DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2001/58

AEM Greenland 1994–1998 – summary report

Thorkild M. Rasmussen, Leif Thorning, Robert W. Stemp,
Mette Svane Jørgensen and Frands Schjøth

(1 CD-ROM included)

GEOLOGICAL SURVEY OF DENMARK AND GREENLAND
MINISTRY OF ENVIRONMENT AND ENERGY

G E U S

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GEUS

Contents

Abstract

The CD-ROM released with this report provides an overview of high-resolution geophysical data from a five year combined airborne electromagnetic and magnetic survey programme referred to as project ‘AEM Greenland 1994–1998’. The Government of Greenland financed the project as an integral part of the efforts aimed at the stimulation of mineral exploration in Greenland.

Geophysical data from six survey areas covering regions of high potential for mineralisations is presented. They are Inglefield Land in North-West Greenland, the Maniitsoq-Nuuk region in southern West Greenland, the Grønnedal region in South-West Greenland, Jameson Land in central East Greenland, Washington Land and Daugaard-Jensen Land in western North Greenland and J. C. Christensen Land in eastern North Greenland.

Electromagnetic (GEOTEM, multi-coil frequency domain and VLF) data and magnetic total field data is available from all surveyed areas. Radiometric data is also available from the Grønnedal region.

The data in this presentation is provided as maps in Oasis Montaj® ‘map’-format and as georeferenced images in ‘tif’-format (GeoTiff). The resolution of the images is 100 m. The Oasis Montaj Free Interface® software for viewing the images is provided with the CD-ROM. A document included in ‘html’-format on the CD-ROM provides a fast overview of the project.

Original data and printed maps on which the images are based are available at cost from GEUS.

Introduction

In 1994, the Government of Greenland was seeking ways to take the initiative to stimulate mineral exploration in Greenland. Erik O. Andersen, Head of the Minerals Office in Nuuk, the Greenlandic Government's former administration office for mineral resources (now the Bureau of Minerals and Petroleum, BMP), proposed a 5-year programme of airborne electromagnetic and magnetic surveying. The survey areas were to be chosen on the basis of potential for the discovery of economic mineral deposits. Funding for this 5-year programme was unanimously approved in the Greenlandic legislature.

Management of the airborne programme was contracted out to GEUS (then GGU). Over the course of the programme, high-resolution combined airborne electromagnetic and magnetic surveys were carried out in six areas of high mineral resource potential.

In addition to the short-term objective of stimulating mineral exploration, the objective of the AEM programme, together with a subsequent complementary programme of magnetic only surveys, was to provide a lasting data base of high quality geophysical data that could provide a new dimension to the understanding of the geology of Greenland.

The complementary programme of magnetic only surveys is described in Rasmussen & van Gool (2000) and references therein.

The six areas surveyed in the AEM Greenland 1994—1998 project are shown in Figure 1. They are Inglefield Land in North-West Greenland, the Maniitsoq-Nuuk region in southern West Greenland, the Grønnedal region in South-West Greenland, Jameson Land in central East Greenland, Washington Land and Daugaard-Jensen Land in western North Greenland and J. C. Christensen Land in eastern North Greenland. The survey in the Grønnedal region also included radiometric measurements. Additional reconnaissance lines were measured adjacent to some of the main survey areas. In total, 75 000 line-km covering an area of 23 305 km^2 were measured in the project.

This report and the enclosed CD-ROM present an overview of data collected in the project. The main purpose of this report and CD-ROM release is to provide the mining industry and geoscientists with easy access to information on data from the project. The information on the CD-ROM is presented as georeferenced images in ‘tif’-format with 100 m resolution of interpolated data from the survey areas. The CD-ROM does not provide the raw data but the included images are sufficiently detailed for the purpose of qualitative interpretations. A complete collection of raw data would require at least an order of magnitude in the number of CD-ROMs to hold the data. Topographic base maps are included on the CD-ROM.

The images provided on the accompanying CD-ROM can be viewed with the enclosed Oasis Montaj Free Interface® software from Geosoft Inc., which can be installed on a personal computer in a Windows® environment (details on software and hardware requirements follow below). Furthermore, a number of Geographic Information System (GIS) packages can be used for the visualisation of the data. A document in ‘html’-format is included on the CD-ROM. The document in ‘html’-format serves as a quick introduction to the data from the

project and includes most of the images with the above mentioned high-resolution. However, this document does not allow visualisation of the data with the same functionality as provided in the Oasis Montaj Free Interface® software.

Separate reports have been published for each of the surveys by GEUS to accompany the release of data from the project. These reports, in addition to a detailed presentation of the survey parameters and data, include a summary of the geology in the survey areas. References to these reports are included in the subsequent sections. Furthermore, technical reports are provided with each data set. A Ph.D. project reported in Poulsen (2000) on processing and interpretation of data from the AEM Greenland 1994—1998 has been finalised.

A number of ground follow-up studies have been conducted after the completion of the geophysical surveys. Some of these have been carried out by GEUS and others have been carried out by prospecting companies. The results from the studies carried out by GEUS are publicly available. Availability of results from the activities of the prospecting companies follows the rules for field work and reporting regarding mineral resources, which could imply that the information in some cases is still confidential.

Only the main geological features are mentioned in this report. Henriksen *et al.* (2001) provides an updated overview of the geology of Greenland and a comprehensive list of literature references.

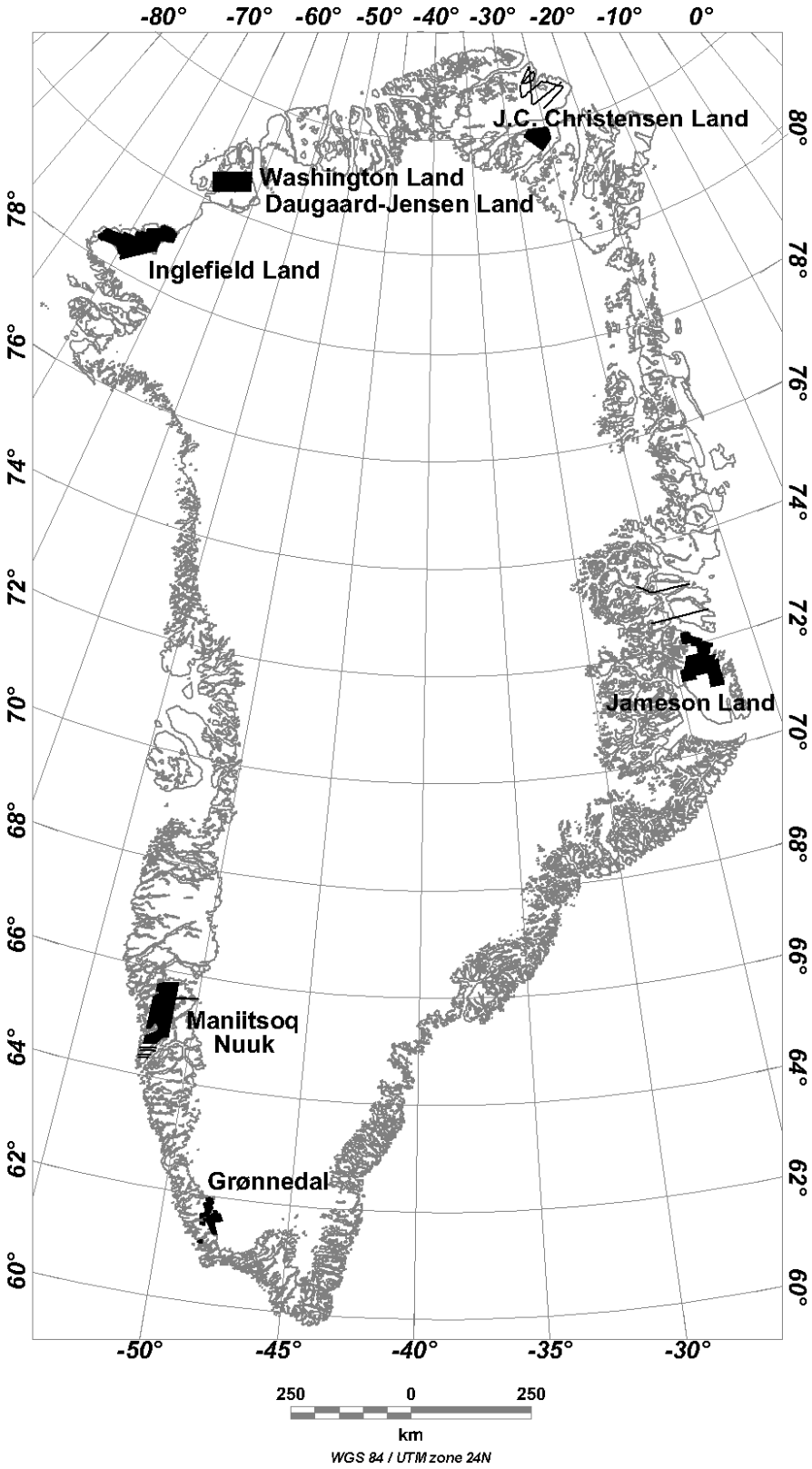

Figure 1. *Map of Greenland with locations of the surveyed areas marked in black shading. The black lines show the location of reconnaissance flights adjacent to the main survey areas. (Topographic base: G/2.5M Vector, Copyright KMS/GEUS 1997).*

Project AEM Greenland 1994–1998

Project AEM Greenland 1994–1998 was financed by the Government of Greenland with, in 1995, participation of industry (Cominco). The Geological Survey (GGU, from 1995 GEUS) has been responsible for the project design, administration, interpretation and distribution of the data. Commercial geophysical companies carried out the measurements and the initial data processing. The selection of geophysical companies were made through a European Union Open Tender Procedure for each of the five years.

The project was designed for the benefit of industry. Thus, at the start all holders of prospecting and exploration licenses in Greenland were contacted to solicit views on possible target areas for the five-year period. The selection of areas was primarily governed by the knowledge of mineral occurrences in the areas but guided to some extent by a wish to cover different types of geological settings. In addition to the government-financed surveys, several companies undertook surveys of a similar type, in some cases in adjacent areas to the government-organised activities. The company activities were facilitated by an option in the contract between the Survey and the geophysical contractor whereby the mobilisation costs to and from Greenland could be discarded for the prospecting company.

A combined GEOTEM and aeromagnetic survey was flown by Geoterrex Ltd., Ottawa, Canada, in Inglefield Land, North-West Greenland (see Figure 1) in 1994 and in the Maniitsoq – Nuuk region, southern West Greenland in 1995.

Aerodat Inc., Mississauga, Canada was awarded the contract for helicopter-borne combined multi-frequency electromagnetic (EM), Very Low Frequency (VLF) electromagnetic, magnetic and radiometric measurements in five surveys block in the Grønnedal region in southern West Greenland. The five blocks are: Sermiligaarsuk North, Midternæs, Grænseland, Sioralik South and Arsuk Ø.

The survey in Jameson Land, central East Greenland 1997 was carried out as a combined GEOTEM and aeromagnetic by Geoterrex-Dighem Ltd.

Two areas were covered in 1998: Washington Land and Daugaard-Jensen Land in western North Greenland and J. C. Christensen Land in eastern North Greenland. Both surveys were flown by Geoterrex-Dighem Ltd. as combined GEOTEM and aeromagnetic surveys.

Digital data archives and printed maps have been produced for each of the survey areas. These products are listed in appendices A–F, and can be purchased from GEUS.

Content and technical use of the CD-ROM

General information and directory structure

The directory tree-structure of the CD-ROM is displayed in Figure 2. The files on the CD-ROM are distributed in two directories found in the root directory named '/'. The two directories are named 'AEM Greenland 1994 - 1998', which contains specific data and information from the project, and 'OasisMontajFreeInterface', which contains files for the Oasis Montaj Free Interface® software.

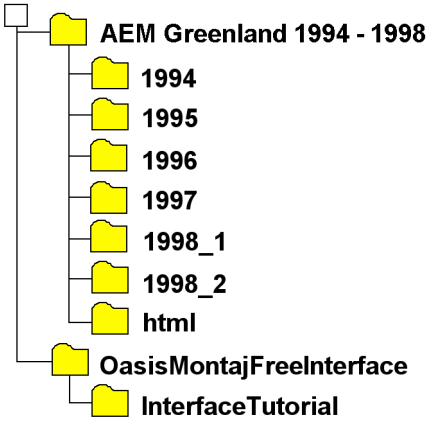

Figure2. *Directory structure of the CD-ROM with data and information from the AEM Greenland 1994–1998 project.*

The directory 'AEM Greenland 1994 - 1998' is divided further into seven sub-directories, which contain the data and maps in Oasis Montaj® 'map'-format from each survey area and a directory 'html' with project description in 'html'-format. The six data-directories are named according to the year when the survey was carried out (1998_1 is used for Washington Land and Daugaard Jensen Land and 1998_2 is used for the survey in J. C. Christensen Land).

All maps are packed in accordance to the Oasis Montaj® utility for transferring data together with the maps. The images on the original maps have been read from geo-referenced 'tif'-files (GeoTiff). These tif-files are included on the CD-ROM and can also be read in other GIS software packages. However, if the data used in the Oasis Montaj® maps is restored into files by using the 'Map | Unpack map files'-utility in Oasis Montaj®, the geo-referenced 'tif'-files are converted into the georeferenced Oasis Montaj® 'grd'-format. The 'grd'-format is the default binary format used by Oasis Montaj® for storing interpolated and gridded data. Except for the extension '.tif', the geo-referenced files in 'tif'-format have the same names as the corresponding 'map'-files. No requirements of unpacking maps are needed for the display of the maps.

The directory called ‘html’ contains files, which can be used together with a standard html-browser software for a quick overview of data from the project.

The html-document

The file named ‘AEM.htm’ on the ‘AEM Greenland 1994 – 1998’ directory serves as the introductory node for all information in the html-directory. By opening this file, access is obtained into information on all the surveys of the AEM Greenland 1994–1998 project. The ‘Internet Explorer’ software or other html-browser software can open the ‘AEM.htm’ file. Clicking the mouse-button twice on the file-icon opens the file, provided that files with the extension ‘.htm’ are associated with the appropriate software. In the case of the introductory page not opening immediately when clicking the mouse, the file can be opened by starting Internet Explorer® (or similar software) and then from the ‘file’-menu use the ‘open file‘-menu and browser utility.

The introductory page includes a map of Greenland where the survey areas are displayed. Clicking on the outlined areas or the associated text opens a file with information about the specific survey.

The ‘html’-documents contain images of the available data. However, it must be emphasised that the most appropriate method for viewing the images is to use the Oasis Montaj Free Interface® or other software with similar functionality.

Software and hardware requirements for Oasis Montaj Free Interface®

In order to install and run Oasis Montaj Free Interface®, the following software and hardware is required:

- Windows NT® 4.0, Windows 95, or 98 required (NT is recommended)
- A Pentium CPU
- RAM memory: 32 Mb or more recommended, 16 Mb minimum
- A 16 or 24-bit graphics card is recommended and required for full colour imaging
- VGA resolution minimum. 8-bit (256 colour) devices are also supported.
- Any Windows® supported colour printer
- In order to use the Internet capabilities in Oasis Montaj®, you will need to install Internet Explorer 5.0® or later versions. This does not mean that you have to have Internet Explorer® as your default browser; Oasis Montaj® just uses the Internet connection technology supplied in Internet Explorer 5.0® to connect to the web

Installing the Oasis Montaj Free Interface®

In the directory 'OasisMontajFreeInterface' there are two files with extension .exe: one file is called 'Interface.exe' and the other file is called 'OASISmontaj.exe'. If you are not familiar with the Oasis Montaj® software from Geosoft Inc. you can double-click on the file 'Interface.exe' and get an on-screen demonstration of the Oasis Montaj Free Interface® software. To install the free interface, double-click on the self-extracting file 'OASISmontaj.exe' (currently version 5.06) by using Windows Explorer® or go to 'Start | Run'. Then follow the install-wizard instructions. Updated versions of Oasis Montaj® software are located on the homepage of Geosoft Inc. http://www.geosoft.com/

Oasis Montaj Free Interface® can only be installed on your local drives. It is not recommended to install this on any network drive. It is recommended that Oasis Montaj® is installed off a root directory and not off the 'Program Files'-directory or directories with space characters in the name.

Using Oasis Montaj Free Interface®

Before opening any of the supplied maps on the CD-ROM with the Oasis Montaj Free Interface® software, a *workspace* is required. For the purpose of displaying the information on the CD-ROM, the workspace file can be interpreted as a container that holds all the maps plus information that tells the software about the state in which it was left the last time you used it. The workspace is stored in files with extension '.gws'. More information about workspaces, as well as information on other subjects, can be found by clicking the 'help'-button when the Oasis Montaj® window is opened.

It is recommended, but not required, that separate workspace files should be created for each of the surveys. Furthermore, it is recommended to place the workspace files in separate directories. A workspace is created by clicking the 'File | Open Workspace …'-button in the Oasis Montaj® window followed by entering a workspace (file) name within an appropriate directory. New directories can also be created from the menu. Note that it is not possible to create any directories or files on the drive containing the CD-ROM. A directory and file structure similar to the one displayed in Figure 2 is recommended.

When creating a new workspace, a message may appear that the software is unable to load some menus due to unavailable licence information. This message can be disregarded. Information about the specific workspace that has been created can be entered by clicking the 'Workspace comments…'-button in the 'file'-menu and typing a description in the file opened by the editing software. The name of the file is '_gws_comments.rtf'. The Oasis Montaj® software returns to its idle mode when the editing software is closed.

It is possible to read the maps directly from the CD-ROM into the Oasis Montaj® window. This is done by using the 'Map | Open Map …'-menu and selecting one of the enclosed maps at a time. All maps can be displayed simultaneously in the same workspace. Although the maps can be read directly from the CD-ROM, the user may find it convenient to copy all maps of a particular survey from the CD-ROM into the directory containing the cor-

responding workspace. The main reason for transferring the data is that the Oasis Montaj® software will display messages that the map is write protected when read directly from the CD-ROM.

The reader is referred to the on-line 'Help'-utility in Oasis Montaj® for obtaining information on specific functions provided with the software. The most commonly used functions are likely to be the zoom-function (see Figure 3) in combination with the dynamic linking utility (shadow cursors icon). This allows the user to display multiple maps simultaneously and visualise the same anomaly-location for different data types (i.e. using magnetics, electro-magnetics and topographic base maps together). Clicking the shadow cursors icon in the Oasis Montaj® window activates the dynamic linking when the maps are opened. When the 'All maps'-icon is activated, application of the zoom-utility in one map will be mirrored in all other opened maps.

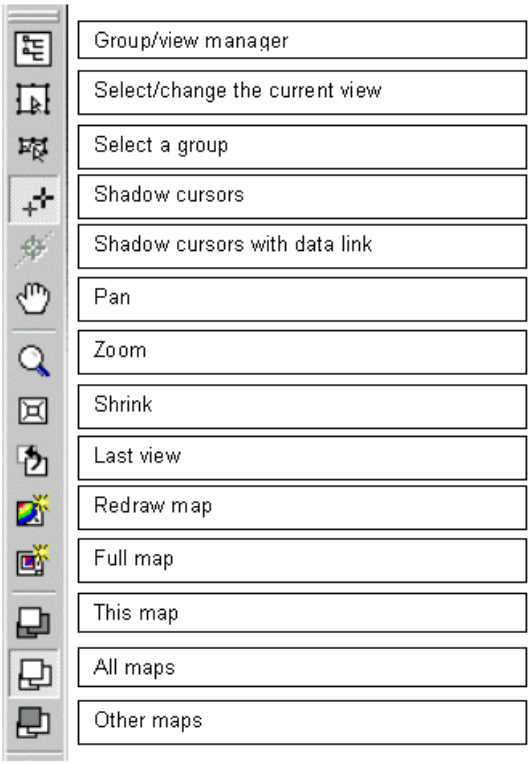

***Figure 3**. The push-buttons used to control the appearance of maps in the Oasis Montaj® window. Information on the use of the push-buttons can be found in the Oasis Montaj® help-documents in the sections 'Map viewing tools' and 'Mode selection tools'.*

It is recommended to use the 'File | Close workspace'-menu before exiting the Oasis Montaj® software.

Topographic information and map projections

Topographic information on the survey areas is found on the maps including the geophysical data and on separate topographic base maps. The topographic base maps include a detailed description of topographic features as line drawings. In order to avoid the hiding of geophysical features by the line drawings and text the topographic information on the geophysical maps has been reduced to a subset of the full information. However, the full information about the topographic base maps can be utilised together with the maps of the geophysical data by using the dynamic data link function in Oasis Montaj®, when these maps are opened simultaneously. The cursor movements and zoom function in the active map can be mirrored on all other maps opened in the same workspace. The information on the geophysical maps includes coastlines and ice-cover. The additional information on the base maps is lakes, rivers, islands in lakes, nunataks and some location names.

Except for Jameson Land, the topographic information is based on the G250 Vektor digital topographic map in scale 1:250 000, produced jointly by the National Survey and Cadastre/ Kort og Matrikelstyrelsen (KMS) and GEUS in a project financed by the Bureau of Minerals and Petroleum (BMP, Mineral Office 1997). The vectorised map data is based on the printed maps as published by KMS but is fitted to new geodetic control points, or where possible on new photogrammetric maps in scale 1:100 000. The topographic information in Jameson Land is based on photogrammetric maps in scale 1:100 000 produced at GEUS.

The projection parameters for the maps are referred to the WGS84 ellipsoid and datum level in the standard Universal Transverse Mercator (UTM) projection adopted by KMS for the specific regions:

- Inglefield Land : WGS84/UTM-zone 20N
- Maniitsoq-Nuuk region: WGS84/UTM-zone 22N
- Grønnedal region: WGS84/UTM-zone 23N
- Jameson Land: WGS84/UTM-zone 26N
- Washington Land and Daugaard-Jensen Land: WGS84/UTM-zone 20N
- J. C. Christensen Land: WGS84/UTM-zone 27N

The maps in Oasis Montaj® format have been produced in scales suitable for printing on A4 size paper. Resizing can be made in Oasis Montaj® whenever this is required.

It is emphasised that the copyright to the G250 Vektor belongs to KMS and restrictions apply on the use and distribution of this data. In short, the digital topographic information must only be used in conjunction with the data on the enclosed CD-ROM and must not be copied and distributed in any way for other purposes. For further information, see the cover of the CD-ROM.

The topographic information on the Oasis Montaj® maps is supplied as digital information in ArcView® shapefiles. The information is distributed in a number of layers as listed in Table

1. In Oasis Montaj®, the information on the topographic base maps can be imported into the maps of the geophysical data whenever this is required.

The naming convention for the ArcView® shapefiles, with # denoting the survey year for the specific area, is listed in Table 1.

Table 1. *Filenames in ArcView® shapefile-format with topographic information on the base maps. The lines showing the coast and ice-cover are in light grey colour on the geophysical maps.*

Feature	**Filename**	**Colour**
coast	AEM#_coast	black
nunatak	AEM#_nunatak	cyan
ice	AEM#_ice	orange
lake	AEM#_lake	dark blue
island in lake	AEM#_island_lake	green
river	AEM#_river	light blue

Survey descriptions

Inglefield Land – AEM Greenland 1994

Survey specifications

The survey in Inglefield Land, North-West Greenland was flown from 6th July to 27th August, 1994. Geoterrex Ltd did the data acquisition and processing. The survey includes measurements of controlled source time-domain electromagnetic data (GEOTEM) and measurements of the Earth magnetic total field. Figure 4 shows a schematic presentation of the GEOTEM system setup.

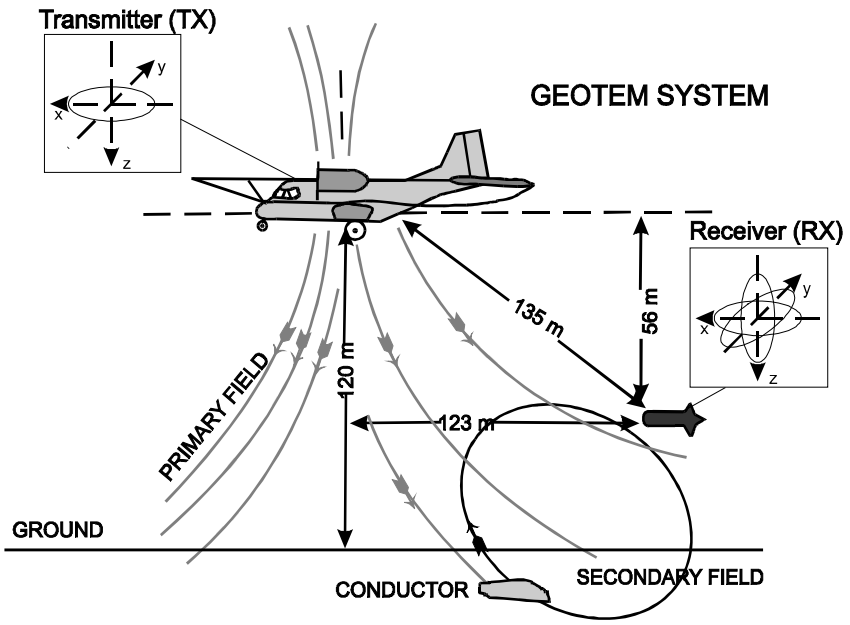

***Figure 4**. Schematic view of the GEOTEM transmitter and receiver configuration. The number of receiver coils vary between the surveys in the AEM Greenland 1994–1998 project. The transmitter loop is attached to the wings, tail and nose of the aircraft. The magnetic total field is measured in a second bird (not shown) towed behind the aircraft.*

The main flight lines are oriented north-south and spaced at 400 m intervals with a set of orthogonal tie-lines at 4000 m intervals. A total of 17 365 line km were flown.

Nominal flight altitude is 120 m over terrain with the total field magnetic sensor and the electromagnetic sensor 75 m and 70 m above ground, respectively. The size of the survey area is 6493 km^2.

The parameters of the GEOTEM system are listed below:

Base frequency:	150 Hz
Pulse width:	1042 µs
Pulse delay:	104 µs
Off-time:	2188 µs
Transmitter moment:	500 000 Am^2
Receiver component:	Horizontal component along flight direction
Number of time gates:	12

Gate centre time from end of pulse:

Channel 1:	403 µs	Channel 7:	1340 µs
Channel 2:	560 µs	Channel 8:	1496 µs
Channel 3:	716 µs	Channel 9:	1653 µs
Channel 4:	872 µs	Channel 10:	1810 µs
Channel 5:	1028 µs	Channel 11:	1966 µs
Channel 6:	1184 µs	Channel 12:	2122 µs

Detailed information on the equipment and processing can be found in a report by Geoterrex Ltd. (1994). The geophysical data are analysed in Stemp & Thorning (1995), Schjøth *et al.* (1996), Schjøth & Thorning (1998) and Poulsen (2000).

Geology

Crystalline Proterozoic basement rocks are found throughout Inglefield Land and are overlain in the coastal region by a Mesoproterozoic (Thule Basin) and Lower Palaeozoic (Franklinian Basin) cover. Mapping of the areas has occurred in several reconnaissance programs and during a major study in 1999 (Dawes *et al*., 2000). An interpretation in terms of a single lithotectonic terrane in Inglefield Land was presented by Dawes *et al.* (2000).

The Precambrian basement rocks can be divided into two main groups: supracrustal rocks and associated gneisses (Etah Group) that are intruded on all scales by an igneous suite (Etah meta-igneous complex). The basement rocks have been subjected to several phases of deformation and metamorphism. Both complexes show wide lithological diversity and they have been metamorphosed under high amphibolite and granulite facies.

The Etah Group is composed of marble, calc-silicate rocks, pelitic schists and gneisses and psammitic rocks. The metasediments are found in coherent linear belts in the south-western part of Inglefield Land and as highly-deformed supracrustal belts in the north-eastern part of Inglefield Land.

The Etah meta-igneous complex is composed of intermediate to felsic meta-igneous rocks and subordinate metagabbros and magnetite-rich rocks.

The Mesoproterozoic Thule Group overlies the peneplaned crystalline shield and consists of clastic strata with basaltic sills.

Cambrian siliciclastic rocks and carbonates of the Franklinian Basin overlie the strata of the Thule Basin in the south-western part of Inglefield Land and are found directly on top of the crystalline basement in the northern part of the survey area.

A review of geoscientific exploration and geology in the Kane Basin region of Greenland, central Nares Strait is presented by Dawes (1999). Sulphide mineralisations are widespread in central and north-eastern Inglefield Land, and form impressive rust zones several kilometres in length. The rust-zones are formed by oxidation of sulphides, typically hosted by siliceous grey gneisses. Graphite is common in the gneisses. Reports on mineralisations include mainly gold, copper and zinc. Two additional references to those cited in Dawes (1999) are Thomassen *et al.* (2000a, 2000b), where gold indications are reported as a result of a ground follow-up study on the geophysical survey and on the geochemical anomalies reported in Steenfelt & Dam (1996). The gold is located along a 70 km long belt coinciding with a pronounced aeromagnetic anomaly in north-eastern Inglefield Land.

A result of the airborne geophysical survey was the discovery of more than 100 circular structures called 'Minturn rings'. Numerous dark-coloured circular structures, 50–250 m wide were detected from the inspection of the video-tape recordings of the ground passing below the aircraft. Without the possibility of an immediate ground check, an interpretation in terms of kimberlite pipes could not be excluded. However, the ground follow-up study in 1995 revealed a surficial origin of the structures (Appel 1996). This type of structures had not been known before.

Maps and digital data archive

A complete list of printed map products and digital data can be found in appendix A. The enclosed CD-ROM contains the following maps in Oasis Montaj® format with filenames listed in parenthesis:

- EM decay constant (tau.map)
- EM X-coil channel 2 amplitude (ampl_X2_dh.map)
- Broadband apparent conductivity (app_cond_dh.map)
- Magnetic total field anomaly (tmi.map)
- Calculated vertical gradient of magnetic total field anomaly (vg.map)
- Topographic base map (topographic base map.map)

The three maps of EM parameters are based on interpolated data corrected for system asymmetry (de-herringboned).

Maniitsoq-Nuuk region – AEM Greenland 1995

Survey specifications

The survey in the Maniitsoq-Nuuk area of southern West Greenland was flown from 15th July to 12th September, 1995. Geoterrex Ltd. did the acquisition and processing. The survey includes electromagnetic (GEOTEM) and magnetic total field measurements. Reconnaissance lines were flown south and east of the main area (se Figure 1).

Nominal flight line spacing was 400 m with 200 m spacing in the central part of the survey area. Control lines were correspondingly spaced at four km and two km intervals. A total of 20 446 line km were flown. Nominal flight altitude was 120 m over terrain with the total field magnetic sensor and the electromagnetic sensor 73 m and 64 m above ground, respectively. The size of the survey area is 5235 km^2.

The parameters of the GEOTEM system are listed below:

Base frequency:	150 Hz
Pulse width:	1042 µs
Pulse delay:	104 µs
Off-time:	2187 µs
Transmitter moment:	500 000 Am^2
Receiver component:	Horizontal component along flight direction (X-coil) and vertical direction (Z-coil)
Number of time gates:	20

Gate centre time from end of pulse:

Channel 1:	404 µs	Channel 11:	1967 µs
Channel 2:	560 µs	Channel 12:	2123 µs
Channel 3:	717 µs	Channel 13:	287 µs
Channel 4:	873 µs	Channel 14:	209 µs
Channel 5:	1029 µs	Channel 15:	131 µs
Channel 6:	1185 µs	Channel 16:	53 µs
Channel 7:	1342 µs	Channel 17:	-26 µs
Channel 8:	1498 µs	Channel 18:	-78 µs
Channel 9:	1654 µs	Channel 19:	-494 µs
Channel 10:	1810 µs	Channel 20:	-911 µs

Detailed information on the equipment and processing can be found in a report by Geoterrex Ltd. (1996). The data is presented and discussed in Stemp (1996a, 1996b).

Geology

The Nuuk-Maniitsoq region is underlain by an Archaean high-grade grey gneiss–amphibolite complex. A geological map at 1:500 000 scale (Allaart 1982; Kalsbeek & Garde 1989; GEUS 1998) covers the survey area, and three maps at 1:100 000 scale covers the

southern part (Garde 1987, 1988, 1989). Garde (1997) has given a comprehensive account on the geological evolution of the southern region. The orthogneisses were formed in the period c. 3200 to 3000 Ma and are dioritic, tonalitic to granodioritic in composition. They are interpreted to have been formed by magmatic accretion, probably in convergent plate-tectonic environments. Supracrustal rocks are dominated by amphibolites of assumed volcanic origin, but also comprise ultrabasic to ultramafic and minor pelitic rocks. The supracrustal packages, possibly of oceanic origin, are strongly deformed together with the gneiss units. Large parts of the area has been subjected to granulite facies metamorphism, but retrogression have taken place both at regional and local scale (see Garde 1997, p. 76, for the distribution of metamorphic facies in the southern part of the survey area).

Locations of terrane boundaries are discussed in Friend & Nutman (1994) and Garde *et al*. (2000). The survey area is situated in the northern part of the Akia terrane. A northern boundary of the Akia terrane has not yet been identified but tentative interpretations based on isotope work of Friend & Nutman (1994) and Garde *et al*. (2000) suggest that it is located south-east of Maniitsoq approximately along the northern boundary of the survey area. A correlation with the Saglek block in Labrador is discusssed in Friend & Nutman (1994).

A number of gabbro/norite bodies form an irregular belt in the area between Fiskefjord and Søndre Isortoq. The noritic rocks are homogenous with a composition of plagioclase and hyperstene with variable proportions of hornblende and biotite and with local concentrations of sulphide.

Commercial exploration, including drilling, has been generally confined to the central norite belt, which also includes a large carbonatite complex as well as some kimberlite dykes. The diamond potential of the Archean craton of West Greenland has been established for many years. Kimberlite dykes and float have been reported from many localities (Larsen, 1991) and both micro- and macrodiamonds have been reported by prospecting companies.

A regional compilation of geoscience data from the Nuuk-Maniitsoq area is available in Steenfelt *et al*. (1990).

Maps and digital data archive

A complete list of printed map products and digital data can be found in appendix B. The enclosed CD-ROM contains the following maps in Oasis Montaj® format with filenames listed in parenthesis:

- Total Energy Envelope of GEOTEM channel 1 (energy.map)
- Apparent conductivity calculated from the Z-coil channel 20 (app_cond_dh.map)
- Magnetic total field anomaly (tmi.map)
- Calculated vertical gradient of magnetic total field anomaly (vg.map)
- Topographic base map (topographic base map.map)

The two maps of EM parameters are based on interpolated data corrected for system asymmetry (de-herringboned).

Grønnedal region – AEM Greenland 1996

Survey specifications

A helicopter-borne geophysical survey system was used in the Grønnedal region, South-West Greenland from 30th May to 22th October, 1996. The geophysical system included a multi-frequency and multi-coil controlled source EM system, a magnetometer for measuring the magnetic total field, a VLF-EM sensor and a system for radiometric measurements. Aerodat Inc. did the data acquisition and processing. An ASTAR (AS-350B2) helicopter owned and operated by Greenlandair A/S served as the platform for the geophysical system.

The multi-frequency EM system shown in Figure 5 is housed in a lower bird at a mean survey terrain clearance of 30 m. The upper bird is flown at 45 m terrain clearance and houses both the magnetometer and VLF sensors. An Exploranium GR820 – 256 channel gamma ray spectrometer (16.8 litre NaI crystal) installed in the helicopter was used for radiometric measurements.

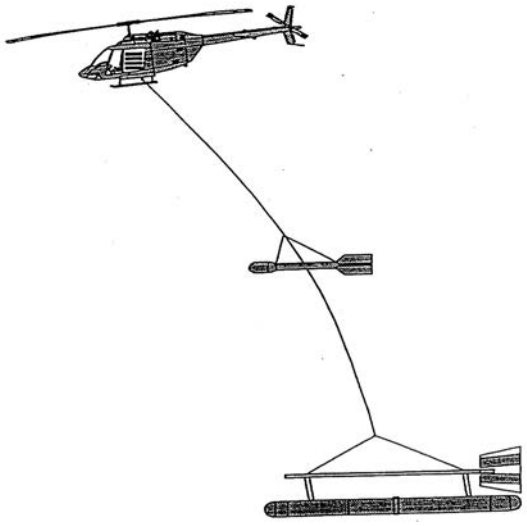

Figure 5. *Schematic illustation of the geophysical measuring system used in the 1996 survey. The multi-frequency electromagnetic transmitter and receiver loops are found in the lower bird, which during measurements are carried at a height of 30 m above the ground. Distances of 6.40 m and 4.96 m between the receiver and transmitter loops are used. The upper bird contains the instrumentation for the VLF and magnetic total field measurements.*

Five frequencies were used in the EM system that included both vertical co-axial and horizontal co-planar transmitter-receiver loops. The co-axial system used frequencies of 920 Hz and 4600 Hz and the co-planar system used frequencies of 515 Hz (or 860 Hz), 4200 Hz and 33 000 Hz. About 10 % of area 1 (Sermiligaarsuk North) had to be measured with three frequencies due to operational problems. Twice the complete bird assembly was released from the cargo hook of the helicopter. Bird damage (repairable) occurred on a third occasion during an emergency landing as a result of failure to the helicopter.

VLF-anomaly signals from the Rugby transmitter (GBR) at 16.0 kHz and the Cutler transmitter (NNA) at 24.0 kHz were recorded. The data are presented as the ratio in percentagebetween the magnitudes of the vertical and horizontal components of the measured field (tipper function).

The survey was flown at a mean helicopter terrain clearance of 60 m with survey lines spaced at 200 m and orthogonal tie-lines at 2000 m. A total of 8756 line-km of geophysical data were acquired over five separate survey blocks as listed in Table 2.

Table 2. *Line directions and numbers of line-km for each of the five survey blocks in the Grønnedal region.*

Survey	Name	Line direction	Line kilometres
1	Sermiligaarsuk North	150º	3540 km
2	Midternæs	150º	2950 km
3	Grænseland	90º	1515 km
4	Sioralik South	90º	463 km
5	Arsuk Ø	0º	288 km

The total size of the surveyed area is 1560 km^2.

Additional information on survey specifications and data compilation procedures is available in a report by Aerodat Inc. (1997). The data are presented and discussed in Stemp (1997).

Geology

The survey areas are situated in the southernmost part of the Archaean craton of southern West Greenland. To the south the craton is flanked by the Palaeoproterozoic Ketilidian orogen. The Archaean is tectonically disturbed by the orogen and display an increasing degree of Proterozoic deformation towards the boundary. A description of the data and the mineral potential in the area (which is the most complete publication to data) is found in two publications from GEUS: A CD-ROM by Schjøth *et al.* (2000) with accompanying report (which is the most complete publication today) documents the available digital data. The CD-ROM includes both old and newly digitised data. The data are reviewed in relation to the mineral resource potential in Steenfelt *et al.* (2000).

The 1:500 000 scale geological map (Allaart, 1975) and map description (Kalsbeek *et al.,* 1990) give a good introduction to the geology. More detailed descriptions are found in Higgins (1990) for the area north of latitude 61°30'N and Berthelsen & Henriksen (1975) for the area south of latitude 61°30'N.

The Archaean is dominated by 2.7 to 2.9 Ga old gneisses, but contains the older Tartoq Group supracrustals consisting of mafic to ultramafic metavolcanic units with subordinate felsic metavolcanic or metasedimentary rocks. The Tartoq supracrustals are intruded by a granitoid dated at *c.* 2.944 Ga. The Archean basement is unconformably overlain by Ketilidian supracrustal rocks and is intruded by Ketilidian dolerite dykes and granites. The supracrustal rocks comprise a lower unit of shales and greyvackes with subordinate quartzite, conglomerate and carbonate rocks and an upper unit of predominantly basic lavas intruded by basic sills and sheets. The supracrustal rocks are almost unmetamorphosed at Midternæs, while the metamorphic grade increases to amphibolite facies in southern Grænseland and Arsuk Ø.

The Ketilidian domain is divided into four zones (Allaart 1976; Chadwick & Garde 1996). They are from north to south: (1) the Border Zone, where Palaeoproterozoic supracrustals are overlain the Archaean basement, (2) the Batholith Zone in which granites were intruded from 1850 to 1790 Ma; (3) the Psammite Zone and (4) the Pelite Zone. Arsuk Ø is entirely within the Border Zone whereas the Midternæs and Grænseland Blocks also cover part of the Archaean craton.

In Mesoproterozoic times (Gardar period, 1.3 to 1.1 Ga) the boundary region between the Archean and Ketilidian terrains was subjected to rifting and intrusions of numerous dykes of basaltic to trachytic compositions as well as of felsic alkaline complexes including carbonatites.

Maps and digital archive

A complete list of printed map products and digital data can be found in appendix C. The enclosed CD-ROM contains the following maps in Oasis Montaj® format with filenames listed in parenthesis:

- apparent resistivity based on the 4200 Hz vertical coplanar system (res.map)
- VLF-EM tipper data (vlf.map)
- Magnetic total field anomaly (tmi.map)
- Calculated vertical gradient of magnetic total field anomaly (vg.map)
- Total count radiometric (tc.map)
- Potassium count (k.map)
- Uranium count (u.map)
- Thorium count (th.map)

Jameson Land – AEM Greenland 1997

Survey specifications

The survey area covers Northern Jameson Land (including eastern Scoresby Land), central East Greenland and was flown by Geoterrex-Dighem Ltd during the period from 7th July to 24th August, 1997. The survey includes electromagnetic (GEOTEM) and magnetic total field measurements. Reconnaissance lines were flown over Traill Ø north of the main area (se Figure 1).

The survey lines were oriented east-west at 400 m intervals with north-south directed tie-lines spaced at four km intervals. Nominal flight altitude was 120 m over terrain with the total field magnetic sensor and electromagnetic sensor 75 m and 70 m above ground, respectively. The size of the survey area is 5194 km^2.

The parameters of the GEOTEM system are listed below:

Base frequency:	150 Hz
Pulse width:	1042 µs
Pulse delay:	104 µs
Off-time:	2187 µs
Transmitter moment:	500 000 Am^2
Receiver component:	Horizontal components along flight direction (X-coil) and orthogonal to flight direction (Y-coil) and vertical direction (Z-coil)
Number of time gates:	20

Gate centre time from end of pulse:

Channel 1:	403 µs	Channel 11:	1966 µs
Channel 2:	560 µs	Channel 12:	2122 µs
Channel 3:	716 µs	Channel 13:	273 µs
Channel 4:	872 µs	Channel 14:	169 µs
Channel 5:	1028 µs	Channel 15:	78 µs
Channel 6:	1185 µs	Channel 16:	-78 µs
Channel 7:	1341 µs	Channel 17:	-287 µs
Channel 8:	1497 µs	Channel 18:	-495 µs
Channel 9:	1654 µs	Channel 19:	-703 µs
Channel 10:	1810 µs	Channel 20:	-912 µs

Detailed information on the equipment and processing can be found in Geoterrex-Dighem Ltd. (1997a,b). Results from the survey are presented in a report by Stemp (1998).

Geology

The survey area covers the northern portion of the Jameson Land basin which is a thick sequence (up to 17 km) of Palaeozoic and Mesozoic continental and marine sediments invaded by a variety of Tertiary sills, dykes and intrusions.

The Blyklippen lead-zinc deposit in the Mesters Vig region is situated within the survey area. The deposit was commercially mined between 1956–1962 by Nordisk Mineselskab A/S and, although small, is one of the few operating mines in Greenland's history.

Many other mineral occurrences are known. The Malmbjerg porphyry molybdenum deposit is probably the best known prospect in the area and is associated with a Tertiary intrusion situated west of the geophysical survey block.

In 1998 selected anomalies were visited in a follow-up study (Pedersen & Stendal, 1999) by GEUS, which concluded that most electromagnetic anomalies were found in relation to thick Tertiary sills intruded into black Jurassic shales. The high conductivities are probably caused by a combination of contact-metamorphosed, graphite-bearing black shales and massive to semi-massive contact-skarn sulphide/magnetite layers found in these sediments.

Maps and digital data archive

A complete list of printed map products and digital data can be found in appendix D. The enclosed CD-ROM contains the following maps in Oasis Montaj® format with filenames listed in parenthesis:

- Amplitude of the GEOTEM X-coil channel 12 (ampl_X12_dh.map)
- Conductance calculated from the GEOTEM Z-coil data (app_cond_dh.map)
- Magnetic total field anomaly (tmi.map)
- Calculated vertical gradient of magnetic total field anomaly (vg.map)
- Digital elevation model calculated form GPS and radar measurements (dem.map)
- Topographic base map (topographic base map.map)

The two maps of EM parameters are based on interpolated data corrected for system asymmetry (de-herringboned).

Washington Land and Daugaard-Jensen Land – AEM Greenland 1998 (1)

Survey specifications

The survey area in Washington Land and Daugaard-Jensen Land in western North Greenland was flown by Geoterrex-Dighem Ltd. from 29th May to 24th June, 1998. The survey includes electromagnetic (GEOTEM) and magnetic total field measurements.

Geoterrex-Dighem Ltd collected a total of 9321 line-km of data in the area indicated in Figure 1. The survey is divided into a main part flown with a line distance of 400 m and a detailed part within the main area with a distance between the lines of 200 m. Line direction for the main area is N156.5°E, and N66.5°E in the detailed part. The objective of the detailed survey was to provide a better coverage of an area with a known Zn-Pb-Ag occurrence (Jensen & Schønwandt 1998) for which a flight line direction of N66.5°E was most favourable with respect to topographic conditions.

Different aircraft were used for the main part and the detailed part, but data recordings from coincident line sections showed good agreement between the two systems. Tie lines were directed N66.5°E with a distance of 4000 m between lines.

Nominal flight altitude was 120 m over terrain with the total field magnetic sensor and electromagnetic sensor of 75 m and 70 m above ground, respectively. The size of the area is 3220 km^2.

The parameters of the GEOTEM system are listed below:

Base frequency:	90 Hz
Pulse width:	5555 µs
Pulse delay:	130 µs
Off-time:	3385 µs
Transmitter moment:	487 000 Am^2
Receiver component:	Horizontal components along flight direction (X-coil) and orthogonal to flight direction (Y-coil) and vertical direction (Z-coil)
Number of time gates:	20

Gate centre time from end of pulse:

Channel 1:	-1930 µs	Channel 11:	718 µs
Channel 2:	-1518 µs	Channel 12:	891 µs
Channel 3:	-953 µs	Channel 13:	1065 µs
Channel 4:	-389 µs	Channel 14:	1282 µs
Channel 5:	1 µs	Channel 15:	1564 µs
Channel 6:	153 µs	Channel 16:	1868 µs
Channel 7:	240 µs	Channel 17:	2171 µs
Channel 8:	327 µs	Channel 18:	2497 µs
Channel 9:	435 µs	Channel 19:	2844 µs
Channel 10:	566 µs	Channel 20:	3191 µs

Detailed information on the equipment and processing can be found in a report by Geoterrex-Dighem Ltd. (1998a). Furthermore, the data and some preliminary interpretations are presented in Rasmussen (1999a).

Geology

Lower Palaeozoic sedimentary deposits dominate the geology of Washington Land and Daugaard-Jensen Land. The sediments were deposited in the Franklinian Basin that has

an extension of approximately 2000 km across North Greenland and Canada. Approximately 8 km of Lower Palaeozoic strata is exposed within the North Greenland part of the basin. An overview of the evolution of the Franklinian Basin in North Greenland can be found in Higgins *et al.* (1991a, b) two papers that cite a large number of references to descriptions and interpretations of the geology.

In Washington Land and Daugaard-Jensen Land the depositional environment of the basin is reflected by shelf sediments located to the south and deep-water sequences further to the north. Exposed rocks in the survey area consist mainly of carbonates deposited on the shelf with subordinate siliciclastic sediments and evaporites. The Precambrian-Cambrian boundary is not exposed in Washington Land and Daugaard-Jensen Land. However, the Precambrian shield is exposed on the south side of Humbolt Gletcher (Peel *et al.* 1982) and at the head of Victoria Fjord in central North Greenland about 300 km east of the survey area (Henriksen 1992). A geological map of the area is available in scale 1:250 000 (Jepsen *et al.* 1983).

During a geological reconnaissance flight over eastern Washington Land in 1997, a Zn-Pb-Ag mineralization was discovered (Jensen & Schønwandt 1998). The mineralization is within the evaporite-rich part of Lower Ordovician platform sediments.

Maps and digital data archive

A complete list of printed map products and digital data can be found in appendix E. The enclosed CD-ROM contains the following maps in Oasis Montaj® format with filenames listed in parenthesis:

- Apparent conductance from the main survey (app_cond_dh.map)
- Apparent conductance from the detailed survey (app_cond_detail.map)
- Z-coil channel 10 amplitude from the main survey (ampl_Z10_dh.map)
- Z-coil channel 10 amplitude from detailed survey (ampl_Z10_detail.map)
- Total magnetic intensity from the main survey (tmi.map)
- Total magnetic intensity from the detailed survey (tmi_detail.map)
- Calculated vertical magnetic gradient from the main survey (vg.map)
- Calculated vertical magnetic gradient from the detailed survey (vg_detail.map)
- Digital elevation model (dem.map)
- Topographic base map (topographic base map.map)

The maps of EM parameters are based on interpolated data corrected for the system asymmetry (de-herringboned). Data from the detailed survey is shown with similar topographic base map information and in the same scale as for the main area. The EM data from the detailed survey area is displayed with the same colour coding which is used for the main area, however different colour scales were more suitable for the display of the magnetic total field anomalies and the associated vertical derivatives.

J. C. Christensen Land – AEM Greenland 1998 (2)

Survey specifications

The survey in J. C. Christensen Land and reconnaissance lines in eastern Peary Land, eastern North Greenland were flown from 29th May to 24th June, 1998. The survey includes electromagnetic (GEOTEM) and magnetic total field measurements.

The survey was flown with lines directed along NE45.8º and distance between lines of 400 m. Orthogonal tie-lines were flown with a line separation of 4000 m. A total of 4492 line-km were collected. In total 485 line-km were flown in eastern Peary Land as reconnaissance lines.

Nominal flight altitude is 120 m over terrain with the total field magnetic sensor and electromagnetic sensor 75 m and 70 m above ground, respectively. The size of the survey area is 1603 km^2.

The measuring system was identical to the one described above for the survey in Washington Land and Daugaard-Jensen Land.

Detailed information on the equipment and processing can be found in a report by Geoterrex-Dighem Ltd. (1998b). Furthermore, the data and some preliminary interpretations are presented in Rasmussen (1999b).

Geology

Information on the geology of J. C. Christensen Land and adjacent areas is available from several studies. Jepsen & Henriksen (1986) have compiled a map in scale 1:100 000 covering J. C. Christensen Land. The regional geology of North Greenland north of 81°N is documented in two maps (Bengaard & Henriksen 1986; Henriksen 1989) in scale 1:500 000 and accompanied by a descriptive text of Henriksen (1992).

Predominantly sedimentary rocks are exposed in North Greenland. Surlyk (1991) identified minimum eight major tectonostratigraphic basins ranging in age from Middle Proterozoic to Tertiary. In most cases, the basin developments are separated by episodes of deformation caused by compressional loading of the crust. Crystalline basement rocks of early Proterozoic and Archean age have not been located in J. C. Christensen Land. A volcanic unit with widespread occurrence east of Independence Fjord is the tholeiitic Middle Proterozoic Zig-Zag Dal Basalt Formation and the intrusive equivalent Midsommersø Formation. An age of 1230 Ma (Kalsbeek & Jepsen 1983) is quoted for the Midsommersø Formation. The magma intruded a thick sequence of undeformed Proterozoic sandstones which is referred as the Independence Fjord Group (Collinson 1980, 1983). The Independence Fjord Group is overlaid conformably by the Zig-Zag Dal basalts.

Maps and digital data archive

A complete list of printed map products and digital data can be found in appendix F. The enclosed CD-ROM contains the following maps in Oasis Montaj® format with filenames listed in parenthesis:

- Apparent conductance from the main survey (app_cond_dh.map)
- Z-coil channel 10 amplitude from the main survey (ampl_Z10_dh.map)
- Total magnetic intensity from the main survey (tmi.map)
- Calculated vertical magnetic gradient from the main survey (vg.map)
- Digital elevation model (dem.map)
- Topographic base map (topographic base map.map)

The maps of EM parameters are based on interpolated data corrected for system asymmetry (de-herringboned).

Final comments

In Greenland, compared to the rest of North America and Europe, the use of airborne geophysical surveys as a basic tool in mineral exploration came rather late. However, the AEM Greenland 1994–1998 project has shown that airborne geophysical methods can be utilised with success in Greenland despite the special climatic and logistic conditions.

The AEM Greenland 1994–1998 project, together with the public funded regional aeromagnetic surveys, have established a data base with modern high-quality geophysical data. This serves as an important source of information in the understanding of the geology in Greenland. The CD-ROM released with this report is intended to make the data available to the public based on modern information technology. The information is provided with sufficient resolution for the purpose of qualitative interpretations. However, it must be emphasised that the digital line archives and grids, which are referred to in the appendices, provide detailed information, which cannot be accomplished by this CD-ROM presentation.

The AEM Greenland 1994–1998 was specifically defined for the purpose of serving the mining industry. The activities and interest from the prospecting companies, which has been seen after the release of data from the surveys, have confirmed that modern high resolution geophysical data is of upmost importance in the search for mineral deposits. Although a result in terms of locating mineralisations of immediate realisable economical value is lacking from the project, the data contains valuable information to be used in a continued search for mineralisations.

Data from the project has been used as an efficient tool in the planning of geological mapping in Greenland. In particular, structural information obtained from the data has served as guidelines for the search of structures in the field and for locating mineralisations. The advance of new quantitative methods for the interpretation of the data is expected to significantly increase the amount of information, which can be extracted. The available data is of sufficiently high quality to justify application of these new techniques.

Acknowledgement

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Appendix A

Below follows a list of printed maps and digital products from the survey in Inglefield Land, North-West Greenland (AEM Greenland 1994).

Printed maps:

1 map at 1:250 000
8 maps at 1:50 000

Parameters and scale:

- Total magnetic intensity (colours and contours)
- Total magnetic intensity (contours, at 1:50 000 only)
- First vertical derivative of magnetics (colours and contours)
- First vertical derivative of magnetics (contours, at 1:50 000 only)
- EM decay constant (colours and contours)
- EM decay constant (contours, at 1:50 000 only)
- Broadband apparent conductivity (colours and contours)
- Broadband apparent conductivity (contours, at 1:50 000 only)
- EM X-coil channel 2 amplitude (colours and contours, at 1:250 000 only)
- Flight-lines/planimetry/EM anomalies (at 1:50 000 only)

Digital data archive:

Grid data: All final data used for the printed map products. The format is Geosoft grid exchange format.

Profile and line data: All final processed data in Geosoft ASCII-format

- Northing X
- Easting Y
- Fiducial
- Radar height
- Applied compensation of magnetics
- Magnetic total field, IGRF removed
- Latitude (WGS84)
- Longitude (WGS84)
- Regional
- Powerline monitor
- Diurnal
- Decay constant with EM X-coil channel 2 inversion
- Full wave form apparent conductivity
- Chargeability
- Processed EM X-coil channel 1 (ppm)
- Processed EM X-coil channel 2 (ppm)
- Processed EM X-coil channel 3 (ppm)
- Processed EM X-coil channel 4 (ppm)
- Processed EM X-coil channel 5 (ppm)
- Processed EM X-coil channel 6 (ppm)
- Processed EM X-coil channel 7 (ppm)
- Processed EM X-coil channel 8 (ppm)
- Processed EM X-coil channel 9 (ppm)
- Processed EM X-coil channel 10 (ppm)
- Processed EM X-coil channel 11 (ppm)
- Processed EM X-coil channel 12 (ppm)

Processed EM X-coil channel 20 (ppm)

The levelled magnetics consist of the following:

- Editing and filtering of the air magnetics
- Subtraction of the long wavelength component of the ground magnetics
- Addition of the mean ground station
- Levelling
- Regional removal

Special data resulting from or used in the levelling procedure are provided in the archives (calculated compensations, IGRF values, ground magnetics, etc.)

A continuous video-tape record of the terrain passing below the aircraft is available.

Appendix B

Below follows a list of printed maps and digital products from the survey in the Maniitsoq–Nuuk area, southern West Greenland (AEM Greenland 1995).

Maps and scale:

1 map at 1:250 000
10 maps at 1:50 000
19 maps at 1:20 000 (central part of area only)

Parameters on maps:

- Total magnetic intensity (colours and contours)
- Total magnetic intensity (contours, at 1:20 000 and 1:50 000 only)
- First vertical derivative of magnetics (colours and contours)
- First vertical derivative of magnetics (contours, at 1:20 000 and 1:50 000 only)
- Total energy envelope of channel 1 (colours and contours)
- Total energy envelope of channel 1 (contours, at 1:20 000 and 1:50 000 only)
- Apparent conductivity of z-coil channel 20 (colours and contours)
- Apparent conductivity of z-coil channel 20 (contours, at 1:20 000 and 1:50 00 only)
- Landsat TM image (at 1:250 000 only)
- Flight-lines/EM anomalies (at 1:20 000 and 1:50 000 only)

Digital data archive:

Grid data: All final data used for the printed map products. The format is Geosoft grid-exchange format.

Profile and line data: All final processed data in Geosoft ASCII-format

- Northing X
- Easting Y
- Latitude (WGS84)
- Longitude (WGS84)
- Fiducial
- Radar height
- Barometer altimeter
- Magnetic diurnal field
- Magnetic total field
- Residual magnetics
- EM primary field
- Total energy envelope of X- and Z- channel 1
- Apparent conductivity
- Processed EM X- and Z-coil channel 1 (ppm)
- Processed EM X- and Z-coil channel 2 (ppm)
- Processed EM X- and Z-coil channel 3 (ppm)
- Processed EM X- and Z-coil channel 4 (ppm)
- Processed EM X- and Z-coil channel 5 (ppm)
- Processed EM X- and Z-coil channel 6 (ppm)
- Processed EM X- and Z-coil channel 7 (ppm)
- Processed EM X- and Z-coil channel 8 (ppm)
- Processed EM X- and Z-coil channel 9 (ppm)
- Processed EM X- and Z-coil channel 10 (ppm)
- Processed EM X- and Z-coil channel 11 (ppm)

Processed EM X- and Z-coil channel 12 (ppm)
Processed EM X- and Z-coil channel 20 (ppm)
Raw EM X-channel 13 (ppm)
Raw EM X-channel 14 (ppm)
Raw EM X-channel 15 (ppm)
Raw EM X-channel 16 (ppm)
Raw EM X-channel 17 (ppm)
Raw EM X-channel 18 (ppm)
Raw EM X-channel 19 (ppm)

A continuous video-tape record of the terrain passing below the aircraft is available.

Appendix C

Below follows a list of printed maps and digital products from the survey in the Grønnedal region, South-West Greenland (AEM Greenland 1996; 5 sub-areas: Sermiligaarsuk North, Midternæs, Grænseland, Sioralik South, Arsuk Ø).

Maps and scale:

1 map at 1:100 000
17 maps at 1:20 000

Parameters:

Total magnetic intensity (colours and contours)
First vertical derivative of magnetics (colour and contours)
Resistivity (with EM anomalies for maps at 1:20 000)
VLF (colour and contours)
In-phase and quadrature EM profiles for coaxial 4600
Hz EM (colours and contours, at 1:20 000 only)
Total count, K, U and Th radiometrics (colour and contours)

Digital data archive:

Grid data: All final data used for the printed map products. The format is Geosoft grid exchange format.

Profile and line data: All final processed data in Geosoft ASCII-format

The EM anomaly data file (DNORM.UTM) contains the following information:

UTM Easting
UTM Northing
flight number
line number
time (hours)
time (mins)
time (secs)
code (A, B, C, etc.) – anomaly classification code
type for digitizing input (1, 2, 3, etc. - for Aerodat internal use only)
bird height
category (class based on conductance 0 through 6)
inphase amplitude (ppm)
quadrature amplitude (ppm)
CTP (conductivity thickness product) (Siemens)
depth to conductor

The EM line profile archive at a sample rate of 0.2 seconds (i.e. 5 readings per second):

X = easting (WGS84, Zone 23)
Y = northing (Wgs84, Zone 23)
radar altimeter
barometric altimeter
935 Hz coaxial EM inphase (ppm)
935 Hz coaxial EM quadrature (ppm)
4600 Hz coaxial EM inphase (ppm)
4600 Hz coaxial EM quadrature (ppm)
865 Hz coplanar EM inphase (ppm)

865 Hz coplanar EM quadrature (ppm)
4175 Hz coplanar EM inphase (ppm)
4175 Hz coplanar EM quadrature (ppm)
32000 Hz coplanar EM inphase (ppm)
32000 Hz coplanar EM quadrature (ppm)
resistivity from 4175 coplanar EM
time
manual fiducials
camera fiducials
julian day
flight number

The MAG/VLF line profile archive at a sample rate of 0.2 seconds (i.e. 5 readings per second):

X = easting (WGS84, Zone 23) [m]
Y = northing (Wgs84, Zone 23) [m]
radar altimeter [m]
barometric altimeter [m]
levelled total field magnetics
levelled total field magnetics (IGRF removed)
calculated vertical magnetic gradient
total field VLF (line direction)
quadrature VLF (line direction)
total field VLF (orthogonal direction)
quadrature VLF (orthogonal direction)
digital elevation model
time
manual fiducials
camera fiducials
julian day
flight number

A continuous video-tape record of the terrain passing below the aircraft is available.

Appendix D

Below follows a list of printed maps and digital products from the survey in the northern part of Jameson Land, central East Greenland (AEM Greenland 1997).

Maps and scale:

1 maps at 1:250 000
13 maps at 1:50 000

Parameters:

Total magnetic intensity (colours and contours, contours)
Total magnetic intensity (shadow, at 1:250 000 only)
Total magnetic intensity (colour and shadow, at 1:250 000 only)
First vertical derivative of magnetics (colours and contours, contours)
Conductance (colour and contours, contours)
Amplitude of X-coil channel 1 (colours and contours, contours)
Amplitude of X-coil channel 12 with shadow of magnetic total field
Flight-lines and EM anomalies
Digital terrain model (at 1:250 000 only)

Digital data archive:

Grid data: All final data used for the printed map products. The format is Geosoft grid exchange format.

Profile and line data:

Easting (X)
Northing (Y)
Fiducial
Date
Flight number
Latitude (WGS 84)
Longitude (WGS 84)
Radar altimeter
GPS elevation
Barometric altimeter
Calculated terrain elevation
Total field magnetics (filtered)
Diurnal magnetics
Total field magnetics (final, IGRF removed)
IGRF correction
Calculated vertical gradient of magnetic total field anomaly
Compensation of magnetics after levelling
Compensation of magnetics after microlevelling
Conductance, from Z-coil
EM primary field
EM powerline monitor
Processed EM X-, Y- and Z-coil channel 1 (ppm)
Processed EM X-, Y- and Z-coil channel 2 (ppm)
Processed EM X-, Y- and Z-coil channel 3 (ppm)
Processed EM X-, Y- and Z-coil channel 4 (ppm)
Processed EM X-, Y- and Z-coil channel 5 (ppm)

Processed EM X-, Y- and Z-coil channel 6 (ppm)
Processed EM X-, Y- and Z-coil channel 7 (ppm)
Processed EM X-, Y- and Z-coil channel 8 (ppm)
Processed EM X-, Y- and Z-coil channel 9 (ppm)
Processed EM X-, Y- and Z-coil channel 10 (ppm)
Processed EM X-, Y- and Z-coil channel 11 (ppm)
Processed EM X-, Y- and Z-coil channel 12 (ppm)
Processed EM X-, Y- and Z-coil channel 13 (ppm)
Processed EM X-, Y- and Z-coil channel 14 (ppm)
Processed EM X-, Y- and Z-coil channel 15 (ppm)
Raw EM X-, Y- and Z-coil channel 16 (ppm)
Raw EM X-, Y- and Z-coil channel 17 (ppm)
Raw EM X-, Y- and Z-coil channel 18 (ppm)
Processed EM X-, Y- and Z-coil channel 19 (ppm)
Processed EM X-, Y- and Z-coil channel 20 (ppm)

A continuous video-tape record of the terrain passing below the aircraft is available.

Appendix E

Below follows a list of printed maps and digital products from the survey in Washington Land and Daugaard-Jensen Land, western North Greenland (AEM Greenland 1998).

Maps and scale:

1 maps at 1:250 000
13 maps at 1:50 000
1 map at 1:20 000 (for sub-area only)

Parameters:

Total magnetic intensity (colours and contours)
Total magnetic intensity (contours, at 1:50 000 only)
First vertical derivative of magnetics (colours and contours)
First vertical derivative of magnetics (contours, at 1:50 000 only)
Conductance (colours and contours)
Conductance (contours, at 1:50 000 only)
Amplitude of Z-coil channel 10 (colours and contours)
Amplitude of Z-coil channel 10 (contours, at 1:50 000 only)
Flight-lines, EM anomalies and planimetry (at 1:20 000 and 1:50 000 only)

Digital data archive:

Grid data: All final data used for the printed map products. The format is Geosoft grid exchange format.

Profile and line data: All final processed data in Geosoft ASCII-format.

Easting (X)
Northing (Y)
Fiducial
Date
Flight number
Latitude (WGS 84)
Longitude (WGS 84)
Radar altimeter
GPS elevation
Barometric altimeter
Calculated terrain elevation
Total field magnetics (filtered)
Diurnal magnetics
Total field magnetics (final, IGRF removed)
IGRF correction
Calculated vertical gradient of magnetic total field anomaly
Compensation of magnetics after levelling
Compensation of magnetics after microlevelling
Conductance, from X and Z-coil
EM primary field
EM powerline monitor
Processed EM X-, Y- and Z-coil channel 1 (ppm)
Processed EM X-, Y- and Z-coil channel 2 (ppm)
Processed EM X-, Y- and Z-coil channel 3 (ppm)
Processed EM X-, Y- and Z-coil channel 4 (ppm)
Processed EM X-, Y- and Z-coil channel 5 (ppm)
Processed EM X-, Y- and Z-coil channel 6 (ppm)

Processed EM X-, Y- and Z-coil channel 7 (ppm)
Processed EM X-, Y- and Z-coil channel 8 (ppm)
Processed EM X-, Y- and Z-coil channel 9 (ppm)
Processed EM X-, Y- and Z-coil channel 10 (ppm)
Processed EM X-, Y- and Z-coil channel 11 (ppm)
Processed EM X-, Y- and Z-coil channel 12 (ppm)
Processed EM X-, Y- and Z-coil channel 13 (ppm)
Processed EM X-, Y- and Z-coil channel 14 (ppm)
Processed EM X-, Y- and Z-coil channel 15 (ppm)
Processed EM X-, Y- and Z-coil channel 16 (ppm)
Processed EM X-, Y- and Z-coil channel 17 (ppm)
Processed EM X-, Y- and Z-coil channel 18 (ppm)
Processed EM X-, Y- and Z-coil channel 19 (ppm)
Processed EM X-, Y- and Z-coil channel 20 (ppm)

A continuous video-tape record of the terrain passing below the aircraft is available.
A continuous video-tape record of the terrain passing below the aircraft is available.

Appendix F

Below follows a list of printed maps and digital products from the survey in J. C. Christensen Land, eastern North Greenland (AEM Greenland 1998).

Maps and scale:

1 map at 1:250 000
8 maps at 1:50 000

Parameters:

- Total magnetic intensity (colours and contours)
- Total magnetic intensity (contours, at 1:50 000 only)
- First vertical derivative of magnetics (colours and contours)
- First vertical derivative of magnetics (contours, at 1:50 000 only)
- Conductance (colours and contours)
- Conductance (contours, at 1:50 000 only)
- Amplitude of Z-coil channel 10 (colours and contours)
- Amplitude of Z-coil channel 10 (contours, at 1:50 000 only)
- Flight-lines, EM anomalies and planimetry (at 1:50 000 only)

Digital data archive:

Grid data: All final data used for the printed map products. In Geosoft grid exchange format.

Profile and line data: All final processed data in Geosoft ASCII-format

- Easting (X)
- Northing (Y)
- Fiducial
- Date
- Flight number
- Latitude (WGS 84)
- Longitude (WGS 84)
- Radar altimeter
- GPS elevation
- Barometric altimeter
- Calculated terrain elevation [m]
- Total field magnetics (filtered)
- Diurnal magnetics
- Total field magnetics (final, IGRF removed)
- IGRF correction
- Calculated vertical gradient of magnetic total field anomaly
- Compensation of magnetics after levelling
- Compensation of magnetics after microlevelling
- Conductance, from X and Z-coil
- EM primary field
- EM powerline monitor
- Processed EM X-, Y- and Z-coil channel 1 (ppm)
- Processed EM X-, Y- and Z-coil channel 2 (ppm)
- Processed EM X-, Y- and Z-coil channel 3 (ppm)
- Processed EM X-, Y- and Z-coil channel 4 (ppm)
- Processed EM X-, Y- and Z-coil channel 5 (ppm)
- Processed EM X-, Y- and Z-coil channel 6 (ppm)
- Processed EM X-, Y- and Z-coil channel 7 (ppm)

Processed EM X-, Y- and Z-coil channel 8 (ppm)
Processed EM X-, Y- and Z-coil channel 9 (ppm)
Processed EM X-, Y- and Z-coil channel 10 (ppm)
Processed EM X-, Y- and Z-coil channel 11 (ppm)
Processed EM X-, Y- and Z-coil channel 12 (ppm)
Processed EM X-, Y- and Z-coil channel 13 (ppm)
Processed EM X-, Y- and Z-coil channel 14 (ppm)
Processed EM X-, Y- and Z-coil channel 15 (ppm)
Processed EM X-, Y- and Z-coil channel 16 (ppm)
Processed EM X-, Y- and Z-coil channel 17 (ppm)
Processed EM X-, Y- and Z-coil channel 18 (ppm)
Processed EM X-, Y- and Z-coil channel 19 (ppm)
Processed EM X-, Y- and Z-coil channel 20 (ppm)

A continuous video-tape record of the terrain passing below the aircraft is available.