

Extension of the Australian Antarctic Geodetic Network in Grove Mountains

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1. BACKGROUND

The Grove Mountains consist of a scattered group of mountains and nunataks extending over an area 65 by 30 km in extent. They are located in Princess Elizabeth land in East Antarctica centred at 76° east 70° south, some 200 kilometres inland and 160km east of the Mawson Escarpment.

The area of the Grove Mountains has attracted very few visitors; it was first sighted and photographed from the air by ANARE Beaver aircraft operating out of Mawson in the 1950s. The initial ground visit was made in November 1958 by ANARE surveyor Knuckey and geologist Macleod (AUSLIG, 1998). This was followed by ANARE visits in the 1972 and 1974 summer seasons, at a time when visits were also made by the Soviet expeditions based at Druzhnaya.



Figure 1. ANARE Surveyor Knuckey performing astronomical observations near Mt Harding in the Grove mountains 9 November 1958.

The Grove Mountains have now become an area of renewed interest for both Russian and Chinese scientists, with both countries active in the region in recent years. A ground party from the Chinese Antarctic Research expedition CHINARE spent an extended period there during the summers of 1998/1999 and 1999/2000. These expeditions used ground vehicles and personnel in an over-snow glaciological traverse to the Grove Mountains from their winter base at Zhong Shan in the Larsemann Hills, 300 km to the north. The Chinese expedition was part of a larger plan to traverse from the Larsemann Hills to Dome Argus (a further 600km inland from the Grove Mountains). Their work in the Grove Mountains consisted mainly of geological research, which also included some large-scale mapping. A Russian expedition undertook an airborne geophysical survey to the north of the Grove Mountains during the previous season.

2. GEODETIC SURVEYS 2000/2001 IN THE GROVE MOUNTAINS

ANARE undertook geodetic survey work in the region in the summer 2000/2001. Initially it was planned to fly into the Grove Mountains from Davis wintering station on four separate days, allowing enough time to complete all the intended work. However owing to the harsh flying conditions encountered 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 achieved 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 – 60km to the West of Mount Harding
- Search for two existing CHINARE geodetic control points established near Mount Harding and Zakharoff Ridge.

2.1 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, AUS 351 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. See Figures 2 and 3 below.

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 2. Location of AUS351 -- Looking North to Mount Harding



Figure 3. 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 4. Solar Panel and GPS warm box set up at AUS 351

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). 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 decimetre). 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.

Continual bad flying conditions between Davis Station and the Grove Mountains meant 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 as in Table 1. 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 2.

Table 1 Summary of GPS observations for Grove Mountains Network.

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
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

Table 2 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)	1891.289

2.2 Austin Nunatak (NMS 50)

Austin Nunatak was the terminal geodetic station in the 1974 ANARE geodetic network traverse from the Mawson Escarpment to the Grove Mountains. Azimuth observations from Austin Nunatak were closed out at the spire of Mason Peak.

The survey 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 the Austin Nunatak station mark, NMS 50, and was initially processed using AUSLIG's on-line processing software using IGS precise ephemerides in the ITRF 1997 Reference Frame. All coordinates refer to a mean epoch of the observation data. The final results were recalculated in ITRF2000 results are shown below in Table 3.

Table 3 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 5. Photo of Austin Nunatak (NMS 50) and looking East to the Grove Mounatins

2.3 CHINARE Geodetic Control

As discussed previously, CHINARE spent two full summers in the Grove Mountains conducting geological research, culminating in the publication of a 1:25 000 scale topographic map (CACSM 2001). As part of their research, two geodetic control points were established and GPS data observed at each point. The coordinates supplied for the points are listed in Table 4 (Wang, 2000). MG8 was

described as being a steel rod, 1.8m above ground surface, cemented into a drill hole in rock near Zakharoff Ridge. MG9 is a steel rod 0.5m high, cemented into a drill hole in rock on the south-eastern side of Mount Harding.

Table 4. CHINARE marks in the Grove Mountains

Site	Latitude	Longitude	Height
MG8	S72 53' 00.76"	75 04' 52.43"	2147.0m
MG9	S72 54' 36.95"	75 09' 27.47"	2160.0m

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.

4. CONCLUSION

The geodynamic mark established in the vicinity of the Grove Mountains is suitable for reoccupation without any possibility of GPS antenna height or centring errors. As such, it is ideal for postglacial rebound and tectonic research relating to the Lambert Rift. Data will be gathered at every opportunity to contribute to this study.

Additionally, establishment of supplementary points in the Grove Mountains will be undertaken as the opportunity arises. The connection of the existing CHINARE marks to the new Australian mark is also of considerable importance, particularly for joint unification of Antarctic geodetic networks in the region.

5. REFERENCES

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