SANAP Digital Geological Database

April 2006

Introduction

Over the past decades, researchers working under the auspices of the South African National Antarctic Program have acquired a considerable volume of geological data from that region of Antarctica that surrounds SANAE IV. This data, which is in the form mainly of ungeoreferenced hard-copy geological maps and geochemical and geochronological data, resides in various scattered archives and university libraries.

In spite of some recent attempts, the derivation of a regional stratigraphy for Western Dronning Maud Land has been elusive. This, it must be assumed, has been in part due to the relative inaccessibility of the data, and more importantly, because of the lack of spatial referencing.

This project involved the compilation of a digital, spatially referenced database (GIS) of geological information resulting from past South African expeditions to Antarctica. It was designed to allow for the international exchange of data on Antarctica as recommended by the consultative parties of the Antarctic Treaty and represents a significant step towards South Africa's fulfilment of it's obligation under resolution 4 (1998) on Antarctic Data Management, recalling the Commitment of Parties under Article III (1)(c) of the Antarctic Treaty.

Objective

The objectives of this project were:

- to compile a GIS-compatible database and to produce geological maps for the Ahlmannryggen, Borgmassivet, H.U.Sverdrupfjella, Kirwanveggen, and Gjelsvikfjella in Western Dronning Maud Land, Antarctica (Figure 3).
- to deliver the database in a format that is usable in the process of future research, and that can be linked with databases from other Antarctic research institutions.
- to attempt to establishing a coherent stratigraphic and tectonic scheme for the entire area.

Accomplishments

The project objectives have been met to the extent that:

- the geology of every rock exposure (nunatak) within the area of interest has been digitised and included in the database, and a set of maps has been produced in both hard-copy and pdf format.
- the maps and the database, which has been compiled in an industry standard (ESRI shapefile and tabular) format has been delivered to the SANAP offices in Cape Town.
- in the process of development of the database, certain advances have been made with regard to the evolution of a unified stratigraphic scheme for the region. There remains scope for detailed analysis, and this is discussed below, in the section on future work opportunities.

Database description and compilation notes

Data Sources

Apart from the research data that forms the fundamental content of the database, the following data sets, which are included in the database, were used either for topographic reference or as cartographic backdrops:

- RAMP RadarSat 125m resolution SAR Mosaic
- RAMP Version 2 200m resolution DEM for contour generation
- MODIS Mosaic of Antarctica (MOA) image map
- ADD vector topographic database for Antarctica
- Chief Directorate - Surveys and Mapping: Kirwanveggen 1:50 000 topographic map series (2001)
- Norsk Polarinstitutt 1:250 000 scale topographic map series

Data formats

The database, which has been written to DVD for distribution, was developed primarily with the use of ESRI ArcView 9.1 software. The following industry-standard data formats have been used:

- **Vector data:** ESRI shape-files with associated attribute tables and projection files
- **Raster data** (map scans and other imagery)**:** GeoTiff or ArcView "bil"
- **Ancillary tables:** ASCII comma delimited (csv)

Datum and projection

Because of the regional extent of the project, and so as to maintain consistency with existing databases such as the SCAR ADD and continental remote sensing data sets such as the RAMP mosaic, the standard Antarctic Polar Stereographic projection has been used throughout:

Projection parameters:
Antarctic Polar Stereographic
Standard parallel: -71°
Central Meridian: 0°
False Easting: 0m
False Northing: 0m

Datum and Spheroid:
WGS 1984

Semi major Axis:	6378137.000
Semi minor Axis:	6356752.314
Inverse Flattening:	298.25722

A note on georeferencing

This is an issue fraught with the vagaries of differing survey methods and historical changes in geodetic models. A variety of map data was used as base georeferencing information. This included the 1:250 000 Norsk Polarinstitutt maps – which were used for the compilation of the ADD database in the region – and the recently published South African (Surveys and Land Information) 1:50 000 Kirwanveggen map series.

After executing appropriate spheroid and datum transforms, it was noted that the South African and Norwegian maps in particular, disagree in lateral positioning by as

much as 600m in places. It has been assumed that this is possibly due to the lack of precise GPS survey methods or datum tie points at the time when the Norwegian maps were made. A geodesist may have a more appropriate explanation, but it has been assumed that the South African maps are the more “accurate” ones.

The data presented in this database has been georeferenced according to the best available base maps for every given locality. Where reliable spot survey data was available, such as GPS sample locations, this has been used to improve on the positional accuracy of the mapped data.

Naming convention

All place names used are in accordance with the *SCAR Place-name Gazetteer*.

Further to the comment above on georeferencing, it should be noted that the place localities as published in this Gazetteer are in most cases extremely unreliable and inaccurate. The fundamental source of this error is in the rounding of coordinates, in some cases, to the nearest degree. This is mentioned in the light of a suggestion that this gazetted data might be used for logistical, or worse, search-and-rescue operations.

A point shape-file containing these gazetted names has been included in the database, and has been cleaned and adjusted within the region of interest. This shape-file is the layer that should be used in place name queries in the GIS.

GIS development and contents

While it has been anticipated that the primary end user of the database shall be a geological researcher with knowledge of the use of such a GIS, the data is nonetheless generally accessible:

Primary Vector layers:

Lithology layer

Using the best available topographic material as a reference, the geological maps that have been generated through years of research work, were extracted from their various sources, scanned, warped, georeferenced and digitised. The resultant polygon shape-file represents the basis of the geological database, and its associated attribute table contains information pertaining to the identification of each rock exposure.

Samples layer

This is a point shape-file that represents a combination of sample points digitised from the geological maps and where available, data imported from tables (tables that included location data). The attributes associated with this layer include primarily the sample identification number. This field (sample number) can be used to “relate” (table relate in ArcView layer properties) the samples shape-file to a more comprehensive table of geochemical and geochronological data.

Structure (faults and fabric)

Structural data digitised from the geological maps has been compiled into separate shape-files depending on their type (polyline or point).

Topographic data

Topographic data includes the ADD coast and outcrop layer. Also included is a contours layer that was generated from the RAMP 200m DEM.

Also included is a shape-file containing the database of SANAP GPS waypoints that have been used over the years for navigation in the field.

Primary Raster Layers

Maps and images

The base maps, which have been mosaiced where appropriate, and remote sensing data listed above have been included in the database with associated ArcView layer files. The layer files allow for quick application of certain properties such as the combination of multiple raster layers with transparency, etc.

Geophysics

Also included as a raster layer, is the total-field magnetic image that was generated as a combination of Russian and South African airborne surveys.

Tables

The database contains a “sample_relate” table, which can be viewed independently of the GIS, or related to the samples point vector layer by way of the “sample” field, which is common to both the shape-file and the comma-delimited table.

Although the database is intended for use within a fully functional GIS package, included on the CD is a directory containing a few freeware packages. None of these packages is fully capable of displaying all of the data simultaneously, but they do at least offer those that do not have access to more serious software, some means of viewing and manipulating the data.

An example of the sort of map that can be produced very quickly from the GIS, is shown in Figure 1 below:

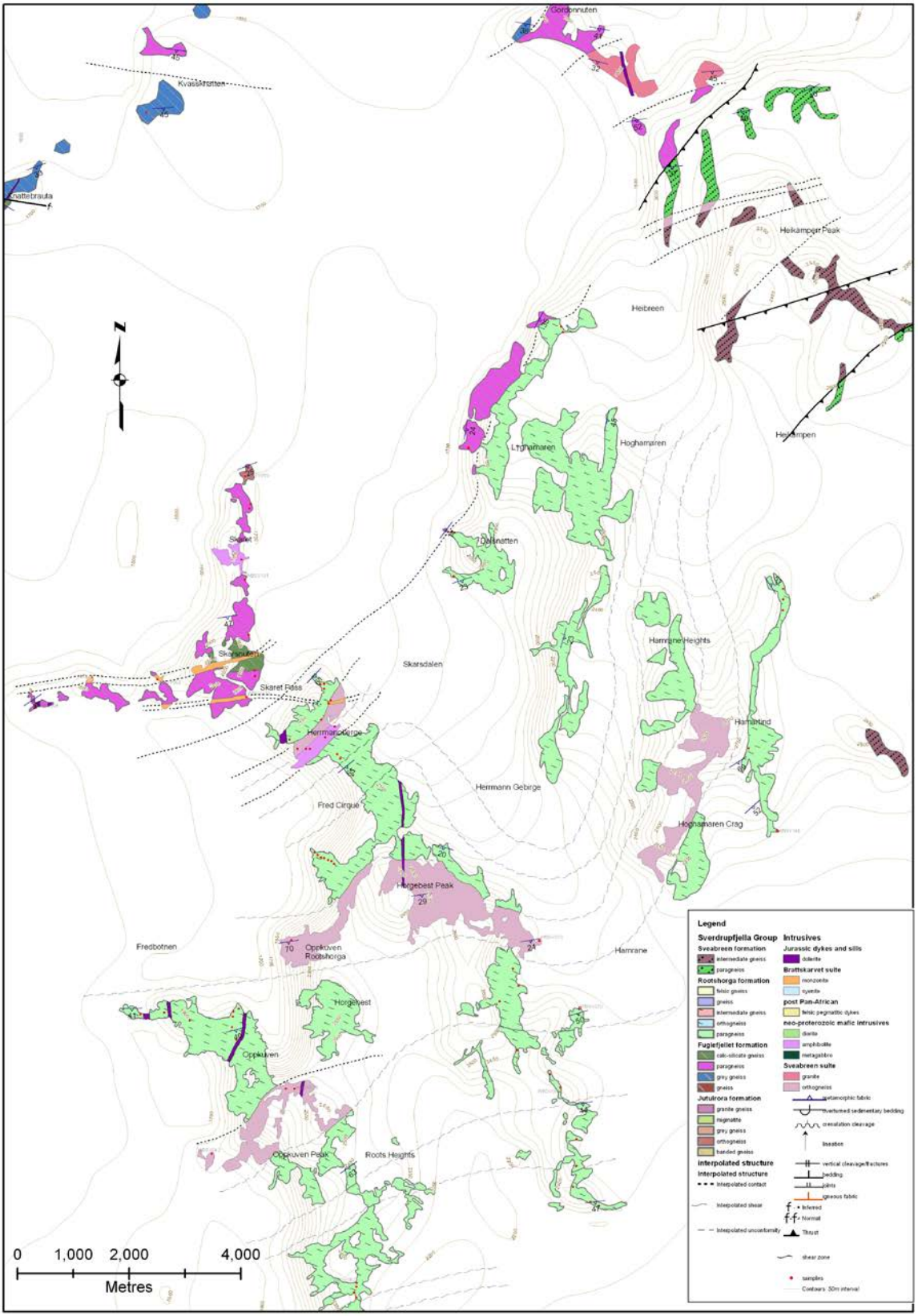

Figure 1: An example of a map product from the GIS

Deliverables

The database

The database is presented on a DVD with the following directory structure:

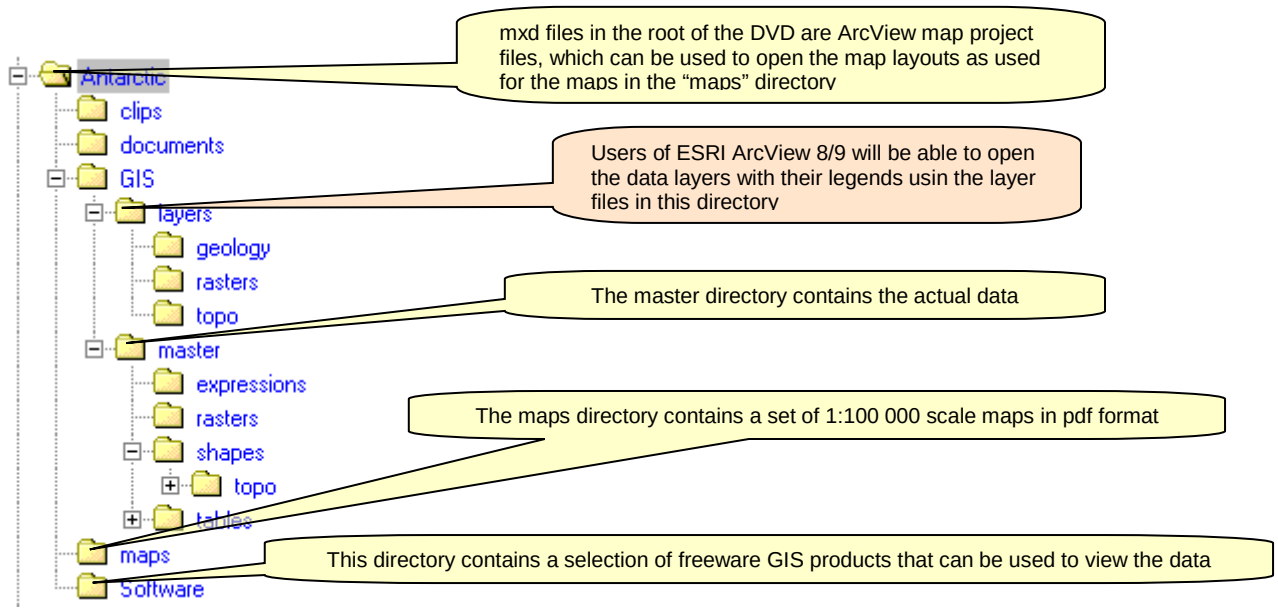

Table 1: DVD directory structure

The root of the DVD contains multiple mxd files, which are ArcView map layout files. These can be used (in ArcView) to reconstitute the printed maps, the pdfs of which, are to be found in the "maps" directory.

Apart from the mxd project files, there are ArcView layer files, which represent predefined symbology and legends for the various data layers. These can be found in the "layers" directory. Like the mxd files, these can only be used by users of ArcView.

Users of GIS software other than ESRIs ArcView will be able to access the data via the "master" directory, which contains the actual data in industry standard formats.

Maps

A series of 1:100 000 sale geological maps have been produced on a composite radar/MODIS background. Hard copies of these, which can be printed directly from the pdf files, form part of the delivered product. The areas that they cover are indicated in Figure 2 below:

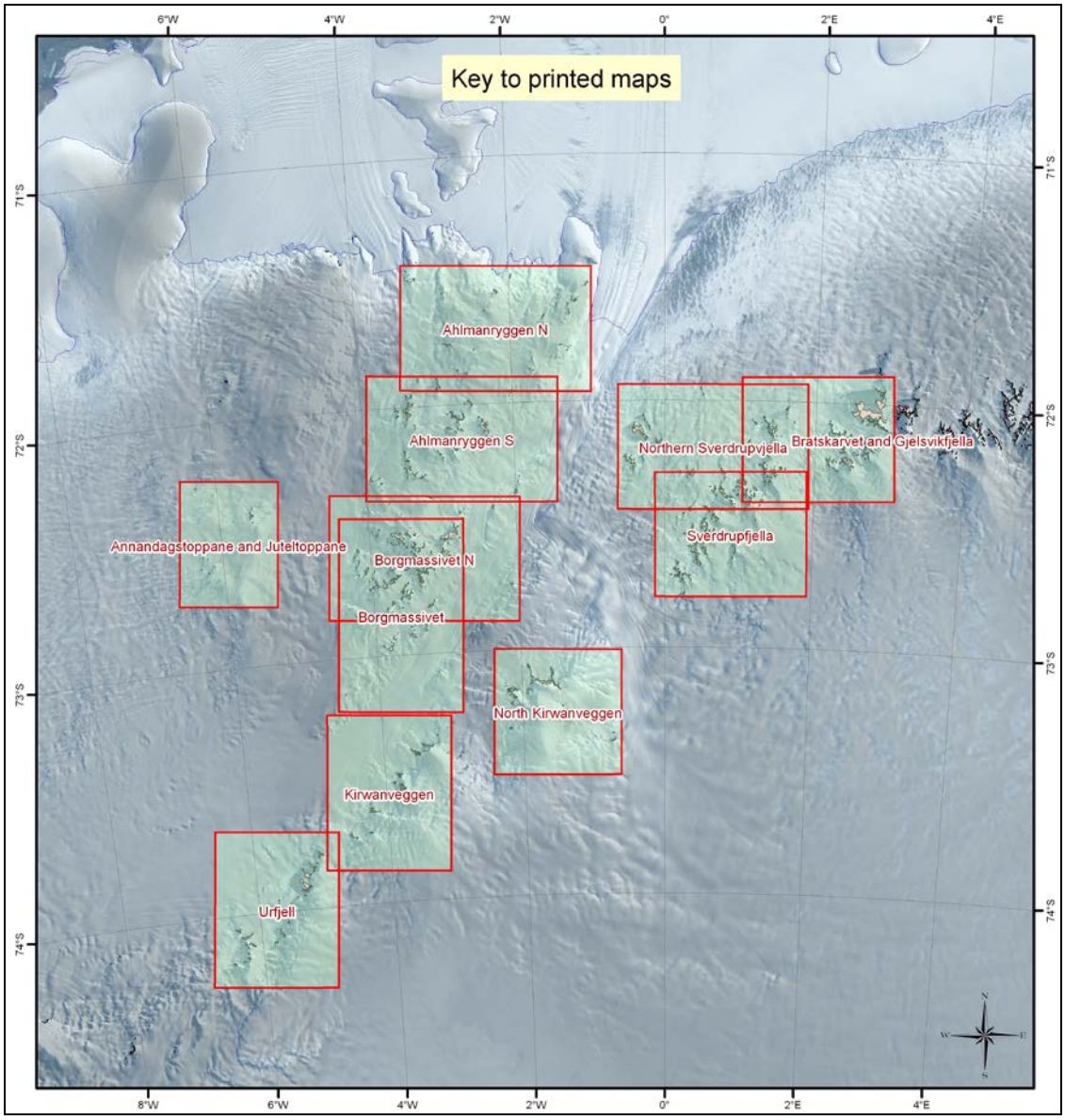

Figure 2 Key to printed and pdf 1:100 000 scale maps

Future work possibilities

Stratigraphic unification

None of the researchers, whose work is included in the GIS, has achieved a unified stratigraphy for the region. While an attempt has been made *– without undue assumptions* – for the purposes of the development of this GIS, this process has yet to be finalised. In order to achieve this fully, there is scope for further academic work that will entail in-depth analysis of the literature in conjunction with this GIS

Geological Interpolation

This GIS should form the basis of an interpolation of geological stratigraphy, not only between nunataks in the immediate Dronning Maud Land region, but possibly also in a Gondwana-wide context.