



Management Plan

for Antarctic Specially Protected Area No 118 SUMMIT OF MOUNT MELBOURNE, VICTORIA LAND

1. Description of values to be protected

An area of 6km² on the summit of Mount Melbourne was originally designated in Recommendations XVI-5 (1987, SSSI No 24, Summit of Mount Melbourne) and XVI-8 (1991 SPA No 22, Cryptogam Ridge, Mount Melbourne) after proposals by New Zealand and Italy on the grounds that these areas contain geothermal soils that support a unique and diverse biological community. The warmest areas of ground created by fumaroles support patches of moss, liverwort and algae along with one species of invertebrate protozoan. ASPA No 118a (SPA No 22) was originally enclosed within ASPA No 118b (SSSI No 24) in order to provide more stringent access conditions to this part of the Mt Melbourne summit area. ASPA 118a and 118b have now been merged in the current plan, and Prohibited and Restricted zones provide for more stringent access conditions within the former SPA. The outer boundaries of the Area follow the original SSSI No 24 designation.

The biotic communities of the closest documented fumarolic ground, 400km to the south on Tramway Ridge, Mt Erebus and on Mt Rittman, in the Mountaineer Range over 180km to the north, are considered significantly different to that on Mt Melbourne. Mount Melbourne has the only known leafy example of the moss *Campylopus pyriformis* on the Antarctic continent (the moss is present on Mt Erebus only in the protonema stage). A new species of moss *Pohlia nutans* (very genetically similar to another species found on

Mt Rittman) was discovered in 2002 in small mosses in the fumaroles on the NW slope of Mt Melbourne. The algae *Stigonema ocellatum* and *Chlorella* cf. *reniformis* are the only Antarctic records. Several other algal species are not recorded elsewhere in Antarctica, apart from Mt Erebus. An entirely new species of thermophilic bacteria, *Bacillus thermoantarcticus*, has also been discovered on the summit (Manca *et al* 1996; Lama *et al* 1996, 2001; Nicolaus *et al* 2000, 2001, 2002), and some enzymes have been isolated from these microorganisms (Lama *et al* 2001, 2004, 2005; Nicolaus *et al* 2002, 2004). Biochemical and microbiological studies have also been carried out on hot substrata in the area (Bargagli *et al* 2004; Pepi *et al* 2005).

The total cover of vegetation within the Area is hard to assess due to largely permanent snow cover, but is estimated at 100-200 m². Despite this relatively small area of cover, the uniqueness and fragility of the biological communities and their physical environment are such that the Area is of high scientific and conservation value and vulnerable to human disturbance. The dangers of introducing new organisms and disturbance by trampling and sampling are great and justify this site being given long-term special protection. Extensive ice-free geothermal areas at high altitude, supporting a unique community of flora and microbiota and accumulations of organic matter, make this Area of exceptional scientific interest.

2. Aims and objectives

Management at Mount Melbourne aims to:

- avoid degradation of, or substantial risk to, the values of the Area by preventing unnecessary human disturbance;
- allow scientific research on the ecosystem in the Area, in particular on the plants, liverworts, algae and invertebrates, while ensuring protection from oversampling;
- allow other scientific research provided it is for compelling scientific reasons which cannot be served elsewhere;
- minimise the possibility of introduction of alien soils, plants, animals and microbes into the Area;
- preserve a part of the natural ecosystem of the Area, which is declared a Prohibited Zone, as a reference site for the purpose of future comparative studies;
- allow visits for the purposes of installation and maintenance of essential communications equipment that does not compromise the values of the Area;
- allow visits for management purposes in support of the aims of the Management Plan.



3. Management activities

The following management activities are to be undertaken to protect the values of the Area:

- Information showing the location of the Area (stating the special restrictions that apply) shall be displayed prominently, and a copy of this Management Plan shall be kept available, in all of the research hut facilities located within 25km of the Area, and in the radio repeater equipment box on the summit of Mt Melbourne.
- Markers, signs or structures erected within the area for scientific or management purposes shall be secured and maintained in a good condition.
- Visits shall be made as necessary to assess whether the Area continues to serve the purposes for which it was designated and to ensure management and maintenance measures are adequate.
- National Antarctic Programmes operating in the region are encouraged to consult together with a view to ensuring these steps are carried out.

6. Description of the Area

6(i) Geographical coordinates, boundary markers and natural features

Mount Melbourne (2733m, 74°21'S 164°42'E) in northern Victoria Land, is situated between Wood Bay and Terra Nova Bay, on the western side of the Ross Sea, and Campbell Glacier, about 10km to the west (see Map A). The Area encompasses all terrain above the 2200m contour surrounding the main crater of Mt Melbourne. Boundary markers are not installed at points on the 2200m contour, due to access being predominantly via helicopter to the summit of the mountain, making assessment of altitude straightforward.

Mount Melbourne is part of the McMurdo volcanics, which are a line of dormant and extinct volcanoes running along the coast of Victoria Land. The Mt Melbourne area is thought to be late Quaternary in age and the most recent eruption may have been as little as 150 years ago. The volcanic rocks have been detailed as trachyte to trachyandesite on the mountain itself, with basalt at its base.

Mount Melbourne is an almost perfect low-angle volcanic cone with extensive areas of hot ground, fumaroles, and ice towers prominent around the summit crater and on some upper parts of the mountain. The summit caldera is about 1km in diameter and forms the névé for a westward flowing glacier. Several smaller basaltic cones and mounds occur near the base and on the flanks of the mountain. The summit also contains the most extensive areas of warm ground, marked by snow-free warm or steaming ground, fumaroles and ice towers or pinnacles. Surface soil (0-2cm depth) temperatures of up to 42°C, areas of cooler ground where activity is discontinuous, and zones of geothermal activity are marked by ice and snow hummocks up to a metre in height.

There are three main areas exhibiting thermal activity (see Map B); two situated on the edge of the caldera, and a third about 250m lower on the northern slopes. However, areas of surface activity extend at least as low as 2400m on the north-west side of the mountain. These geothermal areas support a unique biological assemblage of species

4. Period of designation

Designated for an indefinite period.

5. Maps and photographs

- Map A: Mount Melbourne, location map. Map specifications: Projection: Lambert conformal conic; Standard parallels: 1st 72°40'0.000"S; 2nd 75°20'0.000"S; Central Meridain: 165°0'0.000"E; Latitude of Origin 74°0'49.2"S; Scale approx. 1:350,000. Spheroid: WGS84.
- Map B: Mount Melbourne, site map. Map specifications: Projection: Lambert conformal conic; Standard parallels: 1st 72°40'0.000"S; 2nd 75°20'0.000"S; Central Meridain: 165°0'0.000"E; Latitude of Origin 74°0'49.2"S; Scale approx. 1:16,000. Spheroid: WGS84. Photography USGS/DoSLI (SN7851) 22 November 1993.

otherwise restricted to low altitudes. The species are not of a local provenance and must have been dispersed over long distances to reach the Area. The total cover of vegetation at the site is small, perhaps only 100-200 m² with plant life only possible through the occurrence of small water droplets formed by the condensation of steam keeping the soils moist. Known sites of vegetation are marked as A-E on Map B. Site D is known to have been disturbed and possibly contaminated by human activity.

Mount Melbourne exhibits high biodiversity relative to other geothermal sites in the Antarctic, both maritime and high altitude. Biota includes algal crusts and felts (11 species) that coat small stones, gravel and finer substrata, bryophytes (one species of moss and one of liverwort), a protozoan, and a range of microflora. A lichen association has been observed as a component of black crusts over small areas of warm soil. The warmest areas of ground support yellowish-green patches of the moss *Campylopus pyriformis*, along with the liverwort *Cephaloziella varians* and brownish crusts of algae. The unusual occurrence of shallow peat is evidence of bryophyte growth over at least several decades. The amoeboid protozoan *Corythion dubium* was observed as empty shells in both mineral substrates and amongst bryophytes. The species is not common in continental Antarctica, and only found at one other site in Victoria Land.

6(ii) Prohibited, restricted and managed zones within the Area Prohibited and Restricted Zones - Cryptogam Ridge

An area on the southern rim of the main summit crater (known as Cryptogam Ridge) is designated as a Prohibited Zone and a Restricted Zone (see Map B) in order to protect the most extensive stand of vegetation and preserve part of the Area as a reference site for future comparative study. The remainder of the Area, similar in biology, features, and character, is available for research programmes and controlled sample collection.



The zones consist of areas of snow-covered cool ground, warm snow-free ground, and ice-hummocks covering steam emissions and extend 40m in all directions from the ridge line. Most of Cryptogam Ridge is incorporated within the Restricted Zone, which may be accessed by permit for essential scientific reasons which cannot be met elsewhere in the Area. The western most 100m of the Cryptogam Ridge is a Prohibited Zone, to which access is strictly prohibited until such time it is agreed by management plan review that access should be allowed.

Managed Zones

Two Managed zones (see Map B) have been established within the Area where survey marks used in deformation studies need to be regularly accessed, and a radio repeater is installed and maintained each season. The zones extend 15m around the survey marks and are located as follows:

Summit of Mt Melbourne, containing survey mark No. 600 and radio repeater site; and south-east of Cryptogam Ridge, containing survey mark No. 601.

7. Permit conditions

Entry into the Area is prohibited except in accordance with a specific Permit issued by the appropriate national authorities under Article 3 of Annex II. Permits may be issued for the following purposes:

- For activities outside the Restricted and Managed zones, permits may be issued only for scientific study of the ecosystem, for a compelling scientific or management purpose that cannot be served elsewhere, or for essential management purposes consistent with the plan objectives such as inspection, monitoring or review.
- Permits to access to the Restricted Zone may only be issued for essential scientific or management purposes that cannot be met elsewhere in the Area.
- Permits to enter only the Managed Zones may be issued for essential operational or scientific purposes consistent with the objectives of the Management Plan, such as to access survey marks and radio repeater sites.

Conditions for issuing a Permit to enter the Area are that:

- the actions permitted are not likely to jeopardise the natural ecological system or scientific values of the Area;
- any management activities are in support of the objectives of the Management Plan;
- the actions permitted are in accordance with all requirements of the Management Plan;
- a Permit, or a copy, shall be carried within the Area, including a copy of all relevant maps from the Management Plan;
- a visit report shall be supplied to the authority named on the permit; and
- any Permit shall be issued for a stated period.

7(i) Access to and movement within the Area

The following restrictions apply within the Area:

- land vehicles are prohibited within the Area;
- helicopters may only land at the established survey marks within the two Managed Zones (see Map B), unless specifically allowed by Permit for purposes consistent with the aims of this plan;

6(iii) Structures within and near the Area

A total of six survey marks, consisting of a metal tube set into a concrete base, are located around the summit area (see Map B) and are used in an ongoing Italian scientific programme examining the deformation study on the mountain. A radio repeater to support communications for the Italian Antarctic programme, consisting of an equipment box and aerial, is also installed annually on cool, ice-free ground near the summit.

6(iv) Location of other protected areas within close proximity of the Area

The nearest protected areas are: Edmonson Point ASPA No 165, approximately 13km east of Mt Melbourne; Cape Hallett, Victoria Land ASPA No 106 (SPA No 7), approximately 300km to the north; and, Botany Bay, Cape Geology, Victoria Land ASPA No 164 (SSSI No 37) approximately 300km to the south.

- use of helicopter smoke grenades within the Area is prohibited;
- any overflight of the Prohibited or Restricted Zone must be more than 50m above the ground level; and
- hovering over any part of the Area is not permitted lower than 50m, and ice-free areas should be avoided unless absolutely necessary for access to the Area.

Visitors must avoid walking on areas of visible vegetation or moist soil, both on ice-free ground and among ice hummocks, and should not interfere with any ice structures unless specified in the permit. Pedestrian traffic should be kept to the absolute minimum necessary consistent with the objectives of any permitted activities and every reasonable effort should be made to minimise effects.

7(ii) Activities that are or may be conducted in the Area, including restrictions on time or place

As outlined above, permitted activities within the Area may include:

- scientific research that will not jeopardise the ecosystem of the Area and cannot be conducted elsewhere;
- essential management activities, including monitoring and inspection; and
- essential operational activities, such as access to survey marks and radio repeater sites.

7(iii) Installation, modification or removal of structures

No structures are to be erected within the Area except as specified in a Permit. All scientific equipment installed in the Area must be approved by Permit and clearly identified by country, name of the principal investigator, and year of installation. All such items should be made of materials that pose minimal risk of contamination of the Area. Removal of specific equipment for which the Permit has expired shall be a condition of the Permit.



7(iv) Location of field camps

Camping is permitted only in the ice-filled summit of the caldera or outside the Area (i.e. below the 2200m contour).

7(v) Restrictions on materials and organisms which can be brought into the Area

To avoid compromising the values of the ecosystem for which the Area is protected, the following restrictions apply to all activities in the Area:

- no living animals, plant material or microorganisms shall be deliberately introduced into the Area and precautions shall be taken against accidental introductions;
- chemicals, including radio-nuclides or stable isotopes, which may be introduced for scientific or management purposes specified in the Permit, shall be removed from the Area at or before the conclusion of the activity for which the Permit was granted;
- fuel is not to be stored in the Area, unless required for essential purposes connected with the activity for which the Permit has been granted and shall not be stored on ice free areas; and
- all materials introduced shall be for a stated period only, shall be removed at or before the conclusion of that stated period, and shall be stored and handled so that risk of their introduction into the environment is minimised.

7(vi) Taking or harmful interference with native flora or fauna

Any removal or disturbance of the vegetation or invertebrates is prohibited, except in accordance with a Permit issued under Article 3 of Annex II by the appropriate national authority specifically for that purpose. Any sampling is to be kept to the absolute minimum required for scientific or management purposes, and carried out using techniques which minimise disturbance to the surrounding soil, ice structures and biota. Any sampling or experimental sites should be photographed and the location recorded in detail and reported to the Permitting authority.

7(vii) Collection or removal of anything not brought into the Area by the Permit holder

Material may be collected or removed from the Area only in accordance with a Permit issued under Article 3 of Annex II by the appropriate national authority specifically for that purpose and should be limited to the minimum necessary to meet scientific or management needs. Sampling is to be carried out using techniques which minimise disturbance to the surrounding soil and biota. Material of human origin likely to compromise the values of the Area, which was not brought into the Area by the Permit holder or otherwise authorised, may be removed from any part of the Area, including the Restricted Zone, unless the impact of removal is likely to be greater than leaving the material *in situ*: if this is the case the appropriate authority should be notified.

7(viii) Disposal of waste

All wastes, including all human wastes, shall be removed from the Area.

7(ix) Measures that are necessary to ensure that the aims and objectives of the Management Plan can continue to be met

Permits may be granted to enter the Area to carry out biological monitoring and site inspection activities, which may involve the collection of small samples for analysis, or for protective measures and other essential management activities.

Any specific sites of long-term monitoring shall be appropriately marked (as in 7iii above).

To help maintain the ecological and scientific values derived from the isolation and relatively low level of human impact at the Area, visitors shall take special precautions against introductions, especially when visiting several thermal regions in a season. Of particular concern are microbial or vegetation introductions sourced from:

- thermal areas, both Antarctic and non-Antarctic;
- soils at any other Antarctic sites, including those near stations;
- soils from regions outside Antarctica.

To this end, visitors shall take the following measures to minimise the risk of introductions:

- Any sampling equipment or markers brought into the Area shall be sterilised and maintained in a sterile condition before being used within the Area. To the maximum extent practicable, footwear and other equipment used or brought into the Area (including backpacks or carry-bags) shall be thoroughly cleaned or sterilised and maintained in this condition before entering the Area;
- Sterilisation should be by an acceptable method, such as by UV light, autoclave, or by washing surfaces in 70 percent ethanol solution in water.
- Sterile protective overclothing shall be worn. The overclothing shall be suitable for working at temperatures of -20°C or below and comprise at a minimum sterile overalls to cover arms, legs and body and sterile gloves suitable for placing over the top of cold-weather gloves. Disposable sterile/protective foot coverings are not suitable for the scoria surface and should not be used. Instead, all footwear should be thoroughly brushed to remove soil particles and wiped with 70 percent ethanol.
- Both the interior and exterior of helicopters should be cleaned as far as practicable before landing within Area.

7(x) Requirements for reports

Parties shall ensure that the principal holder for each Permit issued submits to the appropriate authority a report describing the activities undertaken. Such reports should include, as appropriate, the information identified in the Visit Report Form suggested by SCAR. Under item 10 of this form (mode of transport to/from the area), particular note should be made of where any helicopter used took off from and which landing site was used.

Parties shall maintain a record of such activities and, in the Annual Exchange of Information, shall provide summary descriptions of activities conducted by persons subject to their jurisdiction, in sufficient detail to allow evaluation of the effectiveness of the Management Plan. Parties should, wherever possible, deposit originals or copies of such reports in a publicly accessible archive to maintain a record of usage, to be used both for review of the Management Plan and in organising the scientific use of the site.



8. Bibliography

- Bargagli R., Skotnicki M.L., Marri L., Pepi M., Mackenzie A., Agnorelli C., 2004. New record of moss and thermophilic bacteria species and physico-chemical properties of geothermal soils on the north-west slope of Mt. Melbourne (Antarctica). *Polar Biol.* 27: (2004) 423-431.
- Broady, Paul A, Given, David R.; Greenfield, Laurence G.; Thompson, Keith., 1987. The biota and environment of fumaroles on Mt Melbourne, Northern Victoria Land. *Polar Biology*, 1987, 7(2): 97-113.
- Lama L., Nicolaus B., Calandrella V., Esposito E., Gambacorta A., 1996. Xylanase Produced by *Bacillus thermoantarcticus*, a new thermophilic bacillus. *Enzyme Engineering XIII*, 799, 285-289.
- Lama L., Nicolaus B., Calandrella V., Basile R. and Gambacorta A., 2001. Purification and characterization of thermostable xylose (glucose) isomerase from *Bacillus thermoantarcticus*. *J. Ind. Microbiol. Biotechnol* 27, 234-240
- Lama L., Calandrella V., Gambacorta A., Nicolaus B., 2004. Purification and characterization of thermostable xylanase and beta-xylosidase by the thermophilic bacterium *Bacillus thermantarcticus*. *Res Microbiol.* 155, 283-289
- Lama L., Nicolaus B., Gambacorta A., 2005. Thermozyms from Antarctica bacteria *Biocatalysis: Chemistry and Biology*, 111-125. Antonio trincone ed. Research Signpost, trivandrum 695 023 Kerala, India
- Manca M.C., Lama L., Esposito E. Improta R. Gambacorta A. and Nicolaus B., 1996. Chemical Composition of Two Exopolysaccharides from *Bacillus thermoantarcticus* *Appl. Env. Microbiol.* 62 (9), 3265-3269
- Nicolaus, B. Lama, L. Esposito, E. Manca, M.C. Di Prisco, G. Gambacorta, A., 1996. *Bacillus thermoantarcticus* sp. nov., from Mount Melbourne, Antarctica: a novel thermophilic species. *Polar Biology.* 16(2). pp.101-104.
- Nicolaus B., Lama L., Esposito E, Bellitti M.R., Improta R., Panico A., and Gambacorta A., 2000. Extremophiles in Antarctica. *Ital. J. Zool.* 1, 169-174
- Nicolaus B., Manca M.C., Lama L., Esposito E., and Gambacorta A., 2001. Lipid modulation by environmental stresses in two models of extremophiles isolated from Antarctica. *Polar Biol.* 24, (2001) 1-8
- Nicolaus B., Lama L., and Gambacorta A., 2002. Thermophilic *Bacillus* isolates from Antarctic environments. In: *Applications and Systematics of Bacillus and Relatives* (Berkeley R, Heyndrickx M, Logan N, De Vos P, eds) Blackwell Publishing Vol 5, 47-63
- Seppelt R.D., Green T.G.A., 1998. A bryophyte flora from southern Victoria Land. *New Zealand Journal of Botany.* Vol 36. pp 53-59.
- Seppelt, R.D., 1983. *Cephaloziella exiliflora* (Tayl.) Steph. from the Windmill Islands, continental Antarctica. In: (Ed.). *Lindbergia.* Vol 9. pp 27-28.
- Skotnicki, M.L, Selkirk, P.M., Broady, P. Adam, K.D. and Ninham, J.A., 2001. Dispersal of the moss *Campylopus pyriformis* on geothermal ground near the summit of Mount Erebus and Mount Melbourne, Victoria Land, Antarctica. *Antarctic Science* 13 (3). pp 280-285.
- Smith, G.H., 1992. Distribution and ecology of the testate rhizopod fauna of the continental Antarctic zone. *Polar Biology.* Vol 12. pp 629-634.



