

Management Plan for Antarctic Specially Protected Area No. 148

MOUNT FLORA, HOPE BAY, ANTARCTIC PENINSULA

Introduction

The primary reason for the designation of Mount Flora, Hope Bay, Antarctic Peninsula (Latitude 63°25' S, Longitude 57°01' W, 0.3 km²) as an Antarctic Specially Protected Area (ASP) is to protect scientific values associated with the rich fossil flora present within the Area.

Mount Flora was originally designated as a Site of Special Scientific Interest through Recommendation XV-6 (1989, SSSI No. 31) after a proposal by the United Kingdom. It was designated on the grounds that 'the site is of exceptional scientific importance for its rich fossil flora'. It was one of the first fossil floras discovered in Antarctica and has played a significant role in deducing the geological history of the Antarctic Peninsula. Its long history as an easily accessible site and the large amount of fossiliferous debris occurring in scree has made it vulnerable to souvenir collectors, and the amount of material available for serious research has been considerably depleted. The Management Plan underwent a major revision in 2002 (Measure 1) including changes to the boundary. The last review of the plan was undertaken in 2015 (Measure 8), in which minor changes or amendments were made.

Geologist Johann Gunnar Andersson discovered Mount Flora during the Swedish South Polar Expedition (1901-04)¹, whose original stone hut (Historic Site and Monument No. 39) remains nearby at Seal Point, Hope Bay. Otto Nordenskjöld, the leader of the expedition, named Mount Flora (as 'Flora-Berg') following the geological observations of Andersson, recognising it as the first significant fossil locality discovered in Antarctica. The Area subsequently became of great scientific importance for interpreting key geological relationships in the region.

The Area is approximately three kilometres southeast of Esperanza Station (Argentina) and Teniente de Navio Ruperto Elichiribehety Station (Uruguay). Among the scientific research currently in progress within the Area is the project "Stratigraphy and Paleobotany of the Jurassic of the northern Antarctic Peninsula", carried out by the Argentine Antarctic Institute, which aims to conduct detailed petrographic and paleobotanical studies in Jurassic sedimentary and/or volcanic outcrops in the northern Antarctic Peninsula.

The Area fits into the wider context of the Antarctic Protected Area system as one of the few ASPAs protecting primarily geological values. Resolution 3 (2008) recommended that the Environmental Domains Analysis for the Antarctic Continent, be used as a dynamic model for the identification of Antarctic Specially Protected Areas within the systematic environmental-geographical framework referred to in Article 3(2) of Annex V of the Protocol (see also Morgan et al., 2007). Using this model, ASPA No. 148 is contained within Environment Domain A: Antarctic Peninsula northern geologic (Morgan et al., 2007). ASPA No. 148 sits within Antarctic Conservation Biogeographic Region (ACBR) 1 Northeast Antarctic Peninsula. Through Resolution 5 (2015) Parties recognised the usefulness of the list of Antarctic Important Bird Areas (IBAs) in planning and conducting activities in Antarctica. Important Bird Area ANT074 Hope Bay comprises ice-free ground on the eastern side of

¹ Led by Otto Nordenskjöld, and under the command of Carl Anton Larsen, the expedition party included geologist Johan Gunnar Andersson, botanist Carl Skottsberg, zoologist Axel Ohlin, naval scientist José María Sobral, and artist Frank Wilbert Stokes.

Hope Bay, to the north of ASPA No. 148. The IBA qualifies on the basis of the large Adélie Penguin (*Pygoscelis adeliae*) colony present.

1. Description of values to be protected

Following a visit to the ASPA by environmental managers from Argentina in January 2011 and January 2013 the values specified in the earlier designation were reviewed and re-confirmed. Similarly, the scientific staff who made visits to Mount Flora in 2017 and 2019 re-confirmed the specific ASPA values and also mentioned the future need to evaluate new areas close to the Area with visible outcrops exposed following glacial retreat. Values within the Area are set out as follows:

- Mount Flora has important scientific and historical values associated with this significant heritage of geological discovery in Antarctica.
- Mount Flora is characterised by three distinct geological formations: the Hope Bay Formation (Trinity Peninsula Group), which is separated by an unconformity from the overlying gently tilted plant beds of the Mount Flora Formation (Botany Bay Group), which in turn are overlaid by ignimbrites and welded tuffs of the Kenney Glacier Formation (Antarctic Peninsula Volcanic Group). The relationships between these formations have been fundamental for determining the age of the plant beds, which has been vital to the interpretation of the geology of the Antarctic Peninsula.
- Historically, the site has played an important role in comparisons with other Southern Hemisphere floras.
- The fossil flora has been important for providing Mesozoic palaeoclimate data from a region where such information is otherwise sparse.
- Mount Flora holds one of the few Jurassic floras known from Antarctica and it is the only site that has been relatively well studied and documented. The Mesozoic plant assemblages from Mount Flora include members of the sphenophytes, ferns, cycadophytes (cycads and bennetites), pteridosperms and conifers. Samples of the fossils have served as a major reference source for many studies of Jurassic and Cretaceous palaeobotany.
- In addition to the important fossil flora, recent work has resurfaced discoveries confirming the presence of Jurassic freshwater bivalve fossils in Monte Flora.

2. Aims and objectives

Management at Mount Flora aims to:

- avoid degradation of, or substantial risk to, the values of the Area by preventing unnecessary human disturbance and sampling in the Area through uncontrolled access and inappropriate collections of geological material;
- allow scientific geological and palaeontological research, while ensuring protection from over-sampling;
- allow other scientific research within the Area provided it will not compromise the values for which the Area is protected;
- allow scientific research in the Area provided it is for compelling reasons which cannot be served elsewhere;
- allow visits for management purposes in support of the aims of the Management Plan.

3. Management activities

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

- A map showing the location of the Area (stating the special restrictions that apply) shall be displayed prominently at Esperanza Station (Argentina) and Teniente de Navio Ruperto Elichiribehety Station (Uruguay), where copies of this Management Plan shall be made available.

- Persons wishing to make the ascent of Mount Flora shall be instructed not to enter the Area without a Permit issued by the appropriate authority.
- Markers, signs or other structures erected within the Area for scientific or management purposes shall be secured and maintained in good condition.
- Abandoned equipment or materials shall be removed to the maximum extent possible provided that doing so does not adversely impact on the values of the Area.
- The area shall be visited by experts as necessary to assess whether it continues to serve the purposes for which it was designated and to ensure that management and maintenance activities are adequate. A desk assessment shall also be undertaken to consider the ASPA post-visits reports and available information on fossil collection within the Area.
- The retreat of glacial ice in recent years has exposed new outcrops of fossiliferous rocks in the vicinity of Mount Flora. A periodic update of the boundaries is needed to ensure that these exposed fossiliferous rocks are included within the ASPA if scientific research demonstrates their paleontological value. This may require a revision of the Management Plan within the next few years.
- A record of fossils collections from Mount Flora will be maintained based on post visit reports, in order to better assess the issuance of permits and to minimize over-sampling. (see sections 7(iii), (x) and (xi)).

4. Period of designation

Designated for an indefinite period.

5. Maps

Map 1: Mount Flora ASPA No. 148 in relation to Hope Bay, Trinity Peninsula, and the South Shetland Islands, showing the location of the nearest protected areas. The location of Esperanza Station (Argentina) and Teniente de Navio Ruperto Elichiribehety Station (Uruguay) are also shown. Inset: the location of Mount Flora on the Antarctic Peninsula.

Map 2: Mount Flora ASPA No. 148, Hope Bay, topographic map. Map specifications: Projection: Lambert Conformal Conic: Standard parallels: 1st 76° 40' S; 2nd 63° 20' S Central Meridian: 57° 02' W; Latitude of Origin: 70° 00' S; Spheroid: WGS84. Vertical datum: mean sea level. Vertical contour interval 25 m. Horizontal and vertical accuracy unknown. Note: topography and positions are based on original 1950s survey data, and true positions are known to be in error by up to 500 m. Ice margins are provided based upon 1999 aerial photography.

Map 3: Mount Flora ASPA No. 148 geological map, adapted from the 'Mapa Geológico de Bahía Esperanza Antártida' published by the Instituto Geológico y Minero de España and Instituto Antártico Argentino (Scale 1:10,000).

6. Description of the Area

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

GENERAL DESCRIPTION

Mount Flora (latitude 63°25' S, longitude 57°01' W, 0.3 km²) is situated on the southeastern flank of Hope Bay, at the northern end of Trinity Peninsula, Antarctic Peninsula (Map 1). The summit of Mount Flora (520 m) is approximately 1 km from the southern shore of Hope Bay. Four glaciers surround Mount Flora. The Flora Glacier extends from the cirque below the summit of Mount Flora in a northeasterly direction for one kilometre before it flows into a larger glacier that flanks the eastern and southern slopes of Mount Flora, extending northeast from The Pyramid (565 m) (Map 2). The western slopes of Mount Flora are bounded by the Kenney Glacier, which joins Depot Glacier before flowing

into the head of Hope Bay. The Pyramid is a distinctive peak 1.5 km to the SSE of Mount Flora. To the north of the Area is the ice-free Five Lakes Valley and Scar Hills, and to the northeast is Lake Boeckella.

BOUNDARIES

The boundaries designated in the original Management Plan were amended during the 2002 Management Plan revision to include most of the known exposed fossiliferous strata on the northern slopes of Mount Flora. The ASPA boundary was amended again in 2021 to include all the strata of the Mount Flora Formation to the north of the Area. The summit ridge and highest peak of Mount Flora (520 m), which were formerly within the boundary, are comprised of non-fossiliferous volcanic rocks and have been excluded from the Area. The boundary runs from the north summit of Mount Flora (516 m) – the highest point of the boundary – westward down the ridge to Kenney Glacier. The boundary then follows the eastern margin of Kenney Glacier northward to the 100 m contour, then eastward across scree slopes along the 100 m contour for 1200 m. At this point, the boundary runs south-southwest for 100 m towards the north-western margin of the Flora Glacier. From here the southern boundary of the Area follows the north-western margin of the Flora Glacier southwestward to the ridge leading westward to the north summit of Mount Flora (see Map 3). Where present, the glacier margins, lower outcrops, western ridge and northern summit of Mount Flora form visually obvious features that indicate the boundaries. The Area remains otherwise unmarked.

The boundary co-ordinates of the Area, starting with the north summit of Mt Flora and moving clockwise, are shown in Table 1.

Table 1. Boundary co-ordinates of ASPA No. 148 Mt Flora, Hope Bay, Antarctic Peninsula

Number	Latitude	Longitude
1	63° 24' 53'' S	057° 01' 26'' W
2	63° 24' 56'' S	057° 02' 02'' W
3	63° 24' 49'' S	057° 02' 10'' W
4	63° 24' 38'' S	057° 00' 50'' W
5	63° 24' 41'' S	057° 00' 47'' W
6	63° 24' 45'' S	057° 01' 05'' W
7	63° 24' 51'' S	057° 01' 10'' W

CLIMATE

No climate data are available for Mount Flora but local conditions are indicated by those at Esperanza Station. In summer (December, January and February), the average maximum temperature ranges between 2.6 °C and 3.2 °C, while the average minimum temperature ranges between -2.9 °C and -1.8 °C. During this season the temperature can reach as high as 18.4 °C, as in 2020, or as low as -12.0 °C, as in 1985. In winter, average maximum temperatures are around -6.0 °C, while the minimum averages are about -15.0 °C. Exceptionally, the temperature may rise to 13.0 °C, or fall to -32.3 °C, as in 1975. Temperatures at Mount Flora are likely to be lower owing to its greater elevation. The least windy months are December and January (mean wind speed 20-22 km h⁻¹), compared to May, July, August and September when winds are stronger (mean wind speed >30 km h⁻¹). During April and May gusts of more than 380 km h⁻¹ have been recorded, resulting from katabatic winds from the local glacier. Strong winds (at or above 43 km h⁻¹) have been observed throughout the year, with an average frequency of c. 15 days per month. The average annual frequency of days with snow is 181 days per year. Throughout the year, snow fall occurs, on average, on 13-16 days each month, with a minimum average of 13 days in June. The average frequency of days with overcast skies is high in summer (23 days in January) but lower during the winter months (c. 13 days per month). The frequency of days with clear skies it is low throughout the year, ranging between 1 and 5 days per month. (Servicio Meteorológico Nacional, Argentina).

GEOLOGY, SOILS AND PALAEOONTOLOGY

The geology of the Area comprises three main formations: the Hope Bay Formation, the Mount Flora Formation and the Kenney Glacier Formation. At the base, the Hope Bay Formation (Trinity Peninsula Group) is more than 1200 m thick and is characterised by marine siliciclastic turbidite and sandstone. It has an inferred Permo-Carboniferous age based on supposed Carboniferous spores (Grikurov and Dibner 1968) and Rb-Sr isotopic dating of 'grits' and mudstones (281 ± 16 Ma; Pankhurst 1983) but the age evidence is sparse and open to ambiguous interpretation (Smellie and Millar 1995). The Hope Bay Formation is separated by an angular unconformity and a long stratigraphic gap from the overlying Mount Flora Formation. The Mount Flora Formation (Botany Bay Group) is composed mainly of sandstones, conglomerates and shale, and contains the most significant fossil strata. The overlying Kenney Glacier Formation (Antarctic Peninsula Volcanic Group), which is also separated from the Mount Flora Formation by an angular unconformity, is composed of ignimbrites and welded tuffs. There has been debate over the age of the Mount Flora Formation (Andersson 1906, Halle 1913, Bibby 1966, Thomson 1977, Farquharson 1984, Francis 1986, Gee 1989, Rees 1990); the most recent palaeobotanical and radiometric data available support an age of Early to Middle Jurassic (Rees 1993a, b, Rees and Cleal 1993, Riley and Leat 1999). Faults have been observed in the northern face of Mount Flora (Birkenmajer 1993a) and mapped separating the Trinity Peninsula Group and Mount Flora Formation (Smellie pers. comm. 2000).

The Mount Flora Formation is about 230-270 m thick and may be subdivided into an older Five Lakes Member and an upper Flora Glacier Member, which contains the most important fossil deposits. The Five Lakes Member is about 170 m thick and consists of plant-bearing coarse sedimentary breccias, conglomerates and sandstones. The dominant lithology, particularly in the lower part of the succession, is clast-supported cobble to boulder conglomerate (Farquharson 1984). It is well-exposed on the northern and northeastern slopes of Mount Flora between the Flora Glacier and Five Lakes Valley. The lower boundary of this member is an angular unconformity against the Hope Bay Formation. The contact between the Mount Flora Formation and the Hope Bay Formation is covered by scree. Some 50 m of basal beds of the Five Lakes Member are presumed unexposed. A higher section of the Five Lakes Member is well-exposed at a buttress which separates Flora Glacier from Five Lakes Valley (Martín Serrano et al. 2005, Montes et al. 2004).

The Flora Glacier Member comprises a sandstone-conglomerate complex 60-100 m thick, locally overlain by a shale complex up to 10 m thick, which is the main fossiliferous zone. It is best exposed at a buttress that divides the Flora Glacier cirque from Five Lakes Valley at approximately 350 m. A one metre-thick sill occurs in the upper section of the shale, close to the contact with the Kenney Glacier Formation. The sandstone association is dominated by fining upward cycles (characterised by decreasing grain size) that range in thickness from 2.5 to 11.5 m (Farquharson 1984). Although mostly inaccessible, good exposures of the Flora Glacier Member continue in the steep slopes of Mount Flora above Five Lakes Valley, extending westward to the margin of the Kenney Glacier. The thickness of the unit increases from 50-60 m at the buttress to about 100 m at the glacier margin. Volcanogenic deposits form a small but significant part of the Mount Flora Formation. A single ignimbrite 26 m thick forms a pale band across the north face of Mount Flora, approximately halfway up the sedimentary sequence (Farquharson 1984). The Kenney Glacier Formation volcanic rocks overlie the Mount Flora Formation, exposed in the highest part of Mount Flora. It also unconformably overlies the Hope Bay Formation on the eastern spur of the Pyramid (Smellie, pers. comm. 2000). The incomplete formation is a complex of predominantly evolved, rhyolite-dacite lavas, ignimbrites, agglomerates and tuffs (Birkenmajer 1993a & b). Farquharson (1984) identified the presence of tuffs, fine-grained agglomerates and welded tuffs. The most significant fossil exposures are found on the northern and northwestern faces of Mount Flora.

Most research has been conducted on samples from the relatively accessible northern face. The fossil flora was first comprehensively described by Halle (1913) and since then has been considered a standard for Mesozoic gondwanan floristic and biostratigraphic studies (Rees and Cleal 1993). Halle (1913) originally described 61 species from the fossils; this was revised to 43 species (Gee 1989), then to 38 species (Rees 1990) and, later still, to 32 species (Baldoni, 1986, Morel et al. 1994; Rees and Cleal

2004). More recently, 41 taxa have been described (Ociepa 2007; Birkenmajer and Ociepa 2008; Ociepa and Barbacka 2011). Fossil wood from the ASPA has also been studied (Torres et al. 2000).

The flora is represented typically by small scale-like leaves of Hepatophyta, stems and cone fragments of sphenophytes (Equisetaceae, *Equisetum*), as well as foliage of several ferns families (Dipteridaceae, Matoniaceae, Dicksoniaceae, Osmundaceae) and leaves and wood of gymnosperms (Caytoniales, Cycadales, Bennettitales, pteridosperms and conifers). Cycadophyte and conifer cone scales, seeds and other unidentifiable stems, leaves and foliage branches are also preserved (Taylor, no date; Rees pers. comm. 1999). Other floral fragments have been interpreted as fertile fern fronds or pollen organs of conifers but it remains uncertain how this species is related to other taxa because no spores or pollen have been obtained from the material to date (Ociepa and Barbacka, 2011). More generally, identifiable palynomorphs from the plant beds of Mount Flora Formation could not be recovered (Rees and Cleal 2004; Ociepa and Barbacka 2011). Four beetle (Order: Coleoptera) elytra (exoskeletons) have been identified from a small sample of shale, also containing plant fossils, from Mount Flora (Zeuner 1959). These were identified as *Grahamelytron crofti* and *Ademosynoides antarctica*. *G. crofti* is possibly a Carabidae, although it resembles a Chrysomelidae, while *A. antarctica* has been referred to as a Carabidae, Tenebrionidae, Elateridae or the fossil family Permosinidae (Zeuner, 1959). Recent research has confirmed the presence of the oldest freshwater mollusk fossil from Antarctica, *Antediplodon esperanzaensis*, in Jurassic outcrops exposed by the retreat glaciers to the east of the Area (Martinez et al, 2019). No other examples of fossil fauna have been recorded. There are no known marine fossil floral or faunal deposits in the Area.

Climate warming has resulted in widespread glacial retreat in the northern Antarctic Peninsula region. For example, in the northern Trinity Peninsula the area of ice-free ground has increased by c. 40 km². More specifically, in the Hope Bay area, which encompasses ASPA No. 148, the ice-free area has increased by c. 4.5 km² (Sotille, 2015). As a result, the formation of soil and colonisation of vegetation has increased throughout the area, revealing the dynamic process occurring in the region, which are of important scientific value (Poeiras, 2011).

TERRESTRIAL AND FRESHWATER BIOLOGY

The living flora within the Area is sparse and patchily distributed. Although a full floristic survey has not been made, a number of moss and lichen species have been identified as present. Moss species identified are: *Andreaea gainii*, *Bryum argenteum*, *Ceratodon purpureus*, *Hennediella heimii*, *Pohlia nutans*, *Sanionia uncinata*, *Schistidium antarctici* and *Syntrichia princeps*. Lichen species identified are: *Acarospora macrocyclos*, *Buellia anisomera*, *Buellia* spp., *Caloplaca* spp., *Candelariella vitellina*, *Cladonia pocillum*, *Haematomma erythromma*, *Physcia caesia*, *Pleopsidium chlorophanum*, *Pseudephebe minuscula*, *Rhizocarpon geographicum*, *Rhizoplaca aspidophora*, *Stereocaulon antarcticum*, *Tremolecia atrata*, *Umbilicaria antarctica*, *Umbilicaria decussata*, *Umbilicaria kappenii*, *Usnea antarctica*, *Xanthoria candelaria* and *Xanthoria elegans*. There are no permanent streams or lakes within the Area. No information is available on the invertebrate fauna or microbial communities present at Mount Flora.

BREEDING BIRDS

Little information is available on bird communities present at Mount Flora, although a report on the exact nesting sites of some species suggested that birds are unlikely to breed within the Area (Marshall 1945). However, the breeding birds of Hope Bay generally have been well-studied, for instance, Argentina has been monitoring the penguins colonies within IBA ANT074 since the early 1990s. Part of one of the largest colonies of Adélie penguin (*Pygoscelis adeliae*) on the Antarctic Peninsula, numbering c. 104,139 pairs, is situated about 500 m northeast of the Area (Santos et al. 2018) (Map 2). Other birds breeding at Hope Bay include around 500 pairs of gentoo penguins (*Pygoscelis papua*) (Argentina Monitoring Program), brown skua (*Catharacta loennbergi*), south polar skua (*Catharacta maccormicki*), Antarctic tern (*Sterna vittata*), Wilson's storm petrel (*Oceanites oceanicus*), kelp gull (*Larus dominicanus*), and sheathbill (*Chionis alba*). Further information on the number of breeding birds in the vicinity of Mount Flora can be found in Argentina (1997), Santos et al. (2013) and Coria and Montalti (1993).

HUMAN ACTIVITIES AND IMPACTS

Mount Flora was discovered in 1903 by Johann Gunnar Andersson, a member of the Swedish South Polar Expedition of 1901-04, which explored and mapped much of the northern Antarctic Peninsula. Andersson collected fossil and mineralogical specimens from Mount Flora while stranded and awaiting rescue at Hope Bay over the winter of 1903. Andersson and his companions over-wintered in a stone hut (Historic Site and Monument No. 39). The leader of the expedition was Otto Nordenskjöld, who named Mount Flora because of the geological findings of Andersson. The United Kingdom established Base 'D' at Hope Bay in 1945 as part of 'Operation Tabarin'. The station was operational until February 1964 with a winter complement of 7-19 personnel. Base 'D' was transferred from the United Kingdom to Uruguay in 1997 and renamed as Teniente de Navio Ruperto Elichiribehety Station. Argentina established Esperanza Station on 31 December 1951 and has operated the station continuously since, with approximately 50 winter and up to 70 summer personnel, devoted to the study of different scientific disciplines such as seismology, geology, geomorphology, and the monitoring of different parameters of the ecosystem and contamination.

The Hope Bay area is subject to tourist visitation, with between 1,500 and 3,000 tourists per year visiting local sites including Esperanza Station and the nearby penguin colony at Eagle Cove (IBA Ant074). Mount Flora was designated as a Site of Special Scientific Interest in 1989 as a result of concern that the best examples of fossils were being collected by casual visitors and might therefore be lost to science. Tourism and any other recreational activity is not permitted within the Area, albeit access to the sites is considered difficult making such visits unlikely.

6(ii) Access to the Area

All access to the areas shall be on foot. The lower slopes of Mount Flora are easily accessible by foot from both the local research stations and from Hope Bay. However, reaching the boundary of the ASPA, and moving within it, requires a demanding hike, due to the steep nature of the local terrain. To access the area, follow the relatively flat ground south of Esperanza Station to Boeckella Lake. From there, follow a trail that heads southward towards the eastern end of the ASPA, which allows access via the least steep ground (see Map 2). Helicopter landings within the Area are prohibited, except under emergency conditions when the use of helicopters may be considered under the conditions set out in section 7 (ii) *Access to and movement within or over the Area*.

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

There are no structures present within the Area. The nearest scientific research stations are Esperanza Station (Argentina) (latitude 63°24'S, longitude 56°59'W) and Teniente de Navio Ruperto Elichiribehety Station (Uruguay) (latitude 63°24'S, longitude 56°59'W), both approximately 1.5 kilometres northeast of the Area. The remains of a British Base, which burnt down in 1948, are situated 300 m to the northeast of the Uruguayan base. The graves of two British men who died in the above fire are located on a small promontory some 300 m to the north of the Uruguayan base. Two shelters, run by Argentina, are situated east of Mount Flora (latitude 63°25'10" S, longitude 56°59'50"W and latitude 63°27'36" S, longitude 57°11'14"W).

6(iv) Location of other Protected Areas in the vicinity

The nearest protected areas to Mount Flora are Potter Peninsula (ASPA No. 132), Western Shore of Admiralty Bay (ASPA No. 128), Lions Rump (ASPA No. 151), and Narębski Point, Barton Peninsula (ASPA No. 171), all of which are located on King George Island, South Shetland Islands, lying approximately 150 km to the west (Map 1). A stone hut (Historic Site and Monument No. 39) built by members of the Swedish South Polar Expedition and a bust of General San Martín, grotto with a statue of the Virgin of Luján, and a flag mast erected by Argentina in 1955, together with a graveyard with stele in memory of members of Argentine expeditions who died in the area (Historic Site and Monument No. 40) are present within the vicinity of Esperanza Station (Map 2).

6(v) Special zones within the Area

None.

7. Terms and condition 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 as designated under Article 7 of Annex V of the Protocol on Environmental Protection to the Antarctic Treaty.

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;
- any management activities are in support of the objectives of the Management Plan;
- 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 and historic values of the Area;
- should the applicant for a Permit propose to make rock collections, the applicant shall demonstrate to an appropriate national authority that the research proposed cannot be adequately served by samples already collected and held in the various collections worldwide, before a Permit is granted;
- the Permit, or an authorised copy, shall be carried when in the Area;
- a visit report shall be supplied to the authority named in the Permit;
- the Permits shall be issued for a finite period;
- the appropriate authority should be notified of any activities/measures undertaken that were not included in the authorised Permit.

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

- Access to and movement within the Area shall be on foot.
- Due to the steepness of the ground, which makes it technically difficult to land a helicopter within the Area, access to the Area by helicopter is not permitted, except in the event of an emergency. In an emergency, and if wind conditions allow, a helicopter can enter the ASPA, preferably without landing, to perform a rescue. If necessary or useful for the type of emergency in question, the helicopter may land on Flora Glacier. Should an emergency arise which necessitates the use of a helicopter, the helicopter flight paths shown in Map 2 are recommended. Furthermore, helicopter lands in the surrounding area are not recommended due to the high concentration of birds nesting in the vicinity of Mount Flora. The recommended helicopter landing site is the Esperanza Station helicopter pad (see Map 2). The 'Guidelines for the Operation of Aircraft near Concentrations of Birds' contained in Resolution 2 (2004) should also be consulted.
- Land vehicles are prohibited within the Area.
- Pedestrian traffic should be kept to the minimum necessary to undertake permitted activities and every reasonable effort should be made to minimise trampling effects, such as breakage of rocks, especially of rocks *in situ*.
- Overflight of the Area by Remotely Piloted Aircraft Systems (RPAS) shall not be permitted unless for scientific or operational purposes, and in accordance with a permit issued by an appropriate national authority.

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

Activities which may be conducted within the Area include:

- Compelling scientific research which cannot be undertaken elsewhere;
- Scientific research that will not jeopardise the scientific values of the Area.
- Essential management activities, including monitoring.

Where geological sampling is involved this should, as a minimum standard, be in accordance with the following principles:

1. Sampling should be done with the minimum disturbance practical.
2. Sampling should be kept to the minimum necessary to achieve the research objectives.
3. Enough material/specimens should be left to allow future workers to understand the context of the material.
4. Sample sites should be left free of markings (paint, labels, etc.).
5. Specimens should be retained in a recognised repository after the project finishes.
6. Details of the GPS location of collection sites, volume/weight, sample orientation, type of material collected, and where the removed material will be housed, should be detailed in visit reports submitted to the appropriate national authority.
7. A copy of these details should also be provided to the Proponent Parties to facilitate the review of the Management Plan and to facilitate the provision of advice to other Parties regarding the existence of materials in geological repositories, with a view to minimising unnecessary new or additional sampling.

7(iv) Installation, modification, or removal of structures

No structures are to be erected within the Area, or scientific equipment installed, except for compelling scientific or management reasons and for a pre-established period, as specified in a permit. Permanent structures or installations are prohibited. All markers, structures or scientific equipment installed in the Area must be clearly identified by country, name of the principal investigator or agency, year of installation and date of expected removal. All such items should be free of organisms, propagules (e.g. seeds, eggs) and non-sterile soil, and be made of materials that can withstand the environmental conditions and 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(v) Location of field camps

Camping is prohibited within the Area.

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

In addition to the requirements of the Protocol on Environmental Protection to the Antarctic Treaty, restrictions on materials and organisms which may be brought into the area are:

- The deliberate introduction of animals, plant material, microorganisms and non-sterile soil into the Area shall not be permitted. Precautions shall be taken to prevent the accidental introduction of animals, plant material, microorganisms and non-sterile soil from other biologically distinct regions (within or beyond the Antarctic Treaty area). Furthermore, all tools (drills, picks, shovels, geological hammers, etc.) should be thoroughly cleaned before being taken to Antarctica, particularly those tools which have been used previously in high altitude and high latitude areas outside the Antarctic Treaty area.
- No herbicides or other pesticides shall be brought into the Area.
- Any other 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 or other chemicals shall not be stored in the Area unless specifically authorised by Permit condition. They shall be stored and handled in a way that minimises the risk of their accidental introduction into the environment.
- Materials introduced into the Area shall be for a stated period only and shall be removed by the end of that stated period. If release occurs which is likely to compromise the values of the Area, removal is encouraged only where the impact of removal is not likely to be greater than that of leaving the material *in situ*.
- The appropriate authority shall be notified of any materials released and not removed that were not included in the authorised Permit.

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

Taking of, or harmful interference with, native flora and fauna is prohibited, except in accordance with a permit issued in accordance with Annex II of the Protocol on Environmental Protection to the Antarctic Treaty. Where taking or harmful interference with animals is involved this should, as a minimum standard, be in accordance with the SCAR Code of Conduct for the Use of Animals for Scientific Purposes in Antarctica.

7(viii) 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 and should be limited to the minimum necessary to meet scientific or management needs (see sections 7(iii) *Activities which may be conducted in the Area* and 7(x) *Measures that may be necessary to continue to meet the aims of the management plan*). Permits shall not be granted if there is a reasonable concern that the sampling proposed would take, remove or damage such quantities of fossiliferous rocks that their abundance on Mount Flora would be significantly affected. Other 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 authorised, may be removed from the Area unless the environmental 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

All wastes, including all human wastes, shall be removed from the Area in accordance with Annex III (Waste disposal and waste management) to the Protocol on Environmental Protection to the Antarctic Treaty (1998).

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

In view of the fact that geological sampling is both permanent and results in cumulative impact the following measures shall be taken to safeguard the scientific values of the Area:

- Visitors removing geological samples from the Area shall complete a record describing the geological type, quantity and location of samples taken, which should, at a minimum, be deposited with their National Antarctic Data Centre and/or with the Antarctic Master Directory.
- Visitors planning to sample within the Area shall demonstrate that they have familiarised themselves with earlier collections to minimise duplication. Sample collections exist in repositories around the world including:

Repositories	Information/repository website
Museum of Natural Sciences, B. Rivadavia, Buenos Aires, Argentina	http://wander-argentina.com/natural-sciences-museum-buenos-aires/
Museum of Natural Sciences, La Plata, Argentina	http://www.welcomeargentina.com/laplata/museum-natural-sciences.html
Natural History Museum, London, UK	https://www.nhm.ac.uk/our-science/collections/palaeontology-collections.html
British Antarctic Survey, Cambridge, UK	https://www.bas.ac.uk/data/our-data/collections/geological-collections/
Swedish Natural History Museum, Stockholm	http://www.nrm.se/english.16_en.html
Byrd Polar Research Center Polar Rock Repository, Ohio, USA	http://bprc.osu.edu/rr/
Institute of Geological Sciences, Polish Academy of Sciences, Krakow, Poland	https://www.ing.pan.pl/en/
Department of Geology, Institute of Geosciences, Federal University of Rio de Janeiro, Brazil	http://www.ufrgs.br/english/the-university/institutes-faculties-and-schools/institute-of-geoscience

Antarctic Repository of Paleontological and Geological Collections of the Argentine Antarctic Institute, Buenos Aires, Argentina	https://www.cancilleria.gob.ar/es/iniciativas/dna/instituto-antartico-argentino/repositorio-de-fosiles
--	---

7(xi) Requirements for reports

The principal permit holder for each visit to the Area shall submit a visit 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 *Antarctic Specially Protected Area visit report form* contained in the *Revised Guide to the Preparation of Management Plans for Antarctic Specially Protected Areas* (Appendix 2). Amongst other details, the visit report should include the information requested in bullet point 6 of section 7(iii) *Activities which may be conducted in the Area* of this Management Plan. Wherever possible, the national authority should also forward a copy of the visit report to the Proponent Parties, 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, to be used both in any review of the Management Plan and in organising the scientific use of the Area.

8. Supporting documentation

Andersson, J.G. 1906. On the geology of Graham Land. *Bulletin of the Geological Institution of the University of Upsala* **7**:19-71.

Argentina. 1997. Environmental review of Argentine activities at Esperanza (Hope) Bay, Antarctic Peninsula. *ATCM XXI, Information Paper* 36.

Baldoni, A.M. 1986. Características generales de la megafloora, especialmente de la especie *Ptilophyllum antarcticum*, en el Jurásico Superior-Cretácico Inferior de Antártida y Patagonia, Argentina. *Boletim IG-USP, Instituto de Geociencias, Universidade de Sao Paulo* **17**: 77-87.

Bibby, J.S. 1966. The stratigraphy of part of north-east Graham Land and the James Ross Island group. *British Antarctic Survey Scientific Report* **53**.

Birkenmajer, K. 1992. Trinity Peninsula Group (Permo-Triassic?) at Hope Bay, Antarctic Peninsula. *Polish Polar Research* **13**(3-4): 215-240.

Birkenmajer, K. 1993a. Jurassic terrestrial clastics (Mount Flora Formation) at Hope Bay, Trinity Peninsula (West Antarctica). *Bulletin of the Polish Academy of Sciences: Earth Sciences* **41**(1): 23-38.

Birkenmajer, K. 1993b. Geology of late Mesozoic magmatic rocks at Hope Bay, Trinity Peninsula (West Antarctica). *Bulletin of the Polish Academy of Sciences: Earth Sciences* **41**(1): 49-62.

Birkenmajer, K. and Ociepa, A.M. 2008. Plant-bearing Jurassic strata at Hope Bay, Antarctic Peninsula (West Antarctica); geology and fossil plant description. In: K. Birkenmajer (ed.) Geological Results of the Polish Antarctic Expeditions, Part 15. *Studia Geologica Polonica* **128**: 5-96.

Coria, N. R., and Montalti, D. 1993. Flying birds at Esperanza Bay, Antarctica. *Polish Polar Research* **14**(4): 433-439.

Croft, W.N. 1946. Notes on the geology of the Hope Bay area. Unpublished report, British Antarctic Survey Archives Ref AD6/2D/1946/G1.

Farquharson, G.W. 1984. Late Mesozoic, non-marine conglomeratic sequences of Northern Antarctic Peninsula (Botany Bay Group). *British Antarctic Survey Bulletin* **65**: 1-32.

Francis, J.E. 1986. Growth rings in Cretaceous and Tertiary wood from Antarctica and their palaeoclimatic implications. *Palaeontology* **29**(4): 665-684.

Gee, C.T. 1989. Revision of the late Jurassic/early Cretaceous flora from Hope Bay, Antarctica. *Palaeontographica* **213**(4-6): 149-214.

Grikurov, G.E. and Dibner, A.F. 1968. Novye dannye o Serii Trinita (C1-2) v zapadnoy Antarktide. [New data on the Trinity Series (C1-2) in West Antarctica.] *Doklady Akademii Nauk SSSR*: **179**, 410-412. (English translation: *Proceedings of the Academy of Science SSSR (Geological Sciences)* **179**: 39-41).

Halle, T.G. 1913. The Mesozoic flora of Graham Land. *Wissenschaftliche ergebnisse der Schwedischen Südpolar-expedition 1901-1903* **3**(14).

Harris, C.M., Lorenz, K., Fishpool, L.D.C., Lascelles, B., Cooper, J., Coria, N.R., Croxall, J.P., Emmerson, L.M., Fijn, R.C., Fraser, W.L., Jouventin, P., LaRue, M.A., Le Maho, Y., Lynch, H.J., Naveen, R., Patterson-Fraser, D.L., Peter, H.-U., Poncet, S., Phillips, R.A., Southwell, C.J., van Franeker, J.A., Weimerskirch, H., Wienecke, B., and Woehler, E.J. 2015. *Important Bird Areas in Antarctica 2015*. BirdLife International and Environmental Research & Assessment Ltd., Cambridge.

Hathway, B. 2000. Continental rift to back-arc basin: stratigraphical and structural evolution of the Larsen Basin, Antarctic Peninsula. *Journal of the Geological Society of London* **157**: 417-432.

Marshall, N.B. 1945. Annual report. Base D. Biology and Hydrography. Unpublished report, British Antarctic Survey Archives Ref AD6/1D/1945/N2. Nathorst, A.G. 1906. On the upper Jurassic flora of Hope Bay, Graham Land. *Compte Rendus, 10th International Geological Congress, Mexico* **10**(2):1269-1270.

Martínez, S., Scasso, R. A., Elgorriaga, A., Capelli, I., del Valle, R., Puerta, P., Lirio, J.M, and Amenábar, C. R. 2020. The (truly) first fossil freshwater molluscs from Antarctica. *Paläontologische Zeitschrift* **94**(3): 513-518.

Martín-Serrano, A., Montes, M., Martín, F. N., and Del Valle, R. 2005. Geomorfología de la costa austral de Bahía Esperanza (Península Antártica). *Geogaceta* **38**: 95-98.

Montes, M. Martín-Serrano, A., Nozal, F. 2005. Geología de la Costa austral de Bahía Esperanza (Península Antártica). *Geogaceta* **38**: 91-94.

Montes, M. J., Martín-Serrano, A., and del Valle, R. A. 2004. Mapa Geológico de la costa austral de Bahía Esperanza y el Monte Flora, Península Antártica. In S. Marensi (Ed.), 5º1º Simposio Argentino Latinoamericano sobre Investigaciones Antárticas. Buenos Aires: Instituto Antártico Argentino.

Montes, M., Martín-Serrano, A., Nozal, F., Rodríguez Fernández, L. R., and Del Valle, R. 2013. Mapa geológico de Bahía Esperanza. Antártica; scale 1:10,000. 1st edition. Serie Cartográfica Geocientífica Antártica. Madrid: Instituto Geológico y Minero de España, Buenos Aires: Instituto Antártico Argentino.

Morel, E. M., Artabe, A. E., Ganuza, D. G., and Brea, M. 1994. Las plantas fósiles de la Formación Monte Flora, en Bahía Botánica, Península Antártica, Argentina. 1. Dipteridaceae. *Ameghiniana* **31**: 23-31.

Morgan, F., Barker, G., Briggs, C., Price, R. and Keys, H. 2007. Environmental Domains of Antarctica Version 2.0 Final Report, Manaaki Whenua Landcare Research New Zealand Ltd. 89 pp.

Nozal, F., Martín-Serrano, A., Montes, M., and Del Valle, R. 2013. Mapa geomorfológico de Bahía Esperanza. Antártica; scale 1:10,000. 1st edition. Serie Cartográfica Geocientífica Antártica. Madrid: Instituto Geológico y Minero de España, Buenos Aires: Instituto Antártico Argentino.

Ociepa, A. M. 2007. Jurassic liverworts from Mount Flora, Hope Bay, Antarctic Peninsula. *Polish Polar Research* **28**(1): 31-36.

Ociepa, A. M. and Barbacka, M. 2011. *Spesia antarctica* gen. et sp. nov. – a new fertile fern spike from the Jurassic of Antarctica. *Polish Polar Research* **32**(1): 59-66.

Pankhurst, R.J. 1983. Rb-Sr constraints on the ages of basement rocks of the Antarctic Peninsula. In Oliver, R.L., James, P.R. and Jago, J.B. eds. *Antarctic Earth Science*. Canberra, Australian Academy of Science: 367-371.

Pankhurst, R.J., Leat, P.T., Sruoga, P., Rapela, C.W., Marquez, M., Storey, B.C., and Riley, T.R., 1998. The Chon Aike province of Patagonia and related rocks in West Antarctica: a silicic large igneous province. *Journal of Volcanology and Geothermal Research* **81**: 113-136.

Poeiras, L. M. 2011. Vegetation and environments in Lions Rump e Hope Bay, Maritime Antarctic. (Thesis). Universidade Federal de Viçosa, Viçosa.

Rees, P. M. 1990. Palaeobotanical contributions to the Mesozoic geology of the northern Antarctic Peninsula region. Unpublished PhD thesis, Royal Holloway and Bedford New College, University of London.

Rees, P. M. 1993a. Dipterid ferns from the Mesozoic of Antarctica and New Zealand and their stratigraphical significance. *Palaeontology* **36**(3): 637-656.

Rees, P. M. 1993b. Caytoniales in early Jurassic floras from Antarctica. *Geobios* **26**(1): 33-42.

Rees, P.M., 1993c. Revised interpretations of Mesozoic palaeogeography and volcanic arc evolution in the northern Antarctic Peninsula region. *Antarctic Science* **5**: 77-85

Rees, P.M. and Cleal, C.J. 1993. Marked Polymorphism in *Archangelskya furcata*, a pteridospermous frond from the Jurassic of Antarctica. *Special papers in Palaeontology* **49**: 85-100.

Rees, P.M. and Cleal, C.J. 2004. Lower Jurassic floras from Hope Bay and Botany Bay, Antarctica. *Special Papers in Palaeontology* **72**: 5-89.

Riley, T.R and Leat, P.T. 1999. Large volume silicic volcanism along the proto-Pacific margin of Gondwana: lithological and stratigraphical investigations from the Antarctic Peninsula. *Geological Magazine* **136** (1): 1-16.

Santos, M. M., Hinke, J. T., Coria, N. R., Fusaro, B., Silvestro, A., & Juárez, M. A. 2018. Abundance estimation of Adélie penguins at the Esperanza/Hope Bay mega colony. *Polar Biology*, **41**(11), 2337-2342. Smellie, J.L., and Millar, I.L. 1995. New K-Ar isotopic ages of schists from Nordenskjöld Coast, Antarctic Peninsula: oldest part of the Trinity Peninsula Group? *Antarctic Science* **7**: 191-96.

Sotille, M. E. 2015. Avanço e retração de área glacial no extremo norte da península Trinity, Antártica, entre 1988 e 2015. (Thesis). Universidade Federal do Rio Grande do Sul, Porto Alegre.

Terauds, A., and Lee, J. R. 2016. Antarctic biogeography revisited: updating the Antarctic Conservation Biogeographic Regions. *Diversity and Distribution* **22**: 836-840.

Taylor, B.J. [no date]. Middle Jurassic plant material from Mount Flora, Hope Bay. Unpublished report, British Antarctic Survey Archives Ref ES3/GY30/6/1.

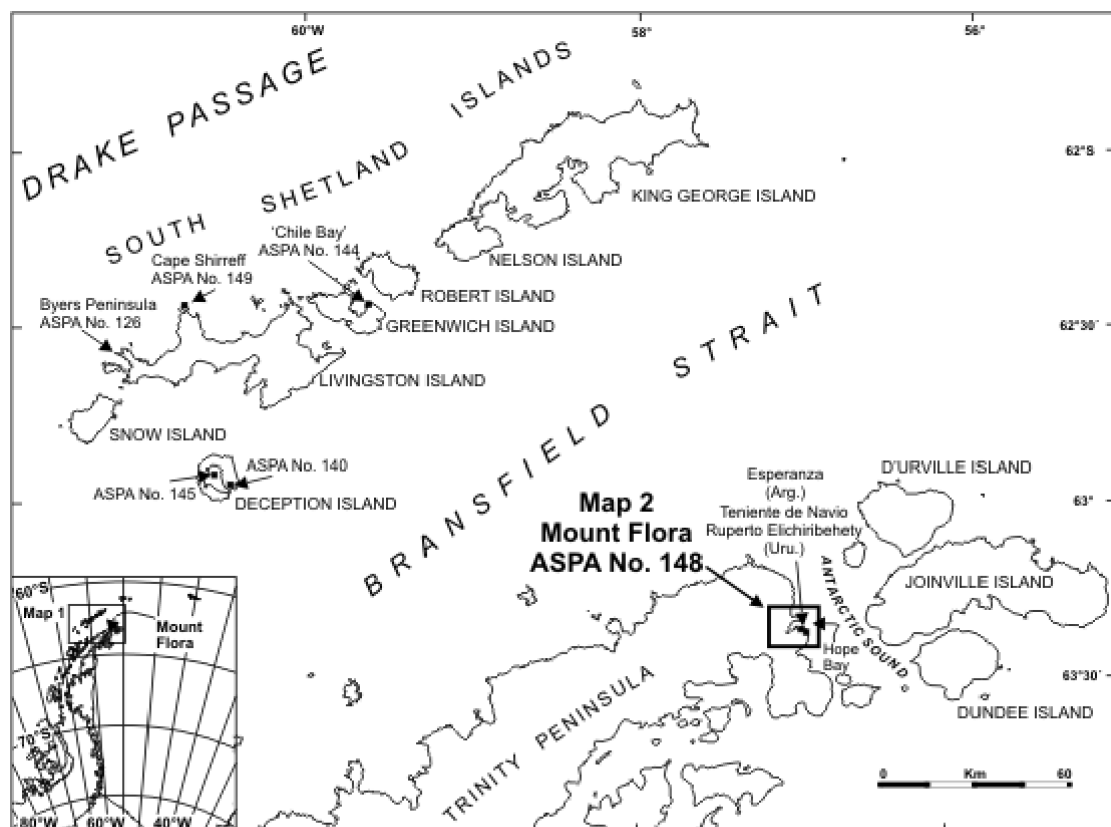
Thomson, M.R.A. 1977. An annotated bibliography of the paleontology of Lesser Antarctica and the Scotia Ridge. *New Zealand Journal of Geology and Geophysics* **20**(5): 865-904.

Torres, T., Galleguillos, H., and Philippe, M. 2000. Maderas fósiles en el Monte Flora, Bahía Esperanza, Península Antártica. In: Congreso Geológico Chileno, No. 9, Actas, Vol. 2, p. 386-390. Puerto Varas.

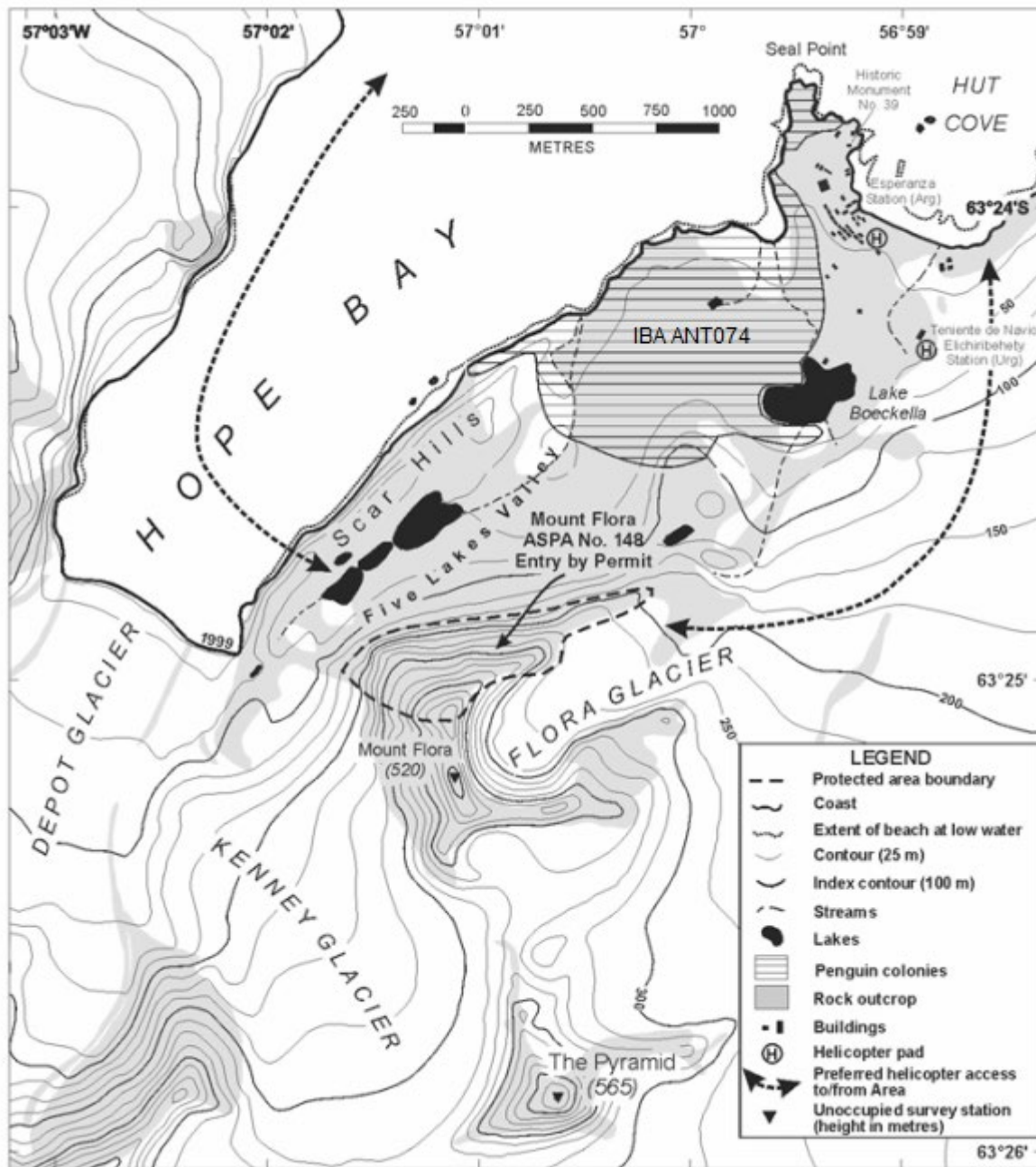
Truswell, E.M., 1991. Antarctica: a history of terrestrial vegetation. In: Tingey, R.J., ed. *The geology of Antarctica*. Oxford: Clarendon Press, 499-537.

Woehler, E.J. (ed) 1993. The distribution and abundance of Antarctic and sub-Antarctic penguins. SCAR, Cambridge.

Zeuner, F.E. 1959. Jurassic beetles from Graham Land, Antarctica. *Palaeontology* **1**(4): 407-409.

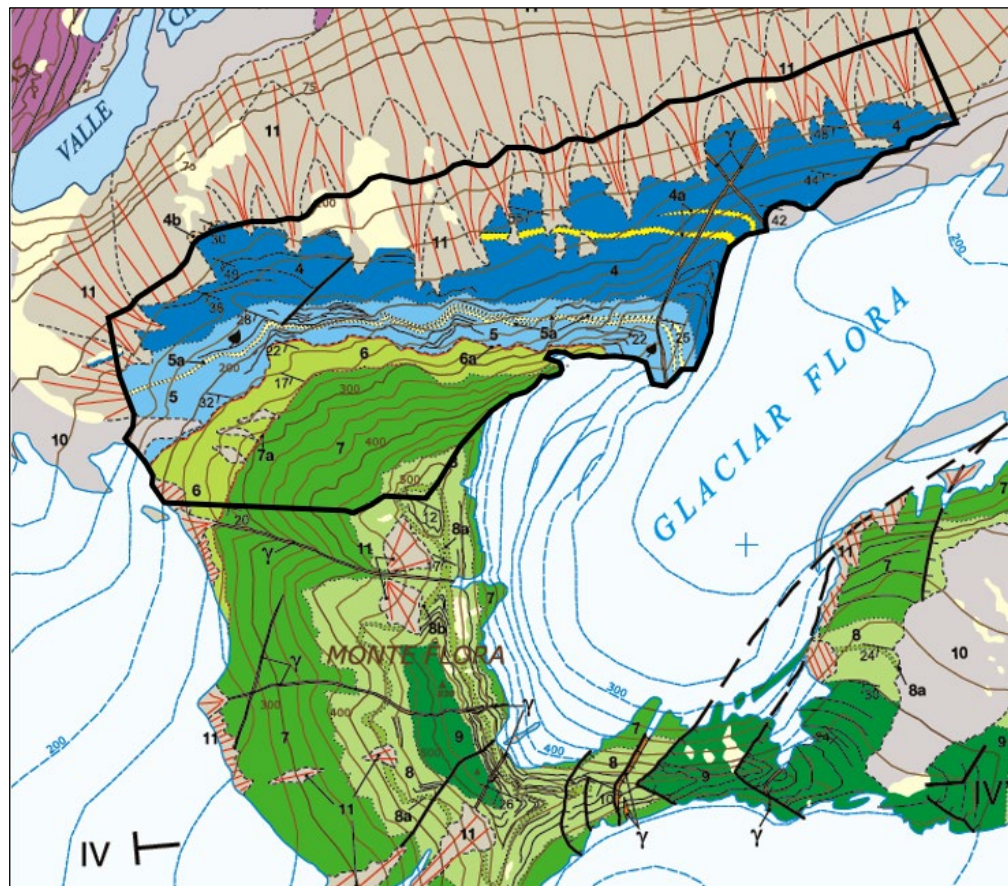


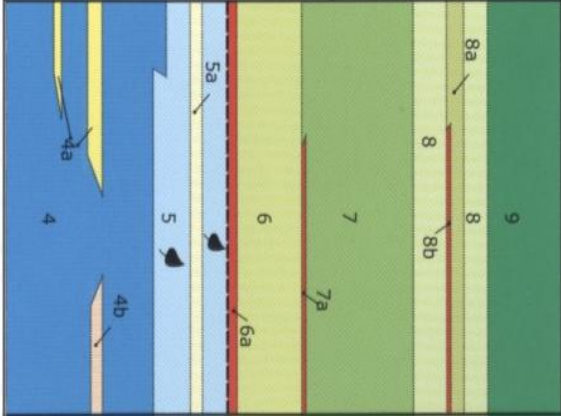
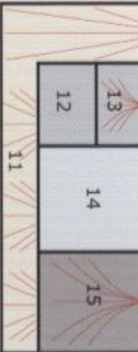
Map 1. Mount Flora (ASPANo. 148), Hope Bay, Antarctic Peninsula, location map.
 Inset: location of Mount Flora on the Antarctic Peninsula



Map 2. Mount Flora (ASPA No. 148), Hope Bay, topographic map.

Map 3: Mount Flora ASPA No. 148 geological map, adapted from the 'Mapa Geológico de Bahía Esperanza Antártida' published by the Instituto Geológico y Minero de España and Instituto Antártico Argentino (Scale 1:10,000). The sketch map is orientated with north to the top of the map. The area depicted is approximately 1.5 km across. **Legend:** 4. Massive conglomerates of different thicknesses. 5. Sandstones, conglomerates and black shales with plant remains. 5a. Fragmented volcanic rocks. 6. Welded tuffs with interbedded sandstones, volcanic breccias and welded ignimbrite beds. 6a. Reddish thermal contact. 7. Breccias, sandstones and siltstones with interbedded volcanic ignimbrites. 8. Welded tuffs, interbedded with welded ignimbrites and beds of breccia and sandstone. 8a. volcanic laminated siltstones, sandstones and volcanic basaltic lava layers. 8b. Reddish thermal contact. 9. Breccias and sandstones with interbedded volcanic ignimbrites. 10. Angular boulders with a sandy-silty matrix. Background till and moraines. 11. Angular boulders. Slopes and debris cones. γ : dyke \blacktriangledown : palaeobotanical remains.



MESOZOIC		QUATER.
JURASSIC		
LOWER	MIDDLE	HOLOCENE
		
FL-1	FL-2	KE-1
KE-2	KE-3	KE-4
MEMBER		
MOUNT FLORA FORMATION		KENNEY GLACIER FORMATION
FORMATION		
BOTANY BAY GROUP		ANTARTIC PENINSULA VOLCANIC GROUP
GROUP		