DEM Data Collection and Mapping of the Grove Mountains Core Area

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1. Introduction

In order to meet the needs of the Geology investigation on the topography of the Grove Mountains, our geodetic surveyors had a manual mapping experiment in the Grove Mountains Core Area, which is about 110 km^2, during the 16th CHINARE (Chinese National Antarctic Research Expedition), 1999/2000 summer expedition. With post process DGPS method, surveying of the control points and topographic detail points were finished at one time.

DGPS, as a useful method to get real-time or post-process coordinates in high precision, is utilized in underwater topographical surveying, engineering setting out, and other fields. With the characteristics of DGPS such as speediness, high-efficiency, high precision and all weather, it has a wide application future in topographical mapping, especially for the small-scale topographical mapping. While real-time DGPS must maintain the data communication between the reference station and the flow station, and the distance and the location of the flow station is limited by the terrain, especially in the complex terrain where data communication is interrupted for the feature obstruction. However, post process DGPS doesn't need to consider the real time communication between the reference station and the flow station, and make the flow station more flexible and efficient. According to the topographical character of Grove Mountains Core Area, atrocious weather and working time limitation in this region, post process DGPS technology and total station were utilized for field data collection, which can guarantee the success in the field surveying. Utilizing post data processing for mapping is more reliable.

2. Field survey and data collection

2.1. General introduction to the surveying area

Grove Mountains area, with bare peaks at inland areas of east Antarctica, is located to the south of the Zhongshan Station about 400 km. Its geographical extension is 72° 40′ – 73° 10′ S, 74° 00′ – 75° 45′ E (see also Fig.1), and the area is about 3200 km^2; meanwhile, the core area extension is 72° 50′ 54″ –72° 56′ 20″ S, 74° 54′ 07″ –75° 14′ 09″ E, and its area is about 110 km^2. In the core area, there are two exposed mountains, many rock peaks, and detritus strips on the surface of the ice sheet with the altitude of 2000 meters, which has great topographical undulation and is densely covered by ice crack. The weather there is atrocious for it has blustery or milky weather half of a year and the average temperature is about thirty degrees below zero centigrade. Field operations are very difficult.

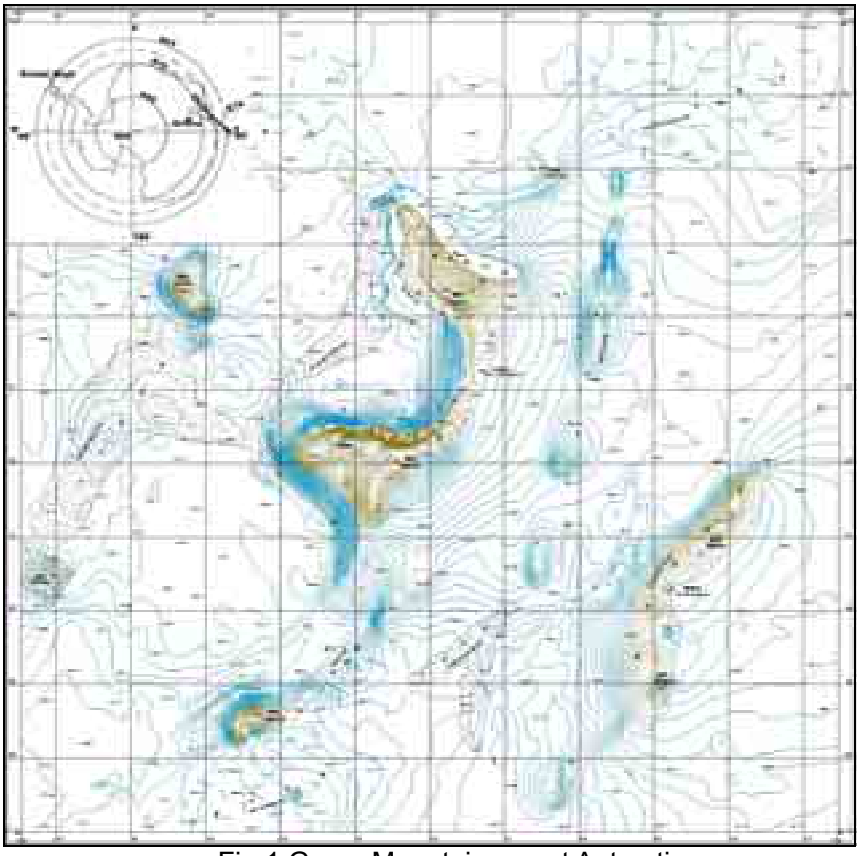

Fig.1 Grove Mountains, east Antarctica

2.2. Adopted instruments

In the field surveying, Geotracer 3220 double frequency GPS receiver was used at the reference station, and Trimble Pro-XR receiver and snow vehicles at the flow stations. The difference correction software was Trimble Pathfinder 1.0. The adopted total station was SET 3B. In the field, power was provided by the inland expedition motorcade.

2.3. Mapping control and data collection of the topographical points

The field surveying was finished in 36 days by two surveyors. 14300 topographical points were obtained through post process DGPS and forward intersection method with total station. Three permanent copper marks as ground control points were set at the Jiangjun Peak, Motian Ridge of the Harding Mount, and the Yingtou Peak of the Zhakroff Ridge respectively. The coordinates of the three points obtained by DGPS method are as follows:

Jiangjun Peak: 72° 52′ 29″ .25(S) 75° 04′ 01″ .24(E) 2354.8m(H)
Motian Ridge: 72° 53′ 40″ .76(S) 75° 02′ 51″ .35(E) 2305.2m(H)
Yingtou Peak: 72° 54′ 04″ .91(S) 75° 11′ 03″ .51(E) 2240.2m(H)

(1) Determining the mapping control points

The ground mapping control point is namely the difference GPS reference station since DGPS method was used to map. In order to realize the verification, two difference reference stations MG8 and MG9, 3.7km apart, were set on the ice surface in the vicinity of the cantonment, and because of the low temperature, gale and the difficulties of power supply, reference stations can not be set on the bedrock directly. Synchronous observation, which was about 6 periods, totally 48~72 hours, was taken at these two reference stations with the permanent GPS tracking station at the Zhongshan Station. So the coordinates of the reference station can be obtained after baseline solution. In addition, in order to verify the reliability of the coordinates obtained by DGPS method, mutual difference observation was taken at these two reference stations respectively in the field surveying. Comparing these coordinates with the precise coordinates obtained after long baseline solution, the results are as follows: ΔX=2.9m, ΔY=1.3m, ΔZ=3.1m, which can meet the mapping demand at the scale of 1:25000.

(2) Data collection of the feature detail points

Data collection by GPS: more than 14,000 points were obtained.

In the field surveying, GPS receiver of the flow stations was equipped at the snow vehicle, which automatically collected the data at intervals of 15 seconds by parallel survey-line method at the level region and low hillock. The interval between flow stations is about 100-150m, and the interval between survey-lines is about 150-200m. The orientation and positioning of the survey-lines were finished with Garmin palm GPS. For the mountainous regions, escarpments, and the bottom of the snow trenches that are beyond the arrival of the snow vehicle, data were collected by foot and the interval was changed to 20-40m when there was great elevation change.

Data collection by total station: more than 300 points were obtained.

For the mountain peak and the edge of the snow cliff, etc, that are beyond the arrival of the surveyor, total station was adopted at the points determined by DGPS technology to determine the coordinates and heights with forward intersection.

3. Post-data processing

Post-data processing is mainly to check the reliability of the field surveying data, precisely calculate the coordinates of the reference stations and process GPS difference correction, etc.

3.1 Verifying the reliability is to verify the internal and external precision of DGPS positioning system. Comparing the length and height difference determined by total station with the result obtained with DGPS method can get external precision, and the results are as follows (see table.1).

Table 1. The result comparison of total station and GPS

ID	GPS		Total Station		ΔS(m)	ΔH(m)
	Distance (m)	Height Difference (m)	Distance (m)	Height Difference (m)		
MG8-MG81	130.7	-3.70	129.8	-3.18	0.9	-0.52
MG82-MG83	1850.6	-198.6	1851.9	-200.2	–1.3	1.6
MG91-MG9	371.5	-25.9	371.1	-27.0	0.4	1.1
D-E	1300.5	-40.3	1301.7	-38.4	-1.2	-1.9

3.2 Considering the map making, single baseline resolution was processed with the multi-temporal data collected at the two reference stations and the data of the GPS tracking station through the software GPSURVEY designed by the Trimble company, and the precise coordinates of the MG8 and MG9 in WGS-84 were obtained. About the observation data at the flow stations, the software Pathfinder Office2.70 was adopted to process post difference correction. After superfluous points and blunder error were removed through checking all the 14,000 GPS points, then 11,000 GPS points are qualified to mapping, and contour mapping was generated by the software Sunway survey and Surfer.

4. Map making

In order to satisfy the demand of the Antarctic expedition, Grove Mountains area (1:25000) was mapped in contour topographic map and stereoscopic topographic map respectively.

4.1 Generation of AUTOCAD graphics

At first, transforming the graphical format of contour lines to *.dxf and *.dwg format (formats of AUTOCAD); then modifying and editing the graphics to export the Grove Mountains topographic map (1:25000) with terrain symbol, elevation annotation and topography characteristic.

4.2 Generation of stereoscopic topographic map and map production with CorelDraw

With the technical support of three-dimension visualization, the topographic map of Grove Mountains Core area was produced in stereoscopic topographic map mode.

Software environment: MapModel module of Atlas2000, a kind of multimedia

electronic map-integrating tool.

DEM generation: the square grid was used to generate DEM of the Grove Mountains. Basing on the original contour lines, elevation point interpolation was finished by the method of distance weighted method.

Generation of the topography model: the regular triangle grid was constructed based on the DEM. Stereoscopic topographic map was established through utilizing the triangle grid to approach the earth surface.

Grove Mountains map was produced on the basis of Desk Top Publishing (DTP) technology in CorelDraw Environment.

5. Conclusion

To meet the urgent need of the small-area map in the Antarctic expedition, it's feasible to map with post process difference GPS method. And compared with satellite remote sensing mapping, it has the merits of shorter periods, more economy and better precision, and the ground controlling and the field surveying and mapping can be completed at one time.