UPGRADES TO THE AUSTRALIAN ANTARCTIC GEODETIC NETWORK, 2000/2001

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1. Introduction

The Australian Antarctic Geodetic Network (AAGN) consists of a series of geodetic control marks placed on solid rock outcrops throughout the Australian Antarctic Territory. The majority of these marks were established placed using terrestrial-surveying techniques from 1965 to 1976. In previous years a number of astro fixes had been observed as control for reconnaissance mapping.

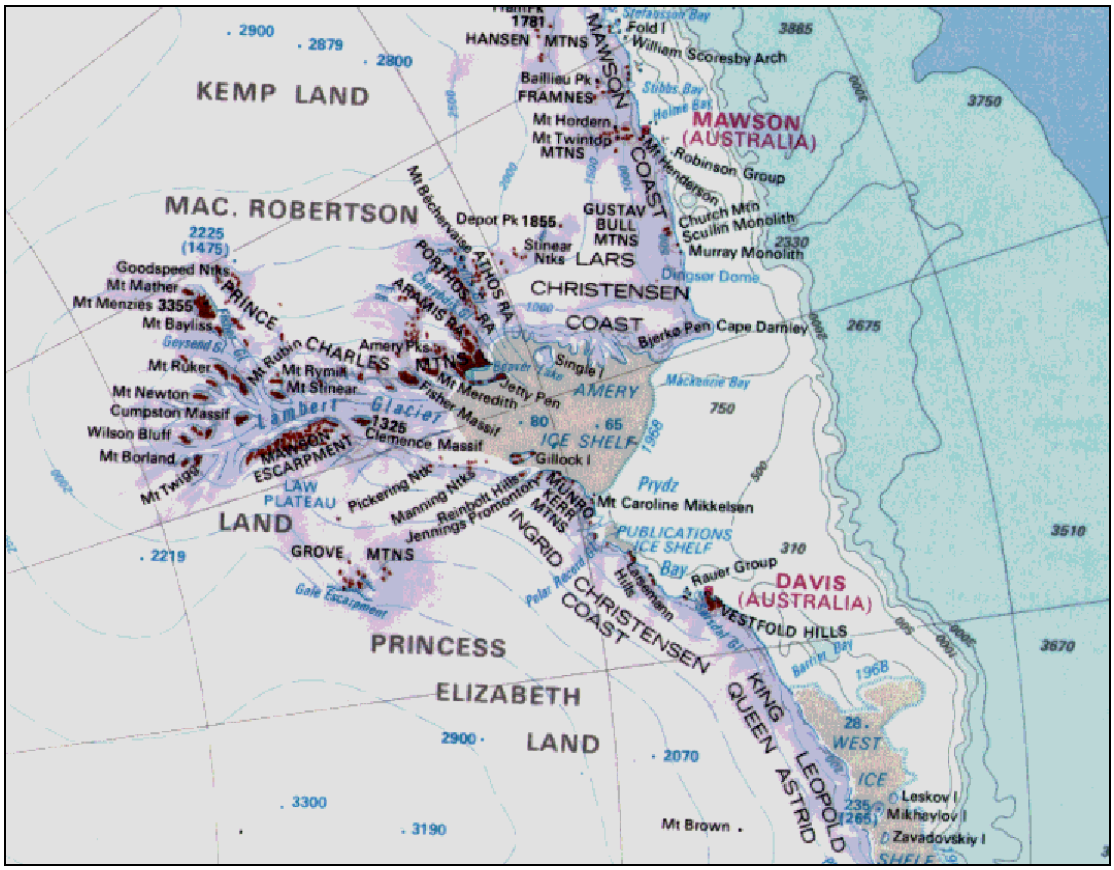

Figure 1. The Lambert Amery basin in East Antarctica

The terrestrial based AAGN was established to support mapping and other geographically dependant sciences in the Australian Antarctic Territory. It consists of survey marks placed typically on mountaintops in solid exposed rock locations. The network was extended south from Mawson station into the northern Prince Charles Mountain's (PCM's) using loops of angles and distances using second order Australian geodetic survey techniques from 1965 to 1970.

The network was later extended (in the 1970's) into the southern PCM's and across to Davis via the eastern Amery and Manning Nunataks (Fig.1). The network extended as far south as Wilson Bluff with a number of rock outcrops intersected including Mt Komsomolsky, the most southerly exposed rock site.

In recent years satellite positioning technology, firstly Doppler NAVSTAR techniques and then the Global Positioning System (GPS) has been used to strengthen the main Terrestrial geodetic network. These techniques enabled connections over intercontinental distances with far greater accuracy and without the need for intervisibility between sites (Fig.2).

The use of space geodetic techniques has gradually incrcreased since the first Pageos experiment in 1969 where stations at Mawson and Casey were used to determine coordinates in a global reference frame. Later the TRANSIT Doppler system was widely used to strengthen the network at a greater density. From 1990 onwards the Global Positioning System has been the primary tool for geodetic surveying in the Antarctic network. Originally it was used in an exclusively baseline mode over relatively short distances, which resulted in significant improvement to the existing network, and more importantly allowed the establishment of new stations in far less time then was achievable historically.

Figure 2: Classical terrestrial methods of surveying used in the terrestrial geodetic network.

3. Recent Survey Work

In late 1993 Continuous GPS (CGPS) installations were established at Casey, Davis, Mawson and Macquarie Island. Data from these CGPS sites is transferred back to Australia for distribution to the international community, in particular the International GPS service (IGS). Data from these sites is processed by the IGS analysis centres to determine coordinates for the station in the latest International Terrestrial Reference Frame (Currently ITRF2000). The AAGN is constrained to the ITRF coordinates for these three stations and adjusted using Least squares techniques, thus propagating ITRF2000 coordinates through the network.

In 1997 AUSLIG undertook the first major GPS campaign in a number of years to upgrade the AAGN. It concentrated on the southern PCM’s where the propagation of errors from the coastal CGPS sites was expected to be greatest (Fig.3).

Figure 3: Recent GPS observations taken in the southern PCM's to strenghen the geodetic network

The data from this GPS campaign was processed and the resultant coordinates in ITRF96 were included in the Least square adjustment of the AAGN. These GPS coordinates had a profound effect on the network, causing a several hundred-metre adjustment to some isolated sites, particularly toward the south western portion of the network. As a result it was decided to continue to strengthen the network whenever possible by observing further GPS data on existing network sites.

4. Current Survey Activity in 2000/2001 Season

In the 2000 / 2001 summer field season the focus of AUSLIG activities as apart of the ANARE activities were focussed on:

- Extending the network into the Grove mountains
- strengthening the long traverse down the eastern side of the Amery ice shelf.

See Figure 4.

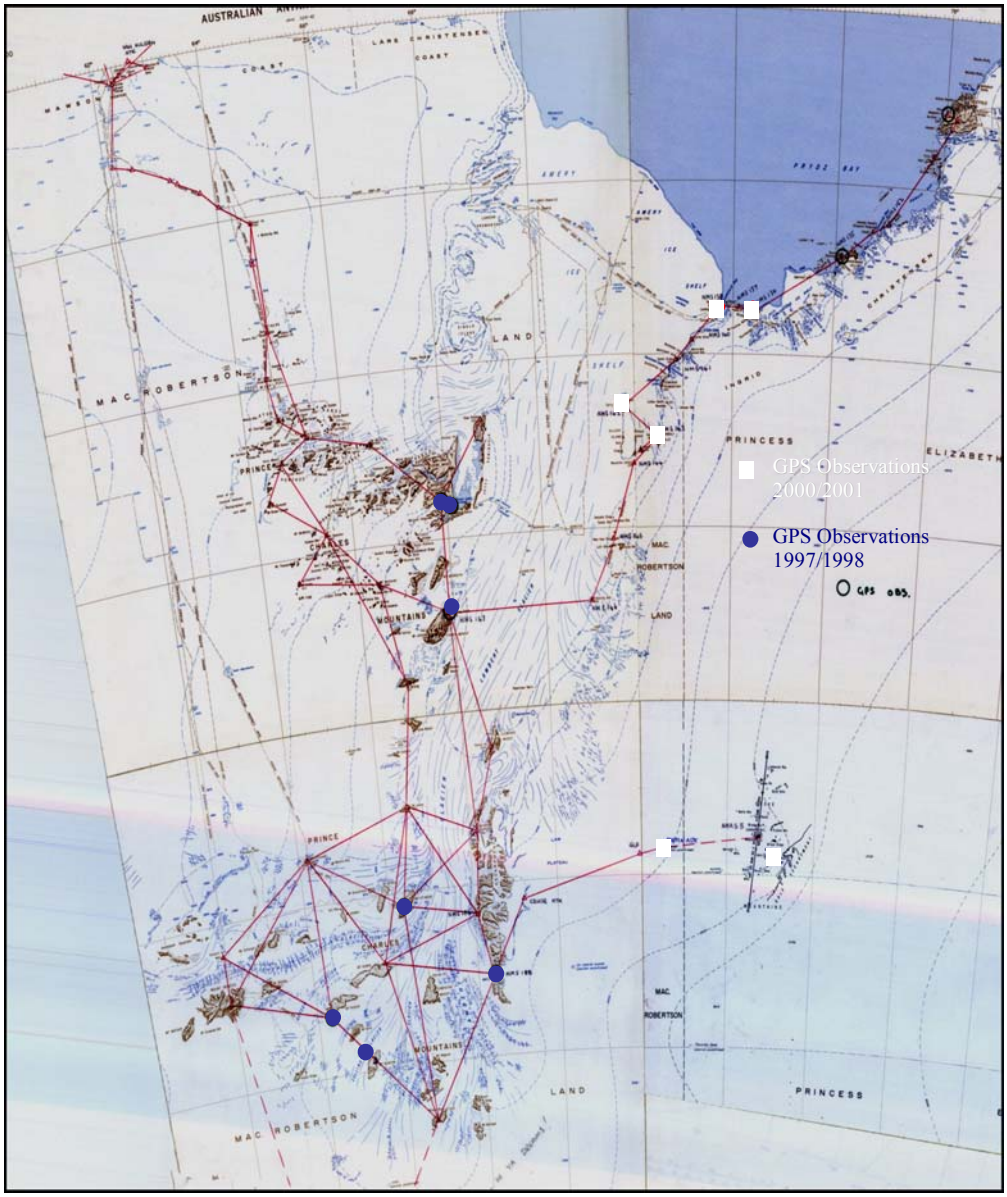

Figure 4: Locations of GPS Observations 2000/2001 Season

The following sections detail the observations undertaken.

- **The first objective** was to locate and obtain geodetic quality GPS observations on existing geodetic sites in the Grove Mountains and extend the network into the centre of the Grove Mountains by establishing a new GPS sites in the vicinity of Mt Harding. These tasks were partially completed during the season and are form the basis of a separate paper presented during AGS01 symposium (Johnston et al, 2001).

- **The second objective** was improving the long single line geodetic traverse from Blundell Peak in the Larsemann Hills to Blustery Peak in the PCM's. This long traverse included very little observational redundancy, being a single line traverse. Yet its proximity being adjacent to the scientifically active Amery Ice Shelf required the determination of accurate station coordinates on

rock as reference sites. To strengthen the traverse, GPS observations were taken at four existing sites on the traverse :

- Landing Bluff;
- Mt Caroline Mikkelsen;
- Corry Rocks; and
- Rubeli Bluff.

The work undertaken at each site is described below.

4.1 Landing Bluff (AUS305)

Landing Bluff is a fundamental site in the Australian Antarctic Geodetic Network, first established in the 1967/68 survey. Three survey marks now exist at this site (Fig. 5.1). The first is a Russian brass plaque set in the original NMS138 drill hole placed by ANARE surveyors from the Australian Division of National Mapping in 1968. This plaque is the primary monument at Landing Bluff and now 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 (placed by AUSLIG, 1991). The final monument is the antenna mount (AUS305) for the Australian National University's CGPS site, which was constructed in 1999. These three sites have all been observed at different times for varying purposes, but were never actually connected to each other.

Figure 5.1 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 4.1. This connection was subsequently included in the new adjustment (ANT2001).

Table 4.1 Summary of GPS observations for AAGN upgrade.

Site	DOY	Date	Start	Finish	Vert Antenna Height (m)	Antenna Type
136E Mt Caroline	17	17/1/2001	4:51:30	23:59:30	1.1325	ASH700936E
Mikkelsen	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
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

4.2 Mt Caroline Mikkelsen (NMS 136E)

The site at Mount Caroline Mikkelsen forms the top mark in traverse down the eastern side of the Amery Ice shelf. It was established in 1967/68 and reoccupied the following year when the station monument was built. 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.

A rock filled 2.5 metre steel pipe surmounts the station mark at Mount Caroline Mikkelsen. The eccentric mark, which was used for the GPS observations, consisted of a 6 inch rock piton (Fig. 5.2).

Figure 5.2 Mt Caroline Mikkelsen - 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 4.1. Resultant positions are included in Table 4.2.

Table 4.2 - 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"	139.638
AUS305	LDBF	S 69° 44' 32.25112"	E 73° 42 37.40090"	133.187
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"	239.835
NMS 138	LANDING BLUFF	S 69° 44' 32.14039"	E 73° 42 36.94688"	133.987

4.3 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 position occupied in the 1967/68 summer geodetic traverse and was used again to continue the traverse next season 1968/69.

Unfortunately the station eccentric mark which consisted of a 6 inch piton approximate 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 1.8 metre stone cairn built over it (Fig 5.3). 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 4.2.

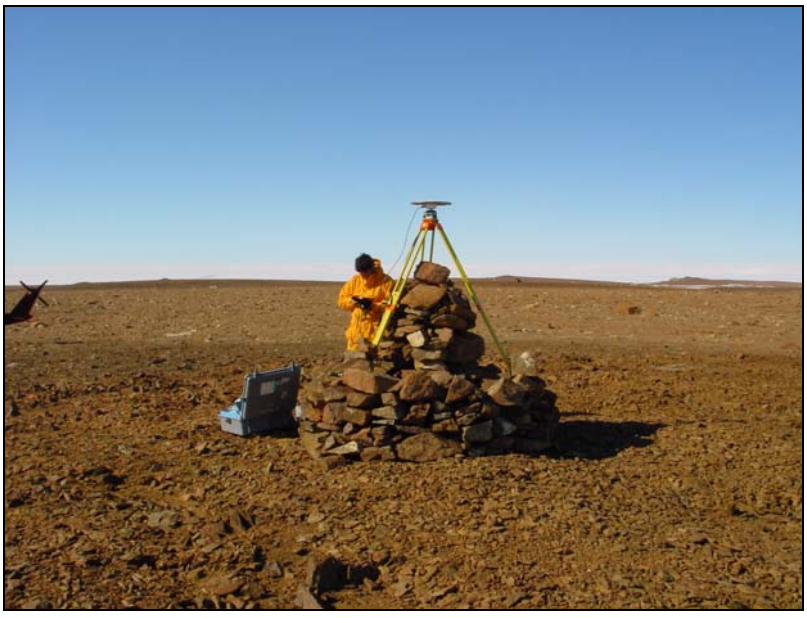

Figure 5.3 Rock Cairn Over Station Mark - Rubeli Bluff NMS 143

4.4 Corry Rocks (NMS 142)

Corry Rocks is a rock outcrop located at the northern end of the ice covered Gillock Island. The station forms part of the east Amery traverse section which extends from the Larsemann Hills to the PCM's. The station was established in 1968, and 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 (Fig 5.4). 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.

The baselines between these stations and Davis and Mawson were included in the Antarctic adjustment (ANT2001) along with data collected by the University of Tasmania in 1998 at New Year Nunatak, AUS037T (Fox Ridge) and AUS072 (Else Platform) in the PCMs. A summary of the data observed in 2000/2001 can be found in Table 4.1 and the results found in Table 4.2. 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 2000.0.

5. Conclusion

Four original stations on the east Amery geodetic traverse were successfully reoccupied with GPS observations. The result enabled the network to be considerably strengthened and a new network adjustment carried out in the IRTF2000 reference frame.

In the future the AAGN will continue to be upgraded by observing geodetic quality GPS in keys areas throughout the network when logistic support is available. These areas include:

- Southern Prince Charles Mountains
- Enderby Land

- Grove Mountains
- Commonwealth Bay
- Trans-Antarctic Mountains

The network will also be further strengthened by long occupation GPS observations in the Grove Mountains and Southern PCM's. The high precision results will also be extremely useful for constraining the adjustment of the AAGN and results from these long occupation observation campaigns will contribute to eustatic studies and evaluation of the dynamics of the Lambert rift.

The integration of geodetic networks and Continuous GPS sites operated by other nations and other scientific researchers will also strengthen the AAGN.

References:

Johnston, G., Digney, P., Manning, J., (2001) *Extension of the Australian Antarctic Geodetic Network in Grove Mountains*, Proceedings of the Antarctic Geodesy Symposium 2001, SCAR Report Number xx, SCAR, Cambridge.