomplish the aims of your science programme.

Allan Hills 1999/2000 Events log for P. Holme

Note: event diaries for other event members were not available at this time.
Every night, all event members stayed at the Main Camp except where noted. No icefalls or crevasse fields were encountered because our event was based on a nunatak and our research was geological so we travelled on rock almost the whole time.

Day	Date	Location	Activity
01	20/11/99	camp	insertion and camp setup
02	21/11/99	camp	camp setup
03	22/11/99	Triangle	recce south to the Triangle area
04	23/11/99	Northwest Platform	recce west across Northwest Platform and up onto west edge of Allan Hills. Found section with good stratigraphic contacts

05	24/11/99	Boulder Ridge	recce east to Boulder Ridge
06	25/11/99	Echo Gully	looked for Hiemstra's sections and found excellent section
07	26/11/99		helped Mark look for Hiemstra's sections
08	27/11/99		did write-up summary of preceding events
09	28/11/99	Sec 01	worked on Section 01
10	29/11/99	Sec 01	worked on Section 01
11	30/11/99	Sec 01	worked on Section 01
12	01/12/99	Manhaul snout to northeast platform	recce along Manhaul snout and out to northeast platform
13	02/12/99	just south of the Northwest Platform	recce – found potential section
14	03/12/99	Northwest Platform	recce, outcrop investigation
15	04/12/99	camp	sore knee – did paperwork
16	05/12/99	Northwest Platform	section 03
17	06/12/99	Northwest Platform	section 03
18	07/12/99	Northwest Platform	recce
19	08/12/99	Triangle, Boulder Ridge	recce
20	09/12/99	?	recce
21	10/12/99	?	recce
22	11/12/99	Lake valley, Trudge valley	recce
23	12/12/99	south to the Rim	recce – looking for Sirius Group
24	13/12/99	camp	paperwork
25	14/12/99	along Manhaul snout to Lake valley	recce
26	15/12/99	central Allan Hills south of the central dyke	GPS measurements of the southern limit of the Beacon butter
27	16/12/99	Echo gully, Trudge valley	recce and GPS measurements of outcrops and striated surfaces
28	17/12/99	South limb	recce, looking for Sirius Group deposits
29	18/12/99	camp	rest
30	19/12/99	Camp valley	section 03
31	20/12/99	Camp valley	section 03
32	21/12/99	Camp valley	section 03
33	22/12/99	Camp valley	section 03
34	23/12/99	Camp valley	section 03
35	24/12/99	Camp valley and contra ridge	recce
36	25/12/99	camp	Christmas
37	26/12/99	camp	Christmas
38	27/12/99	Northwest Platform, Camp valley, contra ridge	outcrop tour
39	28/12/99	contra ridge	recce
40	29/12/99	contra ridge	section 04
41	30/12/99	central and southern Allan Hills (north of the Rim)	recce and sampling
42	31/12/99	contra ridge	section 04
43	01/01/00	camp	New Year's Day
44	02/01/00	contra ridge	section 05
45	03/01/00	contra ridge	outcrop investigation
46	04/01/00	Trudge valley	Beta camp setup
47	05/01/00	north flank of Trudge valley	mapping
48	06/01/00	Beta camp	rest
49	07/01/00	floor and south ridge of Trudge valley	recce
50	08/01/00	south ridge of Trudge valley	recce
51	09/01/00	south ridge of Trudge valley	recce
52	10/01/00	south rim of gully (SE gully) in southeast corner of Trudge	section 06

		valley	
53	11/01/00	gully (Echo gully) in southwest corner of Trudge valley	section 07, outcrop investigation
54	12/01/00	Echo gully	section 07, outcrop investigation
55	13/01/00	Echo gully	section 07, outcrop investigation
56	14/01/00	SE gully	section 06, outcrop investigation
57	15/01/00	north flank of Trudge valley	recce and section 08 outcrop investigation
58	16/01/00		
59	17/01/00	north flank of Trudge valley	mapping and section 08 outcrop description
60	18/01/00	north flank of Trudge valley	mapping and section 08 outcrop description
61	19/01/00	Echo gully	section 07 outcrop description
62	20/01/00	Echo gully/Beta camp	section 07 and breakdown/pullout of Beta camp
63	21/01/00	camp/Scott Base	pullout of Alpha camp and return to Scott Base

8 Event Map

Append a detailed sketch map to show vehicle routes, aircraft landing sites, dangerous areas, depots and camp sites etc. Highlight any inaccuracies on existing topographical maps and provide GPS coordinates where possible.

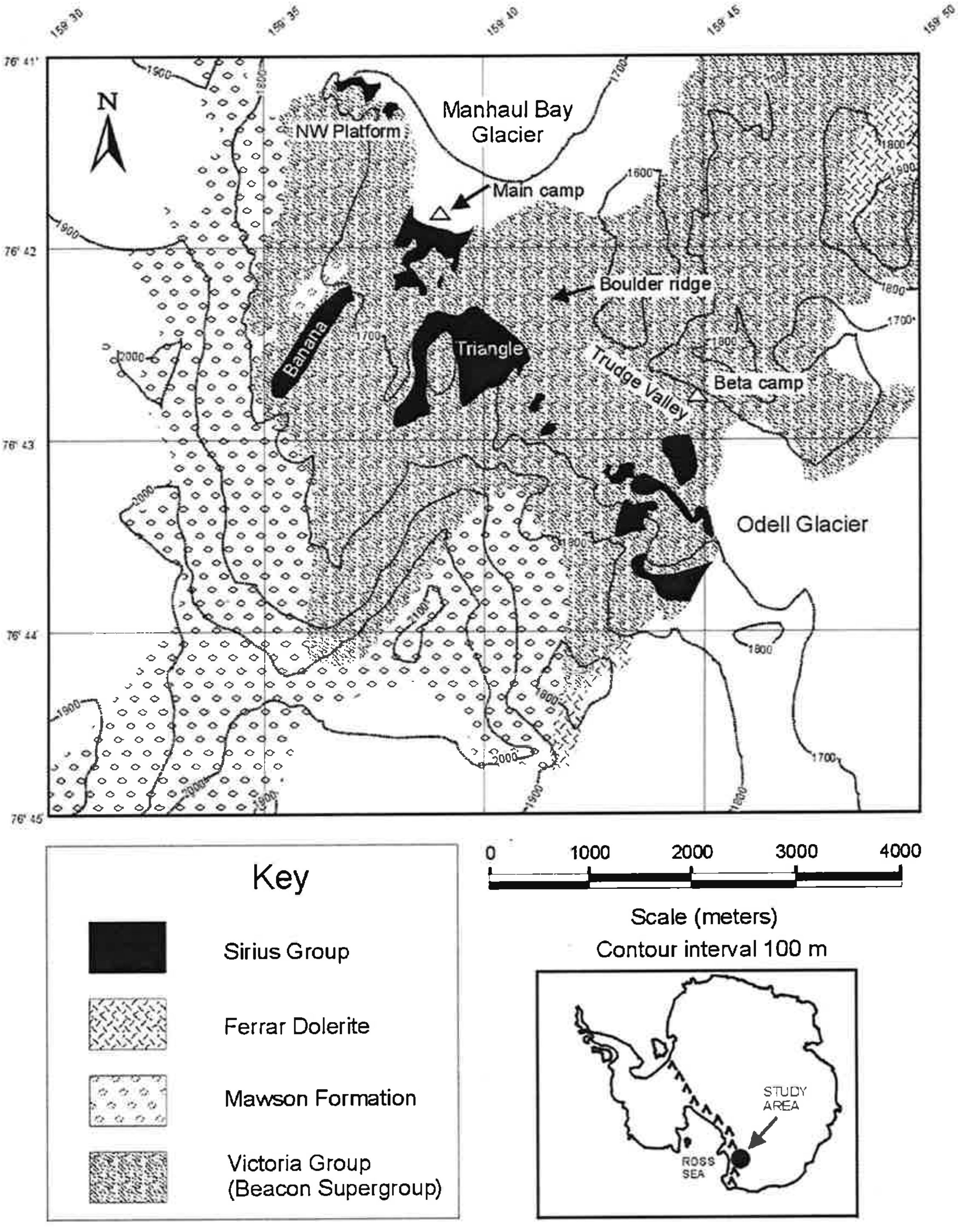

Figure 1. General geology of central Allan Hills highlighting distribution of Sirius Group deposits.

9 **Weather**

1999-2000 Field season Allan Hills Weather Reports. (See note below.)

Note: Weather measurements were taken only on those days when helo visits were expected. Regular records were not kept.

Date	Time (24h)	Temp °C	Wind Spd (Kts)	Wind Dir.	Cloud Cover	Cloud Ht. (m)	Visibility (m)	Sfc Def'n	Horiz Def'n	Weather
30/12/99	0830	-16	10 gust 20	S	2/8	high	6000	good	good	
01/12/99	0830	-17	15 gust 30	S	0/8	unlim.	>10000	good	good	
01/12/99	2030	-18	10 gust 25	S	0/8	unlim.	>10000	fair	good	
06/12/99	?	-12	3 gust 4	ESE	8/8	>2000	>10000	good	good	
12/12/99	?	-14	8	N	8/8	1700	500	poor	poor	light snow
13/12/99	0745	-14	4 gust 5	S	8/8	1000	1000	poor	poor	
13/12/99	1200	-11	2	E	5/8	2000	5000	fair	fair	
13/12/99	2030	-12	0	---	5/8	1800	2000	good	good	
14/12/99	0700	-14	4 gust 7	NW	2/8	4000	8000	good	good	
14/12/99	0900	-14	10 gust 12	W	1/8	>4000	8000	good	good	
27/12/99	0700	-11	1 gust 4	NW	6/8	>2000	8000	good	good	
27/12/99	0900	-10	3 gust 5	NW	7/8	2000	>10000	fair	good	
28/12/99	0700	-12	8 gust 12	SW	2/8	>3000	8000	good	good	
28/12/99	1000	-10	10 gust 12	SW	3/8	>2000	8000	good	good	

The weather at Allan Hills during the 1999-2000 season did not overly hinder our party movements and decisions. Given the geological nature of our work, the only significant restricting weather condition was wind. The average wind speed over the entire field season was approximately 8-12 knots, but daily conditions fluctuated considerably about this mean, with the strongest winds exceeding 50 knots (the maximum limit readable by our anemometer). On windy days (25 knots gusting 30 knots) it became quite uncomfortable to remain standing at an outcrop for more than an hour even when wearing full ECW gear because our hands got cold. Nosewiper mitts were not useful because they were too cumbersome. During extreme weather conditions event members simply pursued tasks which were less susceptible. For the first couple of weeks the temperature was commonly –21 to –17°C. It gradually warmed to daily averages in the –12 to –8 °C range around Christmas and New Year's before slowly decreasing to –16 to –12°C by the time we left on January 21, 2000.

Particular note should be made here about weather conditions in Trudge Valley. It is windier there than Camp Valley and in its eastern half, the dominant wind direction is *easterly*, not southerly as it is in the rest of Allan Hills. This had a significant impact on the activities of the inhabitant(s) of Beta Camp, located there from Jan 4 – 20, 2000. This information should be passed on to subsequent parties that intend to camp in Trudge Valley.

10 **Accidents, incidents or hazards**

No accidents or incidents occurred to K042 event members during the 1999-2000 field season.

11 **Field Equipment**

Comment (if appropriate) on any of the following:

iThe quality, suitability and performance of field clothing issued to you by Antarctica New Zealand;

In general the suitability and performance of the field clothing issued to us by ANZ were excellent. Our fieldsite is at 1600 m elevation and experiences high winds. The clothing supplied to us enabled us work well in the field despite these conditions.

One nosewiper mitt was lost during high winds, and one leather glove was misplaced (P. Cleary was notified of these losses upon our return to Scott Base). The clothing we returned endured reasonable wear and tear during our field season and will be useable again next season.

One recommendation would be that 'wind stopper' gloves (not nose wipers, but ones which allow dexterity) are made available for those persons working on or near the polar plateau.

ii The performance and design of tents, technical climbing equipment, kitchen gear and sledges;

We were issued Polar tents, Olympus tents and an Endura tent. The Polar tents were excellent (and quite new). I would not be content to live at our fieldsite in any other tent. One of our event members slept in an Olympus tent and found it to be a very noisy due to it flapping in the wind even though it was oriented correctly with respect to the prevailing wind direction and dug down 40 cm into the snow with a snow wall built to protect it. We had the Endura tent for only a few days, but really appreciated its roominess compared to Polar tents. It is not an easy tent to erect.

Of all of this gear, only one crampon and two rubber seals for the thermoses failed during the field season.

iii The 20 person day ration box system; detail suggestions to improve the packaging of items or improve palatability and calorific value. Comment on Scott Base diet;

The 20 person day ration box system provides good food and good nutrition and we do not have any major problems with it. It should be noted however that many of the Bumper Bars were up to two years over their expiry dates and did not taste very good. In addition, we suggest the following changes: increase the number of Raro packages in each box by 50%, decrease the amount of margarine in each box – we used about 10% of what was given to us, decrease the number of soup packages in each box.

With regard to Scott Base, the diet there was great. Andrew was a fantastic chef and I hope he's there again next year. Chris was a pretty good cook too.

In all cases fully explain any modification made by you to this equipment during the season. Indicate the general condition of items returned to Scott Base and report any lost equipment.

Positive suggestions are encouraged for improvement to all equipment.

12 Radio Communications

i Report on the suitability and effectiveness of the radio equipment issued to you at Scott Base. Comment on battery power, condition of aerials and utilisation of solar panels.

We had two separate radio setups: an HF unit to communicate with Scott Base and two handheld VHF units for communicating line-of-sight amongst ourselves. We were supplied with a double 12 V battery to power the HF radio and we found the 'B' battery to be much more reliable than the 'A' battery. When using the 'A' battery our radio would often cut out (lose all power) during a radio sked and we would have to quickly switch to battery 'B'. The VHF units worked quite well. The solar panels kept the batteries well charged. During the last couple of weeks a wind storm broke the wire part of our HF aerial (without snapping the plastic casing) causing increased difficulty in contacting Scott Base. We didn't know the aerial was broken until we dismantled the camp at the end of the season.

We feel that a **very** useful addition to the radio kit would be an inexpensive voltmeter so that we can tell how well our batteries are charged. This would be especially useful for the VHF batteries because their charges last for such a short time.

ii Report on reception/transmission conditions and suitability of radio sked timing. Note particularly any periods during your field trip, or regions you visited, where radio reception was especially bad or unexpectedly good. Comment on conditions where repeater stations were used.

In general our communications with Scott Base were loud and clear. We feel that it is not necessary to sked with Scott Base every 12 hours and feel that a sked every 24 hours would suffice.

iii Comment on Scott Base's general efficiency during radio skeds in providing details of forthcoming field movements (eg helicopters), weather forecasts, resupply, or news service.

Scott Base's general efficiency in providing information during skeds was fine. We very much appreciated the relaxed and chatty approach of two radio operators, Matt and Stephen. We were in the field for quite a while and it was really nice to be able to talk to someone on the radio and have them read the headlines and the sports news to us. We also thought it was great that they would read jokes to us as well. It put us in good spirits.

We found that there were some considerable miscommunications between us and the Operations Manager, Peter Cleary, with regard to helo lift capabilities and cargo. An example was when four of our event members were returned to Scott Base. We had previously confirmed with Peter that while the helo was at our field site we would use it to fly to the top of a nearby peak (Mt. Brooke) to investigate findings from a previous group. Peter advised us that the helo could only take four persons and no cargo to the peak because of the elevation. Once the helo arrived, the pilots assured us that they could take the four persons and the full amount of retro cargo (approx. 800 lbs) to the top of the peak and then continue on to Scott Base without a problem. Had we known this we could have left the cargo and taken six persons up instead. We realise the position of Antarctica New Zealand and the Operations Manager in dealing with field party safety, but feel that Peter is overly and restrictively cautious in allowing the movements of persons in the field with regard to air transport.

iv Remember that you are strongly encouraged to keep a detailed radio log while in the field, in particular if you are a deep field party. The log is to be given to the Operations Manager when returning your radio at Scott Base. Such a log can become a vital and lifesaving source of information in the event of a Search & Rescue operation and can become an important LEGAL document.

We wish to point out that at no point during our orientation at Scott Base were we recommended to keep a detailed radio log while in the field.

We feel that as part of the orientation it would be very beneficial to have a briefing from the Comms Operators to orient all event members with proper radio procedure. Although we did not experience any significant difficulties during our field season, all our knowledge relating to this came from the field manual. The meeting would also serve the purpose of allowing field event members to get to know the Comms Ops since they are the only outside people that we will have any contact with for the next couple of months.

13 Scott Base and Arrival Heights Laboratory Facilities

We did not use any of the Scott Base or Arrival Heights laboratory facilities.

14 Refuge and Research Huts

We did not occupy any United States or New Zealand (or any other) refuge or research huts.

15 Environmental Impact

Information from this section helps us to assess the environmental (including cumulative) impacts and overall environmental performance of New Zealand's activities each year. This reporting is a requirement of the legislation which implements the Protocol on Environmental Protection to the Antarctic Treaty in New Zealand. It also forms the basis for annual input into Antarctica New Zealand's environmental database. Please be as specific as possible. For locations occupied, provide the site or protected area name, and GPS coordinates or map references where appropriate.

i. From your event diary, please summarise for <u>each site visit made</u>:

- ***Location (for field camps please give coordinates)***
- ***Dates occupied***
- ***Total days (or part days) spent at site***
- ***Maximum number of people at site***
- ***Total person-days spent at site (e.g. 5 people on site for 3 days = 15 person days)***
- ***Main activity undertaken (e.g. soil sampling, penguin census, hut maintenance)***

If possible, please provide a map of the sites visited, particularly for any rarely visited sites which may not be in the database. For field camps, indicate whether an existing campsite was used.

1) Site 1: *location* - Camp Valley (76°41'42" S, 159°39'36" E); *occupied* - 20/11/99 to 21/01/00; *total days* – 63; *maximum personnel* – 7; *total person-days* - 217; *activities* - geological mapping, outcrop description and rock sampling.

2) Site 2: *location* - Trudge Valley (Beta camp) (approx. 76°42'18" S, 159°47'24" E); *occupied* - 4/01/00 – 20/01/00; *total days* – 17; *maximum personnel* – 2; *total person-days* – 20; *activities* - geological mapping, outcrop description and rock sampling.

ii. For any protected areas visited (including historic huts), provide details of:

No protected areas were visited.

iii. Detail any interference with terrestrial, freshwater or marine plants or animals or animal parts (e.g. shells, bones, feathers etc). For <u>each site and/or species</u> sampled or disturbed, provide:

No animals or animal parts were sampled or disturbed.

iv. Detail any collection of geological material (including meteorites, ventifacts, fossils or sub-fossils) or soil. For <u>each sample</u> (or group of samples) taken describe the location, specimen type and quantity in kg.

<u>VUW</u>

40 samples in total were taken.

Location	# of	Type	Total mass (kg)

	samples		
outcrop in Camp valley	3	rock	8
outcrop on platform northwest of Camp valley	2	rock	5
outcrop on platform west of Camp valley	2	rock	5
outcrop in Camp valley	2	rock	5
outcrop on ridge on west side of central Allan Hills	1	rock	3
outcrops in south central Allan Hills	4	rock	10
outcrop on ridge on west side of central Allan Hills	4	rock	10
outcrop on lower north flank of Trudge valley	1	rock	3
south end of Trudge valley floor	1	rock	3
floor of valley at edge of ice cliff imm. south of Trudge valley	3	rock	8
outcrop on rim of gully in southeast corner of Trudge valley	3	rock	8
outcrop in gully in southwest corner of Trudge valley	2	rock	5
outcrop on rim of gully in southeast corner of Trudge valley	4	rock	10
outcrop on north flank of Trudge valley	4	rock	10
small outcrop in cirque on south flank of Trudge valley	1	rock	3
outcrop in gully in southwest corner of Trudge valley	3	rock	8

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All samples taken, both from the Allan Hills and Taylor Valley, were thought to be glacial diamicts. The combined weight was 259 lbs. The table below lists the majority of samples taken in the Allan Hills only and their respective triangulation (an in some cases GPS) result. Cairns were placed at all these sights. A more complete table will be available upon request.

Sample Name	Site Name	Orientation of Sample	No. of photos taken	Triangulation result	GPS File Number
MS-11 (99) BS-11 (99)	JH8B	Outfacing: WNW	11	Warren Peak: 106^{0}E Watter's Peak: 177^{0}S Tepee Peak: 349^{0}N	
MS-12 (99) BS-12 (99)	JH8A	Outfacing: WNW	6	Warren Peak: 108^{0}E Watter's Peak: 173^{0}S Tepee Peak: 343^0 N(WN)	
MS-13 (99) BS-13 (99)	PH2	Outfacing: W (258^0)	4	Warren Peak: 105^{0}E Watter's Peak: 173^{0}S Tepee Peak: 154^{0}W	
MS-14 (00) BS-14 (00)	JH10	Outfacing: NE (029^0)	11	Warren Peak: 088^{0}E Watter's Peak: 177^{0}S Tepee Peak: 321^0 NW	R121700B
MS-15 (00) BS-15 (00)	JH7D/PH1	Outfacing: ESE (117^0)	9	Warren Peak: 091^{0}E Watter's Peak: 174^{0}S Tepee Peak: 290^0 WNW	R121700A

MS-16 (00) BS-16 (00)	JH7D/PH1	Outfacing: SE (149°)[1]	10	Warren Peak: 091°E Watter's Peak: 174°S Tepee Peak: 290° WNW	R121700A
MS-17 (00) BS-17 (00)	JH7C	Outfacing: SE (130°)	8	Warren Peak: 086°E Watter's Peak: 169°S Tepee Peak: 352°N	
MS-18 (00) BS-18 (00)	AH1	Outfacing: E (101°)	6	Warren Peak: 088°E Watter's Peak: 170°S Tepee Peak: 340°N	
MS-19 (00) BS-19 (00)	JH7A/PH3	Outfacing: ESE (116°)	6	Warren Peak: 081°E Watter's Peak: 171°S Tepee Peak: 358°N	
*	JH7B/PH3		2	Warren Peak: 086°E Watter's Peak: 177°S Tepee Peak: 355°N	
MS-20 (00) BS-20 (00)	JH5A(?)	Outfacing: ESE (116°)	6	Warren Peak: 077°E Watter's Peak: 172.5°S Tepee Peak: 353°N	
MS-21 (00) (I)	JH5B	Outfacing: ESE (121°)	5	Warren Peak: 086°E Watter's Peak: 169°S Tepee Peak: 000°N	
MS-21 (00) (IIa) BS-21 (00)	JH5B	Outfacing: ESE (121°)[2]	included in above	Warren Peak: 086°E Watter's Peak: 169°S Tepee Peak: 000°N	
MS-21 (00) (IIb) BS-21 (00)	JH5B	Outfacing: ESE (121°)[2]	included in above	Warren Peak: 086°E Watter's Peak: 169°S Tepee Peak: 000°N	
MS-22 (00) BS-22 (00)	JH5C	Outfacing: SE (148°)	3	Warren Peak: 082°E Watter's Peak: 169°S Tepee Peak: 354°N	
MS-23 (00) BS-23 (00)	JH5C	Outfacing: SW (215°)[3]	4	Warren Peak: 082°E Watter's Peak: 169°S Tepee Peak: 354°N	
MS-24 (00) BS-24 (00)	JH4	2 Outfacing: SE (122°) & S (199°)	4	Warren Peak: 082°E Watter's Peak: 178°S Tepee Peak: 350°N	
MS-25 (00) BS-25 (00)	JH6A/PH5	2 Outfacing: NWN (300°) & SWS (208°)	5	Warren Peak: 079°E Watter's Peak: 182°S Tepee Peak: 350°N	R121623A (Rubbish Language too)
MS-26 (00) BS-26 (00)	JH6B	Outfacing: WSW (349°)	3	Warren Peak: 082°E Watter's Peak: 180°S Tepee Peak: 351°N	R121623A (Rubbish Language too)
MS-27 (00) BS-27 (00)	JH6C/PH4	Outfacing: SW (243°)	7	Warren Peak: 070°ENE Watter's Peak: 165°S Tepee Peak: 356°N	R121623A
MS-28 (00) BS-28 (00)	JH9A	Outfacing: E (071°)	3	Warren Peak: 088° E Watter's Peak: 187°S Tepee Peak: 343°N	R121622B
MS-29 (00) BS-29 (00)	JH9B	Outfacing: E (084°)	6	Warren Peak: 089°E Watter's Peak: 192°S Tepee Peak: 342°N	
MS-30 (00) BS-30 (00)	JH9C	Outfacing: E (115°)	3	Warren Peak: 090°E Watter's Peak: 189°S Tepee Peak: 341°N	R121622B
MS-31 (00) BS-31 (00)	AH2	Outfacing: NW (338°)	3	Warren Peak: 106°E Watter's Peak: 184°S Tepee Peak: 344°W	
MS-34 (00) BS-34 (00)[4]	PH6	Outfacing: W (284°)	2	Warren Peak: 038°NE Odell Central Island Peak: 125°SE Watter's Peak: 266°W	
MS-33 (00) BS-33 (00)[5]	PH6	Outfacing: W (289°)	1	Warren Peak: 038°NE Odell Central Island Peak: 125°SE Watter's Peak: 266°W	
MS-32 (00) BS-32 (00)[6]	PH6	Outfacing: W (283°)	1	Warren Peak: 038°NE Odell Central Island Peak: 125°SE Watter's Peak: 266°W	
MS-35 (00) (I)	AH10	Outfacing: SWS (204°)	2	Warren Peak: 045°NE Watter's Peak: 257°W	

[1] Sample is on a dip of 41° from the vertical to the ESE

[2] Sample is on a dip of 330 from South to North

[3] MS-23(00) is adjacent to MS-22(00)

[4] Highest grey layer

[5] 2nd down from top pink layer

[6] Lowest grey layer

BS-35 (00)				Tepee Peak: 343^{0}NWN	
MS-35 (00) (II) BS-35 (00)	AH10	Outfacing: SWS (204^{0})	included in above	Warren Peak: 045^{0}NE Watter's Peak: 257^{0}W Tepee Peak: 343^{0}NWN	
MS-36 (00) BS-36 (00)	AH11	Outfacing: N (343^{0})[7]	4	Warren Peak: 048^{0}NE Watter's Peak: 247^{0}SW Tepee Peak: 340^{0}N	
MS-37 (00) BS-37 (00)	PH8	Outfacing: SW (233^{0})	3	Odell Central Island Peak: 169^{0}S Watter's Peak: 239^{0}SW Southern Welsh Peak: 338^{0}NW	
MS-38 (00) BS-38 (00)	AH12	Outfacing: NE (027^{0})	3	Odell Central Island Peak: 151^{0}SE Welsh Peak: 028^{0}NE Tepee Peak: 335^{0}NW	
*	JH1	Exposure Outfacing SE (144^{0})	1	Warren Peak: 079^{0}E Odell Central Island Peak: 143^{0}SE Watter's Peak: 205^{0}SWS	Phil has results
MS-39 (00) BS-39 (00)	AH13	Outfacing: SE (131^{0})	1	Warren Peak:079^{0}E Odell Central Island Peak: 143^{0}SE Watter's Peak: 206^{0}SWS	
*	JH2B	Exposure Outfacing NW (307^{0})	3	Warren Peak: 089^{0}E Watter's Peak: 209^{0}SWS Tepee Peak: 343^{0}N	Phil has results (is also the same for JH2A)
MS-42 (00) BS-42 (00)	JH2A/PH7	Outfacing: NW (326^{0}) & SW (335^{0})	1	Warren Peak: 079^{0}ENE Watter's Peak: 216^{0}SW Tepee Peak: 340^{0}NWN	Phil has results (is also the same for JH2B)
MS-41 (00) BS-41 (00)	JH2A/PH7	Outfacing: W (285^{0})	1	Warren Peak: 079^{0}ENE Watter's Peak: 216^{0}SW Tepee Peak: 340^{0}NWN	Phil has results (is also the same for JH2B)
MS-42 (00) BS-42 (00)	JH2A/PH7	Outfacing: W (264^{0})	5	Warren Peak: 079^{0}ENE Watter's Peak: 216^{0}SW Tepee Peak: 340^{0}NWN	Phil has results (is also the same for JH2B)
MS-43 (00) BS-43 (00)	AH14	Outfacing: SW (227^{0})	1	Most N. Peak on Eastern Limb: 009^{0}N Watter's Peak: 213^{0}SW Tepee Peak: 283^{0}W	
MS-44 (00) BS-44 (00)	AH14	Outfacing: W	1	Most N. Peak on Eastern Limb: 009^{0}N Watter's Peak: 213^{0}SW Tepee Peak: 283^{0}W	
MS-45 (00) BS-45 (00)	AH15	Outfacing: N (015^{0})	2	SEE JM	

v. For each chemical (including radionucleides) taken to Antarctica, provide details of the chemical form and quantity and locations of use. Include details of use of fuel, paints, solvents etc in the field. If unused chemicals were not returned to New Zealand, provide details of location and quantities of material released or stored.

No chemicals or radionucleides were taken to Antarctica.

vi. Detail any use of explosives in Antarctica, including:

- ***Date***
- ***Locations of use***
- ***Explosive type***
- ***Size of charge (kg)***
- ***Number exploded***

No explosives were used in Antarctica.

vii. Detail importation to Antarctica of any animals, plants (including any seeds), micro-organisms or soil, including any inadvertent introductions. Note the name and quantity of the species or substance(s), all the locations they were taken to, and whether they have been returned to New Zealand.

No animals, plants, micro-organisms or soil were imported into Antarctica.

[7] Exposure is facing 2920WNW

viii. List any equipment, markers, stakes or cairns installed in the field during your visit. If any remain in the field, provide details of the location, size and number of items. Note any plans for their retrieval, including the date they will be removed.

After receiving permission over the radio from Antarctica New Zealand (Emma Waterhouse), we left two 60 L drums of kerosene at our main camp in Camp valley. The drums were strapped together and placed upright in a spill-tray. Neither drum had been opened. The kerosene will be used by our party next year.

Lloyd-Davies erected cairns as he outlined in his sample list above. These cairns will be dismantled at the end of the 2000/2001 season.

ix. Provide details of any other environmental impacts of your activities including disturbance by trampling, sampling, use of vehicles (including aircraft), camp operations (including waste disposal), installation of equipment and buildings and/or cumulative impacts.

> ***Note any incidents which occurred or were observed (e.g. fuel spills, wildlife disturbance, inappropriate vehicle or aircraft use) and what reports or records have been made. If unreported, detail the date, time, location and nature of incident, and any action taken.***

We did not experience any fuel spills or any other event which would produce an environmental impact. We pitched our tents on snow patches and removed all equipment with the exception noted above.

x. If the activities described above differ from the Preliminary Environmental Evaluation (PEE) completed for this event (and any approved changes), or from the Environmental Authorisation issued to it, explain how and why they differed.

None.

16 Historic Sites

Detail any visit to a designated 'historic site' in the Ross Dependency and include any general observations about the condition of the site, in particular, note any damage.

We did not have the opportunity to visit any historic sites.

17 Management of Science in the Ross Dependency

Comment on the forward planning of your Antarctic science programme, especially relating to your field of research. Comment on Antarctica New Zealand's ability to cater for your type of work both at Scott Base and in the field.

Our future plans are to return to Allan Hills for the 2000/2001 field season and continue outcrop investigation. We are also hoping to drill and retrieve core of patches of Sirius Group that are not well exposed. We were fully satisfied with the support we received from Antarctica New Zealand both at Scott Base and in the field. Again, we benefited greatly from the willingness of the Scott Base staff to help us far beyond the scope of their specific jobs. We feel it is important for Antarctica New Zealand to fully appreciate this when assessing the success of the New Zealand Antarctic program.

Comment on the involvement of any overseas scientists or students in your event, including the benefits and contribution gained by their participation in your programme.

This event exists because of international cooperation, initially between Swiss and New Zealand researchers, and then later between Holland and New Zealand. With the introduction of Hicock as Holme's Canadian co-supervisor, the international scope of the program was broadened further. This cooperation has brought different and complementary expertise together, greatly enhancing the depth and scope of the science conducted as part of the K042 Event.

Finally, identify any areas where management is required to protect areas of outstanding scientific, environmental, aesthetic or wilderness values. Note that you are able to propose any such area for protection under the Environmental Protocol.

During our stay at Allan Hills, we discovered an equipment cache at the east end of Trudge Valley which we believe to have been left behind by a 1972 expedition. We notified Scott Base (Peter Cleary) and asked what should be done with it, but no decision was made before we returned to Scott Base in January. The cache consists of three or four wooden boxes (at least one of which contains food), three metal fuel canisters and an old, tatty pair of mountaineering boots. In addition there are many (perhaps twenty) rusty tin cans and other bits of trash tucked under nearby rocks. We suggest that the tin cans and other garbage be cleaned up but that the main cache be left for its historical significance. The site does not detract from the surrounding landscape and is in fact very difficult to spot. We only discovered it when one of our members happened to walk within about 10 m of it. We do not feel that there is any environmental danger from the site either because the fuel containers appeared empty.

18 Antarctic Geographic Place Names

Jaap van der Meer of the University of Amsterdam wishes to propose names for two features at Allan Hills. He will be preparing this proposal himself.

K042
1999/2000

IMMEDIATE SCIENCE REPORT

Event K042 Glacial History of the East Antarctic Ice Sheet at Allan Hills

ANTARCTICA NEW ZEALAND 1999/2000

Event Personnel :

Prof. Peter Barrett	(Victoria University of Wellington)
Dr. Stephen Hicock	(University of Western Ontario)
Philip Holme	(Victoria University of Wellington)
Jeremy Mitchell	(Victoria University of Wellington)
Cliff Atkins	(Victoria University of Wellington)
Prof. Jaap van der Meer	(University of Amsterdam)
Mark Lloyd-Davies	(University of Amsterdam)

ANTARCTICA NEW ZEALAND REPORT NO 1:
IMMEDIATE SCIENTIFIC REPORT

Note: this document reports on the activities of two coincident studies conducted under the K042 event. Where necessary for clarity, details and comments for the two studies will be presented separately.

1 Popular Summary of Scientific Work Achieved

VUW

This project is a detailed study of ancient glacial deposits termed the Sirius Group at Allan Hills, Southern Victoria Land, Antarctica. The Sirius Group is a collection of Neogene deposits that crop out at high elevations (mostly >1500 m) throughout the Transantarctic Mountains (TAM). Allan Hills occupies a low point in the TAM, making the site more susceptible to overriding by the EAIS during minor volume fluctuations. The aim of this project is to show whether the Sirius Group was deposited by valley glacier or continental ice sheet, by wet- or dry-based glacial ice, by a single depositional event or several overriding events and to determine paleoflow direction.

This past field season ran from mid-November 1999 to mid-January 2000 at Allan Hills during which time field mapping of early glacial deposits was continued from last season. The Sirius Group takes the form of seven patches of thin debris with a total area of 2 km^2. From these, eight outcrops were selected for detailed description and sampling. The collected data include: orientations of 300 stones, 270 linear glacial abrasions and 90 planar deformational structures. In addition, 37 rock samples were collected for laboratory analysis. Sample processing has not yet begun but evidence indicates wet-based glacial deposition. Although the number of advances is not yet known, the work thus far suggests flow from the southwest and west. The presence of a cirque incised into a surface capped with Sirius deposits on the south side of Trudge Valley reveals a later phase of local temperate ice before the present cold ice sheet formed.

Univ. of Amsterdam

Allan Hills

Research objectives that are of interest to the University of Amsterdam are three fold. Firstly, description and quantification of glacio-tectonised bedrock from 'Sirius' related glaciations. Research of these features further understanding into the character and form of previous glacial overriding in the Allan Hills nunatak, as well as provides indicators for paleo ice flow direction. Secondly, the collection of Sirius diamict samples for analysis using the technique micromorphology. Micromorphology has proved to be a useful tool in distinguishing between glacial diamicts of different origins world-wide. It is envisaged that micromorphology analysis of these Sirius samples will contribute towards understanding the character and regime of the Sirius glaciation(s). A bulk texture analysis sample was also taken in concert with every micromorphology sample. Thirdly, an objective that was only realised once in the field is the description and quantification of glacio-tectonised bedrock from a recent (non-Sirius) advance of the local Manhaul glacier. Furthermore, a diamict associated with these glacio-tectonised bedrock features was collected for micromorphology (and bulk texture) analysis so to provide an *in situ* investigation of the only non-Sirius glacial diamict found in the Allan Hills thus far.

Taylor Valley

Three spatially variable micromorphology samples taken from a discontinuous moraine linear ridge at Taylor glacier snout will provide hitherto unknown information on the microstructures of this deposition feature and help resolve the process(es) behind its formation and hence identity. Additional samples were removed from the compact debris-laden basal layer of Taylor glacier to allow *in situ* textural and structural analysis, by micromorphology, of this subglacial environment.

2 Proposed Programme

VUW

The principal objectives of this season's work were as follows:

1) to complete geological mapping of the Sirius Group at Allan Hills begun during the 1998-1999 season
2) to study deposits of the Sirius Group for the purpose of interpreting the nature of the ice that deposited it
3) to select sites for drilling to be conducted during 2000-2001 season

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1) Build upon research carried out by Hiemstra and van der Meer (1999) in their field report for the Netherlands Centre for Geo-ecological research titled: *Neogene Glacial History of the Allan Hills, South Victoria Land, Antarctica*. This would include quantification of Sirius related glacio-tectonic bedrock deformation structures and further descriptions and sketches.
2) Collect spatially and stratigraphically variable Sirius diamict samples for analyses by micromorphology. Wherever these micromorphology samples are taken, a small sample will also be taken for bulk texture analysis. Determine whether this is possible with a University of Amsterdam hand held drill or by simply removing a block of diamict using a chisel and geological hammer.
3) Describe, sketch and quantify glacio-tectonic deformation of bedrock related to a recent advance of the Manhaul glacier. Collect spatially variable samples of Manhaul glacial diamict associated with the glacio-tectonic deformed bedrock for analysis by micromorphology. Wherever these micromorphology samples are taken, a small sample will also be taken for bulk texture analysis.
4) Collect samples of 'sublimation till' from the snout of Taylor glacier and Suess glacier, Taylor Valley for analysis by micromorphology.
5) Collect samples from the debris-laden basal layer of Taylor glacier itself for micromorphology analysis.
6) Determine the practicality of undertaking pre-impregnation of unconsolidated sediments in the Antarctic field, with daily temperatures considerably below zero.

3 Scientific Endeavours and Achievements

VUW

The study involved collaboration with Dr. Stephen Hicock, an associate professor at the University of Western Ontario in Canada. A concurrent study was done by Mark Lloyd-Davies, a Dutch student under the supervision of Dr. Jaap van der Meer based at the University of Amsterdam. Lloyd-Davies studied micro-scale subglacial deformational features of the Sirius Group at several sites including Allan Hills. Jeremy Mitchell conducted a study of ridge sets at Allan Hills for the purpose of determining their depositional agent(s).

The main focus of the work at Allan Hills was the investigation of Sirius Group deposits. The initial tasks in this continuing investigation were to conduct reconnaissance (recce) to familiarise ourselves with the area and then continue the mapping of Sirius distribution begun the previous season. During this time major outcrops were selected for later detailed investigation. These recces proved to be very fruitful as much was learned about the glacial deposits and they provided an opportunity to examine the variety of diamicts found in the area. As additional event members arrived, detailed studies of outcrops began and continued until the end of the season. Data collected from the outcrop and mapping work include the following: orientational measurements of 300 clasts and 90 deformational features in the Sirius Group at both measured outcrops and stop locations, recorded orientations on 270 abraded (striated) and faceted clasts throughout the study area, collected 37 rock samples for lab analysis.

Recent glacial deposits near the edge of the Manhaul Glacier discovered by Barrett and Atkins during the 1997-1998 field season were studied in more detail this season. This study was the focus of Atkins, while Barrett, Hicock and Holme contributed expertise as well. The study of these deposits was a major focus for van der Meer and Lloyd-Davies as they outline below. Glacial abrasions on bedrock and stone surfaces were documented and their orientations measured. These deposits occur as sparse patches of crushed and comminuted the underlying Beacon Supergroup. This work included delimiting the southern extent of the deposits in central Allan Hills using differentially corrected GPS. A benefit of mapping the distribution of these deposits was establishing their stratigraphic relationship to the Sirius Group.

Most fieldwork was conducted using standard geological field tools (eg. geological hammers, compasses, cameras) with the exception of a Trimble GPS rover unit to which we had access for three days. The GPS rover unit operated adequately in the cold conditions with shortened battery life being the only significant impact of the cold environment on the system.

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From the Allan Hills 50 diamicts were collected for analysis by micromorphology. 10 of these are thought to be related to the advance of the Manhaul glacier, 32 to the Sirius glaciation(s) and the remaining 8 the author, at this stage, is unsure of. The 50 samples came from 40 different sites identified, all of which were triangulated, photographed and given a context description. A table appendix of samples collected can be provided upon request. Where appropriate glacio-tectonised bedrock fractures were quantified using strike and dip measurements. Some of the sites included those described by Hiemstra from field season 1998-1999 and others from sites logged and sampled in depth by Holme during field season 1999-2000.

22 sketches were drawn of glacio-tectonic bedrock deformation thought to be related to the advance of the Manhaul glacier. All the sites, representing variation in both spatial distribution and scales of deformation, were photographed and described with principle fractures quantified by strike and dip measurements.

Finally, in addition to the above, general notes related to observations on geomorphological processes occurring throughout the Allan Hills were taken, although these were on an *ad hoc* basis.

In terms of field methodology, the hand held drill transported from the University of Amsterdam proved ineffective in sampling Sirius glacial diamicts. However owed to the semi-lithified status of many of the Sirius glacial diamicts, the samples could be aptly sampled and orientated using a chisel and geological hammer. With practice this also became possible for the more unconsolidated diamict related to the Manhaul glacier advance.

A principal method developed was using a pre-impregnation technique for samples collected from both the Allan Hills and Taylor Valley. This pre-impregnation technique has been used before in the field, but never at temperatures considerably below zero or upon samples as unconsolidated as those collected in Taylor Valley. All pre-impregnation took place in the Allan Hills. It was found that the samples did pre-impregnate satisfactorily using a 50:50 mixture of acetone and varnish, the difference from the cold being that complete pre-impregnation took 3 to 4 days opposed to the usual 24 hours. Secondly, improvisation was used when pre-impregnating the very unconsolidated samples. Pieces of cardboard were cut out in the same dimensions as the samples, and elastic bands used to secure further the 'propping' action of the cardboard upon the samples. This was a crucial requirement when the supporting micromorphology tin was removed from the sample. All of the samples were labelled and orientated using a piece of paper placed upon their surface and once the samples had been pre-impregnated they were placed in a sample bag and wrapped in brown tape. The brown tape also had the sample name and orientations written on it, and the sample was then placed in bubble wrap and wrapped once again in brown tape. Lastly, the sample field number and orientations were labelled as beforehand. A combination of pre-impregnation and tight multi-layered wrapping insured that the unconsolidated samples maintained an *in situ* structure whilst in transit from the Allan Hills, south

Victoria Land to the University of Amsterdam. Recent production of thin sections, in the University of Amsterdam, from these samples collected in Taylor Valley has yielded satisfactory results. This demonstrates that the method outlined above may be employed in temperatures experienced upon the Antarctic polar plateau during at least December and January.

In Taylor Valley the 90km long Taylor glacier is an easterly flowing outlet of the East Antarctic Ice Sheet. It originates at Taylor Dome and terminates at an elevation of 50-60 metres within the Dry Valleys of South Victoria Land, Antarctica. The first objective was to take 3 micromorphology samples from a discontinuous linear moraine ridge found around the snout of Taylor glacier, the most prominent being a linear ridge up to 7 metres high and over 20 metres in length at the north eastern snout of Taylor glacier[1]. Characteristic features of the moraine are a loosely packed matrix that it is composed of predominantly well sorted fines. This, coupled with the presence of interstitial permanent ice in the majority of the moraine, and the extremely cold and arid conditions of Taylor Valley, has lead many to conclude that the moraine ridges are composed of sublimation till.

Melt out has been thought to be an alternative explanation for the deposition of this 'till'. The two processes are closely related except that sublimation is the direct transformation of ice to vapour, rather than the transformation of ice to water.

It is intended that the micromorphology samples will yield hitherto unknown information on the microstructures of this diamict and help resolve the process(es) behind its formation and hence identity.

Finally, 5 samples were removed from the debris-laden basal layer of Taylor glacier for analysis by micromorphology. Regions of the ice bed interface in Taylor glacier have been estimated to be at pressure melting point, whilst other areas have temperatures approaching -20^0C. The glacier contains a debris-laden basal layer, up to 5 m thick, comprising of laminated, dispersed and massive debris-laden ice. Clean glacier ice overlies this basal layer. Descriptions were made of both the debris-laden basal layer of Taylor glacier and Suess glacier so to provide a context setting for the micro-morphological samples taken. The *in situ* micromorphology samples taken from Taylor glacier will provide new information on the interaction of constituent sedimentary particles in the subglacial environment of a Dry Valley glacier.

4 Publications (planned)

Hiemstra, J.F., and van der Meer, J.J.M., Neogene Glacial History of the Allan Hills, Antarctica – Section Logs, ICG Report 99/3, 36 p.

Schluchter, C., and Tchudi, S., Surface age dates from Allan Hills (in prep).

Atkins, C.B., and Barrett, P.J., Allan Hills Project – field data from 1997-1999 (in prep for April 2000)

Paterson, M.C.H., Allan Hills Project – field data from 1998-1999 (in prep for April 2000)

Atkins, C.B., Barrett, P.J., et al. Striae and other features from a cold-based ice advance, Manhaul Glacier, Antarctica (in prep draft for March 2000).

Atkins, C.B., Holme, P.J., and Mitchell, J., Antarctic Data Series No 24, Holocene glacial data from 1999-00 (in prep for April 2000).

Holme, P.J., Antarctic Data Series No 25, Sirius data from 1999-00. (in prep for June 2000)

Mitchell, J., Antarctic Data Series No 23, Ridge sets from 1999-00. (in prep for August 2000)

Mitchell, J., et al., Gravel-capped ridges in a polar desert – observations and possible origin (in prep draft for August 2000).

5 Acknowledgements

VUW

[1] An additional weekend also provided the opportunity to take 2 samples from a moraine ridge at the snout of Suess glacier.

We are grateful to Antarctica New Zealand and the Victoria University of Wellington for their funding of our research and to the staff of Scott Base for their logistical support.

Univ. of Amsterdam

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The kind hospitality, support and guidance provided by Sean Fitzsimons and his K064 team, from the University of Otago is also gratefully acknowledged. Furthermore useful discussion and ideas provided by Professor Peter Barrett and Mr Cliff Atkins of Victoria University of Wellington and Dr Stephen Hicock from the University of Western Ontario are thankfully acknowledged.

I would also like to gratefully acknowledge the support, aid and recommendations for research from Dr Jaap van der Meer, my supervisor, before and during the field season.

Finally, the academic, field and social environment provided by Mr Philip Holme and Mr Jeremy Mitchell both from the Victoria University of Wellington were invaluable in making such a long field season a successful, productive and enjoyable one.