TECHNICAL REPORT 5
Antarctic Geodesy
Summer 2000 – 2001

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CONTENTS

1. Introduction

The 2000/2001 Antarctic Geodesy Summer Program consisted of a number of distinct components. They include:

- ARGN reference mark surveys at Mawson and Davis.
- Orthometric height connections between the Mawson ARGN site (AUS064) and the Mawson TGBM (AUS258)
- Orthometric height connections between the Davis ARGN site (AUS099) and the Davis TGBM (AUS186)
- Connection by GPS to the Tide Gauge Benchmarks at Mawson, Davis and Larsemann Hills
- Strengthen the Australian Antarctic Geodetic Network with GPS observations where possible
- Establish a permanent Australian monument and connection to existing Chinese monuments in the Grove Mountains
- Connect to Russian and Chinese Geodetic control points in the Larsemann Hills vicinity for datum unification
- Derive ellipsoidal heights for lake benchmarks in the Vestfold hills for the purpose of developing a geometric geoid model for that area.

The following report details the work completed in the 2000/2001 summer season, by AUSLIG geodetic surveyors, Gary Johnston and Paul Digney between November 2000 and March 2001.

2. ARGN Reference Mark Surveys at Mawson and Davis

2.1 Mawson AUS064 – Local Monitoring Survey Report

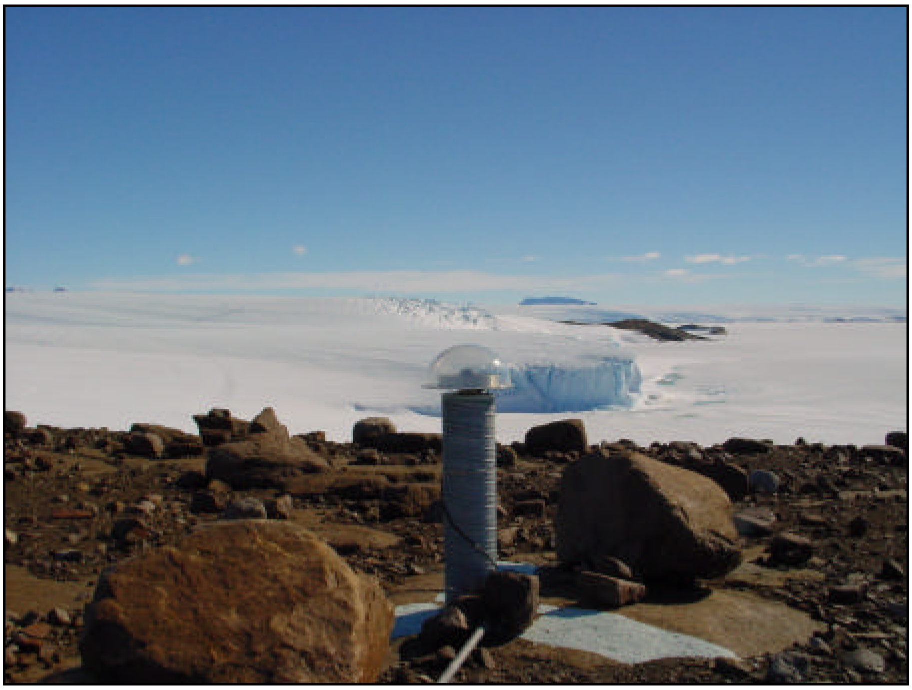

Figure 2.1.1. Photo of the ARGM mark (AUS064) at Mawson Station

This local monitoring survey was conducted at the Mawson Station ARGN site on December 6th 2000.

2.1.1 Survey Results

The Reference Mark survey was performed using a Leica TC2003 Total Station and a set of 3 Leica Precision Prisms. These instruments were used to observe all horizontal and vertical angles and slope distances. Marks were levelled using a Topcon DL-101C Digital Level and fibreglass staff.

All reduced distance observations were corrected for temperature, humidity and pressure. The observations were then processed by the least squares adjustment program GEOLAB to determine final coordinates, and also to evaluate the quality of the measurements. The network was fixed using the known coordinates of AUS064 and the observed RO (Bechervaise Island Trig).

2.1.2 Datum

AUS064 (MAW1) was fixed at its ITRF 2000 coordinate at an epoch of 2001. Accordingly the GRS80 ellipsoid has been adopted.

The adjusted mark coordinates for the survey are shown below:

2.1.3 Reference Mark Survey

Table 2.1.1 Latitude, Longitude and Ellipsoidal height and the associated standard deviation for the RM stations. GRS80 ellipsoid and ITRF2000 @20000.00 Co-ordinates adopted at AUS064 (MAW1).

Mark	**Latitude**	**Std Dev (m)**	**Longitude**	**Std Dev (m)**	**Ellipsoidal Height (m)**	**Std Dev (m)**
AUS064	-67° 36' 17.15923"	0.0000	62° 52' 14.57667"	0.0000	59.1460	0.0000
RM1	-67° 36' 17.95014"	0.0004	62°52' 14.07901"	0.0004	56.7786	0.0002
RM2	-67° 36' 17.53840"	0.0004	62° 52' 16.45657"	0.0004	58.6551	0.0002
RM3	-67° 36' 16.53205"	0.0005	62° 52' 13.27321"	0.0005	55.6890	0.0002

2.1.4 Levelling

The following table shows the results of the optical leveling of the Reference Marks and AUS064. The table indicates the three observed height differences determined between surveys in 1996 by contracted Antarctic Division Surveyors and AUSLIG Surveyors in December 2000.

Table 2.1.2 Height comparisons with previous surveys

AU064 to	Height Diff (AUSLIG 2000)	Height Diff (Ant Div 1996)	Difference (m)
RM1	-2.3662	-2.3654	**0.0008**
RM2	-0.4898	-0.4890	**-0.0008**
RM3	-3.4553	-3.4538	**-0.0015**

2.1.5 Discussion

The comparison of the data in Table 2.1.2 shows very good agreement, with height differences agreeing at the 1mm level.

Although there was an initial survey completed for the AUS064 pillar and associated RM's after construction in 1992, the comparisons of radial distances and derived coordinates are not good. Unfortunately the original field notes for the 1992 survey are not available for checking, as such the results of the 1992 survey were not used to compare against the 2000 survey. Therefore to determine horizontal movement of the pillar a second survey for this site will be required.

In summary the results tabulated above indicate there has been no vertical movement of AUS064, unfortunately there is no adequate data to make an assessment of the pillar's possible local horizontal movement.

Field Book References:

2000 Survey – AUSLIG Geodesy #35, AUSLIG Geodesy #38

2.2 Davis AUS099 – Local Monitoring Survey Report

Figure 2.2.1 Photo of the ARGN MArk (AUS099) at DAVIS Sation

This local monitoring survey was conducted at the Davis Station ARGN site on January 10th 2001.

2.2.1 Survey Results

The Reference Mark survey was performed using a Leica TC2003 Total Station and a set of 3 Leica Precision Prisms. These instruments were used to observe all horizontal and vertical angles and slope distances. Marks were levelled using a Topcon DL-101C Digital Level and fibreglass staff.

All reduced observations were corrected for temperature, humidity and pressure. The observations were then put into a least squares adjustment program – GEOLAB to determine final coordinates, and also to evaluate the quality of the measurements. The network was fixed using the known coordinates of AUS099 and AUS297.

2.2.2 Datum

AUS099 (DAV1) has been fixed at its ITRF 2000 coordinate at an epoch of 2001.
Accordingly the GRS80 ellipsoid has been adopted.

The adjusted mark coordinates for the survey are shown below:

2.2.3 Reference Mark Survey

Table 2.2.1 Latitude, Longitude and Ellipsoidal height and the associated standard deviation for the RM stations. GRS80 ellipsoid and ITRF2000 @2000.00 co-ordinates adopted at AUS099 (DAV1).

Mark	Latitude	Std Dev (m)	Longitude	Std Dev (m)	Ellipsoidal Height (m)	Std Dev (m)
AUS099	-68° 34’ 38.36207”	0.0000	77° 58’ 21.40903”	0.0000	44.4160	0.0000
RM1	-68° 34’ 36.94416”	0.0004	77° 58’ 21.69996”	0.0005	42.0894	0.0002
RM2	-68° 34’ 38.69741”	0.0003	77° 58’ 22.27440”	0.0003	43.9718	0.0001
RM3	-68° 34’ 38.63380”	0.0003	77° 58’ 21.17200”	0.0001	43.4684	0.0001

2.2.4 Levelling

The following table shows the results of the optical leveling of the Reference Marks and AUS064. The table indicates the three observed height differences determined between surveys in 1996 by contracted Antarctic Division Surveyors and AUSLIG Surveyors in January 2001.

Table 2.2.2 Heights comparisons with previous surveys

AU099 to.	Height Diff (AUSLIG 2001)	Height Diff (Ant Div 1996)	Difference (m)
RM1	-2.32710	-2.3270	**0.0001**
RM2	-0.4440	-0.4440	**0.0000**
RM3	-0.9485	-0.9480	**-0.0005**

2.2.5 Discussion

A comparison with the levelling data from 1996 shows very good agreement, with height differences agreeing at the sub-millimeter level.

Although there was an initial survey completed for the AUS099 Mark and associated reference marks in 1994/95, the original field notes and subsequent reduced coordinates for this survey are not available for checking. Therefore to determine horizontal movement of the pillar a second survey for this site will be required.

In summary the results tabulated above indicate there has been no vertical movement of AUS099, unfortunately there is no adequate data to make an assessment of the pillar’s possible local horizontal movement.

Field Book References:

2001 Survey – Auslig Geodesy #35

3. Report on Orthometric Levelling at Australian Antarctic Stations - Mawson and Davis 2000/2001

3.1 Adopted Technique

The technique that was adopted for the level connections at both Mawson and Davis Stations was “Leap-Frog” EDM Height Traversing. This method is a variant of the common technique of spirit levelling, where the differences in height between change points are determined using observations of zenith angles and slope distances. (ICSM Standard Practice for Control Surveys SP1 – Section 2.4.2).

The “Leap-Frog” method involved using a Leica TC2003 Total Station and a single fixed height survey rod and reflector, which was held at a particular change point for both Back-sight (BS) and Fore-sight (FS) observations. In total 12 measurements were taken to both the BS and FS, the theodolite was also swapped between Face Left (FL) and Face Right (FR) for each pointing. Therefore the process of pointings was as follows: BS(FL) BS(FR) BS(FR) BS(FL) FS(FL) FS(FR) FS(FR) FS(FL), with three observations on each face.

The intentions of the levelling for both Stations was to adopt near Class L2A Traversing techniques (ICSM Standard Practice for Control Surveys SP1) to ensure at least Class LA results (due to the environment it is in some cases not practical to use class 2A techniques). Thus the criteria observed for all surveys included:

- Maximum spread of observations per set not exceeds 1.5 mm, with any outlying measurements discarded.
- Misclose to comply with allowable maximum for SP1 Class LA - 4vk
- Sight lengths kept below 50 metres.
- Temperature and Pressure measurements were taken for levelling run, with these values entered into the instrument to enable the instrument to apply first velocity corrections to slope distances.
- Work to be conducted in nil wind conditions wherever possible.

3.2 Mawson Station

As part of the brief two day visit to Mawson Station, a first order level connection was required from the current tide gauge bench mark, AUS258 to AUS064 (Mawson ARGN site) and its reference marks. Due to time constraints this task was not fully completed, with only the section between AUS258 and ISTS 051 being completed both ways, with the remaining sections only levelled one way.

The routes taken for the levelling work at Mawson are shown in Figure 3.2.1. Level connections were also made to other significant marks along the route between AUS064 and AUS258, the Pageos Mark (ISTS 051), AUS300 and AUS301. The values derived from this work are shown in Table 3.2.1. All heights shown in Table 3.2.1 are based on the value derived for ISTS 051 from levelling completed in 1996 quoted in “Antarctic Mapping Program Field Work report 1995-96 Summer Season” by T.W. Gordon (AUSLIG report for Antarctic Division)

Table 3.2.1 - Summary of Levelling Work Undertaken at Mawson Station December 2000

Station	Location	Reduced Level (m)
AUS301	North of Aircraft Hanger	1.8351
AUS258 (TGBM)	Hanger	1.4108
AUS300	North of fuel farm	2.1328
ISTS051 RM4		9.5869
ISTS051#		9.7920
AUS064 RM3	Cosray	28.9905
AUS064 RM2	Cosray	31.9557
AUS064 RM1	Cosray	30.0792
AUS064	Cosray	32.4458
*Misclose: 0.0001 m ---- Allowable Misclose 4v0.6 = 0.0031m		

Note:

* The misclose shown above corresponds to the two way levelling between ISTS 051 and AUS 305

\# Vide T.W Gordon 1996

Table 3.2.2 - Mawson levelling results with a comparison to previous surveys.
(All heights are shown in metres)

Year Station	AUSLIG 2000/2001	1998/99	1997/98	1996/97	1995/96
AUS301	1.835		1.835		
AUS258	1.411	1.411	1.409	1.415	1.413
AUS300	2.133	2.133	2.132		
ISTS051 RM4	9.588	9.591		9.588	
ISTS051	9.792			9.792	9.792
AUS064 RM3	28.990	29.001	28.977	28.996	
AUS064 RM2	31.956	31.967	31.939	31.961	31.959
AUS064 RM1	30.079	30.069		30.084	
AUS064	32.446		32.433	32.450	32.490

Table 3.2.2 shows a comparison of derived heights from the 2000/2001 survey to previous surveys. It is important to note that all previous work had been completed using spirit-levelling methods.

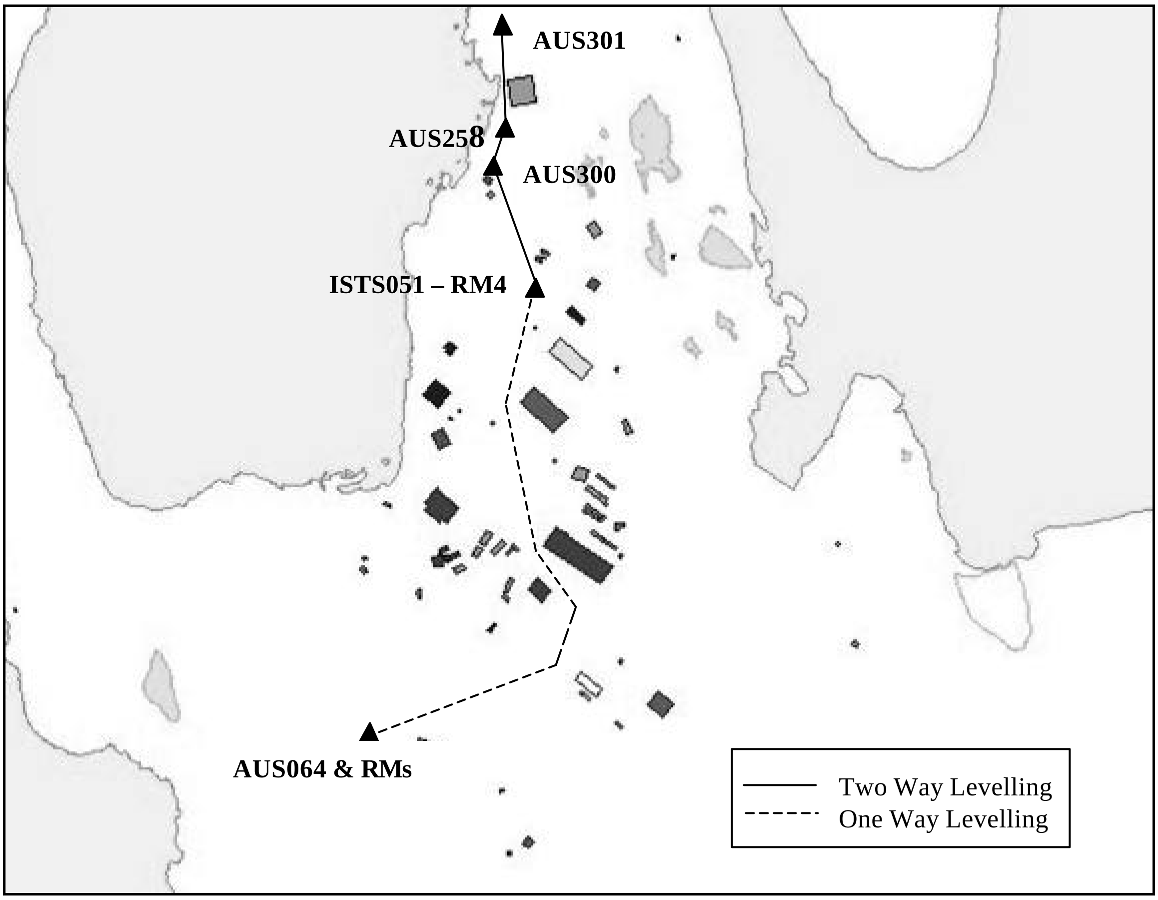

Figure 3.2. 2 Mawson Station Level Connections

Although the two way levelling revealed a very good misclose (0.0001m), the connection from AUS064 to AUS258 has not been verified from this survey, as it is only a one way solution. To verify the results shown in Table 3.2.1 above and also the technique, the remaining section needs to be completed, or alternatively the connection between the two marks requires re-levelling at the next available opportunity.

Also permanent change points need to be placed along the route, to enable future level "runs" to remain consistent. Unfortunately due to time constraints, this was not possible during the visit to Mawson this season.

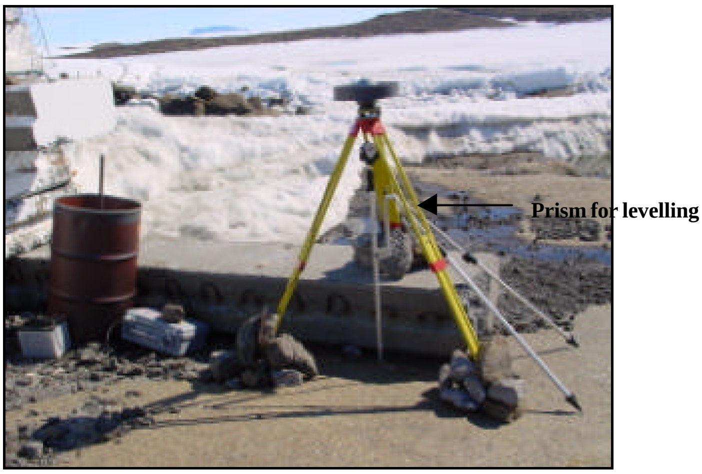

Figure 3.2.3 - AUS258 – Fixed Height Rod used for EDM Height Traversing (Under GPS Antenna)

3.3 Davis Station

The level connection between the tide gauge bench mark at Davis Station AUS184 and AUS099 (Davis ARGN) was also required during the 2000/2001 Summer Season. This task was successfully completed, with other significant marks included in this work. They included: NMVS4 (former NatMap TGBM), AUS303, D5, D3, Met. BM. The values derived from the levelling work are shown in Table3.3.2. All levels shown are based on a 1983 MSL height determination for NMV/S/4.

Table 3.3.1 - Summary of Levelling Work Undertaken at Davis Station January 2001

Station	Location	Reduced Level (m)
AUS186	Approx. 250m North of Station	4.7202
D5	East of Science Bldg.	19.9195
D3	East of Workshop	23.0843
AUS303	Approx. 100 m North of Station	15.4995
AUS099	APS Building	27.8686
RM2	APS Building	27.4245
RM3	APS Building	26.9206
RM1	APS Building	25.5415
NMS5/E	APS Building	27.0174
NMVS4#	Near Beach, West side of Station	2.1790
Met BM	Neat Met Bldg	18.4013
Misclose = 0.0016m – Allowable Misclose = 4v0.6 = 0.0031m		

Note: # Vide AUSLIG 1983

Table 3.3.2 - Davis levelling results with a comparison to previous surveys
(All heights are shown in metres)

Year **Station**	**AUSLIG 2001**	**1999/ 2000**	**1998/99**	**1996/97**	**1994/95**
AUS186	4.7202	4.7202	4.720	4.732	4.7140
AUS303	15.4995	15.500	15.508		
D5	19.9195			19.922	
D3	23.0843	23.087	23.101	23.088	
NMV/S/4	2.1790		2.179	2.179	2.1790
MET BM	18.4013			18.3994	18.4000
AUS99 –RM3	26.9206			26.921	
AUS99 –RM2	27.4245			27.425	
AUS99 –RM1	25. 5415			25.542	
AUS099	27.8686	27.868		27.869	27.8659

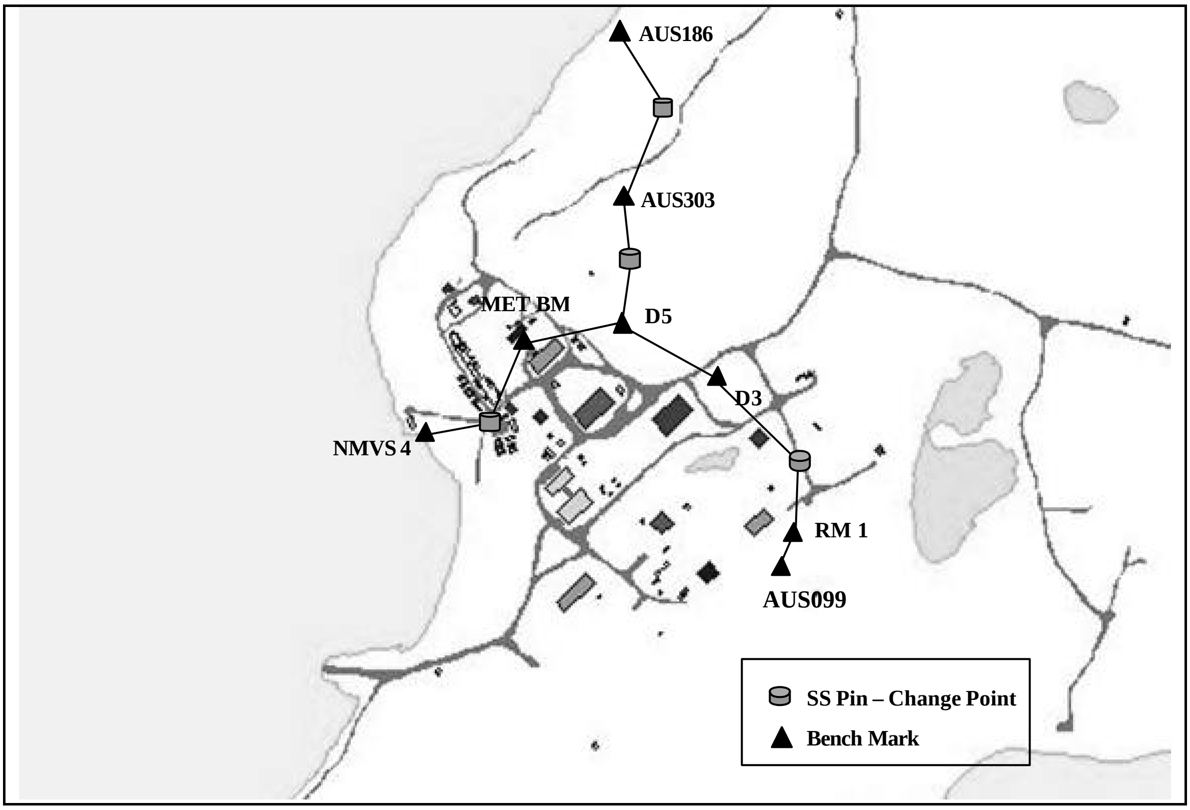

Figure 3.3.1 Davis Station Level Connections

To ensure that sight distances were kept below 50m, and to also institute a fixed route between existing benchmarks, additional change points were established. These change points were made up of a centre punched stainless steel pin, drilled into rock. A total of 4 new change points were placed for future efforts. Figure 3.3.2 shows pictures of the new change point positioned between, D3 and AUS099 – RM1.

Figure 3.3.2 Photos of new Levelling Change Points

The results of the levelling at Davis Station shown in Table 3.3.1 reveal a misclose of 1.6 mm. This misclose indicates an achieved outcome better than Class LA (allowable maximum of 3mm) and closely approximates those of Class L2A (allowable maximum misclose of 1.5mm). Thus the results achieved and techniques used demonstrate an achieved class of at least A (ICSM Standard Practice for Control Surveys SP1 – Section 2.4.2).

3.4 Conclusion

The aim of the differential levelling was to define the relative height differences between each of the Tide Gauge Benchmarks and the Permanent GPS. This connection provides important data as part of the Pilot Project for monitoring long-term sea level change in the Southern Ocean. This connection also helps to better understand the relationship between MSL and derived ellipsoidal heights from GPS.

As discussed near Class 2A observing techniques were used to ensure at least Class A outcomes. Thus the surveys achieved a positional uncertainty[*] in height of approximately 0.2 mm and 3mm for Mawson and Davis Stations respectively.

3.5 Field Books

Field book references are as follows:

Mawson: AUSLIG Geodesy #35, AUSLIG Geodesy #38
Davis: AUSLIG Geodesy #37

[*] *Positional Uncertainty is the uncertainty of the coordinates or height of a point, in metres, at the 95% confidence level, with respect to the defined reference frame.*

Derived from ICSM Discussion Paper introducing the need for a simple and self-explanatory method of specifying accuracy, applicable to all areas of spatial information.

4. GPS at Tide Gauge Bench Marks (TGBM) MAWSON, DAVIS and LARSEMANN HILLS

Chapter 3 of this report details the Orthometric levelling connection between the ARGN monuments and the TGBM at Mawson and Davis. There also exists a requirement to derive ellipsoidal heights at these tide gauge benchmarks. This information is directly relevant to the study of geoids, global geopotential models and sea surface change.

The determination and subsequent monitoring of ellipsoidal heights at these benchmarks allows the separation of genuine sea surface change from benchmark motion, whether on a local or continental scale. The Orthometric levelling can only detect local change in benchmark heights relative to some other monuments.

During this season four TGBMs were observed using good quality geodetic GPS observations: AUS258 at Mawson, AUS186 and NMVS4 at Davis and AUS334 in the Larsemann Hills. AUS258, AUS186 and AUS334 currently have high precision tide gauges operating adjacent to them. The downloading and connection of these tide gauges to the TGBMs is not part of this project. That component of the project is the responsibility of the Australian Antarctic Division. Table 4.1 below shows the observations collected. Table 4.2 lists the coordinate results for the four marks mentioned.

Table 4.1 Summary of GPS observations at Tide Gauge Bench Marks

Site	DOY	Date	Start	Finish	Vert Antenna Height (m)	Antenna Type
A258 Mawson TGBM	340	5/12/2000	13:53:30	23:59:30	1.551	ASH700936E
	341	6/12/2000	0:00:00	10:29:30	1.551	ASH700936E
A186 Davis TGBM	3	3/1/2001	4:47:30	23:59:30	1.1057	ASH700936E
	4	4/1/2001	0:00:00	23:59:30	1.1057	ASH700936E
	5	5/1/2001	0:00:00	23:59:30	1.1057	ASH700936E
	6	6/1/2001	0:00:00	23:59:30	1.1057	ASH700936E
	7	7/1/2001	0:00:00	23:59:30	1.1057	ASH700936E
	8	8/1/2001	0:00:00	9:42:30	1.1057	ASH700936E
NMV4 Old TGBM	15	15/1/2001	4:19:30	23:59:30	1.1963	ASH700936E
	16	16/1/2001	0:00:00	12:32:00	1.1963	ASH700936E
	17	17/1/2001	0:00:00	11:41:30	1.1963	ASH700963E
AUS334	20	20/1/2001	5:29:30	23:59:30	1.082	AOADM_T
	21	21/1/2001	0:00:00	2:42:30	1.082	AOADM_T

Table 4.2 Coordinates for the TGBMs shown in terms of ITRF2000 @2000.

Site	Latitude	Longitude	Ellipsoidal height (m)
AUS258 Mawson	-67° 36' 00.54494"	62° 52' 22.69653"	28.094
AUS186 Davis	-68° 34' 20.59889"	77° 58' 05.63094"	21.265
NMVS4 Davis	-68° 34' 33.92218"	77° 57 '48.96975"	18.724
AUS334 Larsemann Hills	-69 23' 01.16875"	76° 22' 20.61154"	17.162

4.1 Comparison with Orthometric levelling

Table 4.3 - A comparison of GPS Heighting and Orthometric levelling between the ARGN mark and the TGBM.

Year Baseline	2000/2001 Height Difference(m)	1998/1999 Height Difference(m)
AUS064-AUS258(?h GPS)	31.052	30.925
AUS064-AUS258(?H derived)	31.042	30.932
AUS064-AUS258(?H levelled)	31.035	31.035
Difference	***0.007***	***-0.103***
AUS099-AUS186(?h GPS)	23.151	23.148
AUS099-AUS186(?H derived)	23.151	23.152
AUS099-AUS186(?H levelled)	23.148	23.148
Difference	***0.003***	***0.004***
AUS099-NMVS4(?h GPS)	25.682	
AUS099-NMVS4(?H derived)	25.692	
AUS099-NMVS4((?H levelled)	25.689	
Difference	***0.003***	

The derived Orthometric height is obtained by combining the height differences from the GPS with the modelled geoid difference from the EGM96 global geopotential model ($\Delta H_{derived} = \Delta h_{GPS} - \Delta N_{geoid}$). In the above case ΔN_{geoid} is typically in the order of 10mm.

A comparison of the GPS height differences and orthometric levelling shown in Table 4.3 indicates a very good agreement, with the largest discrepancy being of the order of 7 mm from the derived orthomtric height at Mawson. Comparison to previous years shows an improvement in the GPS results, particularly at the Mawson site.

5. Australian Antarctic Geodetic Network (AAGN) Upgrades

The Australian Antarctic Geodetic Network consists of a series of survey marks placed on solid rock outcrops throughout the Australian Antarctic Territory. The majority of these marks were placed using terrestrial-surveying techniques from the 1960’s onwards. In recent years GPS has been used where possible to strengthen the network since GPS can be used over much longer distance with far greater accuracy, without the need for intervisibility.

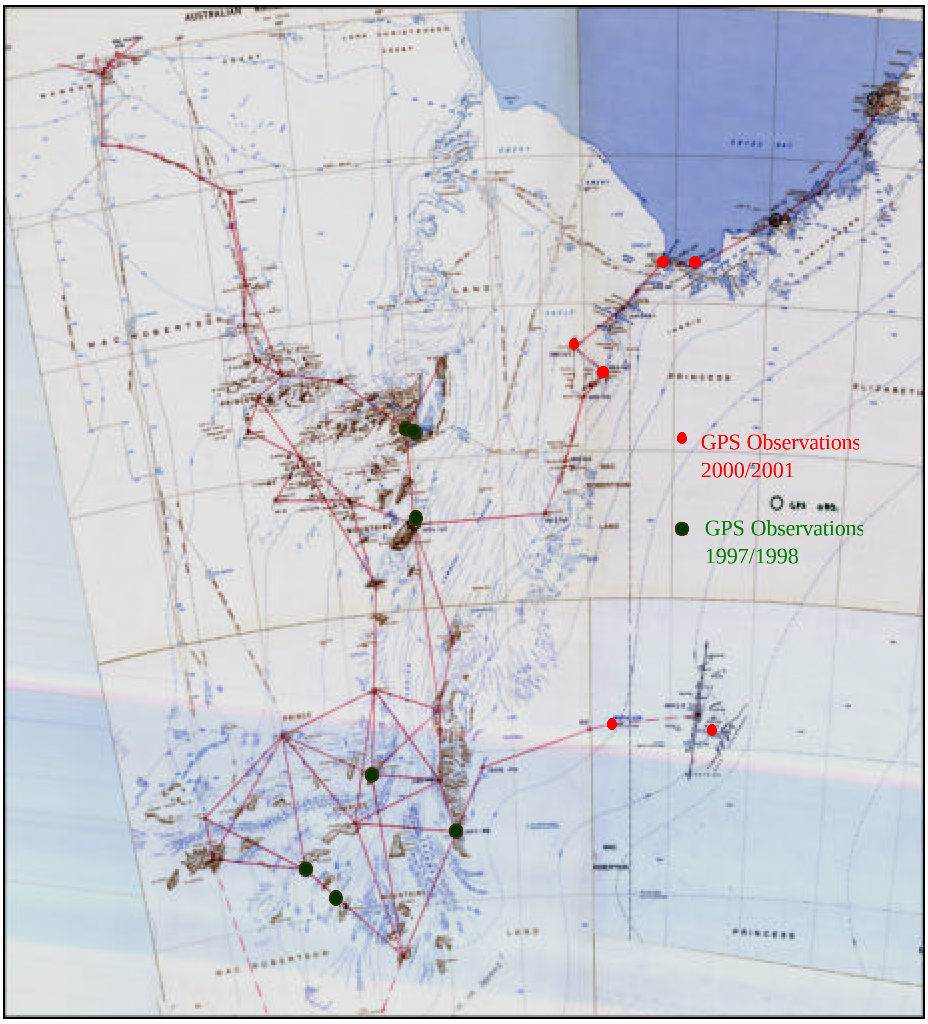

Figure 5.1 Locations of GPS Observations 2000/2001 Season

During the 2000/2001 season the focus was on improving the long traverse from Blundell Peak in the Larsemann Hills to Blustery Peak in the Prince Charles Mountains (PCMs). To strengthen the traverse, observations were taken at Mt Caroline Mickelson, Landing Bluff, Corry Rocks and Rubeli Bluff. Sections 5.1 to 5.4 detail each of the sites visited.

The positions from these data were included in the Antarctic adjustment (ANT2001) along with data collected by the University of Tasmania in 1998 at New Year Nunatak and AUSV17 in the PCMs. A summary of the data observed can be found in Table 5.1 and the results found in Table 5.2. The resultant coordinates were derived from processing the data using the Bernese precision processing software. The results of the processing were then used to undertake a least squares adjustment using NEWGAN software, constraining the ITRF 2000 coordinates of the three ARGN at epoch 2000.

5.1 Landing Bluff (AUS305)

Landing Bluff is a fundamental site in the Australian Antarctic Geodetic Network. Three survey marks exist at this site. The first is a Russian brass plaque set in the original NMS138 drill hole. This plaque is the primary monument at landing bluff and has an empty 1m high gas bottle standing directly over it. The second monument is AUS042, which consists of a stainless steel bolt drilled in to bedrock. The final monument is the antenna mount (AUS305) for the Australian National University's permanent GPS site. These three sites have all been observed at different times for varying purposes, but were never actually connected to each other.

Figure 5.1.1 Landing Bluff monuments. (NMS138 in foreground. AUS042 is in the background. AUS305 covered with radome).

GPS observations were taken at both AUSLIG monuments (DOYs 347, 348 and 349 2000) and have been processed along with data from the ANU installation. The details of this GPS occupation can be found in Table 5.1. This connection was subsequently included in the new adjustment (ANT2001).

Table 5.1 Summary of GPS observations for AAGN upgrade.

Site	DOY	Date	Start	Finish	Vert Antenna Height (m)	Antenna Type
NM50 Austin NTK	364	29/12/2000	7:25:30	23:59:30	0.7879	ASH700718B
	365	30/12/2000	0:00:00	9:53:00	0.7879	ASH700718B
136E Mt Caroline	17	17/1/2001	4:51:30	23:59:30	1.1325	ASH700936E
	18	18/1/2001	0:00:00	23:59:30	1.1325	ASH700936E
	19	19/1/2001	0:00:00	8:50:30	1.1325	ASH700936E
1422 Corry Rocks	17	17/1/2001	6:49:00	23:59:30	1.2520	ASH700718B
	18	18/1/2001	0:00:00	11:10:30	1.2520	ASH700718B
	19	19/1/2001	0:00:00	23:59:30	1.2520	ASH700718B
	20	20/1/2001	0:00:00	23:59:30	1.2520	ASH700718B
	21	21/1/2001	0:00:00	8:52:30	1.2520	ASH700718B
351E Groves	364	29/12/2000	9:50:30	23:59:30	0.0000	ASH700936E
	365	30/12/2000	0:00:00	23:59:30	0.0000	ASH700936E
	366	31/12/2000	0:00:00	23:59:30	0.0000	ASH700936E
A042 Landing Bluff	347	12/12/2000	4:39:00	23:59:30	1.2884	ASH700936E
	348	13/12/2000	0:00:00	23:59:30	1.2884	ASH700936E
	349	14/12/2000	0:00:00	23:59:30	1.2884	ASH700936E
N138 Landing Bluff	347	12/12/2000	5:17:30	22:01:00	1.3086	ASH700936E
N143 Rubeli Bluff	17	17/1/2001	10:30:30	23:59:30	2.500	ASH700936E
	18	18/1/2001	0:00:00	23:59:30	2.500	ASH700936E
	19	19/1/2001	0:00:00	23:59:30	2.500	ASH700936E
	20	20/1/2001	0:00:00	17:15:30	2.500	ASH700936E

5.2 Mt Caroline Mickelson (NMS 136E)

The site at Mount Caroline Mickelson forms the most Easterly mark in the network to the east of the Amery Ice shelf. It is the connecting mark between Blundell Peak in the Larsemann Hills and the Eastern Amery. Previous to the data collected in the 2000/2001 season, there were only terrestrial observations made to this geodetic control point.

The station mark at Mount Caroline Mickelson is surmounted by a 2.5 metre steel pipe surrounded by rocks. The eccentric mark, which was used for the GPS observations, consisted of a 6 inch rock piton (Figure 5.2.2).


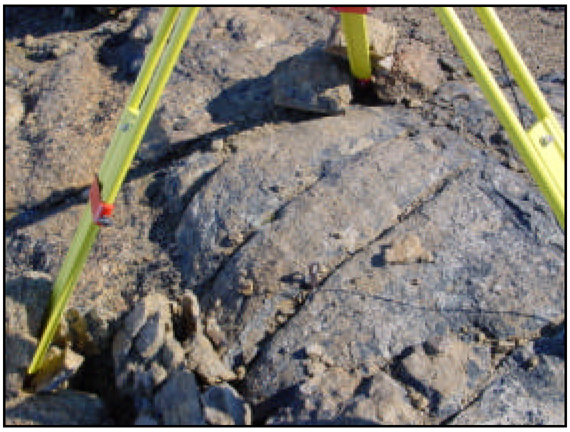

Figure 5.2.2 Mt Caroline Mickelson - 2.5 Metre Steel Cairn and Station Eccentric mark (NMS 136)

GPS data was collected for over 48 hours on the eccentric mark, details of which can be found in Table 5.1. Resultant positions are included in Table 5.2.

Table 5.2 - Coordinate results for AAGN upgrade shown in terms of ITRF2000 @2000.

SITE	Name	Latitude	Longitude	Ellipsoidal Height (m)
AUS042	AUS042	S 69° 44’ 32.23501”	E 73° 42 37.56993”	132.898
AUS305	LDBF	S 69° 44’ 32.25112”	E 73° 42 37.40090”	133.487
NMS 136E	Mt Caroline EC	S 69° 45’ 10.19959”	E 74° 23 54.38701”	249.977
NMS 143	RUBELI BLUFF	S 70° 28’ 39.20983”	E 72° 26 32.94741”	237.488
NMS 142E2	Corry R ECCE 2	S 70° 17’ 46.95769”	E 71° 46 30.21113”	231.115
NMS 138	LANDING BLUFF	S 69° 44’ 32.14039”	E 73° 42 36.94688”	133.647

5.3 Rubeli Bluff (NMS 143)

The Rubeli Bluff mark (NMS 143) located in the Reinbolt Hills is an integral part of the Eastern Amery Traverse. Rubeli Bluff was the final observed mark, which ended the 1968 summer traverse and was used again to continue the 1969 traverse.

Unfortunately the station eccentric mark which consisted of a 6 inch piton approximately 6.2 metres online from the station mark to Corry Rocks NMS 142 was not found. The station mark could also not be used due to the large 6-foot stone cairn built over it. Therefore the GPS antenna was set up over the top of the cairn on the assumption that it was concentrically built over the station mark. The height of the antenna was approximately 2.4 metres above the ground mark. A total of 3 days GPS observations were made at Rubeli Bluff, the resultant positions are included in Table 5.2.

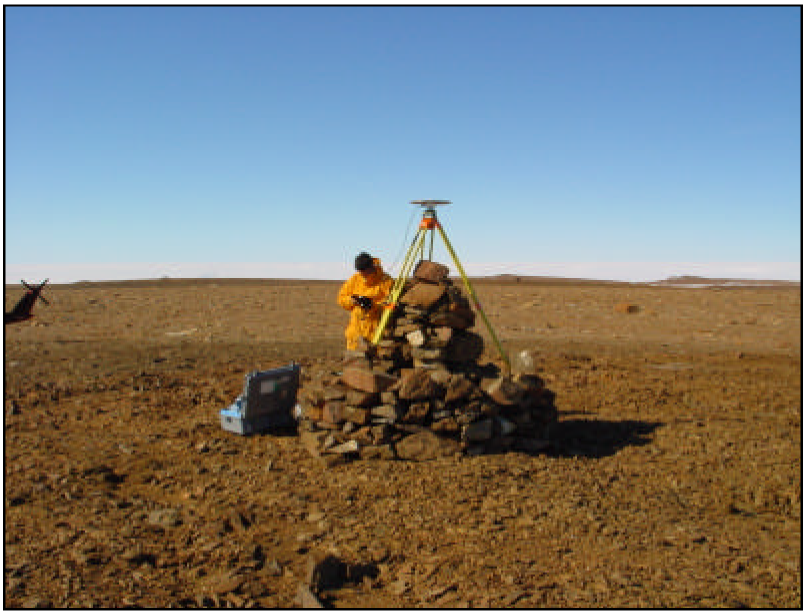

Figure 5.3 Rock Cairn Over Station Mark - Rubeli Bluff NMS 143

5.4 Corry Rocks (NMS 142)

Corry Rocks is located at the Northern End of Gillock Island. The station forms part of the long traverse from the Larsemann Hills to the PCMS. The station was established in 1968, but was revisited in 1991, when an additional station eccentric mark was placed. This new mark NMS 142 ECCE 2, consisted of an expansion bolt set in rock. GPS data was collected on this mark during the visit in 1991.

Figure 5.4 NMS 142 ECCE 2 - With rock cairn over station mark in the background.

6. Report on the Establishment of a new permanent GPS Site in the Grove Mountains

One of the major objectives of the 2000/2001 Antarctic Geodesy Program, was to locate and obtain geodetic quality GPS observations on existing geodetic sites in the Grove Mountains and also establish a new GPS site in the vicinity of Mt Harding. These tasks were partially completed during the season, with the main achievement being the establishment of a new permanent monument near Mt Harding.

6.1 Grove Mountains

The Grove Mountains are a large, scattered group of mountains and nunataks extending over an area of approximately 65 by 30-km, located 160 Km East of the Mawson Escarpment.

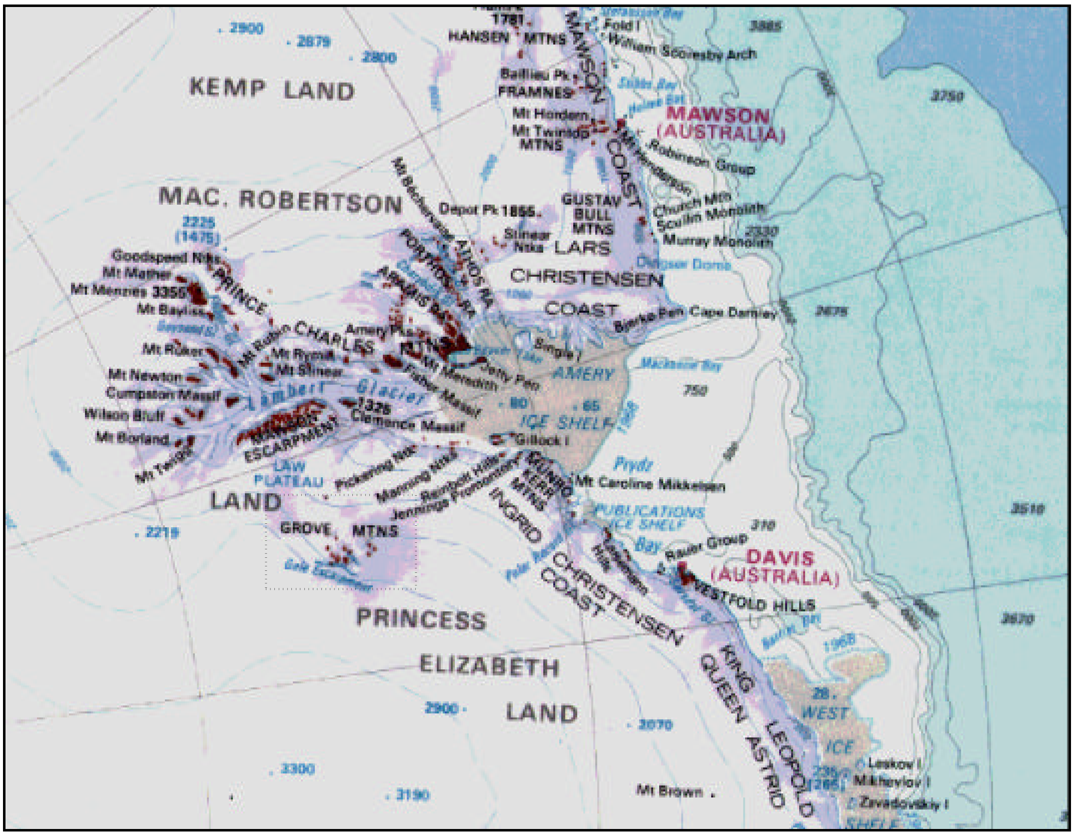

Figure 6.1.1 Map of Lambert Glacier Basin, which indicates the location of the Grove Mountains

The Grove Mountains are a region of the continent that has attracted very few visitors, with an initial visit by ANARE in 1958, followed by National Mapping surveyors and geologists in the early 1970's. Recently the Grove Mountains have become an area of interest for both Russian and Chinese scientists, with both countries visiting the region in recent years. The Chinese spent an extended period there during the summer of 1999/2000, traversing vehicles and personnel to the Grove Mountains from the Larsemann Hills, 300 km to the North. The Chinese effort was part of a larger program to traverse from the Larsemann Hills to Dome Argus (A further 600 km inland from the

Grove Mountains). Their work in the region consisted mainly of geological research, which also included some large scale mapping. The Russians flew aircraft into the Grove Mountains during the previous season, their focus was primarily airborne geophysics.

6.2 Geodetic Surveys 2000/2001

Initially it was planned to fly into the region on four separate days, allowing enough time to complete all the intended work. However owing to the harsh flying conditions and the nature of the terrain there was only time for two visits during the 2000/2001 summer season.

Although only two trips were made into the Grove Mountains a number of outcomes were acheived they included:

- Establishment of a new geodynamic survey monument in the vicinity of Mount Harding, to strengthen the Antarctic geodetic network, and also assist with long term monitoring of crustal motion in Antarctica.

- Several days of GPS data collected on the existing geodetic network point at Austin Nunatak – 60 km to the West of Mount Harding

- Search for two existing CHINARE geodetic control points established near Mount Harding and Zakharoff Ridge.

6.3 A Permanent Geodynamic Mark for the Grove Mountains: AUS 351

A new permanent geodetic quality mark was established on a nunatak to the South West of Mount Harding. The mark, AUS351 was located on a flat ledge at the northern end of the nunatak approximately 50 metres above the ice level. AUS351 consisted of a 150 mm stainless steel plate, with a centred 5/8” spigot.

The site for the new mark was chosen due to its close proximity to Mount Harding, the availability of solid bedrock and its accessibility. The mark is accessible by landing on the ice below and climbing up to the ledge above, typically the climb takes up to 20 minutes. There is sufficient space on the ice to allow landing by both fixed wing and rotary aircraft. Ice conditions were very firm, with small amounts of drift snow visible.

In terms of weather, dimples in the ice, large wind scours around rock outcrops and conditions experienced over the two trips indicated that the Groves was a high wind region with strong winds predominantly from the South-East.

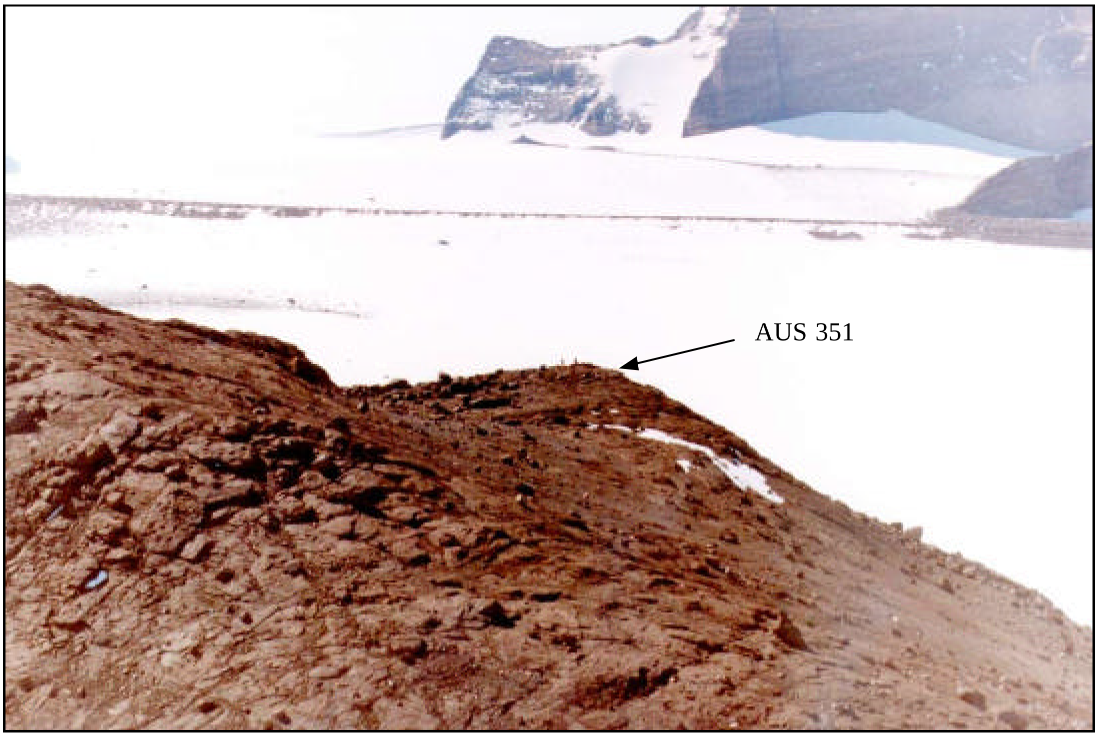

Figure 6.3.1 Location of AUS351 -- Looking North to Mount Harding

Figure 6.3.2 Photo of AUS351 Station Mark and GPS Choke Ring Antenna

To enable a long GPS observation period solar panels were used to maintain battery charge for the receiver. The receiver was also housed in an insulated aluminium warm box to keep the equipment from freezing.

Figure 6.3.3 Solar Panel and GPS warm box set up at AUS351

As indicated above two visits were made to AUS351 during the 2000/2001 summer. The geodynamic type mark was partially installed during the first trip (29th December 2000), but the resin did not set correctly. This mark was subsequently reset on the second visit (11 January) to the groves. Therefore the site referred to as AUS351E is this mark prior to it being reset. Both AUS351E and AUS351 were placed in the same hole however AUS351 is somewhat lower (approximately a decimtre). The second visit shortly after the New Year also enabled the Ashtech GPS receiver to be reset as it had stopped logging due to an end of year changeover problem

Due to the continual bad flying conditions between Davis Station and the Grove Mountains a third and final trip to the area was not possible, Thus only the original small amount of data (2 days) was collected from AUS351E. The remaining 2 weeks data and all equipment remains on site and will be retrieved next season.

Data from AUS351E have been processed using the Bernese processing software. The data were processed using IGS precise ephemerides in the ITRF 2000 Reference Frame, at epoch 2000.0 the results are shown below in Table 6.3.1.

Table 6.3.1 Coordinate for AUS351E shown in terms of ITRF2000 @2000.

SITE	**AUS351E – Grove Mountains**
Latitude	-72° 54’ 29.17479”
Longitude	74° 54’ 36.43606”
Ellipsoidal Height (m)	1907.566

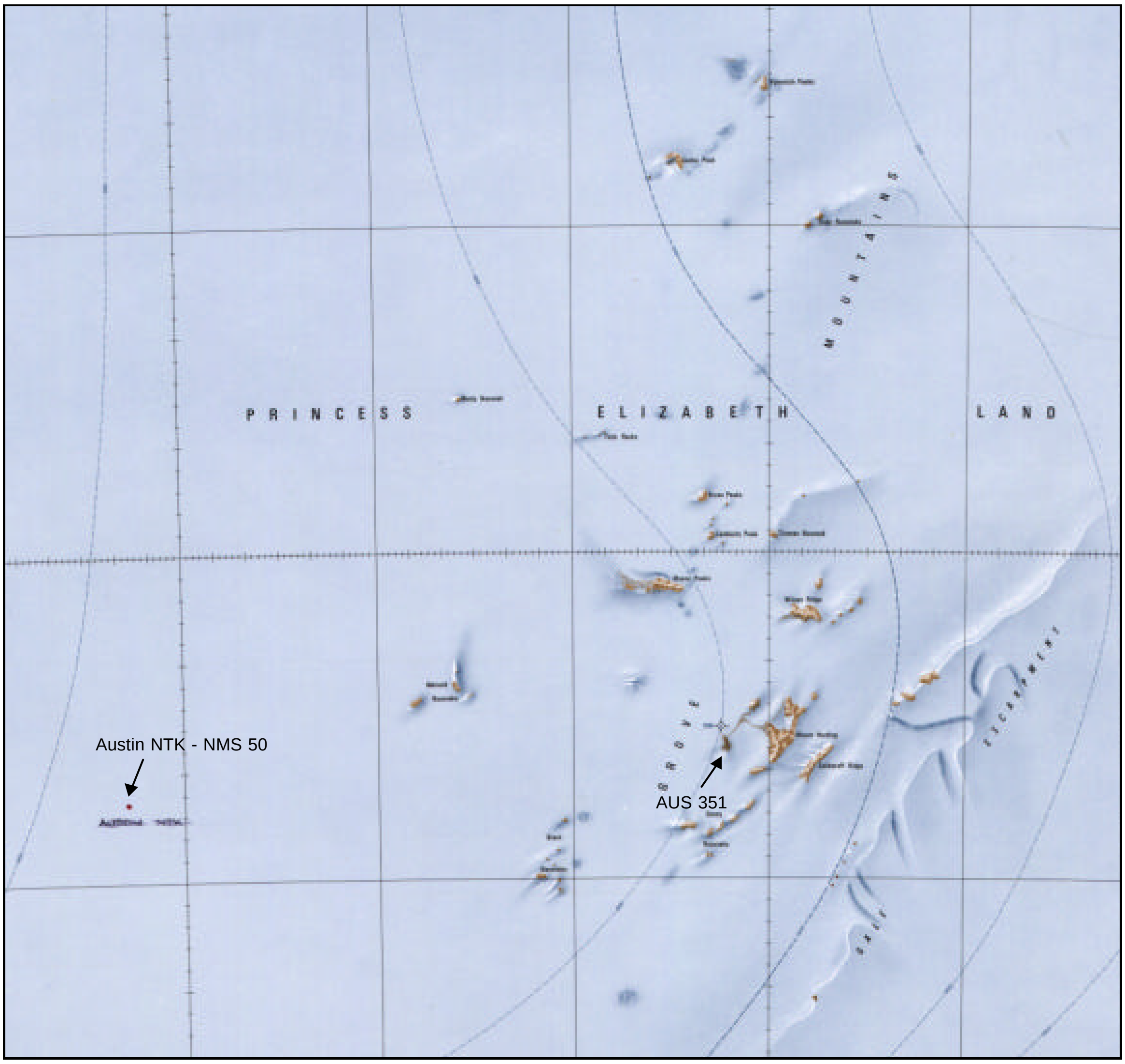

Figure 6.3.5 Map of Grove Mountains, indicating the location of Austin Nunatak, and AUS351

6.4 Austin Nunatak (NMS 50)

Austin Nunatak was the terminal mark in the 1974 Division of National Mapping traverse from the Mawson Escarpment to the Grove Mountains. Observations from Austin Nunatak were made to the Grove Mountains (Mason Peak), however no mark was established at the time.

The mark at Austin Nunatak is located on a flat ledge adjacent to the high point and consists of a rock piton with aluminium tag. The station mark was located in good condition, and all eccentric marks found.

Two-days of GPS data was observed at NMS 50, and was processed using AUSLIG's on-line processing software using IGS precise ephemerides in the ITRF 1997 Reference Frame. The resultant vector between the Davis ARGN mark, AUS099 and NMS 50 were then used within the new antarctic adjustment (ANT2001) to proved coordinates in ITRF2000 at epoch 2000.0. The results are shown in Table 6.4.1.

Table 6.4.1 Coordinates for NMS 50 - AUSTIN Nunatak shown in terms of ITRF2000 @2000.

SITE	NMS 50 AUSTIN Nunatak
Latitude	-72° 56’ 11.50546”
Longitude	73° 21’ 36.88113”
Ellipsoidal Height (m)	1639.637

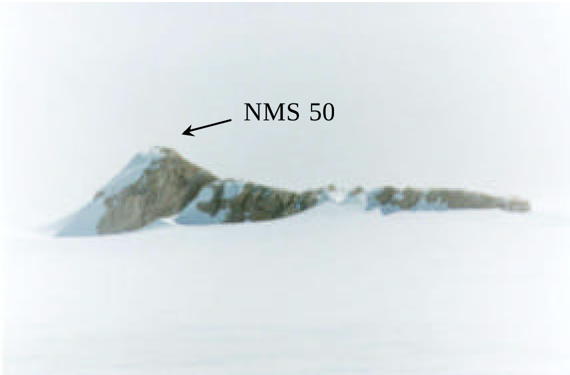

Figure 6.4.1 Photo of Austin Nunatak (NMS 50) and looking East to the Grove Mounatins

6.5 CHINARE Geodetic Control

As discussed previously, the Chinese spent a full summer in the Grove Mountains conducting geological research. As part of their research, two control points were established and GPS data observed at each point. The marks were located on the South-Eastern side of Mount Harding and near Zakharoff Ridge.

An attempt was made to find the marks, which were described as steel rods set in bedrock. However at the supplied coordinates, bamboo canes driven into the snow were discovered. Using a hand-held GPS on the ground to navigate, the cane near Mt Harding located on the snow bank was some 150 metres from rock. From the air the other site at Zakharoff ridge appeared to also be a bamboo cane on snow in the vicinity of some fuel drums.

7. Larsemann Hills Network Unification

The Larsemann Hills is an area of high activity from a science perspective. Australian, Chinese and Russian bases exist within a five kilometre radius of each other. All three nations have created independent survey networks in the area for their own purposes.

Resolution 5 of the Geodesy and Geographic Information Working Group Report (http://www.scar-ggi.org.au/tokyo/scar_rpt.pdf) to the Scientific Committee on Antarctic Research (SCAR) was aimed at that unification of geodetic and mapping datums throughout Antarctica by the year 2001. This would allow the most effective means of transferring information between countries. The basis for AntGD2000 (the name chosen for the unified datum) would be the International Terrestrial Reference Frame 2000 (ITRF2000 @ 2000).

To begin work on this endeavour, a series of Chinese and Russian survey control points were connected to the International Terrestrial Reference Frame by geodetic quality GPS observations. Thirteen sites in total had GPS data observed on them in the Larsemann Hills. The details of the data observed can be found in Table 7.1. The GPS baselines were processed using the Bernese precision processing software. All observations were adjusted using NEWGAN, holding the ITRF 2000 coordinates of the three ARGN marks fixed. The results are listed in Table 7.2 and 7.5. Using these derived coordinates and those supplied by the Chinese for the same marks an attempt at deriving 7 parameter transformation parameters was undertaken. This process requires both data sets to be homogenous but this was not the case. Alternatively a mean block shift for the Larsemann hills has been calculated and the residuals from this block shift are shown in Table 7.3. Figure 7.1 indicates the magnitude and orientation of the resultant block shift vectors for each common station.

The coordination of these control points allows both the extension of the Australian Antarctic Geodetic network and a comparison of the different coordinate sets in an attempt to generate transformation parameters. One of the thirteen sites connected to was the tide gauge benchmark (AUS334) for the Australian tide gauge on Nella Fiord (see section 4.0 for a full discussion). Also the Wo Long Beach Benchmark at Zhong Shan was connected. This benchmark is the source of the Zhong Shan height datum which is based on previous tide board readings.

Table 7.1 Summary of GPS observation in the Larsemann Hills

Site	DOY	Date	Start	Finish	Vert Antenna Height (m)	Antenna Type
AUS334 (TGBM)	20	20/1/2001	5:29:30	23:59:30	1.0819	AOADM_T
	21	21/1/2001	0:00:00	2:42:30	1.0819	AOADM_T
ZI JIN PEAK	27	27/1/2001	8:06:30	23:59:30	0.9110	ASH700936E
	28	28/1/2001	0:00:00	5:49:00	0.9110	ASH700936E
WO LONG BEACH	21	21/1/2001	7:54:30	23:59:30	0.970	AOADM_T

Table 7.1(cont.) Summary of GPS observation in the Larsemann Hills

Site	DOY	Date	Start	Finish	Vert Antenna Height (m)	Antenna Type
ORIGIN CHINESE	23	23/1/2001	6:32:00	23:59:30	0.0040	ASH700936E
	24	24/1/2001	0:00:00	11:59:00	0.0040	ASH700936E
	25	25/1/2001	7:11:30	16:20:00	0.0040	ASH700936E
	26	26/1/2001	6:10:30	23:59:30	0.0040	ASH700936E
	27	27/1/2001	0:00:00	4:28:30	0.0040	ASH700936E
NMS 278	19	19/1/2001	10:38:00	23:59:30	0.0000	ASH700936E
	20	20/1/2001	0:00:00	23:59:30	0.0000	ASH700936E
	21	21/1/2001	0:00:00	23:59:30	0.0000	ASH700936E
	22	22/1/2001	0:00:00	0:31:00	0.0000	ASH700936E
RUSSIA 01	28	28/1/2001	6:11:30	23:59:30	1.2995	AOADM_T
	29	29/1/2001	0:00:00	2:39:30	1.2995	AOADM_T
ORIGIN RUSSIA	28	28/1/2001	6:49:00	23:59:30	0.0860	ASH700936E
	29	29/1/2001	0:00:00	14:01:30	0.0860	ASH700936E
THREE MAN PEAK	29	29/1/2001	10:16:00	23:59:30	1.3964	AOADM_T
V5	29	29/1/2001	15:19:30	23:59:30	0.7595	ASH700936E
	30	30/1/2001	0:00:00	12:02:30	0.7595	ASH700936E
WEATHER PEAK	22	22/1/2001	7:46:00	23:59:30	0.8344	ASH700936E
	23	23/1/2001	0:00:00	5:34:00	0.8344	ASH700936E
WU YAN GANG	27	27/1/2001	12:23:30	23:59:30	0.9263	AOADM_T
	28	28/1/2001	0:00:00	3:46:30	0.9263	AOADM_T
TGBM CHINESE	23	23/1/2001	5:54:00	20:09:30	1.1113	AOADM_T
	25	25/1/2001	7:16:30	23:59:30	1.1113	AOADM_T
	26	26/1/2001	0:00:00	23:59:30	1.1113	AOADM_T
	27	27/1/2001	0:00:00	23:59:30	1.1113	AOADM_T

Table 7.2 Coordinate Values for marks in terms of ITRF2000 @ 2000.

Site	Lat	Long	Ellipsoidal Height (m)
Origin China	-69° 22’ 28.48408”	76° 22’ 23.11836”	44.070
Zi Jin Peak	-69° 22’ 32.65189”	76° 22‘12.93128”	68.082
Weather Peak	-69° 22’ 18.84040”	76°22’ 07.41206”	41.799
Wu yan gang	-69° 22’ 20.72896”	76°21’ 50.61894”	32.169
Wo Long Beach	-69° 22’ 23.93179”	76° 22’ 40.68004”	24.888
RUSSIA 01	-69 22’ 30.37254”	76° 22’ 22.95979”	46.609
Origin Russia	-69° 22’ 51.04930”	76° 23’ 11.57155”	65.260
Three Man Peak	-69° 22’ 49.27987”	76° 17’ 41.22551”	148.422
V5	-69° 24’ 01.46181”	76° 23’ 48.85600“	78.715

Table 7.3 Coordinate Values adopted by the Chinese as indicated by the ellipsoidal parameters for NSWC9Z2

Site	Lat	Long	Ellipsoidal Height (m)
Origin China	-69° 22’ 28.34495”	76° 22’ 22.43440”	45.760
Zi Jin Peak	-69° 22’ 32.51232”	76° 22’ 12.24484”	69.760
Weather Peak	-69° 22’ 18.70116”	76° 22’ 06.72946”	43.460
Wu yan gang	-69° 22’ 20.58960”	76° 21’ 49.93527”	33.950
Wo Long Beach	-69° 22’ 23.79299”	76° 22’ 39.99790”	26.560
RUSSIA 01	-69° 22’ 30.23345”	76° 22’ 22.27598”	48.260
Origin Russia	-69° 22’ 50.91228”	76° 23’ 10.87871”	66.970
Three Man Peak	-69° 22’ 49.13866”	76° 17’ 40.53336”	150.130
V5	-69° 24’ 01.32594”	76° 23’ 48.16219”	80.390

Table 7.4 Tabulated differences between the two systems at the marks listed. Residuals shown are after the mean block shift has been removed.

Site	Diff Lat (m)	Res Lat (m)	Diff Long (m)	Res Long (m)	Bearing	Vector (m)
Origin China	1.520	0.004	-21.194	-0.006	303.1°	0.007
Zi Jin Peak	1.525	0.009	-21.271	-0.083	276.0°	0.083
Weather Peak	1.521	0.005	-21.152	0.036	81.9°	0.036
Wu Yan Gang	1.522	0.006	-21.185	0.003	24.2°	0.007
Wo Long Beach	1.516	0.000	-21.138	0.050	89.6°	0.050
RUSSIA 01	1.520	0.004	-21.189	-0.001	337.9°	0.004
Origin Russia	1.497	-0.019	-21.469	-0.281	266.1°	0.282
Three Man Peak	1.543	0.027	-21.448	-0.260	275.9°	0.261
V5	1.484	-0.032	-21.499	-0.311	264.2°	0.313
Mean	**1.516**		**-21.188**			

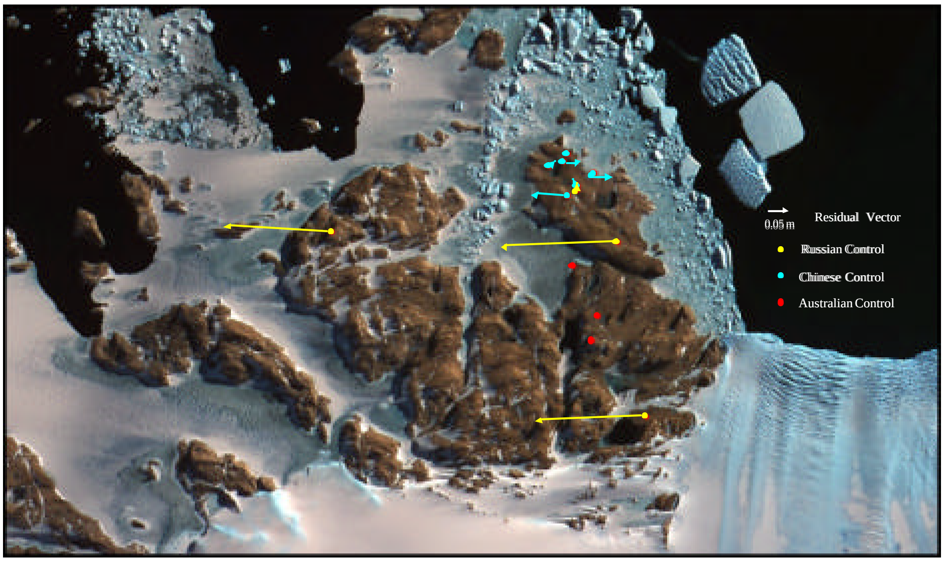

Figure 7.1 Block Shift Residual Vectors for Russian And Chinese Stations

Table 7.5 Coordinate Values for additional Larsemann Hills marks in terms of ITRF2000 @ 2000

Site	Lat	Long	Ellipsoidal Height (m)
C1	-69° 23’ 31.207325”	76° 22’ 44.580448”	130.367
NMVS 278	-69° 23’ 21.178831”	76° 22’ 50.762353”	80.058
AUS334 (TGBM)	-69° 23’ 01.168748”	76° 22’ 20.611541”	17.162
TGBM Chinese	-69° 22’ 23.195421”	76° 22’ 42.134833”	21.920

8. Vestfold Hills Geometric Geoid Determination

The Vestfold Hills is an area of high use for both science and recreation. Expeditioners venturing into the Vestfold's from Davis are commonly using GPS as a tool for Science and Navigation. The conversion of the ellipsoidal heights displayed by GPS units to the more meaningful height above sea level requires the use of an accurate Geoid –Ellipsoid separation (N value).

Due to the sparseness of ground gravity data and geometric control over Antarctica, a gravimetric geoid model is not readily available. The currently best available geoid model is the Earth Geopotential Model 1996 (EGM96). This model is based primarily on satellite data in this region and as such only provides the long wavelength components of the geoid. Also conspiring against the accuracy of this model over Antarctica is the fact that the orbits of the satellites used for the determination of this model generally are not polar so Antarctic coverage is limited. The geometric control of the satellite orbits is also weakest at the far southern latitudes due to a lack of ground observing stations. All these factors result in a geoid model that is low in accuracy over Antarctica.

The Vestfold Hills contain many saline and freshwater lakes. An existing Antarctic Division science program involves measuring the heights of the water surface in approximately 90 of these lakes on an annual basis. To facilitate this program benchmarks were placed in the vicinity of each of these lakes through the 1980s and the majority of them have been connected to the Davis height datum using third or fourth order-levelling techniques.

By observing quality GPS observations on these benchmarks and computing ellipsoidal heights it is possible to compute an accurate geometric N value at each benchmark. The N value is calculate by subtracting the known sea level height from the calculated ellipsoidal height (N = ellipsoidal Ht (h) – MSL Ht (H)).

If a suitable distribution of these benchmarks can be achieved throughout the Vestfold hills the computation of a grid of geometric N values can be achieved. With this in mind during the 2000/2001 season GPS observations were taken at 13 lake benchmarks as well as 3 marks around Davis base this season. A summary of the GPS observations taken can be found in Table 8.1. In addition to these observations, GPS data that had been observed over lake benchmarks in the 1998-1999 summer season was obtained from the University of Tasmania. This data was also processed to determine ellipsoidal heights.

Using the Generic Mapping Tool software (GMT) and the calculated benchmark N values and their associated positions, a geometric geoid was derived over the Vestfold Hills. However it appears that the lake benchmarks closer to the plateau have not been connected to the Davis height datum, resulting in the grid being weaker in that part of the Vestfolds. The grided data set is shown in Figure 8.1. A comparison of the new geometric geoid to EGM96 shown in Figure 8.2 indicates a 2-metre shift. This shift is possibly due to a lack of data in the EGM model, thus making it difficult to detect the short wavelength component.

This is only the first attempt at creating a geometric geoid for the Vestfold Hills and will undoubtably be strengthened in future seasons as more of these lake benchmarks are coordinated using accurate GPS techniques.

Table 8.1 Summary of GPS observation taken in the Vestfold Hills for the geometric geoid.

Site	DOY	Date	Start	Finish	Vert Antenna Height (m)	Antenna Type
AUSV16	46	15/2/2001	6:31:00	23:59:30	0.9431	AOADM_T
	47	16/2/2001	0:00:00	02:38:00	0.9431	AOADM_T
AUSV17	46	15/2/2001	07:33:30	23:59:30	1.3417	ASH700718B
	47	16/2/2001	00:00:30	04:04:00	1.3417	ASH700718B
AUSV18	51	20/2/2001	05:23:30	23:59:30	0.9466	ASH700718B
	52	21/2/2001	00:00:30	09:12:30	0.9466	ASH700718B
AUSV20	51	20/2/2001	04:12:30	23:59:30	1.0884	ASH700718B
	52	21/2/2001	00:00:30	01:17:30	1.0884	ASH700718B
DEEP	51	20/2/2001	08:17:00	23:59:30	1.1771	ASH700936E
	52	21/2/2001	00:00:30	09:25:00	1.1771	ASH700936E
NMVS22	53	22/2/2001	10:12:00	23:59:30	0.8518	ASH700936E
	54	23/2/2001	00:00:30	07:15:30	0.8518	ASH700936E
NMVS30	53	22/2/2001	09:34:30	23:59:30	1.0995	ASH700718B
	54	23/2/2001	00:00:30	23:59:30	1.0995	ASH700718B
	55	24/2/2001	00:00:30	03:04:30	1.0995	ASH700718B
NMVS41	43	12/2/2001	13:13:30	23:59:30	1.0778	ASH700936E
	44	13/2/2001	00:00:30	02:42:30	1.0778	ASH700936E
NMVS56	51	20/2/2001	03:14:30	16:53:30	1.3732	AOADM_T
NMVS59	46	15/2/2001	06:24:30	23:59:30	1.1470	ASH700718B
	47	16/2/2001	00:00:30	23:59:30	1.1470	ASH700718B
	48	17/2/2001	00:00:30	03:58:00	1.1470	ASH700718B
NMVS61	46	15/2/2001	05:44:00	23:59:30	1.2995	ASH700936E
	47	16/2/2001	00:00:30	13:35:00	1.2995	ASH700936E
NMVS73	53	22/2/2001	11:22:00	23:59:30	1.2197	ASH700718B
	54	23/2/2001	00:00:30	23:59:30	1.2197	ASH700718B
	55	24/2/2001	00:00:30	03:14:30	1.2197	ASH700718B
NMVS75	43	12/2/2001	05:57:00	23:59:30	1.2317	AOADM_T
	44	13/2/2001	00:00:30	03:06:30	1.2317	AOADM_T

Table 8.2 1998/1999 GPS data observed by UTAS students and processed by AUSLIG for inclusion in this project

Site	DOY	Date	Duration	Vert Antenna Height (m)	Antenna Type
HBM1	039	3/1/99	05:45	1.118	Leica AT202+GP
NMVS 6	348	14/12/98	03:00	1.040	Leica AT202+GP
NMVS 34	340 341	6/12/98 7/12/98	04:00 04:00	0.353	Leica AT202+GP
NMVS 36	040	9/2/99	06:45	0.650	Leica AT202+GP
NMVS 37	348	14/12/98	02:00	0.882	Leica AT202+GP
NMVS 53	345	11/12/98	03:00	0.980	Leica AT202+GP
NMVS 54	345	11/12/98	02:20	0.961	Leica AT202+GP
NMVS 60	349	15/12/98	03:00	1.123	Leica AT202+GP
NMVS 74	039 041	8/2/99 10/2/99	05:45 07:30	0.779	Leica AT202+GP
NMVS 79	350	16/12/98	04:30	1.315	Leica AT202+GP

Table 8.3 Coordinate results for Vestfold Hills Benchmarks. Results are in terms of ITRF2000 @2000.0

Site	Latitude	Longitude	Ellipsoidal Height (m)	Height above MSL (m) (Davis 1983 datum)
NMVS41	S 68° 28’ 30.21658”	E 78° 15’ 41.44694”	27.735	10.947
NMVS75	S 68° 28’ 15.30314”	E 78° 11’ 35.74749”	27.572	10.817
AUSV17	S 68° 35’ 36.68569”	E 78° 30’ 38.39187”	69.695	N/A
AUSV16	S 68° 35’ 58.10483”	E 78° 30’ 00.55611”	48.042	N/A
NMVS61	S 68° 38’ 29.39188”	E 77° 54’ 34.33069”	19.275	3.001
NMVS59	S 68° 37’ 38.57447”	E 78° 00’ 48.61989”	18.099	1.664
AUSV20	S 68° 26’ 33.23486”	E 78° 22’ 41.76476”	21.976	N/A
AUSV18	S 68° 33’ 29.26971”	E 78° 23’ 31.46373”	52.203	N/A
NMVS 8	S 68° 33’ 22.94198”	E 78° 11’ 16.29822”	-32.983	49.656
NMVS56	S 68° 29’ 47.30406”	E 78° 04’ 27.94099”	20.947	4.282
NMVS73	S 68° 36’ 37.98732”	E 78° 20’ 58.80176”	42.638	26.053
NMVS22	S 68° 31’ 55.80162”	E 78° 16’ 7.78716”	12.385	4.374
NMVS30	S 68° 30’ 43.78400”	E 78° 22’ 32.68457”	25.159	8.338
NMVS34	S 68° 30’ 56.66247”	E 78° 28’ 23.23789”	25.464	8.177
NMVS53	S 68° 27’ 28.19606”	E 78° 11’ 20.86671”	22.573	5.761
NMVS54	S 68° 28’ 41.63293”	E 78° 10’ 35.74324”	21.753	4.878
NMVS37	S 68° 33’ 58.20986”	E 78° 04’ 58.56176”	20.914	4.224
NMVS 6	S 68° 34’ 7.04839”	E 78° 04’ 30.36580”	20.460	3.765
NMVS60	S 68° 37’ 25.26734”	E 77° 58’ 28.00784”	20.364	3.911
NMVS79	S 68° 36’ 55.09008”	E 77° 59’ 30.05521”	17.613	1.077
DHBM1	S 68° 34’ 42.63641”	E 77° 57’ 47.09500”	20.647	4.090
NMVS74	S 68° 37’ 30.09782”	E 78° 14’ 13.59327”	15.288	1.196
NMVS36	S 68° 36’ 35.77603”	E 78° 12’ 1.42861”	-0.281	16.791

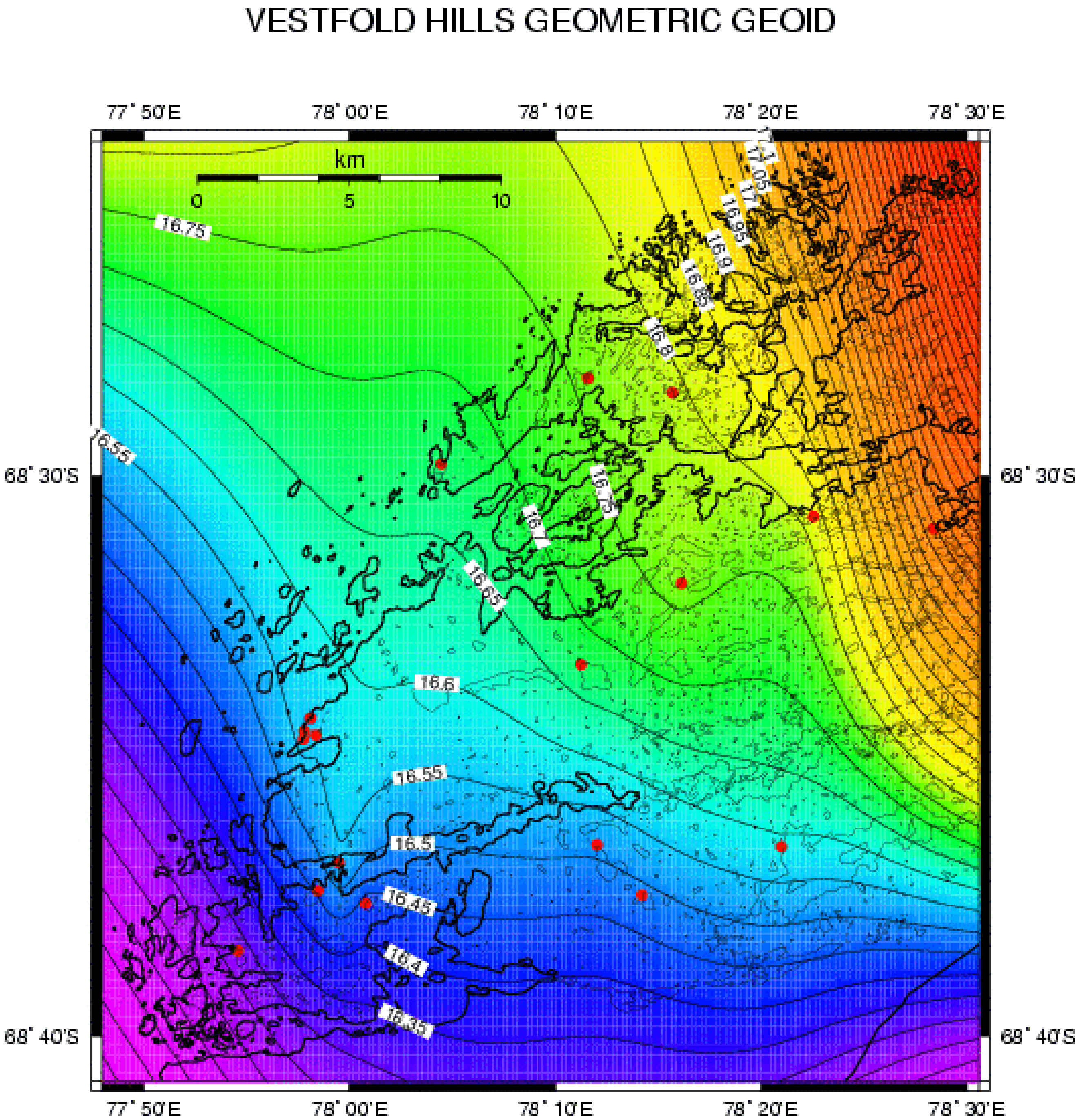

Figure 8.1 Vestfold Hills Geometric Geoid

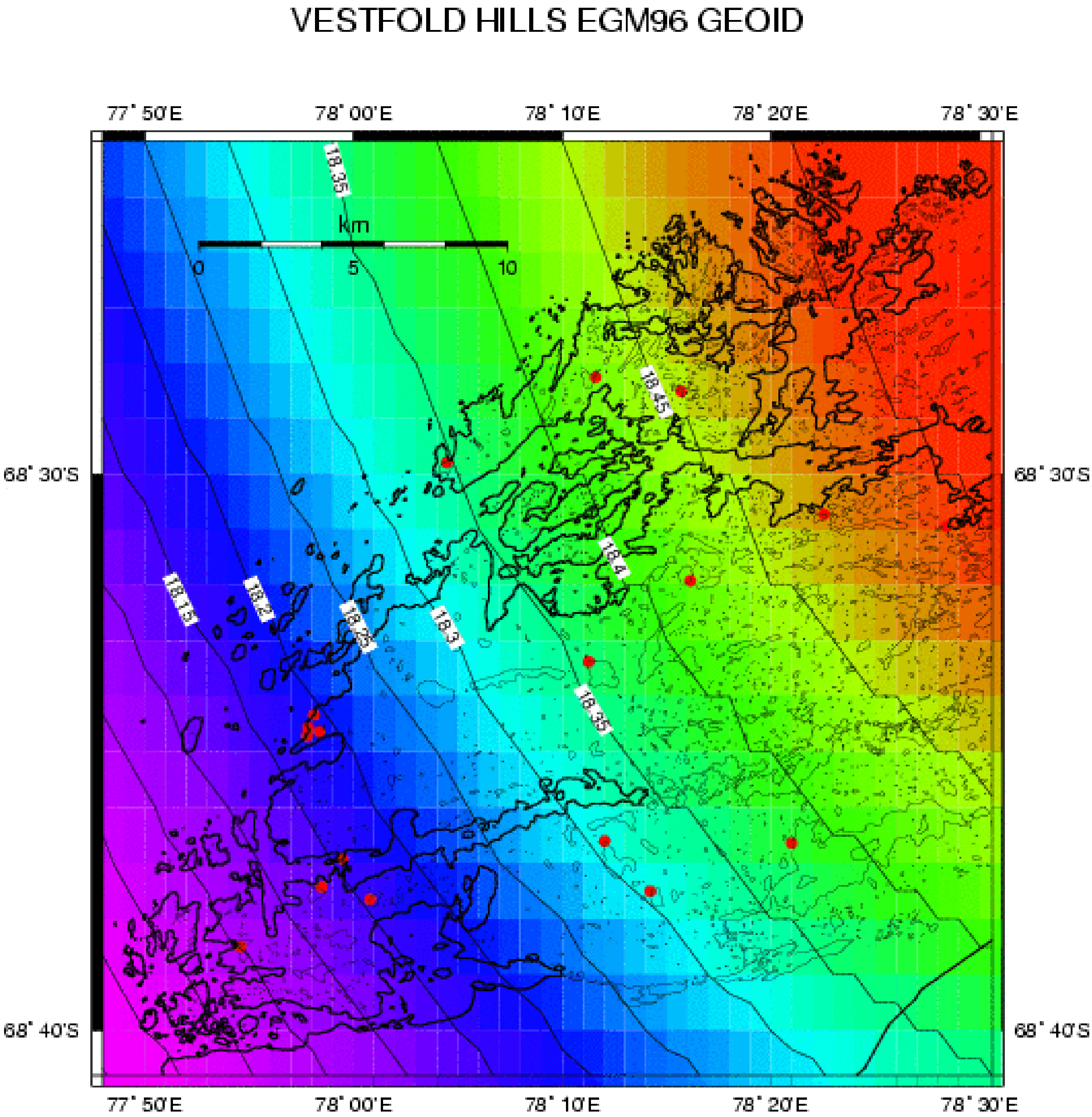

Figure 8.2 VESTFOLD Hills EGM96 Geoid

9. Report on Assistance provided to the Australian National University Research School of Earth Sciences

The Research School of Earth Sciences (RSES) at the Australian National University (ANU) is undertaking a 5 year program to monitor the postglacial rebound which may be occurring near the Lambert Glacier, Prince Charles Mountains region. Thus to determine possible vertical uplift a transect of permanent GPS sites has been established from the coast up to 450 km inland. The sites include Beaver Lake, Landing Bluff and Daltons Corner.

During the 2000/2001 season a request was made by RSES for AUSLIG surveyors to assist in setting up and to reconfigure several of the GPS sites. The following sections describe the assistance provided at each site.

9.1 Landing Bluff

On December 12 2000 AUSLIG Surveyors flew to Landing Bluff to occupy AUS042 and NMS138, adjacent to the RSES continuos tracking GPS. During that visit assistance was also provided to John Hyslop (a contractor with RSES) to erect a second solar panel array to power the RSES GPS instillation. John continued to test the telephone communication system while the solar panel array was erected, weighing down the frame with rocks.

The AUSLIG GPS equipment was retrieved on the 14 December 2000 and John Hyslop made some minor alterations to the RSES system.

9.2 Beaver Lake

Beaver Lake was visited on route to the southern Prince Charles Mountains to retrieve any data stored internally in the ANU GPS receiver and to re-power the receiver by switching the phone power switch. This successfully restarted the receiver at which stage the sampling interval was changed to 60 seconds to extend the memory capacity of the receiver for the a University of Tasmania project.

After the data download and memory purge, the aluminium warm box was resealed and left operating. A second visit to this site was planned to recover the receiver and the Data Storage and Communications Controller (DSCC) however inclement weather prevented this from happening and the equipment remained in place.

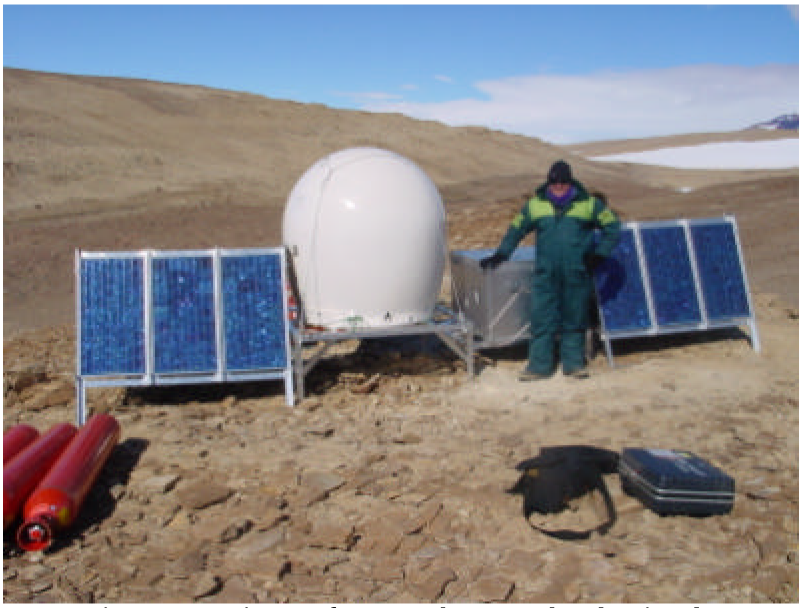

Figure 9.2.1 Picture of set up at beaver Lake, showing the aluminum warm box, solar panels and satllite dish

9.3 Dalton Corner

As indicated one of the permanent ANU GPS receivers is located at Daltons corner, at the Southern end of the Southern Prince Charles Mountains. This location was visited on the same trip as the visit to the Beaver Lake site. During the time at Daltons Corner A full solar panel array was assembled and put in place near the GPS receiver warm box. The existing solar panel array that was partly assembled was disassembled and returned to Davis.

The GPS receiver was checked and found to contain very little data, and it was noticed that the antenna cable had become unattached during the winter period. Clearly it had originally been connected, as data was present in the DSCC flash card.

The monitor and keyboard were connected to the DSCC as instructed and the re-boot sequence followed, however the computer did not re-boot the computer. An attempt was made to reset the bios following the instructions provided, however the instructions provided were not complete and were incorrect, as a result reactivating of the DSCC was not possible.

The backup plan was to reset the receiver and set the sampling interval to 60 seconds in support of the University of Tasmania project. This was completed successfully. The memory flash card was retrieved from the DSCC and returned to Davis where the data for 1999/2000 summer was retrieved and sent to Dr Paul Tregonning at ANU RSES.

A second visit to Daltons Corner was planned to restart the DSCC with an improved set of instructions, or alternatively to remove the entire set up for return to Australia. Again this trip did not eventuate due to inclement weather conditions, and the equipment remained in place operating at 60 seconds.

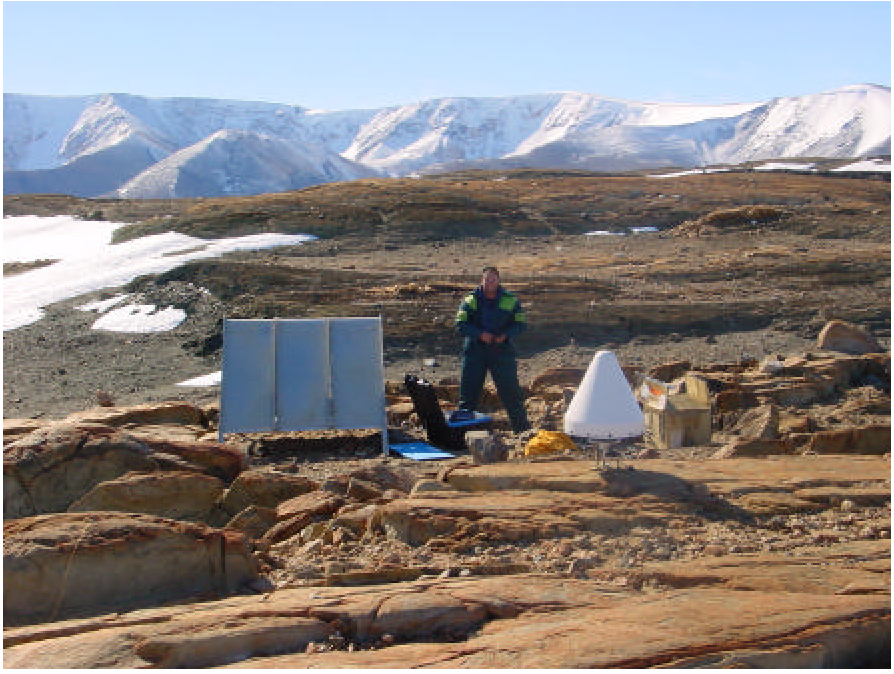

Figure 9.3.1 Photo of Daltons Corner, showing the GPS antenna, solar panels and receiver warm box.

9.4 Davis

A stocktake of ANU equipment was requested in order to determine what equipment could be left on site and what was to be returned to Australia (RTA). This equipment was stored on top of pallets in a large compactus located in the Green store at Davis. Upon lifting the equipment down from the compactus it became obvious that the three solar panels had been damaged and were destroyed. One had been punctured and the other two bent to the point of shattering.

The panel framing retrieved from Daltons Corner and that left at Davis was packaged ready for RTA. Three batteries were also packaged for RTA. The spare DSCC from the aluminium warm box was packaged for RTA. The three solar panels from Daltons Corner were packed with the aluminium warm box (one inside and two flat on top in bubble rap) and re-positioned into the compactus. All fuel cell components were left as found as they were to be moved by the store manager to the flammable liquid store.

10. Miscellaneous Support to ANARE

Survey support was given to a number of additional ANARE programs during the 2000/2001-summer season. The support provided was in the form of a construction set out for an antenna array near Davis Station and a detail survey of the Chinese station – Zhong Shan in the Larsemann Hills.

10.1 Zhong Shan Detail Survey

Whilst undertaking work in the Larsemann Hills, the Zhong Shan (Chinese Station) Deputy Station leader requested a detail survey of the station tarn, in order to determine its water volume. As well as surveying the tarn, additional station features were coordinated, such as pipelines, buildings and antenna locations. The detail survey also assisted the Australian Antarctic Divisions Environment program, who were undertaking research towards the development of a management plan for the Larsemann Hills, by providing positions of certain features.

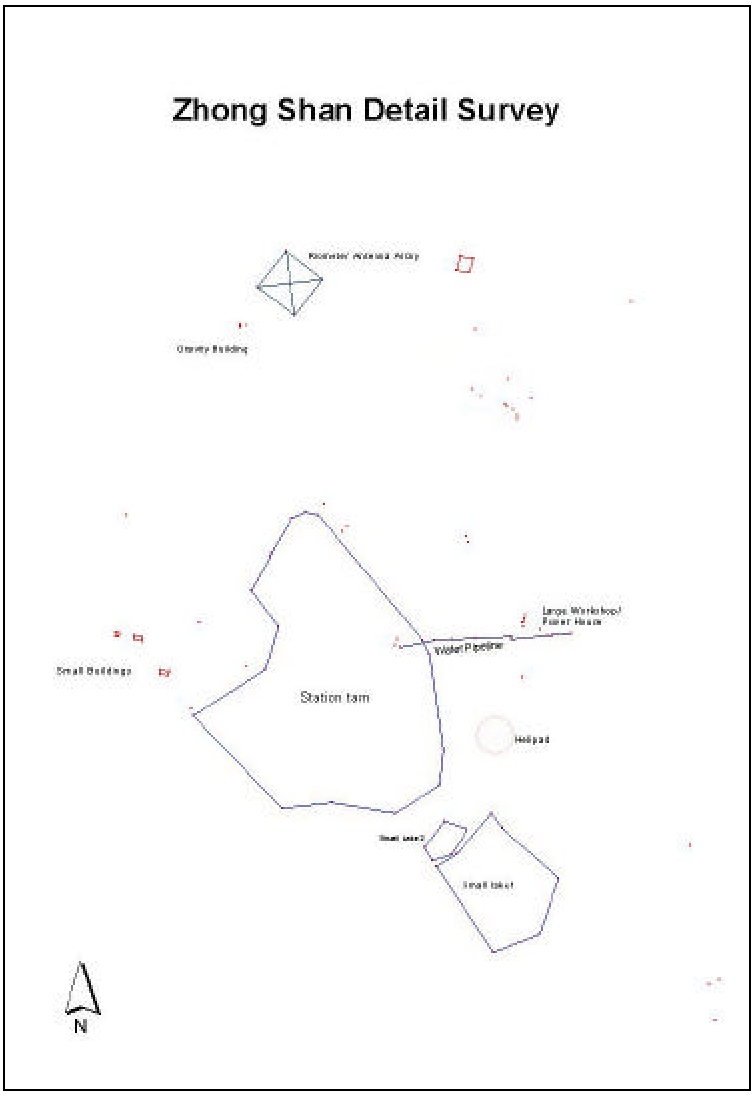

Figure 10.1 Plan of the Detail Survey at Zhong Shan Station

10.2 Antenna Array Set-out

A request was made from the Atmospheric Space Physics (ASP) program to assist in positioning concrete foundations for the construction of four large ASP antennas. The setout required an equilateral triangle to be marked on the ground, with an additional mark at the centre of the triangle. The marks were set out using the total station and survey pole with an attached prism. There was a requirement that one side of the triangle was aligned with magnetic north, this was achieved by observing to two existing antennas, which were known to be aligned with magnetic north.

The work was completed during a 2-week period, with the locations initially marked and then a second survey to accurately mark the antenna locations on the completed concrete foundations.

10.3 Wind Tower height Determination

During the1999/2000 summer a wind tower was erected on a hill approximately 1 km to the east of Davis Station. The wind tower is part a viability study of the use of wind generated power for Australian Antarctic stations.

To assist with this study, the height of the tower needed to be determined. A survey was therefore completed, using the total station and observing slope distances and vertical angles to the base of the tower to enable the height of the base to be determined and consequently the tower height.

11. Acknowledgments

Like most ANARE science programs the success of this summer program owes much to the support of many people. Without the support of these people the task of undertaking a science program in the Antarctic would be almost impossible. We would like to acknowledge and thank those who assisted our program. They include in no particular order:

- John Brooks and Jenny Whitaker (voyage management on V4) for their assistance with our program at Mawson and Landing Bluff on V4.
- Jeremy Smith and Phil Smart (the Davis station management team) who facilitated our program to the maximum extent given the difficult weather conditions for long range flying.
- Leigh Hornsby, Adrian Pate and the Helicopters Resources aircrews for their extremely professional and yet flexible approach to air support.
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- Cameron Quinn, John Aulich, Andy Trigg and Volker Janssen for their assistance in the Vestfold Hills surveys.
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- Darron Lehman, David Correll, Damian Murphy, Malcolm Lambert, Mark Tell, & Mark Healy for their assistance with IT and electronics issues.
- Everyone on Mawson and Davis stations for making summer 2000/2001 an effective and enjoyable season

12. Bibliography

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“http://www.anzlic.org.au/icsm/publications/sp1/sp1.htm”