

A new Topographic Map 1 : 7500 of Cierva Point (Danco Coast, Antarctic Peninsula)

By Frank Rau¹, Tobias Betgen¹, Dirk Beppler¹ and José Luis Agraz²

Summary: Due to its great scientific value Cierva Point was declared as Site of Special Scientific Interest No. 15. Since the foundation of the Argentine research station Primavera Base in 1977, the area has been the focus of numerous scientific research projects. Despite the attention the area received, accurate large-scale topographic mapping was not available prior to this study. Therefore, a topographic survey using simple field methods was carried out during the 1996/97 summer campaign. A digital elevation model with an approximate vertical accuracy of 10 to 20 m was derived from the survey data. Using a GIS, land cover types mapped during the field campaign were superimposed over the topographic data. The result was a 1 : 7500 scale topographic map of Cierva Point with a contour interval of 10 m. The digital data can potentially be used as a spatial base layer for a local environmental information system.

Zusammenfassung: Die Halbinsel Cierva Point ist aufgrund ihrer naturräumlichen Ausstattung als antarktisches Schutzgebiet ausgewiesen (Site of Special Scientific Interest No. 15). Darüber hinaus wurden hier seit Gründung der argentinischen Forschungsstation Primavera im Jahre 1977 zahlreiche Forschungsarbeiten durchgeführt. Dennoch fehlte bislang eine großmaßstäbige topographische Datengrundlage. Aus diesem Grund wurde während der Sommerkampagne 1996/97 mit einfachen Feldmethoden eine topographische Erhebung durchgeführt. Das daraus abgeleitete digitale Geländemodell weist eine Höhengenaugigkeit von 10 bis 20 m auf. Die GIS-gestützte Überlagerung der Höheninformation mit zusätzlich erhobenen Oberflächendeckungsklassen ermöglicht die Präsentation der topographischen Karte Cierva Point (Maßstab 1 : 7500, Äquidistanz 10 m). Die in digitaler Form vorliegende Information kann als räumliche Datengrundlage zum Beispiel zur Erstellung eines lokalen Landschaftsinformationssystems dienen.

INTRODUCTION

In the Antarctic, research and administration still suffer from a lack of detailed topographic information. Basic cartographic data of the entire Antarctic continent are provided by the Antarctic Digital Database (ADD, BRITISH ANTARCTIC SURVEY 1998). For the northern Antarctic Peninsula, the ADD digital maps are based on cartographic data sets at scales ranging from 1 : 100 000 to 1 : 250 000. However, Antarctic research in the fields of ecology, climatology, geography, environmental impact studies, management plans for protected areas, and monitoring of human activities require topographic information on a larger scale than available through the ADD. Therefore, new maps have to be compiled to meet the needs of scientific and operational programs. Generally, these cartographic products should show in detail the current topography, coast lines, and the actual distribution of ice and ice-free areas as exactly as possible. To facilitate regular updating, and to provide easy access and handling of the maps, they should be available in digital format (after BRAUN et al. *submittal*). Preferably, a Geographic Information

System (GIS) should be used, which offers the advantage of easy integration of additional data layers and provides the necessary tools for a subsequent processing of the data.

Despite its declaration as a Site of Special Scientific Interest (SSSI; SCIENTIFIC COMMITTEE ON ANTARCTIC RESEARCH 1998) and numerous scientific activities in the vicinity of the Argentine research station Primavera Base before and since its foundation in 1977 (e.g. LLORENTE et al. 1974 DOMACK et al., 1990, AGRAZ et al. 1994, QUINTANA et al. 1994, BENITEZ & AGRAZ 1997, GODAGONE 1997, BETGEN 1998, MATALONI et al. 1998), an accurate topographic database is not available for Cierva Point (Danco Coast, Antarctic Peninsula). Therefore, during the 1996/97 summer a topographic survey was conducted using simple field methods. Also, major vegetation types, areas free of vegetation, and the current distribution of snow and ice fields were mapped. A digital elevation model (DEM) with an approximate vertical accuracy between 10 and 20 metres was computed from the topographic information. By combining all information layers a 1 : 7500 scale topographic map with 10 metre contours of the Cierva Point peninsula was created. The digital data could potentially be used as a spatial base layer for a local environmental information system.

STUDY AREA

Cierva Point (64° 10' S, 60° 57' W) is located at the northern end of Hughes Bay on the Danco Coast in the north-west of the Antarctic Peninsula. The Cierva Point peninsula is confined by Cierva Cove in the north and the Gerlache Strait in the west (Figs. 1, 2). The slopes of the peninsula rise up to Pico Escombrera (323 m asl) and, separated by a broad ice-covered saddle, to a flat hill of 540 m asl (Cerro Chato). The south-facing slopes are precipitous and predominantly ice-covered. Only the north-west-facing slopes are ice-free and are characterized by steep gullies, scree slopes, and rock terraces. The ice-free areas are extensively covered by lichens, mosses, and grass-dominated communities. Plant communities, such as the lichen-dominated fjellfield, the *Polytrichum–Chorisodontium* moss turf, and the *Deschampsia–Colobanthus* subformation are abundant. Some moss turf covered areas reach sizes larger than a several hundred square metres. The peat accumulation in these areas reaches up to approximately 80 cm in thickness. This type of habitat found on Cierva Point is essential for the establishment of various bird colonies, including gentoo penguins, chinstrap penguins, blue-eyed shags, brown skuas, snow petrels, Wilson's

¹ Department of Physical Geography, University of Freiburg, Werderring 4, D-79085 Freiburg, Germany; frank.rau@ipg.uni-freiburg.de

² Instituto Antártico Argentino (IAA), Gestión Ambiental, Cerrito 1248, 1010 Buenos Aires, Argentina; <jagraz@dna.gov.ar>

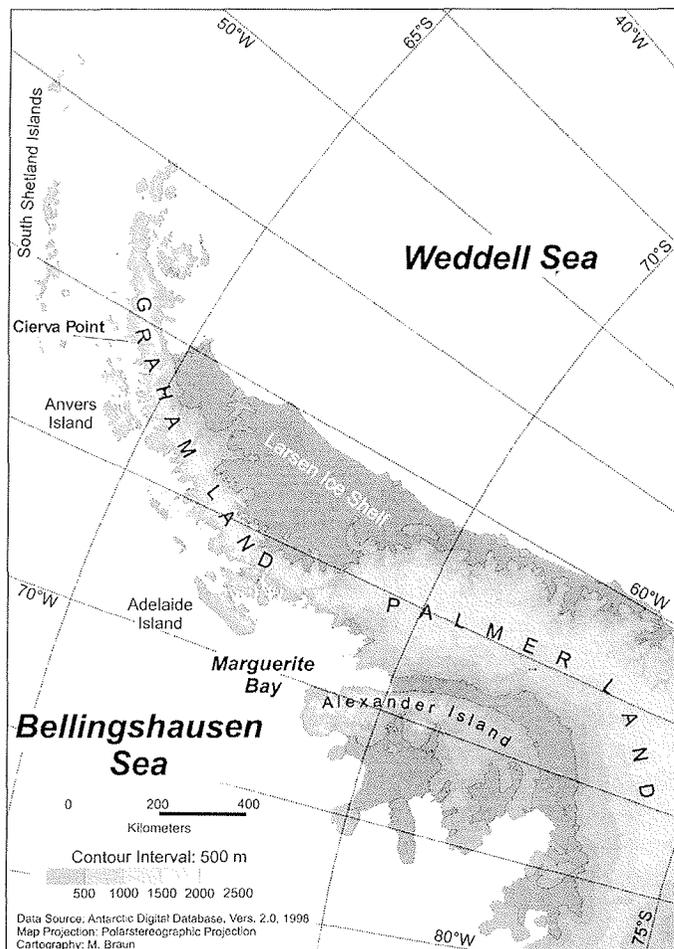


Fig. 1: Location of Cierva Point on the Antarctic Peninsula.

Abb. 1: Lage von Cierva Point auf der Antarktischen Halbinsel.

storm petrels, sheathbills, and kelp gulls (QUINTANA et al. 1997, SCIENTIFIC COMMITTEE ON ANTARCTIC RESEARCH 1998).

Due to the existence of abundant vegetation cover, a diverse flora that includes the two Antarctic flowering plant species (*Deschampsia antarctica* and *Colobanthus quietensis*), mosses, and liverworts, an associated invertebrate fauna, and important bird colonies, the area has an immense scientific value. As a consequence, the Cierva Point Peninsula was designated as SSSI No. 15. It comprises Cierva Point and encompasses the land west of an imaginary line drawn from the north-east of the Cierva Point, across the summit of Cerro Chato, to the south-east of Cierva Point. Also included are the nearby islands. The Primavera Base (Argentina) and all its associated installations and areas of disturbance are excluded from the area of the SSSI No. 15 (Fig. 2, SCIENTIFIC COMMITTEE ON ANTARCTIC RESEARCH 1998).

THE TOPOGRAPHIC MAP "CIERVA POINT"

During the research expedition to Primavera Base in the 1996/1997 austral summer, a topographic survey was conducted in addition to the climatological and snow-hydrological studies. A

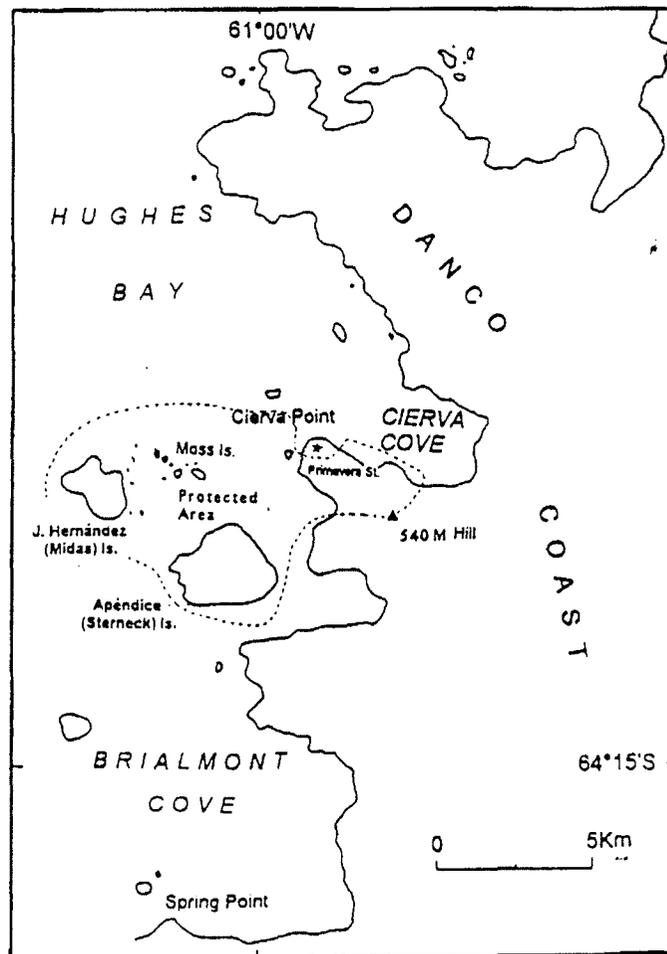


Fig. 2: Location of Cierva Point and adjacent islands in relation to Danco Coast. The dotted line outlines the limits of SSSI No. 15 (SCIENTIFIC COMMITTEE ON ANTARCTIC RESEARCH 1998).

Abb. 2: Lage von Cierva Point im Bereich der Danco Coast. Die gepunktete Linie stellt die Begrenzung des SSSI No. 15 dar (SCIENTIFIC COMMITTEE ON ANTARCTIC RESEARCH 1998).

previously published geological map (LLORENTE et al. 1974) had to be used as reference for the field surveys as large-scale topographic mapping was not available. Elevation data were acquired using barometric precision altimeters. Measurements were repeatedly taken along transects and subsequently compiled into a contour map. After digitizing the contour lines, a DEM was generated using the ARC/INFO TOPOGRID module (Fig. 3). The vertical accuracy of the DEM varies between 10 m in the directly surveyed areas of the peninsula and 15 to 20 m on the steep southern slopes on which the elevation data had to be extrapolated using the ARC/INFO software.

In addition to the elevation data the surface cover was mapped during the 1996/97 field campaign. Hereby, a simple classification scheme was applied. Bare surfaces were subdivided into detritus (predominantly periglacial and glacial deposits) and bare rock (with dominating granodiorites and granophyre, LLORENTE et al. 1974). Snow fields and ice margins were mapped in their current spatial extension on March 1, 1997. Plant-covered areas larger than 100 m² with a coverage of more than 60 % were mapped as vegetation. Subsequently, the vegetation cover was

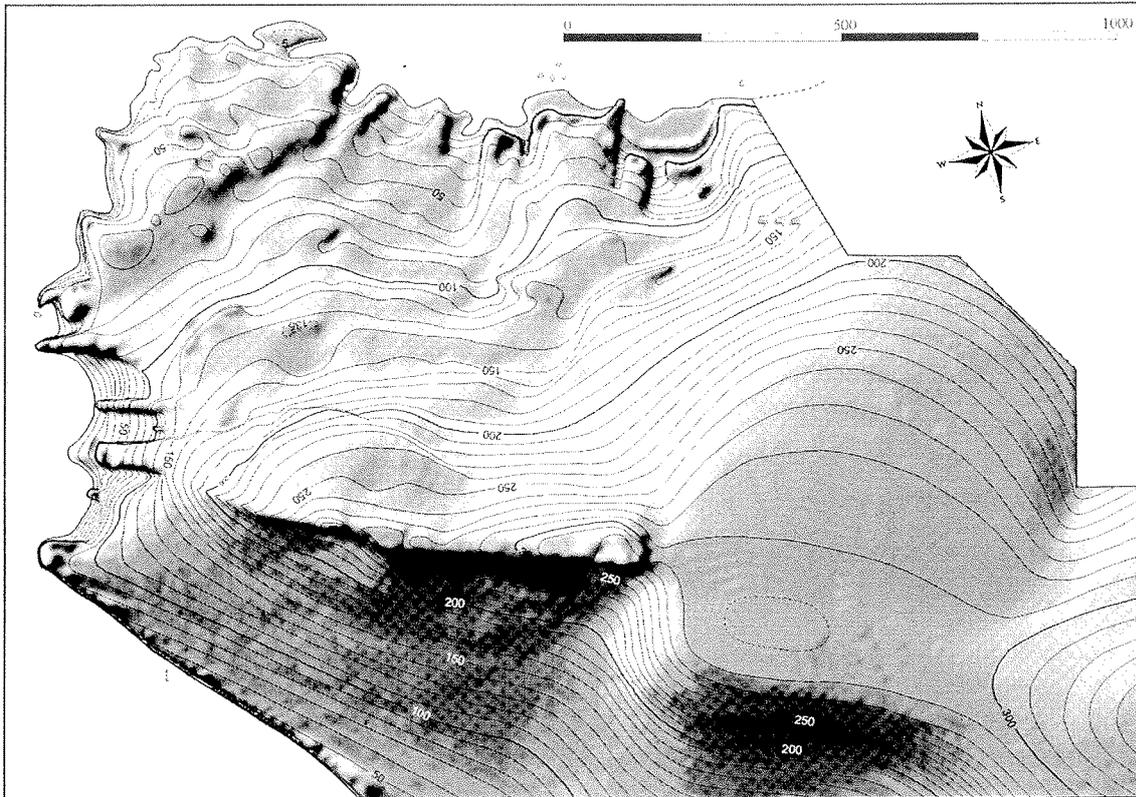


Fig. 3: DEM-derived contour map of Cierva Point underlain by a hillshading illustration.

Abb. 3: Aus dem DEM abgeleitete Höhenlinienkarte von Cierva Point mit unterlagerter Schummerungsdarstellung.

classified into three major mapping units:

- 1) Moss blankets represent the abundant *Polytrichum-Chorisodontium* moss communities (named after *Polytrichum alpestre* and *Chorisodontium aciphyllum*, AGRAZ et al. 1994). These peat-forming communities predominate on well drained, stable rocky surfaces. Typical moss blankets show a hummocky surface, which is frequently inhabited by various lichens and *Deschampsia antarctica*.
- 2) Communities characterized by the mosses *Calliargon austro-sarmentosum* and *Drepanocladus uncinatus* are classified as moss. These communities prevail on humid to wet locations.
- 3) Dry habitats show a dense vegetation cover with predominant *Deschampsia antarctica* and *Colobanthus quietensis*, which form closed grass swards. These stands are classified as grassland.

Due to the widespread distribution of gentoo penguin rookeries, they were classified as an individual mapping unit. In the rookeries, the vegetative cover often is disturbed because of a surplus of nutrients and frequent trampling.

By superimposing all of these data layers in the ARC/INFO GIS, a 1 : 7500 scale topographic map of Cierva Point was created (see supplement map). A 10 m contour interval was chosen for presentation. Where necessary, auxiliary 5 m contours were

generated to facilitate a better visual impression of the topography. In agreement with the extraordinary large scale of the map, a plane metric grid was chosen. The DEM and the mapped surface cover types both serve as base layers for a local information system of Cierva Point. Additional terrain parameters, such as slope, aspect, or watershed boundaries can be easily derived. By integrating additional data layers an excellent database could be established that can be used for monitoring purposes and for environmental management plans.

OUTLOOK

The presented 1 : 7500 scale map of Cierva Point provides a new topographic database of the area and will therefore suit present-day and future scientific and administrative purposes in the vicinity of Primavera Base. Furthermore, it will be a fundamental prerequisite for the administration of the SSSI No. 15 area.

Due to its consistent GIS-based design, the mapping meets the requirements of easy access and user-friendly handling. Additionally, it facilitates a regular updating and therefore a future monitoring of the natural and anthropogenic processes in the Cierva Point area based on the current land cover identified during the 1996/97 field survey. Hence, the data are well-suited for the subsequent development of an environmental information system. The map and the digital data sets with accompanying metadata are available to the user community.

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References

- Agraz, J.L.; Quintana, R.D. & Acero, J.M. (1994): Ecología de los ambientes terrestres en Punta Cierva (Costa de Danco, Península Antártica).- Publ. Instituto Antártico Argentino, 439. IAA, Buenos Aires.
- Benítez, O. & Agraz, J.L. (1997): Efectos del tránsito a pie sobre dos comunidades muscícolas de Punta Cierva (64° 09', 60° 57' W), Antártida.- Cuartas Jornadas sobre Invest. Antárticas. September, 1-5, 1997, 163-169. Buenos Aires.
- Betgen, T. (1998): Wetter und Witterung in Cierva Point (Antarktische Halbinsel) im Südsommer 1996/97.- Unpubl. Thesis, Institut für Physische Geographie (IPG), Universität Freiburg.
- Braun, M., Simões, J.C., Vogt, S., Bremer, U.F., Blindow, N., Pfender, M., Saurer, H., Aquino, F.E. & Ferron, F.A. (submitted): An improved topographic database for King George Island – compilation, application and outlook.- Antarctic Science.
- British Antarctic Survey (1998): Antarctic Digital Database, Version 2.0. Manual and bibliography.- Scientific Committee on Antarctic Research, Cambridge.
- Domack, E.W. & Williams, C.R. (1990): Fine Structure and suspended Sediment Transport in three Antarctic Fjords.- Contr. Antarctic Res. 1, Ant. Res. Ser. 50: 70 - 89. AGU, Washington.
- Godagone, R.E. (1997): Los suelos de Punta Cierva (Costa de Danco), Península Antártica, y su relación con el cambio climático global.- Cuartas Jornadas sobre Investigaciones Antárticas. September, 1-5, 1997, 476-479. Buenos Aires.
- Llorente, R.A., Mendia, J.E. & Spikermann, J.P. (1974): Geología del extremo occidental del Cabo Spring - Costa de Danco Antártida Argentina.- Publ. Instituto Antártico Argentino, 173. IAA, Buenos Aires.
- Mataloni, G., Tesolin, G. & Tell, G. (1998): Characterization of a small eutrophic Antarctic lake (Otero Lake, Cierva Point) on the basis of algal assemblages and water chemistry.- Polar Biology 19: 107-114.
- Quintana, R.D., Agraz, J.L. & Borgo, L. (1994): Refugios de alta biodiversidad en ecosistemas terrestres antárticos y los efectos del desarrollo de actividades humanas.- Grupo de Estudios sobre Ecología Regional (GESER). Departamento de Biología. Universidad de Buenos Aires.
- Quintana, R.D., Cirelli, V. & Orgeira, J.L. (1997): Abundance and spatial disposition of bird populations at Cierva Point, Antarctic Peninsula.- Cuartas Jornadas sobre Investigaciones Antárticas. September, 1-5, 1997, 111-121. Buenos Aires.
- Scientific Committee on Antarctic Research (1998): Management Plan for Site of Special Scientific Interest (SSSI) No. 15, Cierva Point, Danco Coast, Antarctic Peninsula.- SCAR BULLETIN 128, Annex D.