

# Chapter 1



## Introduction to the Antarctic Digital Database

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### History of the Antarctic Digital Database, Version 1.0

An Antarctic topographic database was first mooted in 1984, when the International Geographical Union and the International Cartographic Association considered the development of a *World Digital Database for Environmental Science* (WDDDES). However, the WDDDES programme was subsumed by the Digital Chart of the World (DCW) project, initiated by the US Defense Mapping Agency in 1988. The DCW project relied on source maps at 1:1,000,000 scale. In August 1989 Petroconsultants (CES) Ltd developed a joint project with the Scott Polar Research Institute (SPRI) in Cambridge, UK, to prepare a digital map of Antarctica. This project, based on maps at 1:1,000,000 scale, was a continuation of work begun by SPRI in 1988 for the Antarctic section of WDDDES. Its data capture programme was never completed but the work accomplished was incorporated into a new project, the Antarctic Digital Database Project (ADD).

The ADD was proposed in May 1990 by a Cambridge-based consortium comprising the British Antarctic Survey (BAS), SPRI and the World Conservation Monitoring Centre (WCMC) (now UNEP World Conservation Monitoring Centre). The objective of this new project was to prepare a seamless digital map of the Antarctic from the most appropriate map sources available: time limitations precluded the use of any source data at scales larger than 1:200,000/1:250,000.

International participation in the ADD project was agreed through the Scientific Committee on Antarctic Research (SCAR) and its Working Group on Geodesy and Geographic Information. Thus substantial amounts of data, both in digital form and as hard copy, were provided by various national agencies actively involved in Antarctic mapping programmes. Eleven nations participated in the project and many more supported its aims although they were unable to contribute data at that time.

The ADD was published by SCAR on CD-ROM in 1993, together with the *Antarctic Digital Database User's Guide and Reference Manual*. The manual provided detailed information on the content of the database and a full bibliography of the source material used in the preparation of the ADD Version 1.0. The copyright of the database is held by SCAR.

Although several nations provided digital data to the project, the bulk of the data capture and data management was undertaken in Cambridge. Work on Version 1.0 in the UK was funded initially by BAS and, for a further 18-month period, by The British Petroleum Company p.l.c. (BP). Other contributing nations sponsored their own data capture through either their national mapping agencies or their Antarctic research organizations.

### Preparation of ADD Version 2.0

After completion of Version 1.0, the maintenance and revision of the ADD was passed to BAS by the UK Consortium. This action was endorsed by the SCAR Working Group on Geodesy and Geographic Information (WG-GGI) at its meetings in 1992 (XXII SCAR) and 1994 (XXIII SCAR).

The widespread change from PC to Workstation environment for the majority of GIS applications performed at BAS and elsewhere influenced the evolving plans for a new version of the ADD. The major difference between the first and second version of the ADD is that ADD Version 2.0 was developed and maintained in Workstation ArcInfo. Moreover, in ADD Version 1.0, many tiles had to be subdivided because of limits imposed by using PC ARC/INFO. There were no such subdivisions in ADD Version 2.0. **Users of PC ARC/INFO should note that they will be unable to import some tiles of ADD Version 3.0.**

### **Corrections**

External and BAS users of ADD Version 1.0 discovered many small errors and some omissions from the database. These were reported to BAS and they formed the framework for a BAS programme of revisions and enhancements of the database.

ADD Version 2.0 contained many amendments to the original data. Most corrections were made in Quadrant 4, which covers the Antarctic Peninsula, parts of Ellsworth Land and Coats Land. A few features, such as Doake Ice Rumples and Theron Mountains, were inadvertently omitted from ADD Version 1.0, and they were included in the new version. The contours in Coats Land were substantially upgraded because of the Theron Mountains insertion and data for the Ronne and Filchner ice shelves were also upgraded. A new map of James Ross Island was incorporated, and the positions of ice fronts of the northern Larsen Ice Shelf, Wordie Ice Shelf and Wilkins Ice Shelf were amended using the latest available information. Many other minor changes were made and these are documented in the bibliography (see Chapter 5).

**Contours** - Most of the structural problems in the database were corrected in Version 2.0. However, one general class of reported errors (discontinuous contours) was not corrected because the discontinuity was intentional. The policy adopted for ADD Version 1.0 was that the data derived from the different sources would represent the original source data as closely as possible after edge-matching. Thus, where contour data were extracted from sources with different contour intervals, the original contour discontinuities across the sheet boundaries would be retained. Contour intervals commonly used in the source material are either 100 m or 250 m. Therefore, where a 250 m contour enters a region contoured at 100 m, that contour will end at the sheet margin. Contours are continuous within regions where the source material uses the same contour interval.

### **Preparation of ADD Version 3.0**

The launch of ADD Version 2.0 on the World Wide Web in July 1998 was well received at XXV SCAR and the WG-GGI agreed to continue with the enhancement of the database as part of its programme for 1999/2000. Proceeds from the sale of the CD-ROM, and funding from SCAR, enabled BAS to continue with the maintenance and development of the database during 1999.

Major changes to the database since ADD Version 2.0 are the incorporation of highly precise elevation data over the Antarctic ice sheet, and amendments to the position of the fronts of several large ice shelves. These and other changes are described in the bibliography (Chapter 5). A generalized version of the ADD, at 1:1,000,000 scale, is also available in ADD Version 3.0, and smaller-scale generalization products are planned for the future.

**Contours** - ADD versions 1.0 and 2.0 were derived mainly from map-based data. Because the most detailed Antarctic maps are of coastal and mountainous regions, map-based elevation data

for the interior of the continent were relatively sparse. However, as part of the RADARSAT Antarctic Mapping Project (RAMP), the Byrd Polar Research Center (BPRC) in Ohio, USA, constructed a digital elevation model (DEM) of the whole continent using mainly ERS-1 satellite radar altimeter data, and elevation data taken from ADD Version 1.0 (Liu *et al.*, 1999). Compared with ADD versions 1.0 and 2.0, the DEM provided much higher resolution elevation data for the ice sheet over regions north of 80°S. Thus vector contours derived from the BPRC DEM by BAS have replaced the existing ADD contours in all parts of Antarctica except in coastal areas and regions of high relief.

### **Acknowledgements**

Without the generous contributions of data made by several nations, ADD Version 1.0 (on CDROM) would never have been completed within the given time-frame. Due acknowledgement of the organizations and ADD project personnel that contributed to the CD-ROM product, including Petroconsultants SA of Geneva and Environmental Systems Research Institute, Inc. of California, was given in the *Antarctic Digital Database User's Guide and Reference Manual*, published with the CD by SCAR in 1993. Appendix 1 lists the people involved in the production of ADD versions 1.0, 2.0 and 3.0. It also identifies all the organizations that have contributed to, and collaborated in, the ADD project since its inception, known as the ADD Consortium.

Careful documentation prepared by the Byrd Polar Research Center, Ohio, USA, provided a checklist of errors found in ADD Version 1.0. This was particularly helpful in planning the revisions of the database for release as ADD Version 2.0. The DEM prepared by BPRC for RAMP provided a fundamental framework for the revisions leading to the release of ADD Version 3.0.

Funding by SCAR in 1999, which allowed the continuation of effort at BAS and the release of ADD Version 3.0 on the World Wide Web in 2000, is gratefully acknowledged.

### **Using the database**

The ADD is a topographic database compiled from a variety of Antarctic map and satellite image sources. ADD Version 1.0 provided the international Antarctic community with a common geographic framework for a range of research applications and logistic support activities. For example, it formed the definitive geographical setting for international projects such as the RADARSAT Antarctic Mapping Project (RAMP) and Antarctic Bedrock Mapping Project (BEDMAP).

Applications of ADD Version 3.0 include:

- Generating maps for use as insets or location maps.
- Creating customized maps for particular purposes.
- As the geographic layer in a GIS.
- Creating digital elevation models and perspective views (when used in conjunction with appropriate software).
- As a data source for ice sheet models.

The database is provided as ArcInfo export files. These can be used with a wide variety of software, and data translation utilities are available. The ADD has been maintained using the ArcInfo LIBRARIAN subsystem with workstation ArcInfo, and the data are best suited for use with ArcInfo, ArcView and ArcExplorer. ArcExplorer is a free viewing utility which can be downloaded from ESRI's web-site (<http://www.esri.com>). Software to translate the data from

ArcInfo export format to either ARC coverages or shape-files will be required to use the data with ArcExplorer.

### Accessing the database

The ADD Version 3.0 web-site provides a mechanism for downloading data from selected tiles, by clicking the required tile on a map. For each tile selected, an encrypted compressed archive of ASCII ArcInfo export files will be downloaded. On MIME-compliant browsers, the name of the compressed archive file will be set to *filename.zip*, where *filename* is the IMW sheet name (e.g. SP19\_20.zip).

### Database design

The design of the database for ADD Version 1.0 was influenced by factors such as: limits on the number of features and the complexity of topology imposed by PC ARC/INFO, the cartographic nature of the data supplied, a requirement to provide simple access to the data, and existing standards for Antarctic mapping applied to the source material. Although the limitations of PC ARC/INFO are no longer relevant for users of the UNIX version of the database (ADD Version 3.0), the general design features adopted for Version 1.0 have been retained in Version 3.0. These are as follows:

- i. The Scale0 data (data at the scale of the source material) are tiled on the International Map of the World (IMW) 1:1,000,000 scale map sheet boundaries; these provide a fixed tiling system which corresponds to the sheet boundaries of many published maps.
- ii. The attribute tables are not normalized so as to allow access to the data using simple GIS programs such as ArcExplorer.
- iii. Arc and point features have been assigned codes according to the *Standard symbols for use on maps of the Antarctic* (SCAR, 1980).
- iv. The map projection is Polar Stereographic, with a standard parallel at 71°S. The spheroid is WGS84. These options correspond to approved SCAR recommendations.

### Units of measure

The metric system is used in the ADD for all units of length, elevation and area. Geographical coordinates are given as decimal degrees. The ArcInfo software-generated items AREA and LENGTH are expressed in metres<sup>2</sup> and metres.

### Standards

Standards in GIS are not yet at a stage where data provided can be transferred between systems transparently. The Open GIS consortium is working towards this goal, through the TC211 subcommittee of the International Standards Organization. Although the TC211 proposals are not yet widely implemented in commercial software, most major GIS suppliers have made commitments to support the Open GIS standards for inter-operability.

The ADD Version 3.0 is not compliant with the current TC211 proposals. The data are provided in ArcInfo Export format, which can be imported into many systems. However, it is acknowledged that the use of a proprietary data format is not satisfactory. It is hoped that future versions of the ADD will be made compliant to Open GIS data exchange standards when the software used to manage the data provides the necessary capabilities.

It is difficult to find appropriate data quality standards. Most standards (e.g. NJUG 13, [USGS DLG http://edcwww.cr.usgs.gov/glis/hyper/guide/2mil](http://edcwww.cr.usgs.gov/glis/hyper/guide/2mil)) are oriented towards digitizing maps of known accuracy in a terrain which is dominated by human features. Therefore, the ADD Project adopted its own standards for accuracy of digitizing and for feature coding (see Appendix 2); these are generally more stringent than commercial standards for digitizing.

## **Links to relevant web sites**

A number of datasets that can be used in conjunction with the Antarctic Digital Database can be accessed via the World Wide Web. These, together with organizations connected with polar research, are given below.

### **Scientific Committee on Antarctic Research (SCAR)**

SCAR (<http://www.scar.org>) is the committee of the International Council for Science (ICSU) charged with the initiation, promotion and co-ordination of scientific activity in the Antarctic. Its members include nations with active and independent research programmes in the Antarctic, and ICSU unions.

### **SCAR Working Group on Geodesy and Geographic Information**

The surveying and mapping activities of SCAR are co-ordinated by the Working Group on Geodesy and Geographic Information (<http://www.scar-ggi.org.au>). Formed in 1958 as the Working Group on Geodesy and Cartography, it changed its name in 1988 to reflect the increasing importance of digital geographic information in Antarctic scientific research.

### **SCAR Composite Gazetteer of Antarctica**

An hierarchical gazetteer of Antarctic place-names, based on a number of national Antarctic gazetteers, was developed especially for ADD Version 1.0 (see Chapter 5 of the *Antarctic Digital Database User's Guide and Reference Manual*, 1993). However, since 1992, a comprehensive SCAR *Composite Gazetteer of Antarctica* (CGA) has been prepared by the SCAR Working Group on Geodesy and Geographic Information, under the supervision of its Italian member. Because the SCAR CGA is accessible on the World Wide Web, no place-names dataset is included in ADD Version 3.0. The address of the SCAR CGA web site is: [http://www.pnra.it/SCAR\\_GAZE](http://www.pnra.it/SCAR_GAZE). The web site is updated quarterly on 1 January, 1 April, etc.

The CGA is a comprehensive alphabetical list of 32,955 approved names for 16,563 Antarctic geographical features; 21,552 names in the list are different. The CGA was collated from 20 national gazetteers of Antarctica and one international agency. It includes the geographical coordinates of the features and a three-letter code identifying the national supplier of the name. Synonyms for a given feature can be easily identified.

The geographical coverage of the CGA lies south of latitude 60°S, which coincides with the geographical extent of the ADD. The hierarchical names database developed for ADD Version 1.0 does not form part of the CGA but it has been expanded for use in the British Antarctic Survey's Meta Data Management System (MDMS). This new hierarchy, which uses an early version of the CGA database of names, can be viewed at: <http://www.antarctica.ac.uk/mdms/cgi-bin/gazetteer.pl>.

The BAS MDMS gazetteer merges the ADD hierarchy with the CGA. The product is a comprehensive compendium of Antarctic place-names that is structured to show the relationship

between smaller geographical features and larger ones. Thus the larger entity of which a name is a part can be traced, and also the smaller features that are included within it can be identified.

**Caution** - Place-names listed in the national gazetteers are located by a single point, defined by geographical co-ordinates. If the feature is extensive (e.g. a land or a coast) it is described by reference to other named features. However, digital gazetteers require all entries to be as coordinate data rather than text. Although the geographical extent of large features such as mountain ranges, large islands and plateaux cannot be reflected meaningfully in a simple pair of coordinates, they are represented in the CGA by the co-ordinates of their nominal centre. Different nations have chosen different nominal centres for some features, giving rise to variations in the co-ordinates applied to the same features (see Annex H of the CGA). Because the co-ordinates of names in the CGA have not been derived directly from the map sources used for the compilation of the ADD, the co-ordinates listed in the CGA may not match the geographical co-ordinates of the feature seen on screen views of maps derived from the ADD Version 3.0.

### **Atlas of Antarctic Research**

An on-line atlas of Antarctica has been developed by the US Geological Survey (USGS). The atlas is based on the Antarctic Digital Database Version 1.0, and it incorporates large-scale maps and digital raster graphics (DRGs) of 1:250,000 scale Antarctic maps published by the USGS. The web site is: [http://usarc.usgs.gov/antarctic\\_atlas](http://usarc.usgs.gov/antarctic_atlas).

### **List of Protected Areas in Antarctica**

The different types of protected areas designated in Antarctica are listed in the UK Foreign & Commonwealth Office's publication *List of Protected Areas of Antarctica*, published in 1997. This publication, which also shows the geographical distribution of the protected areas on maps of the continent, can be accessed from either the ADD pages or via the World Wide Web at: <http://www.nerc-bas.ac.uk/public/magic/protected-area>.

### **UK consortium for ADD Version 1.0**

Three Cambridge-based institutes, referred to as the UK consortium, collaborated in the preparation of ADD Version 1.0. Links to their web sites are given below.

**British Antarctic Survey** (<http://www.antarctica.ac.uk>) has been responsible for the British Government's scientific research in the Antarctic since 1962. The survey originated as a wartime naval operation in 1943 and it transferred to the control of the Colonial Office in 1945, when it was known as the Falkland Islands Dependencies Survey. In 1967 BAS became a component body of the Natural Environment Research Council and, since 1984, it has been the national Antarctic mapping agency for the UK.

**Scott Polar Research Institute** (<http://www.spri.cam.ac.uk>) is part of the Geography Department of the University of Cambridge. It is involved in research in Antarctica and the Arctic and maintains the world's leading polar library and archive. It was founded in 1920 as the national memorial to Captain R.F. Scott.

**UNEP World Conservation Monitoring Centre** (formerly World Conservation Monitoring Centre) (<http://www.unep-wcmc.org/>) provides information for policy and action to conserve the living world. The Centre's work, from an office in Cambridge, is an integral part of the United Nations Environment Programme (UNEP), which has its headquarters in Nairobi, Kenya. The

work of UNEP-WCMC is closely linked to the UNEP Programme on Environmental Information, Assessment and Early Warning.

## **RAMP**

The RADARSAT Antarctic Mapping Project (RAMP) achieved the first complete synoptic image coverage of Antarctica within a period of a few weeks during September/October 1997 (Jezek, 1998). A digital elevation model (DEM) of Antarctica was constructed for the project by the Byrd Polar Research Center (BPRC), based mainly on ERS-1 satellite radar altimeter data, and elevation data taken from ADD Version 1.0. The DEM was used to ortho-rectify the Antarctic SAR imagery, enabling a seamless mosaic of the imagery to be prepared (see <http://www-bprc.mps.ohio-state.edu/>).

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