Management Plan for Antarctic Specially Protected Area No 168

Mount Harding, Grove Mountains, East Antarctica

Introduction

The Grove Mountains (72°20’-73°10’S, 73°50’-75°40’E) are located approximately 400km inland (south) of the Larsemann Hills in Princess Elizabeth Land, East Antarctica, on the eastern bank of the Lambert Rift(Map A). Mount Harding (72°51’ -72°57’ S, 74°53’ -75°12’ E) is the largest mount around Grove Mountains region, and located in the core area of the Grove Mountains that presents a ridge-valley physiognomies consisting of nunataks, trending NNE-SSW and is 200m above the surface of blue ice (Map B).

The primary reason for designation of the Area as an Antarctic Specially Protected Area is to protect the unique geomorphological features of the area for scientific research on the evolutionary history of East Antarctic Ice Sheet (EAIS), while widening the category in the Antarctic protected areas system.

Research on the evolutionary history of EAIS plays an important role in reconstructing the paleoclimatic evolution in global scale. Up to now, a key constraint on the understanding of the EAIS behaviour remains the lack of direct evidence of ice sheet surface levels for constraining ice sheet models during known glacial maxima and minima in the post-14 Ma period.

The remains of the fluctuation of ice sheet surface preserved around Mount Harding, will most probably provide the precious direct evidences for reconstructing the EAIS behaviour. There are glacial erosion and wind-erosion physiognomies which are rare in nature and extremely vulnerable, such as the ice-core pyramid, the ventifact, etc. These glacial-geological features have not only important scientific values, but also rare wildness and aesthetic values and the disorderly human activities would cause perpetual, unrepairable damage to it.

The Chinese Antarctic Research Expedition (CHINARE) has visited the Grove Mountains for several times from1998 to 2014, and plans to visit the Area in the coming 2015/2016 season, focusing on research on geological tectonics, glacial geology and landscape, meteorology, ice-cap movement and mass balance, surveying and mapping, especially on fluctuation of Antarctic icecap surface since the Pliocene, and these research results in some new discoveries.

The Australian Antarctic Programme has visited the Grove Mountains to conduct a range of geoscience and glaciology research and support activities for several times. It currently maintains a continuous GPS station on Tianhe Range and expects to continue to access the region for research and operational

purposes. Besides, Russian Antarctic Research Expedition has ever tripped there in 1958 and 1973 for a short stay, but whether they have arrived at the Area is unclear.

1. Description of values to be protected

The Mount Harding area designated as the site for the specially protected area (Map A) has the precious physiognomies of glacier erosion preserved in the ice sheet of inland Antarctic, which is of great scientific, aesthetic and wilderness values. The aim of this protected area is to preserve its scientific, aesthetic and wilderness values.

1(i) Scientific values

A lot of remains of ice sheet advance and retreat are preserved in Mount Harding, which are the direct evidence of the changes of cold and warm in the global environment since Pliocene. In this Area, the scientists have found the rare extreme cold desert soil, the sedimentary rocks formed in the Neogene Period that are not consolidated completely, as well as the valuable spore pollen assemblages in those paleo-soils and sedimentary rocks. All of these imply there was a warm climate event in this area probably resulting in a large-scale retreat of the EAIS, and its margin might be even beyond the Grove Mountains, 400km south from its present coast of the EAIS.

The unique geomorphological features in this Area includes the integral geologic-geomorphic remains and a series of special physiognomy, such as ice-core pyramid, ventifacts, ice-cored moraine (end moraine and lateral moraine), cold-desert soil, sedimentary erratics, pool of melted water, rochemoutonee, etc.

1(ii) Aesthetic and wilderness values

There is ice-eroded ice field geomorphology which is rare in nature in the Area, such as the pool of melted water, hanging moraine dyke, ice-core pyramid, ventifact, etc (photos 1-6). These geological and glacial landscapes contract finely with the vast blue ice, producing extremely significance and beauty to make high aesthetic and wilderness values.

6. Aims and objectives

Management of Mount Harding, Grove Mountains, East Antarctica aims to:

• Facilitate long-term scientific research while avoiding direct or cumulative damage to vulnerable geomorphological features;

• Allow scientific research in the Area provided it is for compelling reasons which cannot be served elsewhere and which will not jeopardize the values in that Area;

• Allow scientific research in the Area which is consistent with the management aims and objectives and which will not jeopardize the values in that Area;

• Allow visits for management purposes in support of the aims of the Management Plan;

• Minimize the introduction to the Area of alien plants, animals and microbes.

1. Management activities

• Copies of the Management Plan (attached with maps) shall be made available at the Zhongshan Station (China), Davis Station (Australia), Progress Station (Russia), and the map of the protected area should be put up at prominent positions in the stations mentioned above. Personnel in the vicinity of, accessing or flying over the Area shall be specifically instructed, by their national program as to the provisions and contents of the Management Plan.

• National Antarctic Programmes operating in the Area shall consult together with a view to ensuring the above management activities are implemented.

• The Area shall be visited as necessary, and no less than once every five years, to assess whether it continues to serve the purposes for which it was designated and to ensure that management activities are adequate.

• The Management Plan should be reviewed no less than once every five years and, if necessary, updated or revised.

• In case the Antarctic ice sheet continuously retreats so that the new remains of advance and retreat of EAIS are exposed in the vicinity of the protected area and the extent of remains of ice sheet advance and retreat expands, the boundary of the protected area should be updated periodically so as to include the newly exposed remains of ice cap advance and retreat in the area. This should be taken into consideration in examining the Management Plan.

2. Period of designation

Designated for an indefinite period.

3. Maps and photos

• Map A, A1: Position of Grove Mountains. A2: Grove Mountains Area, Antarctica

• Map B, Protected Area around Mount Harding, Grove Mountains, Antarctica

• Map C, Location of Nunataks and Direction of Ice Flow around Mount Harding, Grove Mountains, Antarctica.

•Photo 1, Ventifact

•Photo 2, Ventifact

•Photo 3, Ice-core pyramid

•Photo 4, Hanging moraine dyke

•Photo 5, Pool of ice melted water

•Photo 6, Roches montannees

4. Description of the Area

6(i) Geographical co-ordinates, boundary markers and natural features

The Area is irregular, and approximately rectangular in shape, with a width of about 10km from east to west, a length of about 12km from south to north and an total area of about 120km^2 (Map A).

The proposed ASPA boundary was defined to ensure that the unique geomorphological features, formed in ice sheet advance and retreat in Mount Harding, can be specially protected as a whole.

Geographical Co-ordinates

The Specially protected Area of Mount Harding, Grove Mountains, includes the open blue-ice zone from the moraine on the west side of Mount Harding to the east side of the Zakharoff Ridge as well as a number of nunataks, detritus zone, and moraine etc. within it (Map B). Its geographical coordinates are: 72°51’ -72°57’ S, 74°53’ -75°12’ E.

Boundary marks

The western boundary of the Area is the moraine on the west side of Mount Harding, with its northern end turning eastward to the open blue-ice detritus zone on the east side of the Zakharoff Ridge via the north flank of the northern ridge of Mount Harding and the northern end of the Zakharoff Ridge, turning southwards to the northern end of Davey Nunataks, and then heading westwards to the southern end of the Xi Lake moraine to close the whole area. The geographical coordinates of the nine control points located at its boundary are counter clockwise: 1. 74°57’E, 72°51’ S, 2. 74°54’E, 72°53’ S, 3.74°53’E, 72°55’ S, 4. 74°54’E, 72°57’ S, 5. 75°00’E, 72°57’ S, 6.75°10’E, 72°57’ S, 7. 75°12’E, 72°55’ S, 8. 75°11’E, 72°52’ S, 9. 75°08’E, 72°51’ S.

No markers or signs are currently in place to mark the boundary.

General climate condition in summer

With an average altitude of more than 2000 meters in the Grove Mountains, the daily temperature range and strong wind frequency are greater than those at Zhongshan Station. When affected by the warm-moist current from the north, snowfall would appear constantly in this area, while under the control of the east current, the weather would mainly be sunny. The trend of daily wind speed change is greater than that at Zhongshan Station, where the maximum wind speed appears at around 05:00 am and minimum wind speed occurs at about 17:00 pm commonly. The daily mean wind speed is 7.5m/s from December 1998 to January 1999. Same as Zhongshan Station, the Grove Mountains area is influenced by the katabatic wind, but with a greater force than Zhongshan Station.

From December 1998 to January 1999, the average highest and lowest air temperature in the Grove Mountains area were -13.1°C and -22.6°C respectively, and the estimated average daily temperature range could be -9.5°C. In this area, in January in particular, the air temperature and snow temperature saw an obvious change during a day, where the average air temperature was -18.5°C, and the snow surface temperature was about -17.9°C, that is, the average snow temperature was higher than the average air temperature.

Physiognomy

Mount Harding in the central GMs is shaped as a crescent open to the north-west. Both the northern and southern ends are steep crests, protruding ~200m above the recent ice surface. The central segment of the ridge-line between two summits descends progressively until it reaches the ice surface in a central col, with a relic ice tongue hanging on the lee side. A stagnant field of blue ice, tens of km^2 wide, lies inside the crescent. All of this, shining each other with the vast blue ice, forms the magnificent, beautiful scene of ice-eroded ice field geomorphology.

The nunataks within the area may be divided into two groups. The one in the west is the tall nunataks represented by Mount Harding, and the other is a small part of the area including the low linear nunatak chain on the Zakharoff Ridge. The stoss slopes of rocky nunataks show smoothly abraded bedrock, with surfaces sparsely erratic till patches. The lee and lateral sides of the nunataks show generally sharp bluffs, resulting from both ice flow scraping and collapse along sub-vertical crevasses of rocks. The nunataks leave pair of “wake zone” of superglacial debris tens km in length on the ice surface, marking the path of present local ice flow.

The upper parts of the higher nunataks are usually jagged ridge populating with well-developed ventifacts on the summits, facing the dominant wind from the SE. The scarcity of glacial erosive imprints, also meters of depth inside the hard rock delved by wind- force blowing out indicate that these higher slopes are ice free since rather long time. But the lower parts of slopes beneath ~100m above ice surface have the features of recent glacial erosion such as fresh trimlines and erratics.

Some of small nunataks are typical “roches moutonnée” resulted from the past ice flow overriding. This regional borderline between wind and glacial erosions are considered to represent a former height of ice surface since certain phase, probably early Quaternary glaciations, and the later rises of ice surface did not exceed this limit.

Mount Harding is the largest nunatak in the Grove Mountains. On the west side of the crescent ridge there is a large stretch of lake shaped stagnant blue ice plain (Kunming Lake, Xi Lake) and a dozen ice-cored pyramids (ice-cored cone) are visible at the juncture of the ice lake and the foot of the rocky nunataks.

The geological and glacial phenomena or landscapes that deserve special protection include (Map C)：Ventifact (photo 1, 2): As a result of long-term blow and erosion by fierce winds, there have developed a large number of ventifacts with peculiar shape around the southern summit of Mount Harding.

These ventifacts are the typical wind-erosion physiognomy rarely seen on the earth and are subject to the perpetual damage by disorderly human activities.

Ice-core pyramids (ice-cored cones, photo 3): Along the northern and southern banks of “Kunming Lake” is scattered a dozen ice-core pyramids. These ice-core pyramids are cone shaped with a height of 20-40m and a base diameter of 50-80m. These pyramids are the best marks for directly measuring the pneumatolysis of blue ice and of great importance to the research on the material balance and evolutionary history of the EAIS. They are extremely vulnerable and any human climbing behaviour will lead to their perpetual alteration and destruction.

Hanging moraine dyke (photo 4): On the north-west side of the stagnant blue ice pool lie some of linear floating moraine. These moraines are about 100m wide, 25-35m high and kilometres long. On the surface of the moraine there is a gravel bed with a thickness of 50-100 cm, below which is the blue ice. These exotic rock masses provide precious source material for studying the tectonics of the underlying base rocks of EAIS. The spore pollen assemblages contained in the sedimentary erratics are the key evidence of the large-scale retreat event of the EAIS during the Pliocene. Any walking or climbing activities will very probably cause the irreparable damage to these moraine dykes.

Cold-desert soil: Several cold-desert soil patches were found on the southern slope of Mount Harding above the regional erosion limit of 100m. The existence of such soils indicates also that the ice fluctuation has never been higher than this limit after the formation of soils because any higher rise of the ice would have scraped all of them away.

Microfossil assemblages in the sedimentary erratics: More than 25 species of Neogene microfossil of plant have been identified from such outwash sedimentary boulders. These spore and pollen assemblages provide useful information on the evolution of the EAIS since they are derived from a suite of glaciogenic strata hidden beneath the EAIS. Most of the pollen and spores are originated from local sources as in situ assemblages, representing a continental flora.

Pool of ice melted water (photo5): At the foot of the lee side of huge nunataks are often developed pools of ice melted water, large or small, each with an area from several dozen square meters up to a thousand square meters. The surface ice of these pools is extremely smooth and transparent, and the air bubbles are rich inside the ice from the bottom. The occurrence of the pool of ice melted water suggests the existence of a megathermal event.

Blue ice cliff: On the east side of the protected area are distributed blue ice cliffs or blue ice precipices, with the length of several thousand meters, usually 30-50m high, with a slope of 40-70°.

Roche moutonnees (photo 6): Typical roche moutonnees are distributed on the east and south sides of the protected area. They are peculiar in shape, have a large number of footprints of ice flow on their surfaces, and possess very high wilderness, aesthetic and scientific values.

Paleo-sedimentary basin (ice sheet leading edge): A paleo-ice erosion basin with the marginal sedimentary layer, at the front edge of ice sheet in the Pliocene is inferred to lie below the blue ice basin on the west side of Mount Harding. It is probably a brand-new type of subglacial lakes. Exploration of these paleo-sedimentary lake basins may yield the precious sedimentary records on the paleo-climatic and environmental changes during the Pliocene in this area.

Geological condition

These nunataks consist mainly of upper amphibolite to granulite facies metamorphic rocks, syn-orogenic to late orogenic granite, and post tectonic granodioritic aplite and pegmatite. The absence of active structures and earthquakes, and the lack of Cenozoic volcanism suggest that this region, along with Prydz Bay, have been geologically stable at least since the Late Mesozoic Epoch. New geological evidence obtained from this area shows that in the inland East Antarctica there exists a huge "Pan-African" stage orogenic zone from the Prydz Bay, Grove Mountains to the Prince Charles Mountains, which should be the last segmented suture zone of the Gondwana land.

6(ii) Access to the Area

Access to the area may be gained overland by vehicle or by aircraft landing on snow- and ice covered sites within or adjacent to the Area.

6(iii) Location of structures within and adjacent to the site

Australia maintains a continuous GPS station on Tianhe Ridge at 72°54’29.17479"S,

74°54’36.43606"E. The station consists of a GPS antenna mounted on a geodynamic survey pillar, three rugged cases containing batteries and GPS receivers, a solar panel frame holding four solar panels and a wind turbine. In addition there are three survey reference marks surrounding the GPS pillar, approximately 20m distant.

CHINARE maintains 1 geodetic control point in the Area using duel frequency GPS receivers (No: Z003) at 72º53’55.07437"S, 75º02’14.00782"E to meet the requirement of the satellite image mapping.

6(iv) Location of other protected areas in the vicinity

There are no other protected areas nearby.

6(v) Special Zones within the Area

There are no special zones within the Area.

7. Terms and conditions for entry Permits

7(i) General permit conditions

Entry into the Area is prohibited except in accordance with a Permit issued by an appropriate national authority. Conditions for issuing a Permit to enter the Area are that:

• It is issued for compelling scientific reasons which cannot be served elsewhere, or for reasons essential to the management of the Area. Before the permit is issued, the applicant shall demonstrate to the appropriate competent authorities that the specimens or samples already collected from other parts of the world so far cannot fully meet the needs of the researches proposed;

• The actions permitted are in accordance with this Management Plan;

• The activities permitted will give due consideration via the environmental impact assessment process to the continued protection of the scientific, aesthetic and wilderness values of the Area;

• The Permit or its valid copy shall be carried when in the Area;

• The Permit shall be issued for a finite period;

• Report on the activities must be submitted to the national authorities issuing the Permit and in charge of polar issues.

7(ii) Access to, and movement within or over, the Area

• Entry by land vehicles such as snowmobile and aircraft should avoid destroying the local equilibrium line separating the zone of net ablation from the inland zone of net accumulation, paleo-soil distribution zone, ventifacts, blue-ice cliff, ice-core pyramid, and other geological and natural physiognomy of important scientific research and environmental values;

• As there have many ice crevice in this area, it is recommend that entry by snowmobile would drive down the route along the two sides of which Chinese expedition has set colorful poles for the sake of safety;

• Aircraft operations within the Area should be mindful of the mountainous terrain;

• Climbing up the ice-core pyramids, walking on the floating moraine dyke and roches montannees is strictly prohibited.

7(iii) Activities which may be conducted within the Area

• Compelling scientific research which cannot be undertaken elsewhere and which must not damage the value of the Area;

• Major management activities, including monitoring, inspection, maintenance or review;

• Operational activities in support of scientific research or management within or beyond the Area, including visits to assess the effectiveness of the Management Plan and management activities.

7(iv) Installation, modification and removal of structures

• No structures are to be erected within the Area, or scientific equipment installed, except for compelling scientific or management reasons；

• All the facilities to be set up and installed within the Area shall be specified in the Permit issued by the competent authority of the particular country. Where possible, such installations should avoid sensitive geomorphological features；

• All the facilities installed in the Area must be clearly identified by country, name of the principal investigator or agency and year of installation. All such items should be made of materials that pose minimal risk of contamination of the Area. These facilities must be removed when they are no longer required, and so shall other abandoned equipment or materials as far as possible.

7(v) Location of field camps

For safety reasons, the camping sites must be selected in such a way as not to destroy or affect the special geological and natural physiognomy.

If not destroying the local and adjacent geological and natural physiognomy, Camping is allowed within the Area when necessary for purposes consistent with this Management Plan and where authorized in a Permit. In this area, the encampment near Mount Harding (No 9) and the encampment near Zakharoff Ridge (No 8) are the preferred camping site, shown in Map B. Camping should choose snow or ice surface or rock surface to avoid the remnants of ice sheet.

7(vi) Restrictions on materials and organisms which may be brought into the Area

• No depots of food or other supplies are to be left within the Area beyond the time period or activity

for which they are required;

• No living animals, plant material or micro-organisms shall be deliberately introduced into the Area. All necessary precautions shall be taken to prevent accidental introduction;

• All materials introduced shall be for a stated period, shall be removed at or before the conclusion ofthat stated period, and shall be stored and handled so as to minimize the risk of environment impacts.

7(vii) Taking of, or harmful interference with, native flora and fauna

No native flora and fauna are present.

7(viii) Collection or removal of materials not imported by the Permit holder

• Material may be collected or removed from the Area only in accordance with a Permit and should be limited to the minimum necessary to meet scientific or management needs.

• Material of human origin likely to compromise the values of the Area, and which was not brought into the Area by the Permit holder or otherwise authorized, may be removed unless the impact of the removal is likely to be greater than leaving the material in situ. If this is the case, the appropriate national authority must be notified and approval obtained.

7(ix) Disposal of waste

At a minimum, all wastes, including all human wastes, shall be managed in accordance with Annex III and not disposed of into freshwater streams or lakes, onto ice-free areas, or onto areas of snow or ice which terminate in such areas of high ablation.

7(x) Measures that may be necessary to continue to meet the aims of the Management Plan

None.

7(xi) Reporting requirements

• The principal permit holder for each visit to the Area shall submit a report to the appropriate national authority as soon as practicable, and no later than six months after the visit has been completed.

• Such reports should include, as appropriate, the information identified in the visit report form contained in the Guide to the Preparation of Management Plans for Antarctic Specially Protected Areas. If necessary, the national authority should also make the visit report copy available to the Party that proposed the Management Plan, to assist in managing the Area and reviewing the Management Plan.

• Parties should, wherever possible, deposit originals or copies of such original visit reports in a publicly accessible archive to maintain a record of usage, for the purpose of any review of the Management Plan and in organizing the scientific use of the Area.

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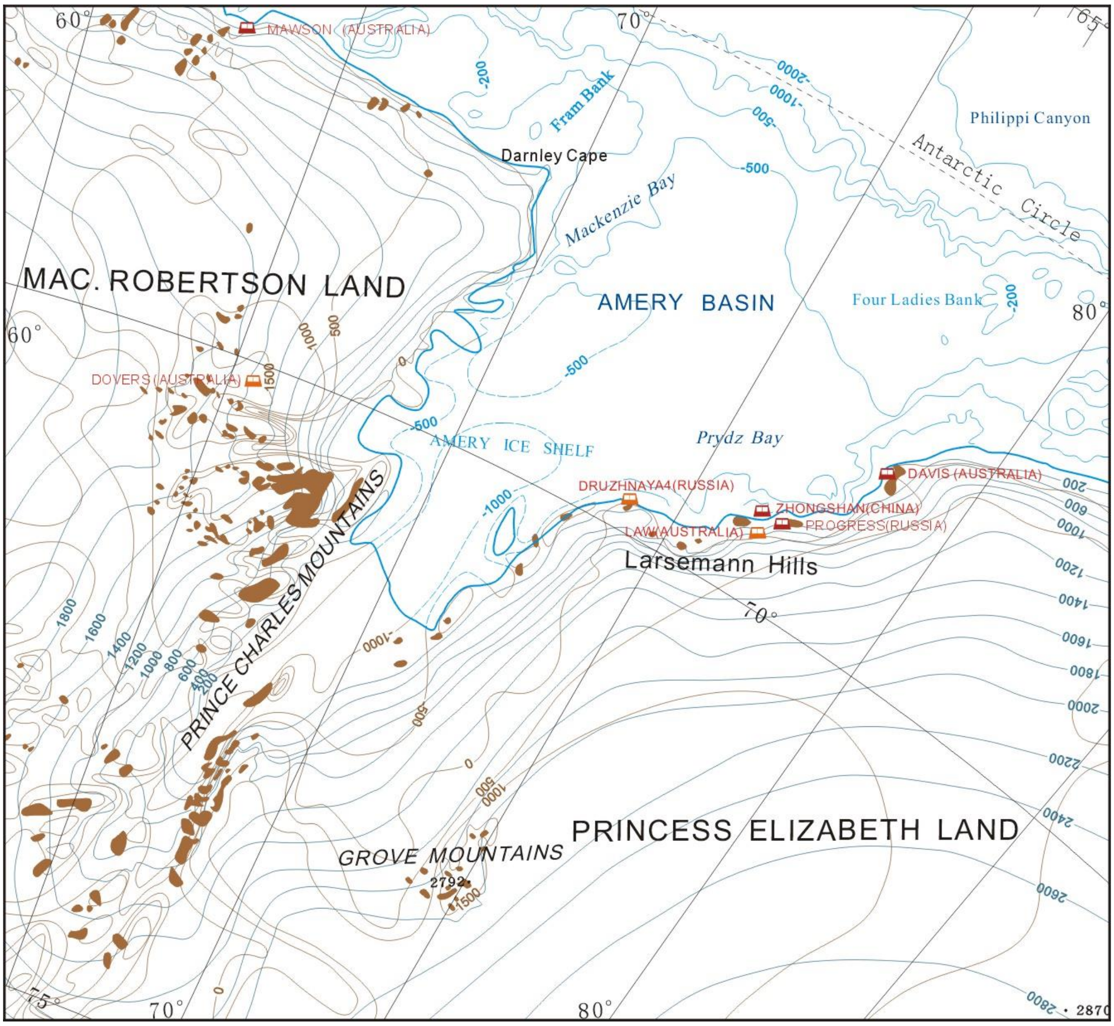
Map A1. Position of Grove Mountains

Mapping Standard: Projection: Normal Stereographic Horizontal datum:WGS-84

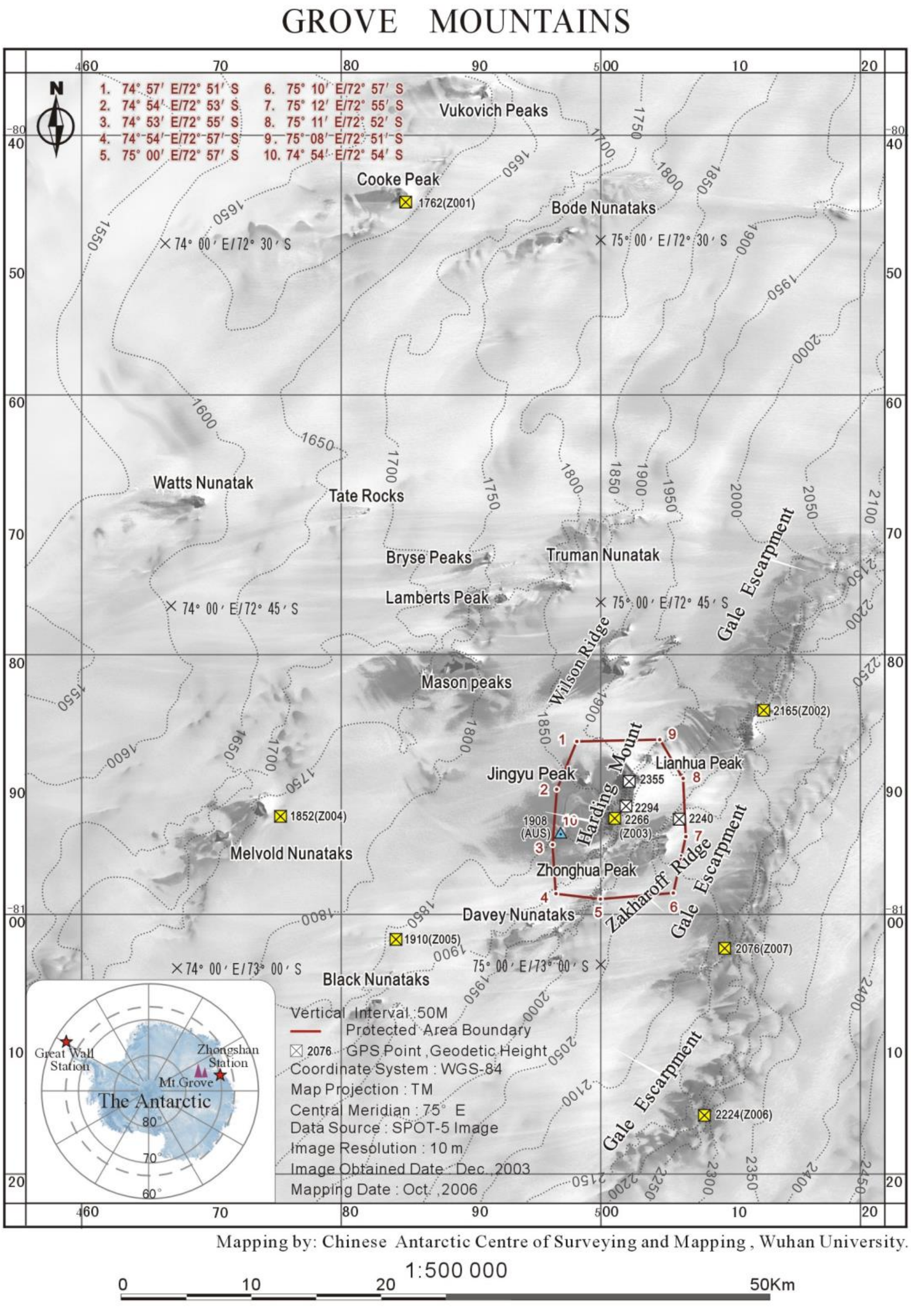
Manufacturer: Chinese Antarctic Centre of Surveying and Mapping, Wuhan University



Map A2. Grove Mountains Area, Antarctica

Mapping standards: Projection: TM, Horizontal datum: WGS-84

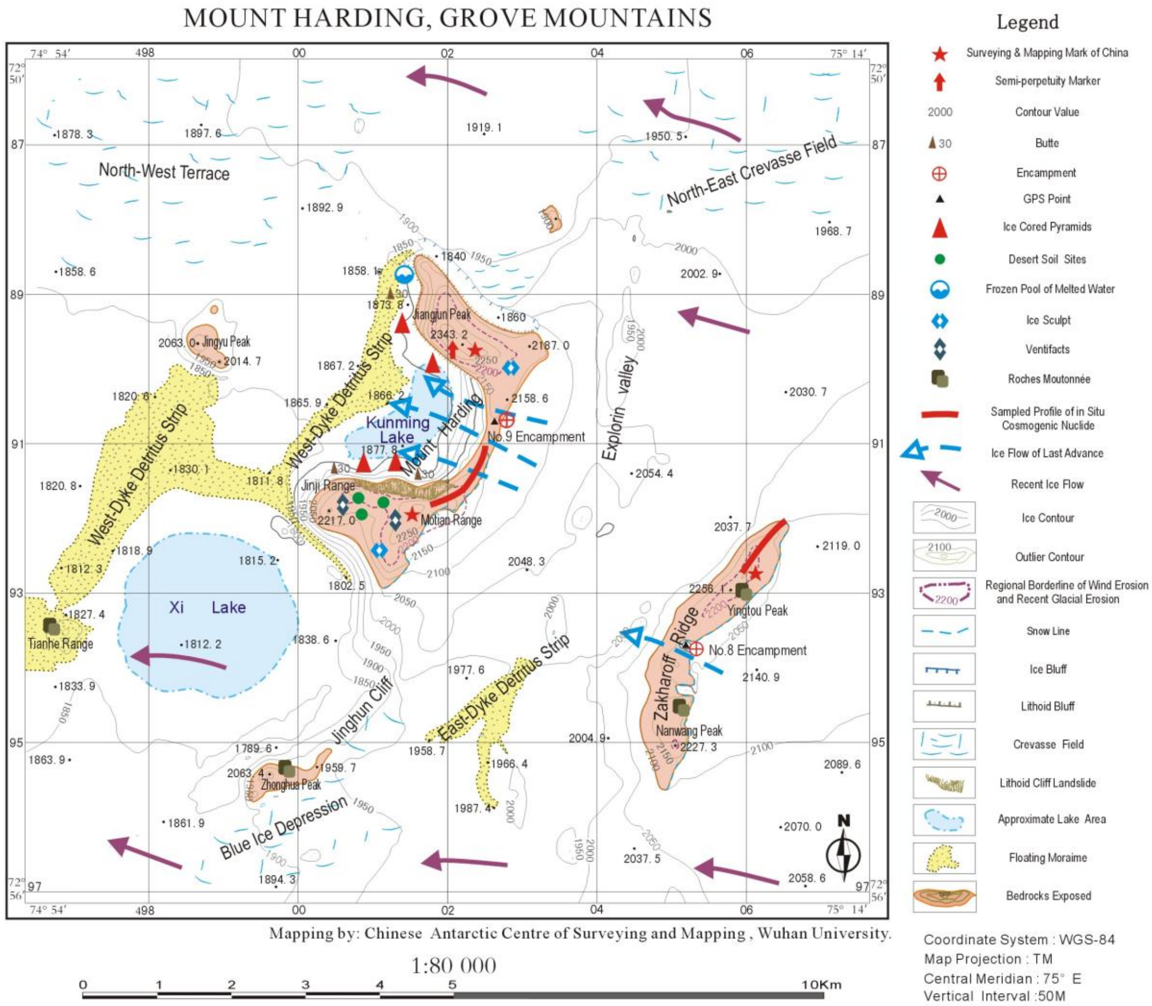
Manufacturer: Chinese Antarctic Centre of Surveying and Mapping, Wuhan University



Map B. Protected Area around Mount Harding, Grove Mountains, Antarctica

Mapping standards: Projection: TM Horizontal datum: WGS-84

Manufacturer: Chinese Antarctic Centre of Surveying and Mapping, Wuhan University



Map C. Location of Nunataks and Direction of Ice Flow around Mount Harding, Grove Mountains, Antarctica

Mapping standards: Projection: TM Horizontal datum: WGS-84

Manufacturer: Institute of Geology and Geophysics, Chinese Academy of Sciences

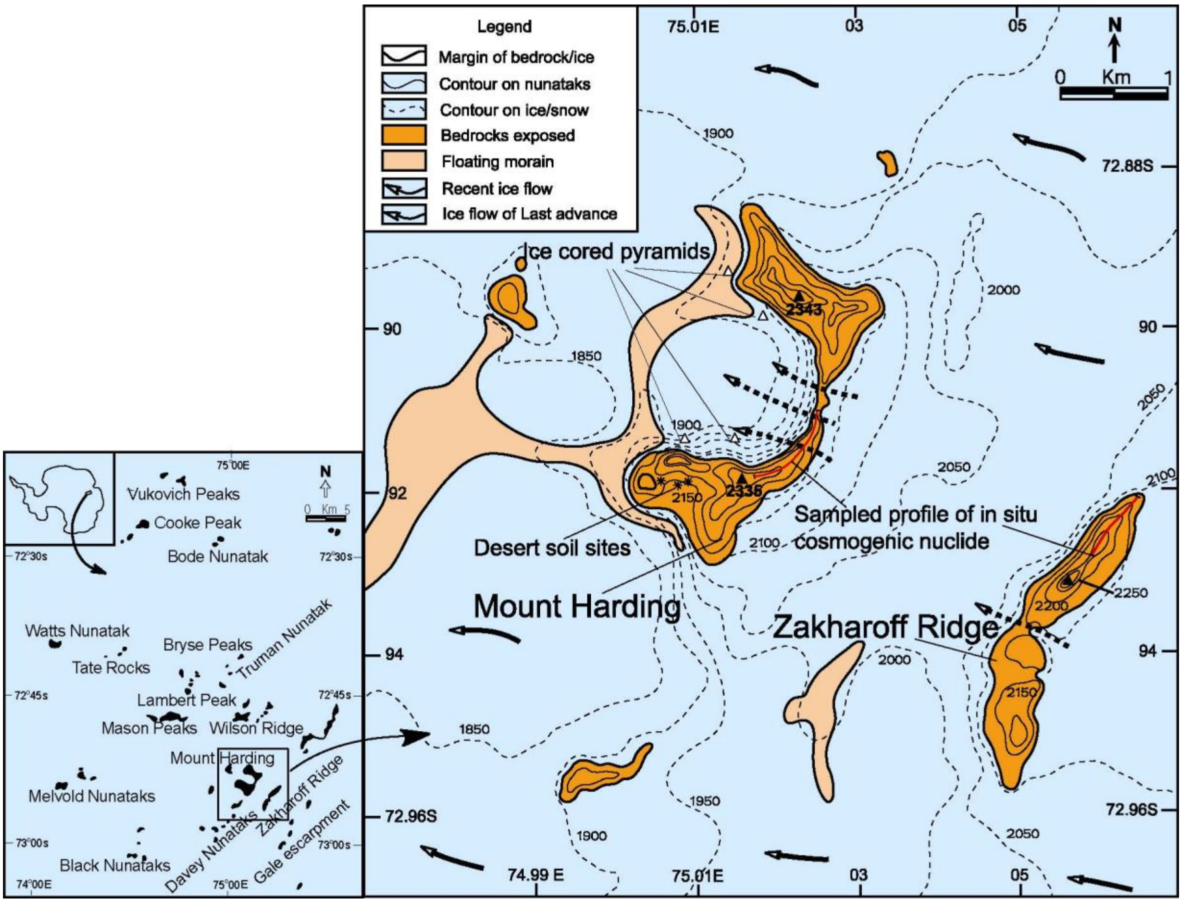


Photo 1: Ventifact, taken on January 13th, 2003

Photo 2: Ventifact, taken on January 13th, 2003

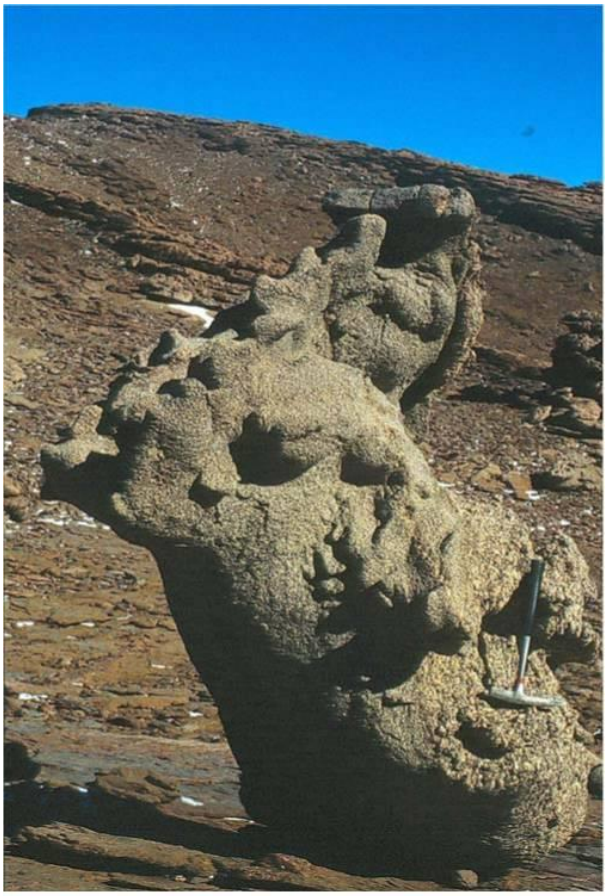


Photo3: Ice-core pyramid, taken on January 12th, 2003

Photo 4: Hanging moraine dyke, taken on January 14th, 2003

Photo 5: Pool of ice melted water, taken on January 14th, 2003

Photo 6: Roches montannees, taken on January 12th, 2003