

# Greenland Mineral Occurrence Map

Status report for the development of a proto type  
for the Internet, January 2004

Leif Thorning, Lisbeth Christensen,  
Frands Schjøth and Henrik Stendal



GEOLOGICAL SURVEY OF DENMARK AND GREENLAND  
MINISTRY OF THE ENVIRONMENT



**GEUS**

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# Content

<b>Content</b>	<b>2</b>
<b>Abstract</b>	<b>4</b>
<b>Introduction</b>	<b>5</b>
Project history .....	5
Geographical area for the prototype.....	6
Focus of the work in 2003 .....	6
Purpose and use of the Greenland Mineral Occurrence Map .....	7
Geoscientific background .....	7
<b>System overview</b>	<b>9</b>
Software.....	10
The GMOM database .....	10
On design criteria, specifications and functionality of the database .....	11
Attributes and Look Up Tables .....	14
Screen-forms for the database .....	15
GIS and Web environment for GMOM .....	19
Hot linking environment .....	21
Views or layers for background .....	22
Mineral occurrences - attribute display on maps.....	23
Examples of ArcIMS maps .....	23
<b>Implementation plan</b>	<b>28</b>
<b>Acknowledgements</b>	<b>29</b>
<b>References</b>	<b>30</b>
<b>Appendix 1: Detailed list of attributes</b>	<b>31</b>
Table (Mineral Occurrence Map) - main table.....	31
Table (Additional images).....	35
Table (Database log) .....	36
<b>Appendix 2: Look Up Tables (LUT)</b>	<b>37</b>
LUT (MO types) .....	37
LUT (Confidentiality Status).....	37
LUT (Commune) .....	37
LUT (Region) .....	38
LUT (Commodity type) .....	38
LUT (Commodity) .....	39
LUT (Ore description) .....	42
	2

LUT (International genetic model) .....	42
LUT (Greenland genetic model) .....	44
LUT (Stratigraphic Chart) .....	44
LUT (Reserve type) .....	45
LUT (Users) .....	46
LUT (Type of operation) .....	46
LUT (Type of image).....	46

<b>Appendix 3: Example of a site description</b>	<b>47</b>
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## Abstract

In the department of economic geology a number of databases for the storage and handling of geoscience data from Greenland, have been developed and used over the years including both company data and data produced in GEUS' own projects in Greenland. Results in the form of maps have been presented as thematic maps of regional compilations, since the mid-nineties on CD-ROMs as structured GIS data. With financial support, new facilities for the presentation of data and results have now been developed as a prototype: the Greenland Mineral Occurrence Map soon to be displayed on the Internet. Based on existing databases, a new Access based database has been constructed as an interface between data hold by GEUS and an ESRI ArcIMS based web-facility for user-oriented display of maps and data from Greenland. Geographically, the present version of the Greenland Mineral Occurrence Map is limited to West Greenland between 66°N and 70° 15' N; the area of coverage will be expanded in 2004.

The report is not the final report, but it is meant as a status report at the beginning of 2004, summarising the development so far as a basis for the work to be concluded in 2004. The report briefly gives the background and history of the project, presents the results obtained so far in the form of 1) the database and 2) a prototype of the mineral occurrence map. Some main work functions are described and suggestions are given for the implementation of a live web-based facility in the subsequent phase of the development project in 2004.

# Introduction

This report describes the development of the Greenland Mineral Occurrence Map (GMOM) and its associated data sources and databases. A mineral occurrence map shows where there are known and to some extent described occurrences of mineralisation or indications thereof. The sources for the map are databases with information compiled about each occurrence. The accompanying maps will eventually be both basic maps of observations (geological, geophysical, geochemical, structural, etc.) and maps produced through skilled interpretation of all available geo-data (e.g. metallogenetic maps, mineral assessment maps, etc.). Thus, the basic observations are the parameters for the interpretation-generated knowledge of existing or potential deposits in certain provinces.

Such maps are important for the understanding and description of the relationships between geological processes, rock types and deposits with an economic potential. The maps and the information contained in the database are needed by the mineral industry for mineral exploration and also in the ongoing GEUS investigation of the economic potential of Greenland's natural resources. The maps express the ambient status of this knowledge and they are all dynamic in the double sense that (1) they will change as additional new information, data and understanding gets integrated and (2) the user will be able to modify the maps online to show selections of data preferred by the user.

Traditionally, the various types of maps of mineral occurrences and their causes and consequences have been printed on paper. Often this has meant that compromises had to be made on choice of symbols and text, the degree of complexity to be represented, background documentation for the information, etc. For scientific and promotional purposes GEUS has over the years produced a number of such mineral occurrence maps, which have been used in e.g. Mining Journal Country summaries or other reports and papers. These maps were all reasonably up-to-date when they were created but new information frequently needs to be added. The modern IT and Internet based technology now provide very different and in many ways more suitable ways of displaying map information in a dynamic fashion.

In 2003, the work title **Dynamic Mineral Occurrence Map** of Greenland was used. However, with the conclusion of the prototype development it is suggested that the name **Greenland Mineral Occurrence Map** be used for the product. The 'dynamic' aspect will hopefully be apparent from the use of the map, which will be updated by GEUS regularly and which can appear differently depending on the users needs. Consequently, the abbreviations **GMOM** and **GMOMDB** are used throughout this report for the Greenland Mineral Occurrence Map and the database underlying it, respectively.

## Project history

In co-operation with the Bureau of Minerals and Petroleum, GEUS has over the last several years completed a series of projects designed to improve the use of digital methods in the research and presentation of the mineral resources of Greenland. Based on a status report at the end of 2002 (Thorning 2002), the present project was started April 2003 with the intention to design a prototype of a mineral occurrence map that could be implemented in

2004. The initial development phase was completed by the end of 2003 and can now be reported. It is expected that the facility will be implemented on a suitable host during 2004 and thus become generally available late in 2004. This report is based on the situation as it was in January 2004.

## **Geographical area for the prototype**

GEUS is presently reporting the results of the mineral resource assessment of a region in West Greenland (66°N and 70° 15' N; e.g. Stendal et al. 2004). It was decided to use the mineral occurrence within this area as the test data for the Greenland Mineral Occurrence Map (GMOM). Thus, the GMOM database (see later) contains the 160 sites from the assessment and the digital maps display the information from these 160 sites.

In 2004, it is planned to enlarge the coverage to include a larger part of Greenland and to include all the known mineralised sites deemed to be of sufficient interest. Other planned 2004 projects will further increase the knowledge of mineralised sites and geological environments in Greenland, and to the extent it is possible and practical the data, information and maps will be included in the GMOM web facility. The final goal of the project is that all known sites from all of Greenland must become part of the product, but at this point it is too early to say how many sites it will be possible to add in 2004.

## **Focus of the work in 2003**

In 2003 focus has been on three different aspects of the project:

1. The economic geology concepts – which data to involve for the mineral occurrence map and subsequently the metallogenetic maps; the compilation of these geodata from various database sources and fieldwork; discussions of suitable definitions of genetic models etc.
2. The organisation of the selected, necessary data in a suitable GimmeX database that will be the best possible basis for the GMOM and otherwise reasonably fitted to other functions required in the mineral resource assessment work.
3. How to organise the display of data on maps on the Internet; what program to use and where to host the interactive map.

This report is mainly concerned with (2) and (3) and only briefly mentions some issues related to (1), because that will be fully reported in the final report expected to be released simultaneously with the opening of the Internet version. Fuller treatment of the economic geology aspects of the work in West Greenland (the content of the present prototype database) can be found in the reports from the mineral assessment programme to be published early 2004. The actual public Web display of the GMOM on the Internet is planned to be implemented later in 2004, but the method how to do it has been developed and tested on an internal server to the level of prototype in 2003. Much of the development work done in other projects, such as e.g. Metadata from Greenland, will come together in the making of the final GMOM web facility. The database described in this report has other possible uses, but the Web displayed map is and has throughout the development been the primary objective.

## **Purpose and use of the Greenland Mineral Occurrence Map**

The primary purpose of the Greenland Mineral Occurrence Map on the Internet is to give information on the mineral resource potential of Greenland to the interested public in an efficient and detailed manner. When fully implemented it will be the most convenient method for access to specific information about mineral resources in Greenland, and provide links or references to associated information. The site displaying the GMOM will also be arranged so as to contain many links to other useful sources.

A secondary purpose of the GMOM is to become the focus point of GEUS endeavours to compile and make available relevant information; the tool to do this will at the same time be valuable in the development process itself, and it will define the standard for how much information should be gathered about potential sites, if possible.

Thus, there will be both internal and external users of the facilities developed so far and described in the following. Additional development will be necessary in 2004 to complete the facility before it is of sufficient quality to be released for general use.

## **Geoscientific background**

'Mineral occurrence maps' are usually perceived as fairly objective presentations of information on known occurrences at known localities, including of course mines and proven deposits. The details of the information can vary considerably from region to region and from site to site. In a fairly under-explored region like Greenland, not only known prospects or mines are of interest. As a matter of fact, because the number of exploited deposits is very limited, it is necessary also to include localities exposing just signs of mineralisation processes: these may be indicative of common processes in a region and can therefore help to define areas of special interest in relation to certain commodities. The objective is to use whatever information is available to define those regions of the crust, where - through certain periods of geological time - conditions have favoured the formation of ore deposits of economic interest. If such interpreted aspects are added to a mineral occurrence map, we can talk of a map of metallogenic provinces.

In the course of this project, many aspects have been discussed before settling on definitions and the choice of parameters to be contained in the GMOM database in order to be able to make the necessary distinctions. When publishing such 'conclusions' on a paper map, it may be difficult at the same time to display all the underlying data. In a digital version of such a map this can be done thanks to new technology. This method and expression can be transferred to the Internet, so that any remote user of the data may see or have direct access to not only the resultant map, but also the basic data underlying the map.

Details in the discussion and conclusions concerning definitions of the terms used will not be dealt with in this status report. But it has to be underlined that the developers are very aware of the importance of this aspect of a system that will be offered for general use on the Internet. The assessment of the various terms and their use will be continued in 2004 and there may be changes from the prototype GMOMDB presented here and the final one that will appear on the Internet. At any rate, all terms will be defined in a special link that will be part of the Web site.

The GMOM will be very useful for the display of GEUS' and other's interpretation of provinces in Greenland. It will probably also be used to present the results of many other proj-



ects, such as Principle Geological Environments in Greenland, project areas and other types of metadata.

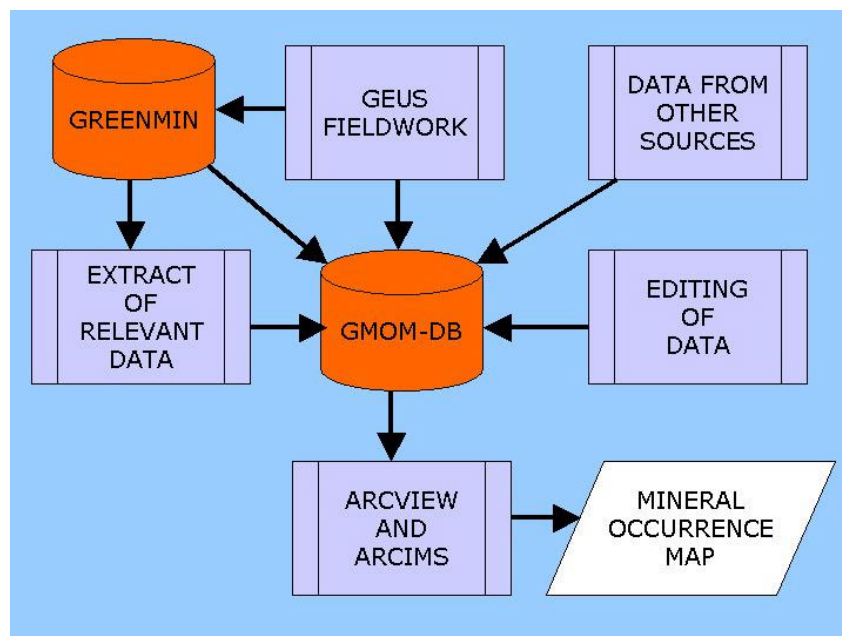
The information stored in the database and displayed on the map will be an important part of the basis for resource assessments and the maps resulting from the assessment could also later be displayed in this environment. The database has a facility – not yet implemented in its entirety but in the planning for 2004 - for the storing of information about 'interpreted geological domains'. This can be used for storing information about e.g. metallogenic provinces or domains (areas in the form of a polygon) created in the interpretation of geophysical and geochemical data.

## System overview

This section will give a brief overview of the system of programmes and work routines involved in the making of the Greenland Mineral Occurrence Map. The objective is to make the GMOMDB a natural part of the work functions in the department responsible for the content that is to be displayed on the GMOM on the Internet by a combination of processes utilising the ESRI ArcView/ArcGIS/ArcIMS environment. Specialists will create new updated versions of the map at regular intervals or when ambient updating of GMOMDB makes it worthwhile. In a more continuous process, individual GEUS interpreters can simultaneously share and use the information internally in relation to ongoing projects. To accommodate users with varying levels of competence, the process needs to be as simple as possible, therefore the structure of GMOMDB has been kept as simple as possible, at least concerning the directly map related data. This will also make it easier for non-specialist users of ArcView or ArcGIS to perform ad hoc searches in GMOMDB, because there usually will be little need for the use of complicated SQL structures in the search.

By design, the system described here will also make it possible to present metadata from Greenland. Basically a Greenland Meta Database (designed but not yet implemented) can be put in the position of GMOMDB in Figure 1. This means that the maps and/or information layers with various types of metadata fairly easily can be made available for the GMOM displayed on the Web.

Finally, the system will allow the production of CD-ROMs with data (the database and the ArcView shapefiles – in the tradition of the department's previous CD-ROMS). This can be exploited to produce yearly mineral occurrence maps on CD-ROM or collections of data from specific regions.



**Figure 1.** Overview of the system in which GMOMDB must function. See text for further discussion

## Software

The following standard programs carry the facilities related to the GMOM and will bring the structured mineral occurrence data on display on the Web:

- Microsoft Access 2000 professional - the GMOM database
- ESRI® ArcView GIS® or ESRI® ArcGIS® - for expert and general user purposes respectively
- ESRI® ArcIMS® – GIS map server; in 2003 and early 2004 preliminary installation on local server – later in 2004 expected installation on external service provider host.
- Geosoft® Oasis montaj™ - used for gridding of geophysical, geochemical and topographic data. Results usually shown in the ESRI environment as georeferenced tif files.
- Acrobat® Reader – used for format of descriptions of mineralised sites.

The ArcView GIS and ArcGIS is able to query the Access 2000 database, which allow the creation of shape files that can be published on a CD/DVD using ArcView GIS and on the Web using ArcIMS. The ArcIMS reads the shape files, the raster formats Tagged Image File Format (.TIF) and TIFF with Geo Header (Geotiff) (.TIF). The Geosoft® Oasis montaj™ (Geosoft) used for modelling of geophysical data and geochemical data has the facility to export the raster format .TIF. The Acrobat Reader is used in ArcView GIS and ArcIMS for the hot linking facilities.

This choice of software ensures that the desired interaction between the structured data in the Access 2000 database can be published either on CD/DVD and/or on the Web. Some further information is given below on the GMOM database and the GIS environment.

## The GMOM database

The GMOM database is meant primarily to be an intermediary between the various sources of data, such as (1) the full Greenland Mineral Occurrence database (GREENMIN), (2) fieldwork by GEUS in Greenland, and (3) any other sources in the literature including company reports, and the Greenland Mineral Occurrence Map on the Web. A secondary function is to provide a tool for other operations related to GEUS work and the production of CD-ROMs with compilations of thematic and/or regional data. Therefore, GMOMDB only contains a subset of the information, which GREENMIN is capable of holding. However, that subset is 'closer' to the content of the map in character and composition and is ideally suited to the production of the map.

The fundamental database concerning mineral occurrences in Greenland is GREENMIN (Thorning et al, 2000) and GMOMDB is not supposed to replace GREENMIN, but rather meant to offer a 'permanently existing' view of a selected part of the content of GREENMIN fitted to the purpose of a mineral occurrence map. It is the intention that GMOM at all times also shall contain sufficient information to document or link to the documentation behind the selection of sites chosen by the project leader/compiler as the basis for the Greenland Mineral Occurrence Map. Finally, the database structure of GMOMDB has deliberately been kept very simple (basically all geoscience data is in one table) to make it easy for non-

expert users to extract data from the database from e.g. within ArcView. Most geoscience searches in the database can be performed by selection of attributes from one table without the need for joins or other more complicated SQL operations.

The extraction of information from GREENMIN will produce much, but not all the input required for the regular updating of GMOMDB. The source of the data in GREENMIN is mainly the company reports; in addition to this GMOMDB can be updated with information acquired during GEUS fieldwork and write-ups based on many sources of information. In general, there will be situations when data of relevance for GMOM come from other sources, e.g. the literature, and therefore facilities that can be used for direct editing, searches, etc. are included in GMOMDB, in the form of normal use of Access 2000 screen-form facilities.

### **On design criteria, specifications and functionality of the database**

The GMOMDB has been designed to be practical for all the imagined uses. However, within the project reported here **main emphasis has been placed on what was necessary for the production of the GMOM on the Web**. Other uses directed towards internal use of data and the production of regional compilations of data on CD-ROM, have been given second priority so far, but will be important if the system is to be sustainable in everyday use.

The GMOMDB is transferable under certain conditions, so that it (or copies of it) can be used on a central departmental server during its construction and for departmental purposes, on a web-server during its function as database for the GMOM on the web, and on a laptop in the field or during travel.

The database has been designed to encompass sufficient attributes to hold the information required from GREENMIN. Furthermore, the attributes have been defined to fit the GREENMIN definitions as closely as possible. Also, in the case of LUTs (look up tables), these are comparable in the two databases. The selection of attributes in GMOMDB does not include all information in GREENMIN, but linking attributes have been included so that an audit trail can be established to provide sufficient documentation of the data in GMOMDB to allow back-tracing to more detailed information, should it be required. On the other hand, GMOMDB includes attributes containing more interpreted data not directly available in GREENMIN. The latter is a general-purpose database, whereas the former is designed directly with the GMOM in mind.

Transfer of data from GREENMIN to GMOMDB can be done in a number of ways and various tests have been carried out; so far a semi-automatic methods utilising a special view constructed in the GREENMIN database to import data to GMOMDB via Excell spreadsheets have been used, but other more direct methods will be tested, as will ways of updating GREENMIN from GMOMDB. In the future it is possible that the two databases may be merged into one, perhaps in connection with the ongoing homogenisation of GEUS databases into an Oracle environment (GREENMIN is presently in an Ingress environment). However, for now the best solution allowing the easiest transfer of the database to other platforms and locations is to continue with the Access 2000 as a platform for GMOMDB.

It is also possible to update GMOMDB with results from GEUS fieldwork – a number of methods can be used depending on the format of the incoming data. The situation is not simple, for there may be more than one rowing copy of the database in the field and they

may all need to unload new information after the fieldwork. Simple to use methods must later be thought out, even if it means that it will be primitive operations, needing manual interaction.

Editing and normal management of the central GMOMDB can be handled using standard Access 2000 devised screen-forms, which can also handle the occasional ad hoc update from other sources.

GMOMDB has also – in structure and attributes – been build so as to be approachable by ArcView/GIS in such a manner that the definitions of the required layers or shape files for the GMOM are possible.

In summary, some of the most important design criteria for GMOMDB that were determining for the definitions of attributes and the construction of the database, can be listed:

- GMOMDB must contain precisely the minimum attributes required according to the scenarios described above
- GMOMDB must contain the attributes required to read and use a mineral occurrence map
- GMOMDB must contain documentation directly or links to documentation that will allow explanation of the selection of sites made for a particular map
- In the project reported here, emphasis must be given to the role of GMOMDB as the foundation for the GMOM on the Web
- When possible, simplicity in the structure of GMOMDB is the rule. If possible, the main table must contain all the attributes needed for the GMOM, even if this means that the database is not perfectly normalised. This will ensure ease of use for non-expert ArcView users (less complicated SQL statements for searches)
- If housekeeping or administrative data are required in GMOMDB, these can be arranged in other tables, because the attributes are not needed on the GMOM itself or for its construction
- Similarly, although the GMOMDB will contain information useful in GEUS field work, it should not be designed to fit the purpose of a GEUS database for fieldwork. However, in all likelihood it will be possible later to create an augmented version of GMOMDB with a few additional tables for GEUS samples, details of the work on a site etc, but that is not encompassed in the project reported here
- There must be agreement between attribute definitions in GREENMIN and GMOMDB, including the LUTs used, ranges allowed, constraints etc. to the extent it is possible and practical
- Screen-forms giving access to all attributes must be constructed in a fashion easy to use for updating and editing
- All update scenarios for GMOMDB must be considered. Should these put constraints on definitions of attributes, then criteria arising from this must be honoured
- Inherent in the choice of attributes and especially the definition of LUTs, are important points involving geoscientific definitions and concepts. In principle it is absolutely necessary that descriptions of a mineralised site stored in GMOMDB follow generally accepted international standards and terms
- In relation to the mineral assessment programme concluded during the autumn of 2003 and being reported during the spring of 2004, a standard form for the description of a mineralised site, important for the understanding of the mineral resource potential of a region, has been discussed and experimented upon within the department. Ideally, it

should be possible to create a standard description of a mineralised site *from* properly and fully filled attributes in GMOMDB. Therefore, some of the attributes will be defined as memos, small notes in their own right. By using e.g. Crystal Reporter or especially constructed Access reports it will be possible to compose a printed or Word version of a report from GMOMDB that can be used directly as the description of that particular site in the mineral resource assessment program, or which can serve as the basis for a manual editorial process towards a final description. A hyperlink to such a description will be stored in the database

- A directory-tree must be devised that allow the organised storage of database files, associated pdf-files, jpeg image files and ArcView/GIS shape files
- Most searches and reporting must be done by standard Access facilities or through ArcView/GIS SQL filter. A couple of special report facilities will be constructed
  - As a starting point, it should be possible to extract the following list of attributes for the purpose of display in the ArcIMS environment, as a table on-screen (the numbers refer to the table descriptions later in this note; modifications in selection may still be necessary)

*For display on-screen as a table in ArcView/GIS or ArcIMS*

- MO2 Name
  - MO7 Region
  - MO8 Longitude
  - MO9 Latitude
  - MO13 Type of MO
  - MO14 Commodity type
  - MO15 Commodity 1
  - MO16 Commodity 2
  - MO17 Commodity 3
  - MO18 Additional commodities
  - MO21 Genetic model
  - MO23 Abs age min
  - MO47 Abs age host
  - MO31 Grade
  - MO33 Reserve size
  - MO35 Resource size
  - MO50 Hyperlink to Pdf-fil with summary description
- Similarly, a report must be generated from the Access GMOMDB, containing the following attributes and delivered as a Word- file, which can be edited by the compiler and later turned into a pdf-file (the hyperlink to this pdf-file is in MO50). These reports will be used for hot-links in ArcIMS (the filenames will be hyperlink'ed to the GMOMDB - further modification in selection may be necessary)

*For composition of site description in Word (/pdf)-file:*

*The location and name:*

- MO2 Name
- MO6 Commune
- MO7 Region
- MO8 Longitude
- MO9 Latitude
- MO10 Altitude

*The ore:*

- MO13 Type of MO
- MO14 Commodity type
- MO15 Commodity 1
- MO16 Commodity 2
- MO17 Commodity 3
- MO18 Additionall commodities
- MO19 Ore description
- MO51 Ore description text
- MO21 Genetic model
- MO23 Abs age min
- MO24 Dating method for mineralisation
- MO25 Relative age min
- MO31 Grade
- MO35 Resource size
- MO34 Resource date
- MO33 Reserve size
- MO32 Reserve date
- MO44 Rcomment

*Setting:*

- MO20 Geological setting
- MO26 Relative age host
- MO47 Abs age host
- MO49 Dating method for host

*General background:*

- MO28 History
- MO22 Greenland Genetic Model
- MO37 References

## **Attributes and Look Up Tables**

Altogether some 67 attributes have been defined for the prototype GMOMDB so far. Some are still under consideration and the final, released version of the database may come to contain a slightly different selection of attributes. It is also still being discussed how much security and audit trailing capability to build into the database (the LOG table and associ-

ated procedures). The attributes are shown in detail in Appendix A, including the links to LUTs.

A number of Look Up Tables have been constructed; they are included in the database for the usual reasons: homogeneous spelling and easier searches. Equally important, they also ensure adherence to generally accepted scientific terms and standards. The Look Up Tables are shown in Appendix B. Some of them may be changed before the final version is released and new ones may be added as required.

## **Screen-forms for the database**

The main Access screen-form has been constructed with an upper part always visible and a lower part which can show one of the five (more can be added) additional parts of the screen-form, by using the 'bars' on the form. The following general characteristics will be used for the final version on the web (the prototype does not yet exhibit all these designs):

- Use of Verdana font, especially well suited for on-screen use. This has so far only been done for the bar headings and the heading
- Name on screen-form indicates that this is a database for this specific purpose, not a general mineral occurrence database
- Labels are placed systematically over left side of field to give better layout and easier to read screens
- TAB order for fields has been build into the forms – as suggestion for a natural order to fill the fields
- Defaults have been included for most fields, though not yet for date fields. The principle of applying a slight colour to fields with default values may later be used
- As can be seen from illustrations, the form can be visible in its entirety on a labtop (true colour, 1024 X 768)

The following illustrations are simple screen catches from a labtop computer. The final version of the database may look different from the prototype, because experiences from an in-house 2004 trial run of the database and the GMOM will be taken into account in the final design.

Convention for the use of LUT on the screen-forms are being tested, but will not be treated further in this status report. It is sufficient to say that attributes with LUTs can only take on one of the values from the LUT. The database has functions allowing access to editing of the LUT but this access may be restricted to certain users in the final version.

On the following pages, the main screen-forms are shown with a few comments. Full details of the attributes (fields on the screen-forms) may be seen in Appendixes A and B.



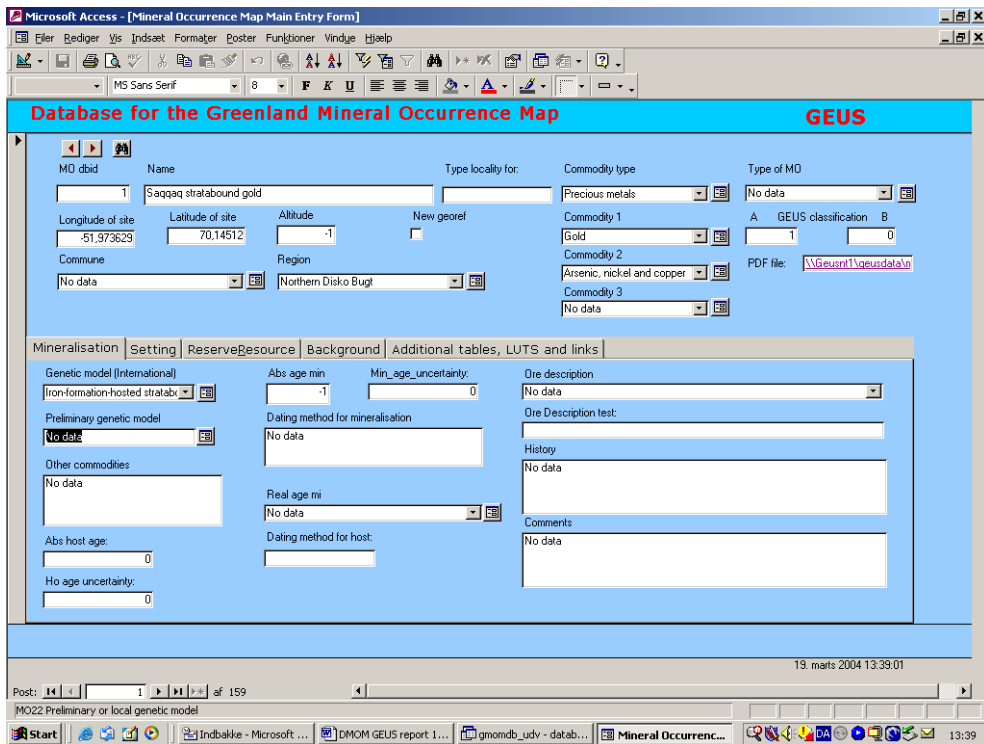


Figure 2. The main screen form showing the top basic part and the lower part for 'Mineralisation'.

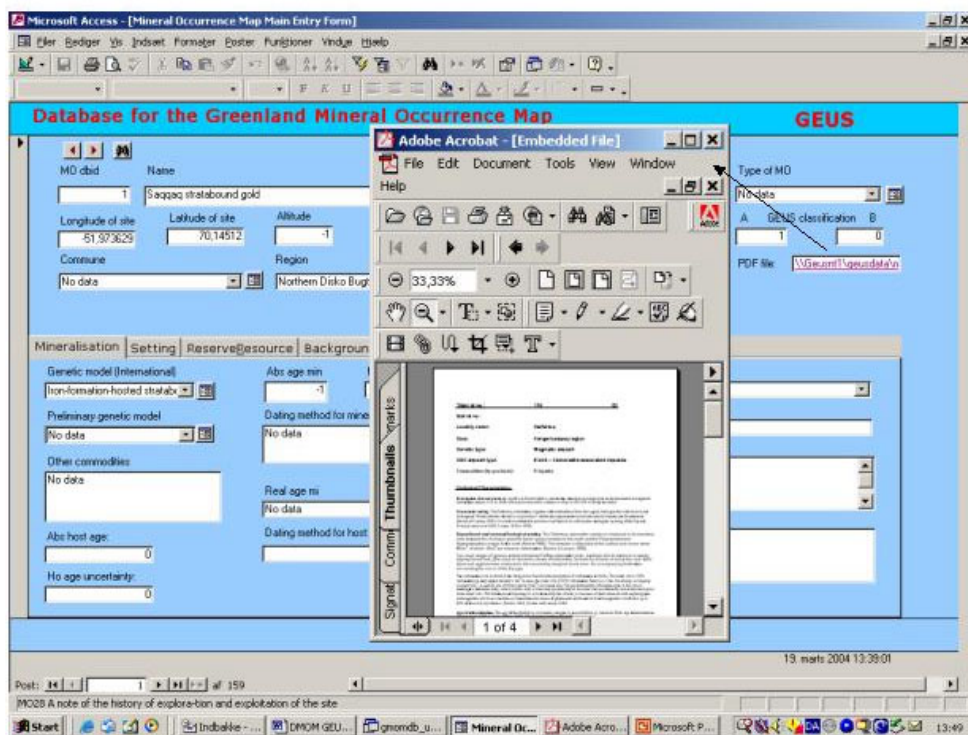


Figure 3. The same view, but now the pdf-file link shown from the database has been used to open a description of the mineral occurrence in a separate window.

**Database for the Greenland Mineral Occurrence Map** **GEUS**

MO dbid: 1 Name: Saqqaq stratabound gold Type locality for: Commodity type: Precious metals Type of MO: No data

Longitude of site: -51.973629 Latitude of site: 70.14512 Altitude: -1 New georef:

Commodity 1: Gold A GEUS classification: 1 B: 0

Commodity 2: Arsenic, nickel and copper PDF file: \\Geusn1\geusdata\...

Commodity 3: No data

Commune: No data Region: Northern Disko Bugt

Mineralisation | **Setting** | ReserveResource | Background | Additional tables, LUTS and links

Production: No date

Reserve date: 01-01-1700 Reserve type: No data Resource date: 01-01-1700

Reserve size: No data Resource size: No data

Grade: No data

Comments to reserve and or resource

19. marts 2004 13:39:01

Post: 1 af 159

MO27 Production from the site to date

Figure 4. The lower part of the screen-form here provides access to information about any available estimates of reserves and resources for this site.

**Database for the Greenland Mineral Occurrence Map** **GEUS**

MO dbid: 1 Name: Saqqaq stratabound gold Type locality for: Commodity type: Precious metals Type of MO: No data

Longitude of site: -51.973629 Latitude of site: 70.14512 Altitude: -1 New georef:

Commodity 1: Gold A GEUS classification: 1 B: 0

Commodity 2: Arsenic, nickel and copper PDF file: \\Geusn1\geusdata\...

Commodity 3: No data

Commune: No data Region: Northern Disko Bugt

Mineralisation | Setting | ReserveResource | **Background** | Additional tables, LUTS and links

GREENMIN DB id no: No date

GEUS site no: No data

Reference: Thomassen and Tukianien 1992: Garde et al. 1999

GREENMIN s nr: 3623/1

Method op location: No data

Status: No data

Release date: 1-1-1700

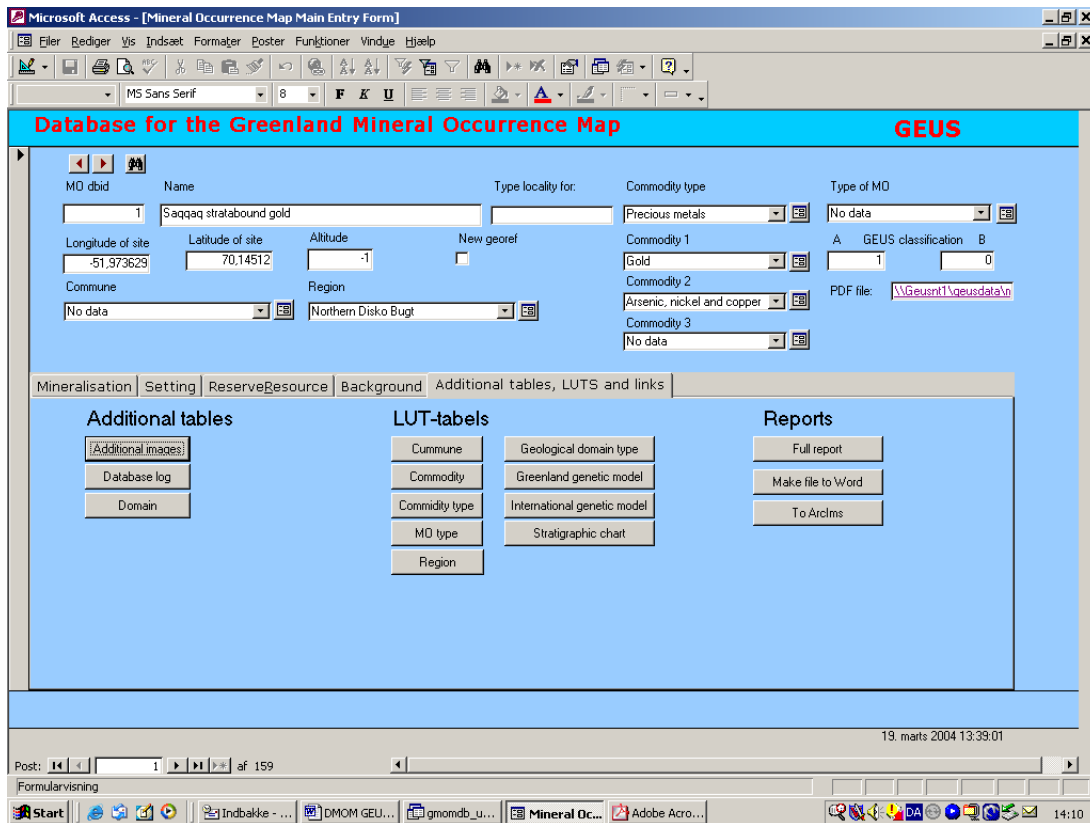
Last modification: by: Adam Garde

19. marts 2004 13:39:01

Post: 1 af 159

MO36 Unique reference to GREENMIN entries

Figure 5. The lower part contains fields describing the general background information.



**Figure 6.** The final lower screen gives access to other tables, the look up tables and a few reporting facilities. Additional features will be added in 2004.

The upper part of the screen, visible on all illustrations, will always show the basic attributes identifying the mineralised site and a few additional characteristics. Ideally, all fields should be filled. However, at this stage and occasionally in the future it will be necessary to allow 'no data' in certain fields. This is therefore the default value for attributes, automatically written in the database and shown on-screen, if no alternative values or data have been entered. In LUT fields, 'no data' is allowed as a legal value (i.e. the term 'no data' is included in the LUT). Positions are given in decimal fractions of a degree. Negative numbers in a field where a number is expected indicates a default value automatically written in.

The lower part of the first screen-form (Figure 2) provides more information on the mineralisation itself. The other bars give access to lower screens with additional information on the **setting** of the mineralisation, estimates of **reserves and resources** (Figure 4), **background** (Figure 5, mostly administrative, audit details), and **additional tables, LUTs and links** (Figure 6).

#### 'Reserve and Resource'

The large field for comments (memo type) is meant for accumulation of information about successive estimates over many dates that can be stored here. The actual date field only refers to the latest addition.

Similarly, the 'production' field should be allowed to keep 'old' estimates, if/when new are added. This also means that such fields (as in many other cases in this database) should contain initials and date for the various comments gradually accumulated in the database.

### **'Background'**

This selection of fields is mostly meant for audit trails – the documentation behind the information. Much of this may not be necessary for the map itself, but the information must be readily available.

### **'Additional tables, LUTS and links'**

These buttons give access to some additional tables, e.g. for storing more than one digital picture (photo or map) from one site. The LUTs can be edited from here and three standard reports can be initiated. One report will print a complete list of all data, the two others will produce a word file that can be edited to become a site description (link to which is stored in the pdf-file attribute) and an excel table, which can be used as input to the standard transfer of data to the mineral occurrence map on the Web, respectively.

## **GIS and Web environment for GMOM**

The GMOM is based on the content of the GMOMDB and the map must be produced in the ESRI ArcView/GIS environment for display in an ArcIMS carried system on the Web. The **Greenland Mineral Occurrence Map** on the Web must provide an interactive environment for the web-user, allowing him/her to choose among a number of features on the map, both backdrops and display of attributes, and using ArcIMS facilities to produce personal versions of the maps. Various elements can be displayed separately or together in ArcIMS and symbols indicating e.g. mineral occurrences can be interrogated via standard ArcIMS tools.

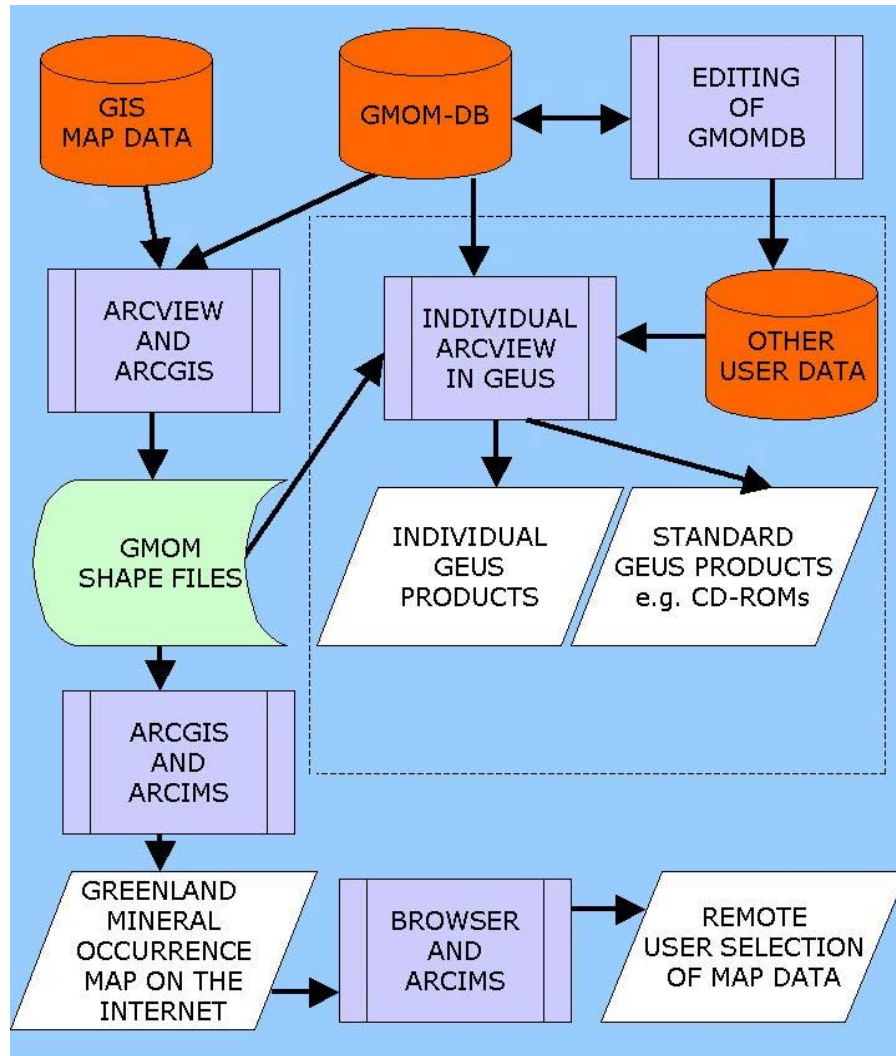
GIS specialists involved must decide upon details in procedures and use of programs used to produce the GMOM. From a simple inside-user point of view the processes necessary to produce the maps can be thought of in the following way:

- Once the required data have been compiled in the GMOMDB, the data can be used in ArcView (or ArcGIS) to build shape files with the mineral occurrence data in (ArcView-)tables and displayed on maps. For much internal work in the department, for combination with other data, and for the production of CD-ROMs, ArcView can be used directly
- For presentation to the outside world via the Web, it is possible subsequently to make the shape files available in an ArcIMS system for wider distribution. The steps from shape files to Arc/MS web map may require expert interaction and perhaps the construction of a few special modules for the sake of an easy process

Another way to envisage the GMOM is to imagine what will become available to a user faced with the map on the web:

- The GMOM will offer a number of map themes that can all be used, some of them in combinations, as backdrops for plots of mineral occurrences
- The mineral occurrence data will be available in a number of layers (views/shapefiles), which the user can switch on or off, and sort or manipulate according to requirements. Those responsible for the data content of the databases will decide the definition of these layers, based on a consensus among the providers of information layers on the quality and relevance of the information for outside users

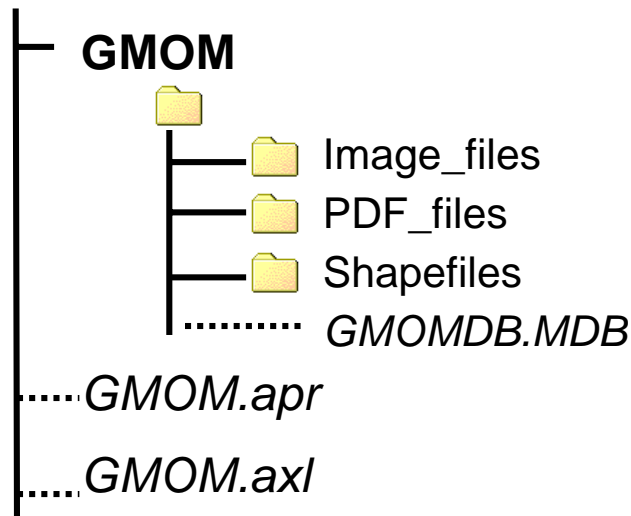
- Using standard ArcIMS facilities, the user can combine data from different shape files into a personal map
- Using the 'info-button', the user can obtain a view of (a selection of) the data in GMOM (as a table shown on-screen in a suitable form)
- Using hotlinks or similar, the user can get access to pdf-documents giving a description of mineralised sites, access to digital photos or illustrations, etc. The hyperlink references to the description files will be in the table and/or attached to the symbol for the site



**Figure 7.** Schematic representation of the system of programs used for the manipulation and presentation of data in the GMOM database on ArcIMS, ArcView or ArcGIS maps.

Because the data will be used in different circumstances, e.g. on the web, internally via ArcView or ArcGIS, on CD-ROMs as a frozen version of the mineral occurrence map, etc., it has been important to find a suitable directory structure that will allow used and referencing in all these different situations. Presently the one in Figure 8 is used. This structure for

the necessary host directories enables portability to both the CD/DVD media and to the Web (-server) environment.



**Figure 8.** Directory structure for the GMOM where the Access-database 'GMOMDB.MDB' is placed in relation to the sublevels 'Image\_files', 'PDF\_files' and 'Shapefiles'. The 'GMOM.apr' is the ArcView GIS project file and 'GMOM.axl' is the ArcIMS project file. The sublevel 'Image\_files' is used for images and the sublevel 'PDF\_files' contains the PDF-files for hot linking both for the 'GMOMDB.MDB' database and for the ArcIMS internet map server.

### Hot linking environment

The PDF-files containing descriptions of mineral occurrences can be hot linked to the symbol for the site, using different techniques depending on whether it happens on the Web via ArcIMS or is done via ArcView GIS for an internal user. The name of the pdf-file can be found in attribute 'PDF\_fi\_sum' in the table in mineral occurrence shape file (or in GMOMDB). The content of this attribute gives the relative path to the PDF-file seen from the active project file (for the Web it is a '.axl' file and for ArcView GIS it is a '.apr' file). Both project files are placed in the directory 'GMOM' (Figure 8), which implies that the relative path to the PDF-file 'MinOcc6.pdf' is

GMOM\PDF\_files\MinOcc6.pdf

The ArcIMS and ArcView GIS only work with full path file names for the PDF-files. To accomplish this full path name, ArcIMS is customised in the file 'ArcIMSParam.js' in 4 lines for 'parameters for setting up hyperlinks in the data display. In ArcView GIS it is done by an Avenue-script (ArcView GIS macro language).

## Views or layers for background

As mentioned previously, in 2003 the geographical target area for the Dynamic Mineral Occurrence Map was limited to the part of West Greenland subjected to the mineral resource assessment to be concluded in 2003 and published in 2004. The limits of the digital maps are 66° – 70° 15' N and 48° - 54° W, but zoom facilities will provide sufficient detail for much smaller map areas.

In ArcIMS it is possible to have several different maps as background for the plotting of symbols related to attributed mineral occurrence data. The Internet user may choose them according to his purpose and/or combine them if it is suitable. Some of the maps can be superimposed on one another and still be readable; others are not suited for this or need to be plotted in a certain order to produce a meaningful backdrop map. The following 'backdrops' have so far been included.

1. Topographical map: In relation to resource assessment program, topographic maps in digital format exist in three different scales (1:100.000, 1:250.000 and 1:500.000); all, however, based on 1:100.000 scale photogrammetric work. For the Web facility, the 1:500.000 version will be used. The themes have been split into well-known elements such as 'coast', 'rivers', 'lakes' etc
2. Major fjords, towns and settlements and names thereof have been adapted to the same scale; they can be switched on/off
3. A suitable geographical grid
4. DEM (digital elevation model) for the area: One exists for the whole area produced from contours created by photogrammetry. This is shown as a bitmap in a suitable colour scale. A more detailed DEM prepared for the HyperGreen survey area can also be made available in the same manner. The grids themselves will not be available
5. Geological map: one is being prepared with assistance from the mapping department. This will be in scale 1:500.000. If possible, it will include separate views of structures, and the lines of polygons, that can be plotted on top of other full colour backgrounds. Probably a special map with faults etc
6. Aerogeophysical maps already exist. A selection of them will be included after consultation with prospective users. The maps will be shown as bitmaps, and the real grids will not be available
7. Gravity map based on KMS/GEUS data; One or two maps showing different types of anomalies will be included. They will be shown as bitmaps and the real grids will not be available
8. Geochemical maps: Probably not all but a few selected maps will be shown as bitmaps; the grids themselves will not be available
9. Concession maps: Probably one for each year will be shown, since and including 1992. They will be shown as polygons, with access to data about the companies holding the licenses
10. Various types of information from the Greenland Metadata Database may be included, subject to further work in 2004

## **Mineral occurrences - attribute display on maps**

'On top' of one or more of these backdrop-maps, can be plotted symbols for mineral occurrences. Technically, the shape files have been constructed in ArcGIS from selections of data in the GMOM database. Eventually it has to be decided how to group the information. Should there be one map (i.e. shape file) with all sites irrespectively of type or commodity, or should there be several groups in separate shape files? One with all precious metals, another with base metals etc. etc.? Should there be different symbols for different commodities? In the prototype only a few examples have so far been included. The options for how to display the mineral occurrences on the map will be evident from the ArcIMS legend to the map; further development will take place in 2004.

The information on which the maps must be based resides in the GMOMDB. Thus, in order to create the maps to display, a number of attributes must be 'transferred' from GMOMDB to the ArcView/GIS environment. There are many standard ways of doing this, but for the present time, GIS experts handle this part of the process. The selection of attributes transferred has already been described above.

The database contains memos (a special Access data type) of texts, but these cannot be transferred to ArcView because of restrictions in this program. (Actually, there are also other restrictions in the ESRI Arc environment, which at this time must be accepted and adapted to). However, by making an Access Report from the GMOMDB, a site description can be produced containing all the necessary information in a clear layout, including long texts, pictures etc. This can of course be printed out directly from the database, but it can also be saved as a word file, which can be edited and polished before storing it as a pdf-file. This pdf-file will be referenced as a hyperlink in the GMOMDB, so the hyperlink file reference can be transferred to ArcView as one of the selected attributes. This is then used to provide hotlinks to the file from an ArcView shape file.

A user of the map on the Web will be able to see all the attributes of a mineralised site as a table displayed in some form of suitable layout on the screen.

The GMOMDB database contains many 'no data' entries. On purpose, this entry has been chosen rather than a 'nul-string' or similar, because it is a clear signal to the user. Probably, this entry should also be displayed to the Web-user, which means that the table shown on-screen will always have the same attributes, although the length of the entries may vary.

Using the GMOM database and the Mineral Occurrence Map should not demand more than a general user training in the composite programs Access 2000, ArcView (ArcGIS) and ArcIMS in a browser environment.

## **Examples of ArcIMS maps**

The following examples have been caught from a full-screen display of the GMOM as it appears in a standard Microsoft Internet Browser.

In Figures 9 – 14 on the following pages, different screen copies taken from the prototype GMOM facility running in ArcIMS from the departmental server, illustrate some of the uses of the GMOM.

In Figure 9 can be seen a typical opening screen, reached by writing the correct address into the file field of MS Internet Browser. The layout of the screen image is designed in Ar-



cIMS. The user from any site on the Internet will have access to the Greenland Mineral Occurrence Map with ArcIMS tool bars (upper and left edge of screen), index map (upper left), the active map itself, list of layers or legend (right segment of screen) and a segment for display of data and information. The final GMOM screen may come to look different and may contain additional facilities, as e.g. links to further explanations.

In Figure 10 the user has zoomed in to an area of interest, switched the display of layers to a legend for the particular map, where the mineral occurrences are symbolised according to commodity. In Figure 11 the ArcIMS 'i' facility (tools to the left side of the screen) has been used to click on a site and display the description of the mineral occurrence. In Figure 12 it can be seen that the site descriptions may contain photos and maps as well as the text. In Figure 13, the user has zoomed to a different area and switched on a different layer showing the occurrences symbolised according to how they are formed. Finally, in Figure 14, the user has displayed the table information (a subset of content in GMOMDB) and by clicking on the content of the hotlink shown in the table (lower right), has displayed the mineral occurrence description.

In future versions more background maps will become available, so that e.g. the mineral occurrence data can be superimposed on a geophysical or geochemical map. Many additional layers are being considered and can be added in 2004.

It is the intention to create a target web-page, which can be used as a link on e.g. the BMP and GEUS web page. Arriving to this 'Welcome to GMOM' target page, the user will be given a number of possible choices, probably by clicking on a index map of Greenland showing the datasets that can be approached and inspected by use of this facility.

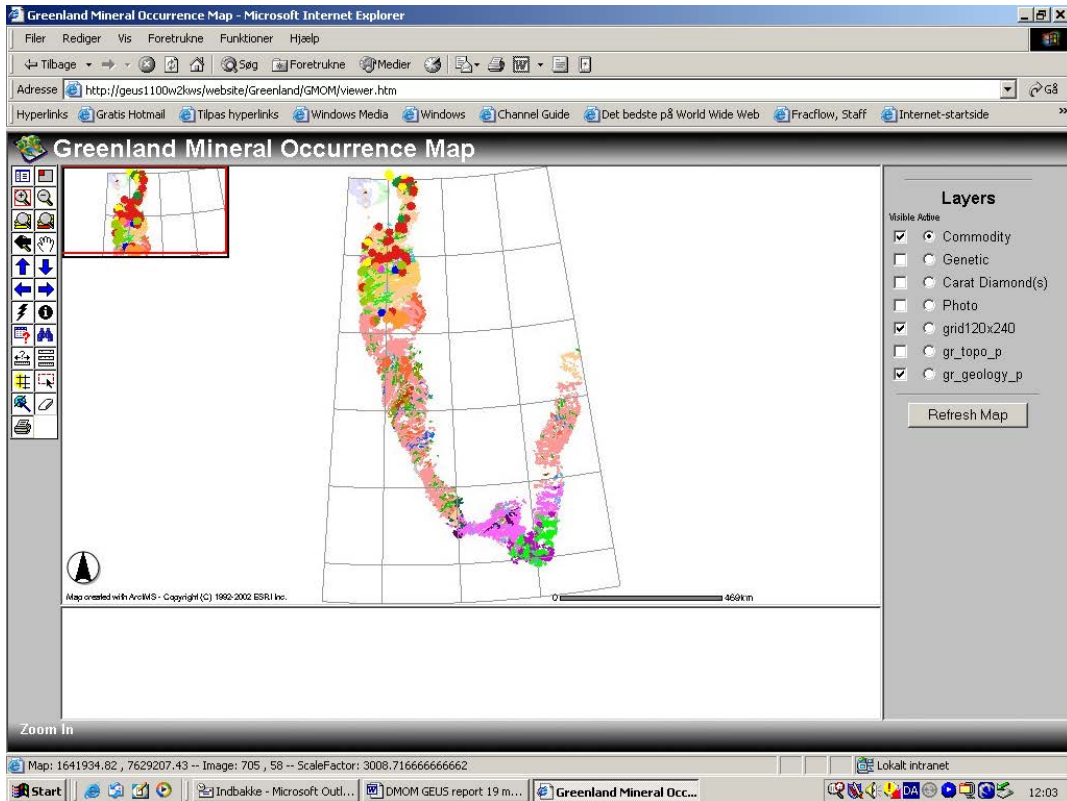


Figure 9. Opening page of proto-type of GMOM on the department server. See text.

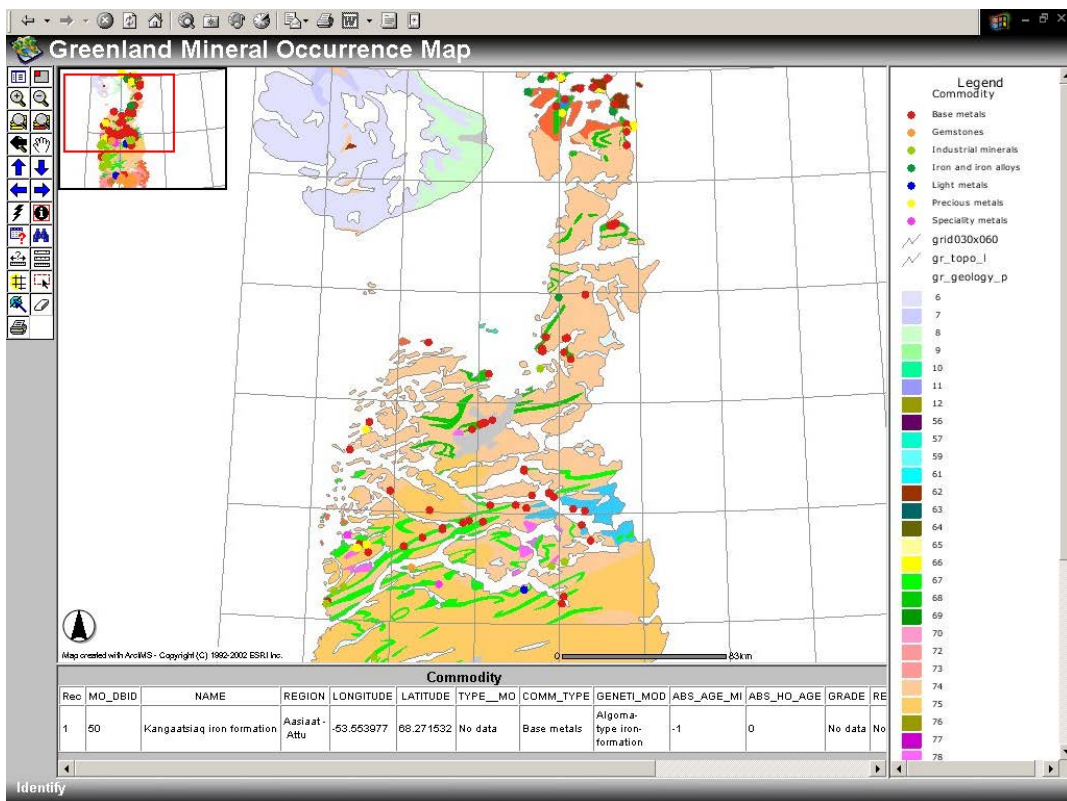


Figure 10. Full screen display, zoom to area of interest, attributes and display of legend.

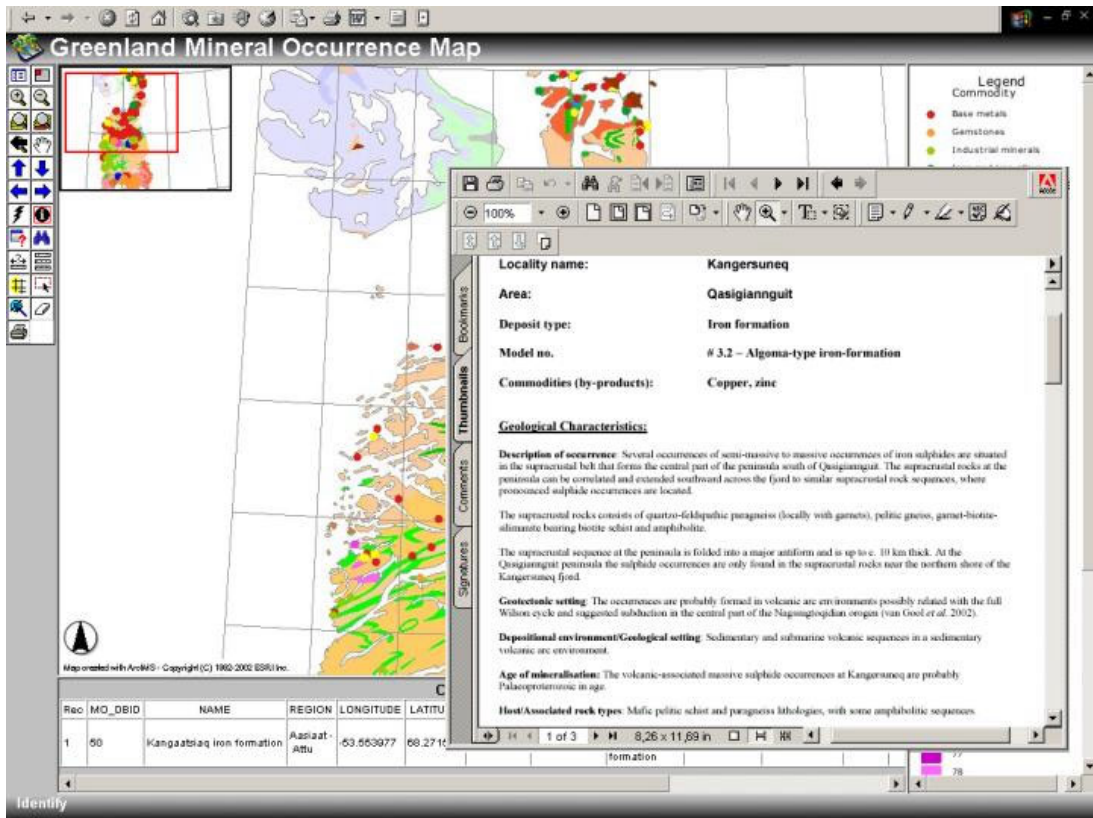


Figure 11. The ArcIMS 'i' facility has been used to open file with description of a site.

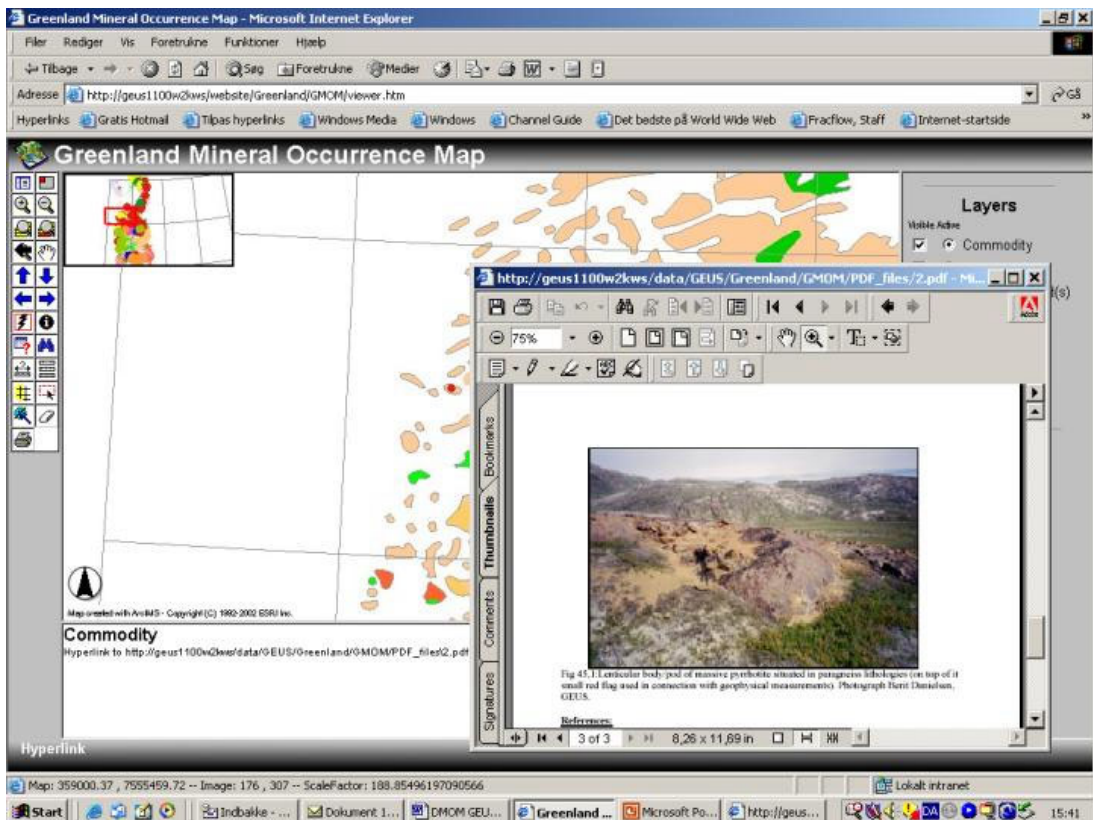


Figure 12: Descriptions may contain photos and maps; or these may be linked directly.

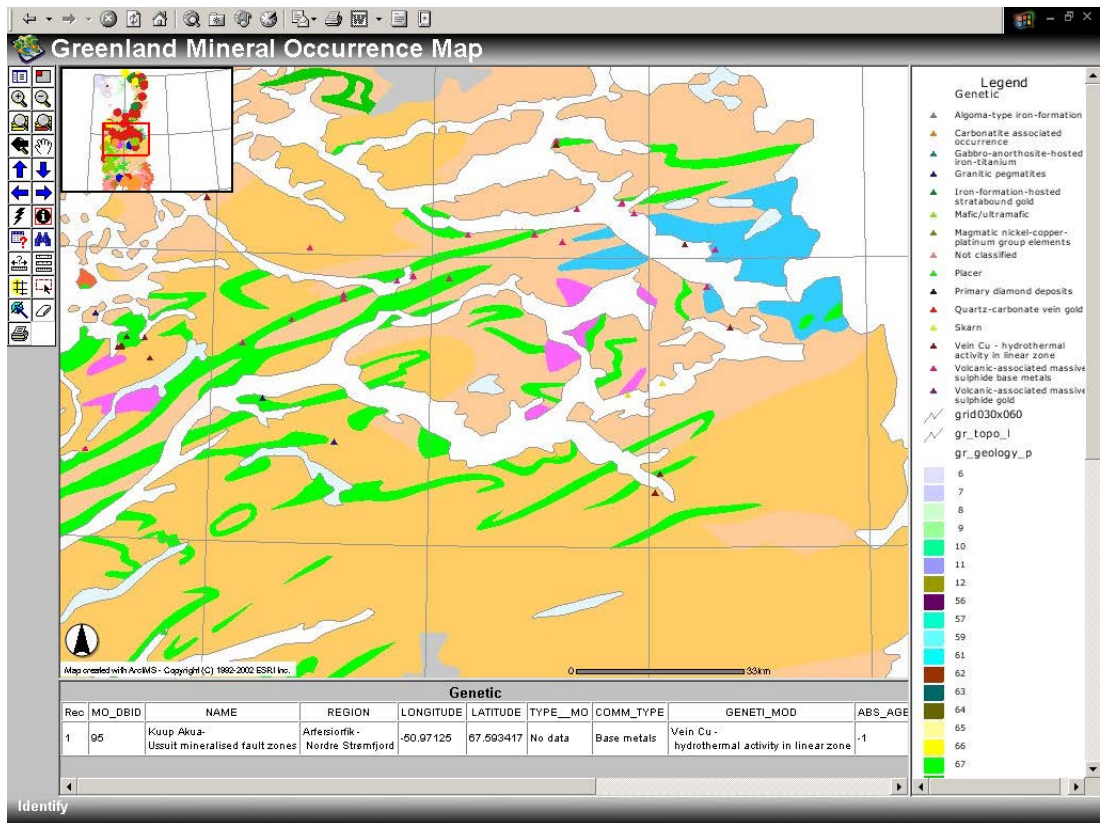


Figure 13. Zoom to another area of interest on different map showing genetic information.

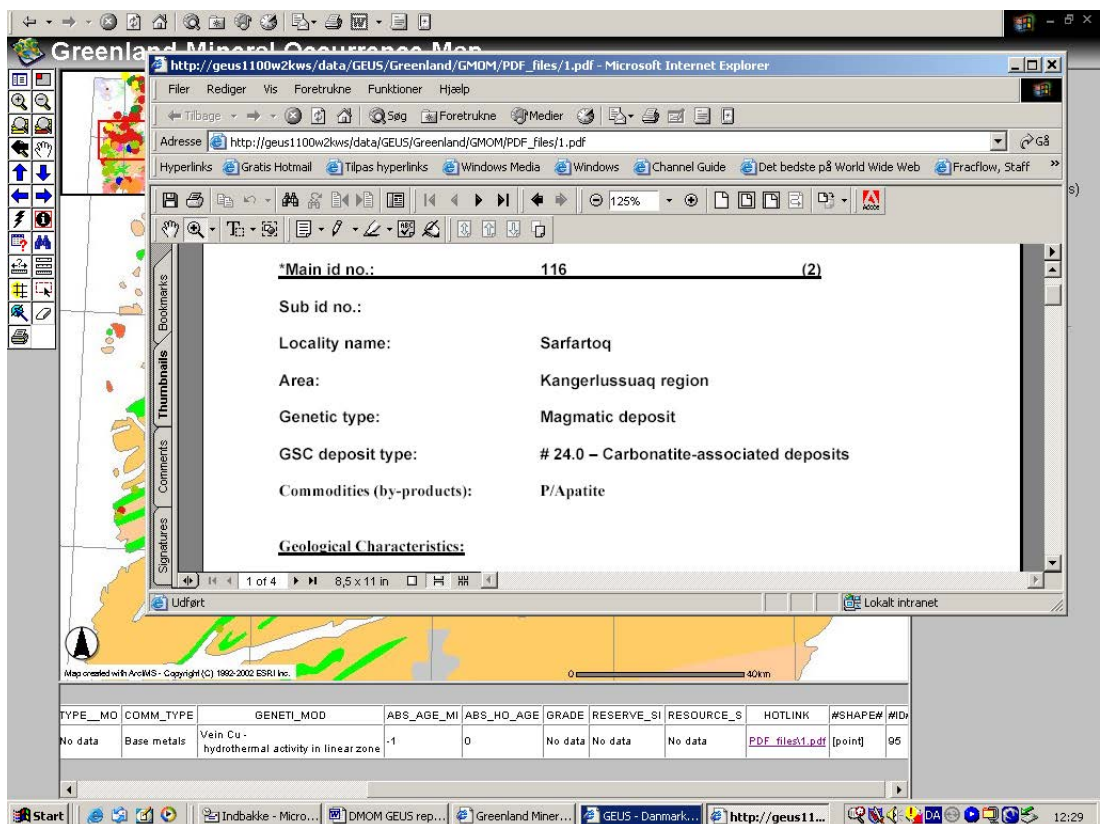


Figure 14. Description opened via click on the hotlink in the table displayed on-screen.

## Implementation plan

The prototype for the Greenland Mineral Occurrence Map developed in 2003 has been installed on a departmental server for testing. This means that all employees with access to the departmental server and visiting co-workers from the Bureau of Minerals and Petroleum will have the opportunity to try out the GMOM before it is generally released. Based on the results of the test period, which will probably last a few months, the version to be released to the public can be improved.

In 2004, the work is expected to progress along the following main avenues of development:

1. Definition, testing and implementation of the technical set-up of the system on a server, which can be the host for the GMOM reachable from outside the Ministry's firewall. This includes planning the routines for regular up-dates of the map. The timing will depend on when the project can be initiated in 2004 but it will hopefully be possible to present the web-facility autumn 2004, using the data from central West Greenland.
2. Fine-tuning of the GMOMDB and its data from the mineral resource assessment programme for central West Greenland. This includes modifications required after the testing and perhaps addition of a few especially constructed tools.
3. Continued discussion and development of the concepts for presentation of mineral occurrence data and the use of these for the construction of metallogenetic maps. This includes the writing of notes and accessory texts to be linked to the web site for explanation and guidance in how to understand and use the data published on the site.
4. Expansion of the area covered by the map; ideally this should be all of Greenland at some point, but precisely how much can be accomplished in 2004 depends on other projects, timing and the total capacity of the group involved.
5. A final report will be produced giving a brief account of the project and providing user hints.

## **Acknowledgements**

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## Appendix 1: Detailed list of attributes

This appendix contains a list of attributes for the three tables that make up the Mineral Occurrence Map database forming the basis for the mineral occurrence map. In the 'Type'-column the appropriate Access attribute type is given. As one of the following: Text, Note, Number (Integer or real), date&time, valuta, auto number, Yes/No, OLE-object, Hyper link, look up. Further details such as validation rules, standard values etc. are defined in the database, but in this list are only approximately described in the 'Comments and notes' column. The Attribute-short column give the name of the attribute fitted within the maximum length of the string allowed in ArcView.

### Table (Mineral Occurrence Map) - main table

Please note that attributes added after 8 August 2003 have been given successive numbers from MO45 and up, but they have been placed in the table where it is logical according to the content of the attribute. The highest number is now MO52.

Attrb No.	Attribute name	Attribute - short	Definition	Type	Comments
MO1	<u>MO-dbid</u>	MO-dbid	Unique identifier given automatically by db	Integer, auto-number	Primary Key; can be referred to as GMOM record number. No default!
MO2	<u>Name</u>	Name	The name of the locality of the mineral occurrence or of the mine	Text	New Greenlandic spelling; default value <i>No data</i>
MO51	<u>Type locality is</u>	Ty_lo_	This record is a type locality for the MO1's listed in this attribute Note that alternative definitions are being considered in 2004	Text	Default value: -1 means this site is not part of a group with a site nominated as type locality
MO3	<u>GEUS site no</u>	GEUS_no	GEUS locality number if relevant	Text	default value <i>No data</i>
MO4	<u>Status</u>	Status	Status of confidentiality	Text	LUT (status); default <i>No data</i>
MO5	<u>Release date</u>	Relea_date	Date when info becomes open	Date	Default <i>1-1-1700</i>
MO6	<u>Commune</u>	Commune	The official 'kommunenavn'	Text	LUT (Kommuner); default <i>No data</i>
MO7	<u>Region</u>	Region	Region according to GEUS definition	Text	LUT (Regions). Default <i>No data</i> .
MO8	<u>Longitude of site</u>	Longitude	Longitude in decimal degrees west of Greenwich	Real	Default value <i>longitude of lower right corner, -1</i> . Check in Greenland range 1 W to 42 W. Must be in datum



Attrb No.	Attribute name	Attribute - short	Definition	Type	Comments
					WGS1984
MO9	<u>Latitude of site</u>	Latitude	Latitude in decimal degrees north of equator	Real	Default value <i>latitude of lower left corner, 58</i> . Check in Greenland range 58 N to 83 N
MO10	<u>Altitude</u>	Altitude	Height in meters above sea level	Real	Check >=-1; default value -1
MO45	<u>New Georef</u>	New_Georef	A flag to indicate if the lat, long, altitude is in the required wgs84 etc system (y) or not (n)	Y/N	Can be used to quickly find sites in need of correction of position.
MO11	<u>Method &amp; Datum</u>	Method	Method used and Datum for the position	Text	A text by the user defining the background parameters for the position. Default: <i>No data</i>
MO12	<u>GREENMIN sub case no</u>	GREEN_s_nr	The GREENMIN locality number	Text	GREENMIN sub-case number; default value <i>No data</i> .
MO13	<u>Type of MO</u>	Type_MO	Main type of MO	Text	LUT (MO types); default value <i>No data</i>
MO14	<u>Commodity type</u>	Comm_type	Main type of commodity	Text	LUT (Commodity type): default <i>No data</i>
MO15	<u>Commodity 1</u>	Commodit_1	The main commodity of interest	Text	LUT (Commodity); default value <i>No data</i>
MO16	<u>Commodity 2</u>	Commodit_2	The second most important commodity	Text	LUT (Commodity); default value <i>No data</i>
MO17	<u>Commodity 3</u>	Commodit_3	The third most important commodity	Text	LUT (Commodity); default value <i>No data</i>
MO18	<u>Additional commodities</u>	Add_commod	Any additional ones required	Text (list separated by ", ")	Using a LUT and adding on commodities to the field to form a list
MO19	<u>Ore Descript</u>	Ore_Desc	Used to describe the ore with terms such as massive, semimassive, etc.	Text	LUT(ore descript)
MO52	<u>Ore Desc text</u>	Ore_Desc_t	Description of the ore minerals, textures etc.	Memo	Can be a note containing any information, including mineralogy, ore and gangue, shape, size etc. Start memo with Name/Initials and date of summary; default value <i>No data</i>
MO20	<u>Geological</u>	Geologl_set	Description of any factors in	Memo	Start with Name/initials

Attrb No.	Attribute name	Attribute - short	Definition	Type	Comments
	<u>setting of MO</u>		the geological setting		of author and date of summary: description of the geological setting of MO; default value <i>No data</i>
MO21	<u>Genetic model (International)</u>	Geneti_mod	Authorised genetic model	Text	LUT (international genetic model); default value <i>No data</i>
MO22	<u>Greenland genetic model</u>	Pre_gen_m_o	Greenland genetic model as defined in GREENMIN	Text	LUT (Greenland genetic model) default value <i>No data</i>
MO23	<u>Abs age min</u>	Abs_age_m_i	Age of mineralisation	Real	Result of dating; default value <i>-1</i> ;
MO46	<u>Min age uncertainty</u>	Min_age_un	Uncertainty in determined age of mineralisation	Real	Here must be room for the usual +/- uncertainty. Default value 0
MO24	<u>Dating method for mineralisation</u>	Dat_method	Method used for dating of the mineralisation	Text	LUT from GREENMIN
MO25	<u>Rel age min</u>	Rel_age_mi	Eon, Era, Period age of mineralisation	Text	LUT (Strat Chart); default value <i>No data</i> e.g. Tertiary, Cretaceous. etc.
MO47	<u>Abs Host age</u>	Abs_ho_age	Absolute date of host rocks	Real	As for mineralisation age
MO48	<u>Host age uncertainty</u>	Ho_age_un_c	The uncertainty in age determination of host	Real	As for mineralisation age; +/-
MO49	<u>Dating method for host</u>	Da_met_ho_s	Method used for dating host rocks	Text	As for mineralisation age
MO26	<u>Rel age host</u>	Rel_age_ho	Eon, Era, Period age of host rock	Text	LUT (Strat Chart); default value <i>No data</i> e.g. Tertiary, cretaceous. etc.
MO27	<u>Production</u>	Production	Production from the site to date	Memo	Start with initials and date; give production an any explanatory text and citation of Ref; default <i>No data</i>
MO28	<u>History</u>	History	A note of the history of exploration and exploitation of the site	Memo	Start with initials and date; default <i>No data</i>
MO29	<u>Comments</u>	Comments	Any comments	Memo	Start with initials and date; default <i>No data</i>
MO30	<u>Reserve type</u>	Reserve_ty	Type of reserve	Text	LUT (Reserve Type); default value <i>No data</i>
MO31	<u>Grade</u>	Grade	Grade description	Text	Grade can be in different units or for different substances;

Attrb No.	Attribute name	Attribute - short	Definition	Type	Comments
					therefore a text, not a number; default value <i>No data</i> ;
MO32	<u>Reserve date</u>	Reserve_da	The date of reserve calculation	Date	default value 1-1-1700
MO33	<u>Reserve size</u>	Reserve_si	The size of the reserve	Text	Text, because units etc vary. default value <i>No data</i>
MO34	<u>Resource date</u>	Resource_d	The date of the identified resource estimate	Date	default value 1-1-1700
MO35	<u>Resource size</u>	Resource_s	The size of the identified resource	Text	USGS classification; default value <i>No data</i>
MO36	<u>GREENMIN DB id no</u>	G_DB-id_no	Unique reference to GREENMIN reference entries	Text	default value <i>No data</i>
MO37	<u>Reference</u>	Reference	Reference of any kind	Text	Write according to GEUS standard default value <i>No data</i>
MO38	<u>Digital photo</u>	Dig_photo	File name of one digital photo	Hyperlink	default value <i>No data</i> (or the name of a standard picture saying the same)
MO39	<u>Digital map and figure</u>	Digi_map	File name of one digital map or figure	Hyperlink	default value <i>No data</i> (or the name of a standard picture saying the same) Note, additional images or maps can be entered in special table, see below.
MO50	<u>PDF-file summary</u>	PDF_fi_sum	A summary produced from info in database or other sources	Hyperlink	Based on the content of the database, a predefined report can be generated as word-file, perhaps to be edited before being stored as PDF file. The resultant PDF file is stored with this name in the directory defined for this.
MO40	<u>GEUS classification A</u>	GEUS_cla_A	Classification according to UN classification for economic significance	Integer	default value 0 meaning no score assigned. Otherwise three-digit code according to UN suggested scheme.
MO41	<u>GEUS classification B</u>	GEUS_cla_B	Degree of investigation	Integer	default value 0 meaning no data; 1 is reconnaissance and 5 detailed study. LUT!
MO42	<u>Last modifica-</u>	Last_modi	Date for latest editing or	Date	default value <i>No data</i>

Attrb No.	Attribute name	Attribute - short	Definition	Type	Comments
	<u>tion</u>		modification of record		
MO43	<u>Original compiler</u>	Modi_by	Name of user who compiled the first entry for this record.	Text	LUT (Users); default value <i>No data</i>
MO44	<u>R comment</u>	R_comment	Comments about reserve and resource estimates	Text	Any comments

## Table (Additional images)

If the two standard images in the main table are not sufficient, more images can be added to the database, but information about them is stored in a special table.

No	Attribute	Short	Definition	Type	Comments
IM1	<u>Imag_id</u>		Unique identification of each image in the image table (generated by database)	Integer; Primary Key	Unique; generated by db
IM2	<u>IMMO_ID</u>		Reference to the mineral occurrence for which this image is relevant	Foreign Key MO1	LUT (Mineral occurrences - main); records can only be entered into this table if MO1 for the mineral occurrence already exists in the main table. Default: <i>No data</i>
IM3	<u>Imag_Typ</u>		Description of Image Type	LUT	LUT of different types, e.g. scanned map, photo, sketch Default: <i>No data</i>
IM4	Imag_Txt		A descriptive text to the image	Memo	Free text; should be thought of as text to a figure, legend to a map, etc. Default: <i>No data</i>
IM5	Imag_Inf		A specification of technical details	Memo	Free text; formats (TIF, JPG, etc), resolution etc. Default: <i>No data</i>
IM6	I_Source		The source of the image	Char	Free text Default: <i>No data</i>
IM7	I_Cright		The correct copyright statement	Char	Free text Default: <i>No data</i>
IM8	Image		The name (address) of the file containing the image	Hyper-link	
IM9	Comments		Any other comments	Memo	Free text; default: <i>No data</i>
IM10	Frst_Ent		Date/time for the first entry of this record into the database	Date/time	Generated by database or entered by user?
IM11	Na_F_Ent		Name of the person who is responsible for the first entry of	LUT	A LUT of Users must be constructed con-

			this record		taining those authorised to enter data into the database.
--	--	--	-------------	--	---

## Table (Database log)

Instead of having the housekeeping attributes as part of each record in the main table, it is possible to arrange for all information of this type to be stored in one particular table created for this very purpose. The events will be recorded in the following table. There is meant to be one entry per session of use. This facility is not yet implemented and will be part of the 2004 test run. Further deliberation on this subject will take place in 2004.

Attr no	Attribute name	Attribute - short	Definition	Type	Comments
DL1	<u>DL-dbid</u>		Unique identifier given automatically by db	Integer, auto-number	Primary Key; can be referred to as database event number
DL2	<u>C-Name</u>		The name of the compiler or user	Text	LUT (Users); Default value <i>No data</i>
DL3	<u>Operation type</u>		The type of operation performed	Text	LUT (Operation Type); default <i>No data</i>
DL4	<u>Operation description</u>		Description of what the user did in this session	Text	Free text by user describing actions in the session; default <i>No data</i>
DL5	<u>TableName</u>		The table or LUT which was the objective for the operation	Text	LUT (tables); default value <i>No data</i>
DL6	<u>Data and time</u>		Date and time for the operation	Text	Default value <i>No data</i>  Can this be generated by database at the time of entry?

## Appendix 2: Look Up Tables (LUT)

So far the following LUTs have been mentioned and are required. Normally, all columns in the LUT must be shown when activated at the field of an attribute, except the first one, which is only there to ensure a certain order of the rows. The column in bold contains the value that are to be returned as entries to the field. If present, other columns are meant as additional information to the user at the time of entry.

Note, that the text returned to the field is the full text, not the code. This is to make it easier for the not-to-frequent user to use the database.

### LUT (MO types)

This contains a description of the **type of mineral occurrence**. The LUT contains two columns, where the first is an integer number ('autonumber'), which will ensure a fixed order of the values in the second column. The second column is the value that will be entered into the data field. On look up from a screen, only the second column is visible.

0	<b>No data</b>
10	<b>Indication</b>
20	<b>Showing</b>
30	<b>Prospect</b>
40	<b>Deposit</b>
50	<b>Mine</b>
60	<b>Mine, closed</b>

### LUT (Confidentiality Status)

This contains a description of the various predefined possibilities for confidentiality status of the information in the record.

0	<b>No data</b>
10	<b>Confidential</b>
20	<b>Confidential company data</b>
30	<b>Confidential GEUS data</b>
40	<b>Confidential mixed source</b>
50	<b>Open file data</b>
60	<b>From the Literature</b>

### LUT (Commune)

This LUT contains a list of official names of communes in Greenland (source SMJ). There is still some editing to do (e.g. merging of SISK and KATK). GIS based function may later

give another method of defining which commune a given position is in. The column in fat type will be entered into the database.

010	NANK	<b>Nanortallip Kommunia</b>	Nanortalik
020	QAQK	<b>Qaqortup Kommunia</b>	Qaqortoq
030	NARK	<b>Narsap Kommunia</b>	Narsaq
040	IVIK	<b>Ivittuut Kommuniat</b>	Kangilinnguit
050	PAAK	<b>Paamiut Kommuniat</b>	Paamiut
060	NUUK	<b>Nuup Kommunea</b>	Nuuk
070	MANK	<b>Maniitsup Kommunia</b>	Maniitsoq
080	SISK	<b>Sisimiut Kommuniat</b>	Sisimiut
090	KATK	<b>Kangaatsiap Kommunia</b>	Kangaatsiaq
100	AASK	<b>Aasiaat Kommuniat</b>	Aasiaat
110	QASK	<b>Qasigiannnguit Kommuniat</b>	Qasigiannnguit
120	ILUK	<b>Ilulissat Kommuniat</b>	Ilulissat
140	QEQK	<b>Qeqertarsuup Kommunia</b>	Qeqertarsuaq
150	UUMK	<b>Uummannap Kommunia</b>	Uummannaq
160	UPVK	<b>Upernaviup Kommunia</b>	Upernavik
170	AVAK	<b>Avanersuup Kommunia</b>	Qaanaaq
180	AMMK	<b>Ammassallip Kommunia</b>	Tasiilaq
190	ILTK	<b>Illoqqortoormiut Kommuniat</b>	Illoqqortoormiut
200	KOAT	<b>Kommuneqarfiit avataanni</b>	

## LUT (Region)

This LUT contains a list of the regions of Greenland according to the definitions used in e.g. most GEUS publications from Greenland and usually shown in publication as an index map. These are the official names, which must be used in publications and reports.

0	<b>No data</b>
1	<b>Greenland</b>
2	<b>Western North Greenland</b>
3	<b>Central North Greenland</b>
4	<b>Eastern North Greenland</b>
5	<b>North-West Greenland</b>
6	<b>Central West Greenland</b>
7	<b>Southern West Greenland</b>
8	<b>South-West Greenland</b>
9	<b>South Greenland</b>
10	<b>South-East Greenland</b>
11	<b>Southern East Greenland</b>
12	<b>Central East Greenland</b>
13	<b>North-East Greenland</b>

## LUT (Commodity type)

0	<b>No data</b>	
---	----------------	--

10	<b>Precious metals</b>	Au, Ag, PGE
20	<b>Base metals</b>	Cu, Pb, Zn
30	<b>Light metals</b>	Al, Mg, Ti
40	<b>Iron and iron alloys</b>	Fe, Mn, Cr, Ni, Co, Mo, W, V
50	<b>Minor metals and non-related non-metals</b>	REE, Y, Zr, Li, Be, As, Bi, Sb, Cd, Ga, Hg
60	<b>Fissionable minerals</b>	U, Th
70	<b>Industrial minerals</b>	Apatite, graphite, olivine etc.
80	<b>Gemstones</b>	

## LUT (Commodity)

The following list has been taken from the USGS web site and seems fulfilling for Greenland

0		<b>No data</b>
10	AG	<b>Silver</b>
20	AL	<b>Aluminum, general</b>
30	AL1	<b>Bauxite</b>
40	AL2	<b>Alumium, other</b>
50	AL3	<b>Alunite</b>
60	ALM	<b>Alum</b>
70	AND	<b>Andalusite</b>
80	AS	<b>Arsenic</b>
90	ASB	<b>Asbestos</b>
100	AU	<b>Gold</b>
110	B	<b>BORON – Borates</b>
120	BA	<b>Barium – Barite</b>
130	BE	<b>Beryllium</b>
140	BI	<b>Bismuth</b>
150	BIT	<b>Bitumens (Asphalt)</b>
160	BR	<b>Bromine</b>
170	BRI	<b>Brines-Salines</b>
180	C	<b>Carbon</b>
190	CA	<b>Calcium</b>
200	CAR	<b>Carbonates</b>
210	CD	<b>Cadmium</b>
220	CE	<b>Cerium</b>
230	CER	<b>Cement rock (natural)</b>
240	CHL	<b>Chlorite</b>
250	CL	<b>Chlorine</b>
260	CLY	<b>Clay, general</b>
270	CIY1	<b>Bentonite</b>
280	CLY2	<b>Fuller's earth</b>
290	CLY3	<b>Kaolin</b>
300	CLY4	<b>Clay, ball</b>
310	CLY5	<b>Clay, fire (refractory)</b>
320	CLY6	<b>Bloating material</b>
330	CLY7	<b>Clay, common brick</b>



340	CO	<b>Cobalt</b>
350	CO2	<b>Carbon Dioxide</b>
360	COA	<b>Coal</b>
370	COA1	<b>Coal, Anthracite</b>
380	COA2	<b>Coal, Butumineous</b>
390	COA3	<b>Coal, Sub-bitumineous</b>
400	COA4	<b>Lignite</b>
410	COLL	<b>Collectible</b>
420	COR	<b>Corundum</b>
430	CR	<b>Chromium</b>
440	CS	<b>Cesium</b>
450	CU	<b>Copper</b>
460	DIA	<b>Diamond</b>
470	DIT	<b>Diatomite</b>
480	DOL	<b>Dolomite, general</b>
490	DOL1	<b>Dolomite, ultra pure</b>
500	DOL2	<b>Dolomite, high magnesian</b>
510	EMY	<b>Emery</b>
520	EVA	<b>Evaporites</b>
530	F	<b>Fluorine – Flourite</b>
540	FE	<b>Iron</b>
550	FLD	<b>Feldspar</b>
560	FLN	<b>Flint</b>
570	GA	<b>Gallium</b>
580	GAR	<b>Garnet</b>
590	GAS	<b>Gas, natural</b>
600	GE	<b>Germanium</b>
610	GEM	<b>Gemstones</b>
620	GEM1	<b>Precious gems</b>
630	GEM2	<b>Semi-precious gems</b>
640	GEO	<b>Geothermal</b>
650	GLA	<b>Glauconite</b>
660	GRF	<b>Graphite</b>
670	GRT	<b>Granite</b>
680	GYP	<b>Gypsum, Anhydrite</b>
690	HAL	<b>Halite</b>
700	HE	<b>Helium</b>
710	HG	<b>Mercury</b>
720	I	<b>Iodine</b>
730	IN	<b>Indium</b>
740	IR	<b>Iridium</b>
750	K	<b>Potassium</b>
760	KYN	<b>Kyanite</b>
770	LA	<b>Lanthanum</b>
780	LAT	<b>Laterite</b>
790	LI	<b>Lithium</b>
800	LST	<b>Limestone, general</b>
810	LST1	<b>Limestone, ultra pure</b>
820	LST2	<b>Limestone, high Calcium</b>
830	LWA	<b>Light-weight Aggregate</b>
840	MBL	<b>Marble</b>
850	MG	<b>Magnesium (Brucite)</b>
860	MGS	<b>Magnesite</b>
870	MIC	<b>Mica</b>

880	MIC1	<b>Mica, sheet</b>
890	MIC2	<b>Mica, scrap</b>
900	MIC3	<b>Mica, flake</b>
910	MN	<b>Manganese</b>
920	MO	<b>Molybdenum</b>
930	MON	<b>Monazite</b>
940	MPG	<b>Mineral Pigments</b>
950	N	<b>Nitrogen – Nitrates</b>
960	NA	<b>Sodium</b>
970	NACO	<b>Sodium Carbonate</b>
980	NASO	<b>Sodium Sulfate</b>
990	NB	<b>Niobium (Columbium)</b>
1000	NI	<b>Nickel</b>
1010	OI	<b>Osmiridium (Osmium+Iridium)</b>
1020	OIL	<b>Petroleum (Oil)</b>
1030	OLV	<b>Olivine</b>
1040	OS	<b>Osmium</b>
1050	P	<b>Phosphorus – Phosphates</b>
1060	PB	<b>Lead</b>
1070	PD	<b>Palladium</b>
1080	PEA	<b>Peat</b>
1090	PER	<b>Perlite</b>
1100	PGM	<b>Platinum group metals</b>
1110	PT	<b>Platinum</b>
1120	PU	<b>Pumice</b>
1130	PYF	<b>Pyrophyllite</b>
1140	PYR	<b>Pyrite</b>
1150	PYR1	<b>Pyrrhotite</b>
1160	QTZ	<b>Quartz</b>
1170	RA	<b>Radium</b>
1180	RAM	<b>Radio-active elements</b>
1190	RB	<b>Rubidium</b>
1200	RE	<b>Rhenium</b>
1210	REE	<b>Rare Earths elements</b>
1220	REF	<b>Refractory</b>
1230	RH	<b>Rhodium</b>
1240	RU	<b>Ruthenium</b>
1250	S	<b>Sulphur</b>
1260	SAM	<b>Sand, molding</b>
1270	SAO	<b>Oil sands</b>
1280	SAP	<b>Saprolite</b>
1290	SB	<b>Antimony</b>
1300	SC	<b>Scandium</b>
1310	SDG	<b>Sand and gravel</b>
1320	SE	<b>Selenium</b>
1330	SEA	<b>Sea water</b>
1340	SHL	<b>Shale</b>
1350	SHO	<b>Oil shale</b>
1360	SIL	<b>Silica</b>
1370	SLA	<b>Slate</b>
1380	SLF	<b>Sulfuric acid</b>
1390	SN	<b>Tin</b>
1400	SO4	<b>Sulfate</b>
1410	SR	<b>Strontium</b>

1420	SST	<b>Sandstone</b>
1430	STA	<b>Staurolite</b>
1440	SST	<b>Stone</b>
1450	STN1	<b>Stone, crushed</b>
1460	STN2	<b>Stone, dimension</b>
1470	STN3	<b>Flagstone</b>
1480	SUL	<b>Sulfides</b>
1490	TA	<b>Tantalum</b>
1500	TE	<b>Tellurium</b>
1510	TH	<b>Thorium</b>
1520	TI	<b>Titanium</b>
1530	TL	<b>Thallium</b>
1540	TLC	<b>Talc – soapstone</b>
1550	TRA	<b>Travertine</b>
1560	U	<b>Uranium</b>
1570	V	<b>Vanadium</b>
1580	VOL	<b>Volcanic materials</b>
1590	VRM	<b>Vermiculite</b>
1600	W	<b>Tungsten</b>
1610	WOL	<b>Wollastonite</b>
1620	YB	<b>Ytterbium</b>
1630	ZEO	<b>Zeolites</b>
1640	ZN	<b>Zinc</b>
1650	ZR	<b>Zirconium</b>

## LUT (Ore description)

This LUT contains a number of often-used terms to describe the ore. Similar to GREENMIN LUT.

1	GREENMIN code	Full text in GMOMDB
10	LEN	<b>Lenticular</b>
20	VEI	<b>Vein</b>
30	STO	<b>Stockwork</b>
40	POR	<b>Porphyry</b>
50	PIP	<b>Pipe</b>
60	IGN	<b>Igneous</b>
70	SKA	<b>Skarn</b>
80	PEG	<b>Pegmatite</b>
90	STR	<b>Stratabound</b>

## LUT (International genetic model)

This is a description of the most likely genetic type according to common consent; the source of the list is Eckstrand et al. (eds), 1995.

0	0	No data
10	1.0	Placer uranium, gold
20	1.1	Palaeoplacer
30	1.2	Placer
40	2.0	Statiform phosphate
50	3.0	Stratiform iron
60	3.1	Lake Superior-type iron formation
70	3.2	Algoma-type iron-formation
80	3.3	Ironstones
90	4.0	Residually enriched deposits
100	4.1	Enriched iron-formation
110	4.2	Supergene base metals and precious metals
120	5.0	Evaporites
130	6.0	Exhalative base metal sulphides
140	6.1	Sedimentary exhalative sulphides (Sedex)
150	6.2	Sedimentary nickel sulphides
160	6.3	Volcanic-associated massive sulphide base metals
170	6.4	Volcanic-associated massive sulphide gold
180	7.0	Unconformity-associated uranium
190	8.0	Stratabound clastic-hosted uranium, lead, copper
200	8.1	Sandstone uranium
210	8.2	Sandstone lead
220	8.3	Sediment-hosted stratiform copper
230	'8.3a	Kupferschiefer-type
240	'8.3b	Redbed-type
250	9.0	Volcanic redbed copper
260	10.0	Mississippi Valley-type lead-zinc
270	11.0	Ultramafic-hosted asbestos
280	12.0	Volcanic-associated uranium
290	13.0	Vein uranium
300	14.0	Arsenide vein silver, cobalt, uranium
310	15.0	Lode gold
320	15.1	Epithermal gold
330	15.2	Quartz carbonate vein gold
340	15.3	Iron-formation-hosted stratabound gold
350	15.4	Disseminated and replacement gold
360	16.0	Clastic metasediment-hosted vein silver-lead-zinc
370	17.0	Vein copper
380	18.0	Vein-stockwork tin, tungsten
390	19.0	Porphyry copper, gold, molybdenum, tungsten, tin, silver
400	20.0	Skarn deposit
410	20.1	Skarn zinc-lead-silver
420	20.2	Skarn copper
430	20.3	Skarn gold
440	20.4	Skarn iron
450	20.5	Skarn tungsten
460	21.0	Granitic pegmatites
470	22.0	Kiruna/Olympic Dam-type iron, copper, uranium, gold, silver
480	23.0	Peralkaline rock-associated rare metals
490	24.0	Carbonatite-associated deposits
500	25.0	Primary diamond deposits
510	25.1	Kimberlite-hosted diamond
520	25.2	Lamproite-hosted diamond
530	26.0	Mafic intrusion-hosted titanium-iron

540	26.1	<b>Anorthosite-hosted titanium-iron</b>
550	26.2	<b>Gabbro-anorthosite-hosted iron-titanium</b>
560	27.0	<b>Magmatic nickel-copper-platinum group elements</b>
570	27.1	<b>Nickel-copper sulphides</b>
580	27.2	<b>Magmatic platinum group elements</b>
59	28.0	<b>Mafic/ultramafic-hosted chromite</b>
60	28.1	<b>Stratiform chromite</b>
61	28.2	<b>Podiform (ophiolitic) chromite</b>

## LUT (Greenland genetic model)

GREENMIN table used

Sequence	GREENMIN code	Entry
0		<b>No data</b>
10	MAG	<b>Magmatic</b>
20	IGN	<b>Igneous</b>
30	VOL	<b>Volcanogenic</b>
40	SED	<b>Sedimentary</b>
50	DIA	<b>Diagenetic</b>
60	SYN	<b>Syngenetic</b>
70	EPI	<b>Epigenetic</b>
80	HYD	<b>Hydrothermal</b>
90	REP	<b>Replacement</b>
110	RES	<b>Residual</b>
120	MET	<b>Metamorphic</b>
130	UNK	<b>Unspecified</b>

## LUT (Stratigraphic Chart)

The IUGS/UNESCO committee (International Stratigraphic Chart) will be used according to the following system. This means to the level of (subsystem-subperiod-series-epoch) for Phanerozoic time and erathem – era for Precambrian time.

0	<b>No data</b>
10	<b>Phanerozoic</b>
20	<b>Cenozoic</b>
30	<b>Quarternary</b>
40	<b>Quarternary/Holocene</b>
50	<b>Quarternary/Pleistocene</b>
60	<b>Neogene</b>
70	<b>Neogene/Pliocene</b>
80	<b>Neogene/Miocene</b>
90	<b>Paleogene</b>
100	<b>Paleogene/Oligocene</b>
110	<b>Paleogene/Eocene</b>
120	<b>Paleogene/Paleocene</b>
130	<b>Mesozoic</b>
140	<b>Cretaceous</b>

150	Cretaceous/upper-late
160	Cretaceous/lower-early
170	Jurassic
180	Jurassic/upper-late
190	Jurassic/middle
200	Jurassic/lower-early
210	Triassic
220	Triassic/upper-late
230	Triassic/middle
240	Triassic/lower-early
250	Paleozoic
260	Permian
270	Permian/Lopingian
280	Permian/Gaudalupian
290	Permian/Cisuralien
300	Carboniferous
310	Carboniferous/Pennsylvanian
320	Carboniferous/Mississippian
330	Devonian
340	Devonian/upper-late
350	Devonian/middle
360	Devonian/lower-early
370	Silurian
380	Silurian/Ludlow
390	Silurian/Wenlock
400	Silurian/Llandivery
410	Ordovician
420	Ordovician/upper-late
430	Ordovician/middle
440	Ordovician/lower-early
450	Cambrian
460	Cambrian/upper-late
470	Cambrian/middle
480	Cambrian/lower-early
490	Precambrian
500	Proterozoic
510	Proterozoic/neo-
520	Proterozoic/meso
530	Proterozoic/paleo
540	Achaean
550	Achaean/neo-
560	Achaean/meso-
570	Achaean/paleo-
580	Achaean/eo-

## LUT (Reserve type)

Classification of the (economic) identified reserve; can be discussed but the LUT suggested here is a simple one, probably generally accepted.

0	No data
---	---------

10	<b>Inferred reserve</b>
20	<b>Indicated reserve</b>
30	<b>Measured reserve</b>

## **LUT (Users)**

Suggestion: LUT with users (initials) in the department.

## **LUT (Type of operation)**

To be used in the database log section. May later be replaced by system calls. Further deliberations will take place in 2004.

0	<b>No data</b>
10	<b>First entry of record</b>
20	<b>Modification of existing record</b>
30	<b>Addition to record</b>
40	?

## **LUT (Type of image)**

0	No data
10	Scanned map
20	Sketch map
30	Figure
40	Photo

## **Appendix 3: Example of a site description**

The following pages show a typical description of a mineral occurrence, as will be available by hotlink from the GMOM. The site is the graphite deposit at Eqaliasuit (Stendal et al. 2004). These mineral occurrence descriptions have been prepared for the mineral resource assessment programme and there is not yet complete agreement between the terms used here and the terms encouraged for the GMOM. In 2004 the work will continue on the definition and use of terms.



<b>Egalussuit (graphite)</b>	<b>Type id. no. 99</b>
<b>Type locality id. no.:</b>	99
<b>Type locality for id. nos.:</b>	98, 99
<b>Locality name:</b>	Egalussuit
<b>Area:</b>	Nassuttooq
<b>Genetic relation:</b>	Graphite schist with iron sulphides
<b>GSC deposit type:</b>	6.3 – Volcanic-associated massive sulphide base metals
<b>Commodity group:</b>	Industrial minerals
<b>Commodities (minor):</b>	Graphite
<b>Economic significance:</b>	1

**Geological characteristics:**

**Description of occurrence:** Graphite accumulations occur in a supracrustal sequence composed of foliated biotite garnet ± graphite ± sillimanite gneiss, locally interlayered with amphibolites, ultrabasics and marble bands. The metamorphic grade is upper amphibolite facies. The supracrustal rocks in the area have an overall strike of 265° and dip 60°N, parallel to the Nordre Strømfjord (Nassuttooq) steep belt. Graphite schists are known from observations further inland to the east, but apparently without substantial accumulation of graphite.

**Geotectonic setting:** In “greenstone belts” believed to be developed in the transition platform/volcanic environment.

**Depositional environment/Geological setting:** Sedimentary and submarine volcanic sequences with pelitic sediments, exhalites and mafic rocks.

**Age of mineralisation:** The graphite rich schist is probably Palaeoproterozoic in age, but precise data are not available.

**Host/Associated rock types:** Graphite, together with pyrite/pyrrhotite lenses is hosted in pelitic sediments (paragneisses).

**Deposit form:** The occurrences are found within two parallel schist layers (supracrustals), up to 20 m thick and traceable for tens of kilometres along strike. Individual graphite rich lenses may reach 1 x 20 m, and are found scattered within the schist. Horizons, where the graphite accumulation is observed, are locally due to shearing and internal folding (Platou 1969; Bondam, 1992).

**Texture/Structure:** The graphite occurrences are generally of a disseminated type of fine-grained flake graphite, and locally developed in lenses with more or less massive graphite, interlayered with pyrrhotite/pyrite, quartz, biotite and garnet. Foliation-parallel pegmatites contain minor amounts of coarse-grained flake graphite (Pedersen 1992).

**Ore mineralogy (principal and subordinate):** Graphite. Associated *pyrite and pyrrhotite*.

**Gangue mineralogy (principal and subordinate):** Quartz, biotite, garnet.

**Alteration:** Distinct limonitisation.

**Weathering:** Graphite sequences are creating gossans and rust zones due to weathering of the sulphides.

**Ore controls:** Graphite is considered to represent a primary carbon content within the supracrustal rocks.

**Genetic models:** Metamorphosed counterpart to primary bituminous sediments.

**Analytical data:** Not applicable.

**Exploration:**

Exploration of the graphite deposits in the area has been carried out since the beginning of the 20<sup>th</sup> century (Ball 1923). Graphite attracted economic interest as one of the first commodities in West Greenland, and the activity increased around 1900, partly because of the demand from the growing electrical industry and partly from the use in the foundry and moulding industry. In the actual area the activity in 1903, 1912 and again in 1916 went as far as to primitive exploitation on a pilot scale. In 1916 a complete plant layout including a miner's accommodation village was presented by the Grønlands Minedrift A/S. However, proper exploitation was not brought to the practical step (Lindås 1916).

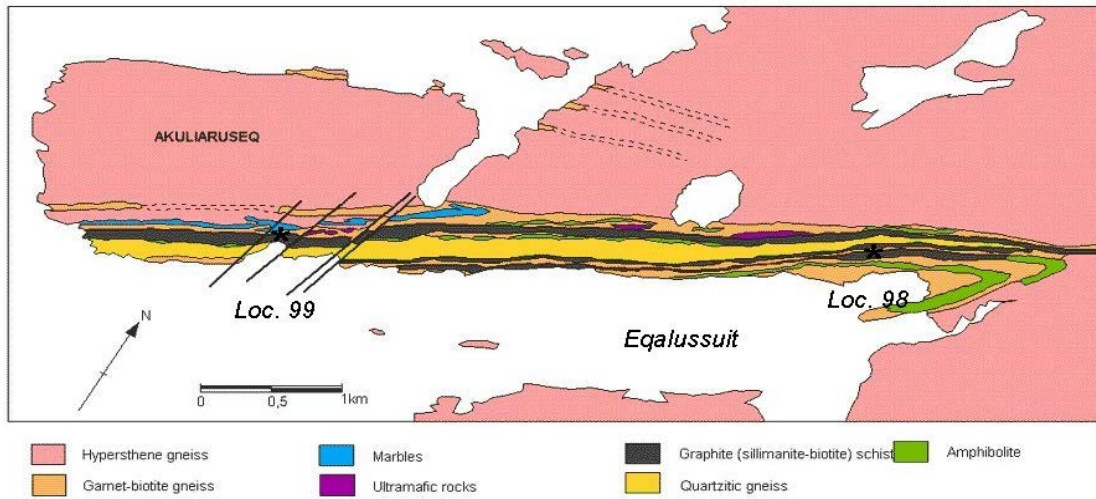
id. no. 99 Eqaussuit West, (Two adits, 1903/1916)

id. no. 98 Eqaussuit East, (Trenching, 1916)

The activity was based on a licence granted in 1904 and later extended to 1933. The locality was later renamed 'Akuliaruseq' and was a target for renewed evaluation from 1982–86 by the Kryolitselskabet Øresund A/S. Geophysical surveys, drillings and flotation tests were carried out during this campaign (Keto et al, 1987). In 1992–93 NunaOilA/S undertook additional investigations (Pedersen 1992). The exploration has at the time of writing ceased.

Resource estimates are primarily based on the data from the Kryolitselskabet Øresund A/S. According to these data the total volume of graphite ore, calculated down to 40 m below surface, is 5.3 million t with an average C-content of 9.5% as flake graphite. At least 1.6 million t of this resource is representing an average of 14.8% C. About 50 wt% of the flake graphite are in the +100 mesh category (Pedersen 1992).

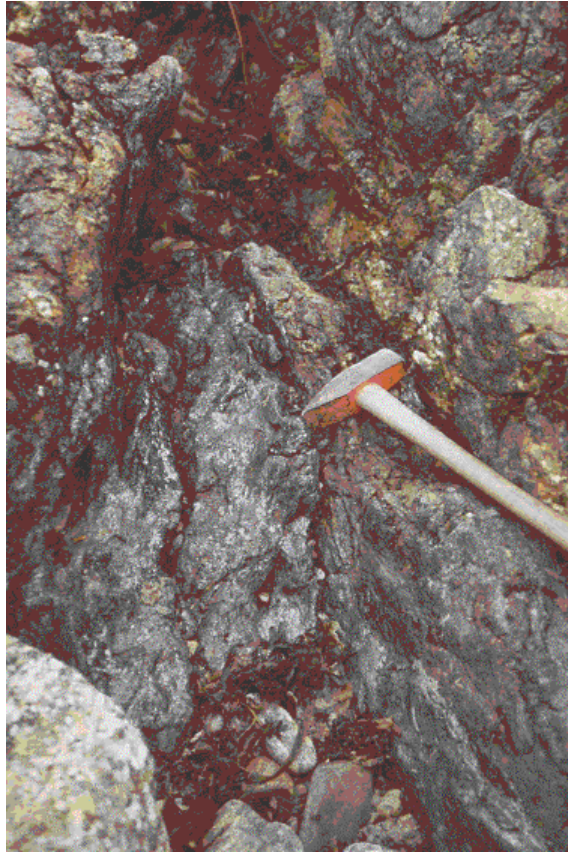
**Photos, figures and maps:**



**Figure 52.** Geological map of the Eqalussuit area.



**Figure 53.** Old pits from graphite mining at id no. 99, Eqalussuit.



**Figure 54.** *Massive graphite (left of hammer head) in mafic metasediments.*



**Figure 55.** *Close-up of graphite ore sample (scale is indicated by green label to the right, 1 cm)*

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