

Scientific evaluation of Programme area 5 'Nature and Environment' (2000-2005) at the Geological Survey of Denmark and Greenland (GEUS)

Ole Humlum, Björn E. Berglund, Cees Laban, Else Marie Friis

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1. Introduction/Summary

A geological survey as GEUS has to operate in a space dominated by political, economical and scientific needs, wishes and requirements. In this report we, the evaluation panel, primarily focus on matters directly related to scientific issues. We are, however, fully aware that the overall management of GEUS need to be seen in a wider context.

GEUS has a long tradition of both applied and strategic research and occupies a prominent position in the Danish geoscience community. The evaluation panel is pleased to find that GEUS aims at strengthening its research activities to become internationally leading in selected research disciplines. We believe that such a strategy, especially when seen over a long time range, will not only strengthen the research efforts, but also strongly benefit consultancy tasks and thus the Danish and Greenlandic societies in general.

High priority at GEUS to research activities is reflected in the task of the present evaluation panel where emphasis is placed on identifying research areas of high quality and research areas that should be strengthened. The programme area 5 “Nature and Environment” has contributed significantly to the status of GEUS as an important research institution. With the increasing public concern over climate change, retreating glaciers, changing frequency of geohazards, and other environmental issues, research within programme area 5 is highly relevant to the society. Baseline studies such as those carried out by GEUS are highly relevant to decision makers when evaluating the effects of future environmental changes.

In this review we have identified areas of particular strength within the programme area. We have also attempted to identify critical issues that in our point of view may restrict a dynamic development of the programme area.

2. Mandate, background and formalities

In accordance with the performance contract the Geological Survey of Denmark and Greenland (GEUS) decided in May 2005 to arrange an international evaluation of research activities within Programme area 5 ‘Nature and Environment’ for the years from 2000 to 2005. This was done in order to help GEUS maintaining and improving scientific standard and performance within the area, and, where relevant, adjust research strategies.

According to the working plan for 2005 programme area 5 “Nature and Environment” comprises three research themes:

- Marine geology
- Vegetation and environmental history
- Geological mapping, glacial processes and glaciology

A panel of international experts, not involved in activities within the Programme area under review, should be appointed and given the task of implementing the evaluation. In addition, staff members from GEUS should be appointed rapporteurs to the expert panel, to provide facts about GEUS, its internal organisation and conditions in the Programme area under review.

The individual members of the evaluation panel were approached early June 2005 and was asked to provide a short statement on their professional relations with GEUS. The Evaluation Panel (Appendix 1) consisting of Professor Björn E. Berglund, Dr. Cees Laban, Professor Ole Humlum and Professor Else Marie Friis was formally appointed in a following letter from GEUS, and dates for the first visit settled. In addition, written material detailing the research activities within the individual working groups was distributed to the panel members.

The mandate and objectives of the evaluation panel was defined in a letter of November 2, 2005, stating that the panel shall undertake an evaluation of research activities within the programme area 'Nature and Environment', constituted by

- Research and development activities within the areas of palaeoclimate, palaeoecology, marine geology and glaciology, with respect to the Quaternary in Denmark and Greenland.
- Research and development activities with respect to the environment and climate change in Denmark and the northern hemisphere; and geological mapping in Denmark.

The evaluation panel was asked to pay special attention to:

- Identifying areas of high quality research.
- Identifying areas, where the research of GEUS should be strengthened in order to meet GEUS vision and strategies.
- Identifying areas which should be strengthened in order for GEUS to expand its ability to provide assistance to third world countries within the broad area of nature and environment.
- Providing comments and proposals as to strategic changes, amendments, and improvements to GEUS' work within the programme area, in order to improve GEUS' ability to fulfil its main mission within the programme area when seen in perspective of statutes and general mission of the survey.

The panel was asked to base its evaluation on:

- Publications from programme area 5 spanning the time interval 2000-2005
- One main visit November 2005 at GEUS in Copenhagen, interviewing scientists, and visiting laboratories and work-facilities at the GEUS premises.
- A supplementary second visit in February 2006 aimed also to present the initial

findings of the panel.

During the visits at GEUS the evaluation panel members should meet the relevant scientific staff. Brief general terms of reference for the evaluations were set up by GEUS (Appendix 2). The evaluation, resulting in a written report to the Direction of GEUS, should be based on the documentation submitted by GEUS as well as presentations, interviews and discussions undertaken in connection with two site visits at the institution.

The Evaluation Panel participated in two meeting sessions at GEUS on November 22-23, 2005 (Appendix 8) and February 23-24, 2006 (Appendix 9), respectively. Documentation from the GEUS and Programme area 5 was distributed to the group in early November 2005.

3. Evaluation panel meetings and background for the present report

At the first panel meeting, November 23-24, 2005, general information on GEUS, its staffing, infrastructure and financing was given in an oral presentation by Assistant Director of GEUS, Dr Johnny Fredericia. This was followed by more specific presentations by the Programme Area 5 manager, Peter Gravesen, and project leaders within the Programme area, Drs J.B. Jensen, A. Kuijpers, K.E.S. Klint and R. Bradshaw. All information was adequately documented by bibliographic and financial data. In addition the panel had separate meetings with members of the different working groups within programme area 5.

Scientific contributions (publications, reports and maps) produced by the working groups over the period 2000-2005 were made available during the meeting, where panel members could select relevant copies to be posted for more in depth study. All panel members exploited this opportunity, and the material was received by mail on December 8th, 2005.

Further, supplementary evaluation material requested by the panel at the November meeting was received by the members on December 22th, 2005. This material included:

- An updated list of peer reviewed papers with number of citations (International Science Citation).
- A list of scientific staff formerly employed within programme area 5, contributing to papers published during the evaluation period.
- A list of journals with the number of papers published by staff from programme area 5.
- The budget for GEUS.
- An overview of relationships between research and advising activities within programme area 5.

In February 2006 the review panel held a second meeting at GEUS, as its report took final shape. This meeting assured that issues of fact were clarified, and that the overall tenor of the report was made known to the staff of Programme Area 5 at GEUS.

Professor Finn Surlyk, University of Copenhagen, was appointed by the Danish Science Research Council to assist the panel by liaison to GEUS, and to provide the panel members with facts about the Geological Survey of Denmark and Greenland.

We compliment the staff of GEUS on the presentations and express our thanks for the logistic and other support afforded the panel during its visits.

4. Purpose and strategic aims of GEUS, with special reference to Programme area 5

The Geological Survey of Denmark and Greenland, GEUS, is a research and advisory institute in the Danish Ministry of Environment. The survey also operates in the private sector. GEUS is partner in Geocenter Copenhagen, together with the Geological and Geographical institutes, and the Geological Museum, University of Copenhagen.

GEUS' overall mission is to provide, to use, and to disseminate knowledge of geological materials, processes and relations that is important for the use and protection of geological resources in Denmark and Greenland. Part of this mission is to support administrative and legislative work in Danish Ministries and the Greenland Home Rule Authority, by providing state-of-the-art geoscientific knowledge of international standard.

GEUS' main tasks are geological mapping, data collection and storage, research, advising, and dissemination of geoscientific knowledge.

The daily activities of GEUS are organised within five programme areas:

1. Data banks, information technology, and information to the general public
2. Water resources
3. Energy resources
4. Mineral resources and Greenland mapping
5. Nature and environment, object for the present evaluation report.

The major end users of GEUS research results and services are:

- The Danish Ministry of Environment
- Other Danish ministries
- Greenland Home Rule
- Danish Governmental agencies

- EU
- Regional and local authorities in Denmark
- The scientific society
- Private companies and organisations

In 2001, GEUS drew up the vision of the institution for the coming decade: Geology for a changing society (Appendix 3). The document which is set up in collaboration between employees, management and the board of directors outlines the identity GEUS is aiming for in 2012.

Among strategic aims and objectives listed in this vision are stated (taken from the GEUS homepage) that

- GEUS is to be an internationally recognised and in selected areas a leading research and consultancy institution in the fields of environmental geology, water resources, energy and mineral resources. GEUS is to be the primary consultancy institution for Danish and Greenland authorities in all questions concerning important geological conditions. GEUS is to be the Danish national geological data centre, on the forefront internationally, which presents reliable and independent information to benefit the public and industry.

For programme area 5 'Nature and Environment' the overall objective of the research and consulting activities is to provide a better understanding of natural processes and ecosystems. This objective is chosen in order to create a baseline for the study of natural and human impacts on environment and climate and for the monitoring and management of nature and environment.

Research output from Programme area 5 is considered especially important for the efficient operation of the following four official Danish-Greenlandic authorities:

- Danish Forest and Nature Agency
- Danish Environment Protection Agency
- Bureau of Minerals and Petroleum, Greenland
- Directorate of Environment and Nature, Greenland

5. Research activities 2000-2005 within Programme area 5: some general considerations

The overall scientific questions addressed by programme area 5 at GEUS concern processes in time and space leading to the current climate and environmental conditions in Denmark in particular and in the North Atlantic region in general. One of the overall research questions has been to improve the ability of distinguishing between natural and man-made

environmental changes. In addition, also mapping of both onshore and offshore geological units and sediments has been a major research focus for the programme area.

The detailed research foci have changed somewhat during the evaluation period. From 2000 to 2003 research was focused on four main issues:

- Development of the cultural landscape and the human impact
- The coastal zone: Sediment dynamics and mapping
- Mapping of the Quaternary surface deposits on land
- Climate changes in the North Atlantic

From 2004 to 2007 the research activities within the programme shifted. The previous explicit focus on the cultural landscape and human impact was given lower priority and the research incorporated in three new main research areas:

- The coastal zone and marine geology
- Climate change and effects
- Geological mapping and landscape studies

In addition to changes in the number of formal research areas over the evaluation period, several different headings for research themes and research groups were used during the presentation and in the official material provided by GEUS. This gave the panel an impression of uncertainty in visions and aims and could perhaps reflect that the new strategic plan is not yet fully adopted in daily life. Thus in the original letter from GEUS to the panel, four research themes were included in programme area 5: Marine Geology; Vegetation and environment history; Geological mapping and glacial processes; Glaciology. In addition, some researchers have contributed to more than one research theme, both before and after 2004, which also may influence the result of publication statistics discussed below.

In our evaluation we have chosen to refer to the following three *working groups*, corresponding to the three groups of scientists introduced to the panel in November 2005:

- Land geology and ice
- Marine geology
- Palaeovegetation and forests

We recognize that these *working groups do not represent individual units in a strict functional sense*, and is used in this report only as a handy reference term for the three groups of scientists interviewed by the evaluation panel. The working groups apparently have a very open structure, with no formal leaders, characterised by a general atmosphere of mutual respect and loyalty, combined with personal commitment.

The evaluation panel have noted that all working groups have been involved in several EU projects during the evaluation period.

The total publication statistics for all three working groups are presented in Appendix 7, while the statistics referring to the individual groups are presented below in chapter 6. Some scientists have contributed to more than one of the working groups under evaluation, and it may therefore be discussed under which working group correctly to record some publications.

According to the development plan 2004-2007 (GEUS' Strategier: Grundlag for Resultatkontrakt 2004-2007, GEUS 2003) the programme area must expect a reduction in base funding from GEUS within the planning period. It is, however, also stated in the development plan (p. 27) that it is important that the programme area remains above the 'critical' mass with respect to manpower and expertise. The funding necessary to ensure this is foreseen to come from various sources.

Land geology and ice

Geological maps of Denmark represent a key resource for planning the use of natural resources, such as sand and gravel, or major landscape changes in connection with construction work. Geological maps also form the basis for planning use and protection of natural groundwater resources, agricultural planning, forest planning, use of wet-areas, and exploitation of other natural resources. The mapping activities comprise both "traditional" as well as applied programmes.

Within the evaluation period 2000-2005, the working group has focused on the following main activities:

- Regional and local geological mapping of Denmark.
- Production of geomorphological maps (scale 1:50,000) of Denmark.
- Applied various geophysical methods (e.g. ground penetrating radar and geo-electrical investigations) for high resolution mapping of natural resources.
- Mapping of glaciotectonic structures, partly as applied research in order to gain insight in glacial dynamics and understanding the spatial distribution of a number of natural resources (e.g. diatomite and bentonite).
- Thematic mapping of for instance till fractures in order to obtain relevant input data for hydraulic models, for evaluating stability of slopes and for planning remediation of contaminated sites, and resource mapping.
- Glaciological work in Greenland, with special emphasis on understanding the relation between current climatic variations, mass balance and dynamic frontal response of the Greenland Ice Sheet.
- Carrying out a number of additional activities, such as, e.g. publication, selection of Danish geo-sites and participating in EU projects.

This working group has experienced a number of staff reductions during the evaluation period, affecting coastal geomorphology, Quaternary geology and glaciology.

Marine geology

Marine geological investigations are carried out by GEUS in the nearshore zone of the North Sea, in the inner Danish waters of the Baltic Sea, in the North Atlantic Ocean, West Greenland, the Arctic Ocean and in the Caribbean. The importance of marine investigations is increasing because of the growing population in the coastal zone, the increasing use of raw materials, coastal erosion problems, beach nourishment, and the preservation of landscapes onshore.

North Sea and the Baltic: The infrastructure is growing. Besides shipping routes, the infrastructure increases by oil and gas platforms, the presence of submarine gas and oil pipelines, submarine cables (telephone, electricity), plans for offshore windmill parks, licence area's for the extraction of marine sand and gravel, and fishery grounds. All these activities make use of the seabed, and for strategic planning of seabed use information of seabed conditions, seabed behaviour and processes are essential for decision makers.

Marine sands and gravels are essential products for the development and maintenance of the built and natural environments. Society benefits greatly from the exploitation and use of marine sands and gravels mainly through construction and coastal defence as a source material for beach replenishment and protection, and in habitat creation/restoration schemes.

The expected sea level rise within the coming decades will threaten low lying coasts with coastal defence problems. Beach nourishment is one of the tools to maintain the coastline, but requires enormous amounts of marine sand.

The exploitation of these resources must, however, be achieved in an environmentally sustainable manner and co-operate with other legitimate uses of the seabed such as marine habitats, fishing and navigation. Extraction of marine sand and gravel has a recognised effect on the seabed and its fauna; for example, it can take several years before dredging tracks disappear and total recovery of the habitat is reached after dredging activities.

North Atlantic and Greenlandic waters: the role of the North Atlantic Ocean circulation patterns is highly important for understanding regional North Atlantic climate change. Knowledge of the circulation patterns since the last glaciation is of great importance by the prediction of the climate change in the near future.

As the interest of the oil industry is focussing on greater water depth knowledge of slope instability, including the importance of gas hydrates becomes important. In addition growing interest in the oil potential of the Arctic makes knowledge of ice berg routes as evidence by the scours in the sea bottoms become important.

Another important information which can be retrieved from sediment cores are information on freshwater discharge – from ice caps and major rivers which has impact on the north Atlantic circulation and climate.

The Arctic Ocean: The present reduction of the sea ice in the Arctic Ocean will have a major impact on the Arctic community and global economic consequences (shipping, fisheries and hydrocarbon exploration). Sediment studies are important to relate former climate change and changes in the Arctic sea ice cover. Furthermore the political issue of outlining territorial claims between the countries bordering the Arctic Ocean basin will be based on geological evidence.

Marine geology plays an active role in the research in the above-mentioned subjects. The activities can be divided into mapping programmes, habitat studies, and the development of acoustic methods for mapping purposes and climate related studies.

- Sea bed sediments and structures at different scales
- Thematic mapping for raw materials
- Quaternary history of the near shore zone of the North sea and the Baltic Sea
- Habitat mapping and morphology
- The implementation of new acoustic methods for sea bed mapping and characterisation

Palaeovegetation and forests

Research in this working group has been focused on problems related to Holocene terrestrial and limnic environments. End users are mainly the Danish Forest and Nature Agency and the Danish Environmental Protection Agency as well as the national and international scientific community. The following items summarize main activities during 2000-2005:

- Impact of long-term land-use and climate change on the environment in Denmark and Greenland.
- Environmental history applied to management of forests, open cultural landscapes and lakes.
- Definition of baseline environments before human impact, in terrestrial and limnic ecosystems.
- Quantification of vegetation changes including biodiversity methodological development for application in cultural landscapes.
- Monitoring forest changes and long-term forest dynamics.
- Presentation of results for authorities and a wider public audience

This research has to a great extent been linked to various EU projects and in the case of land-use changes to the national project Agrar2000. Research students have been included in the group, two have received PhD degrees and two master degree. One project has been related to third world problems, the DANIDA project in Uganda.

Although the working group suffered strongly from financial cut, the group has been scientifically efficient as demonstrated by their publication record. However, over the last

two years the group has lost several leading scientists. At the same time new research students supervised by the group members have been added to the group on shorter-term employment and together they contributed to the publication record.

The present situation for the working group is precarious, which may have been the cause of some scientists leaving for other positions. GEUS has played an important role in developing this area into a strong research discipline engaging both geological and biological aspects of environmental changes. This research theme is essential for a better understanding of natural processes and ecosystems. The high-quality research documented by the scientists over the period 2000-2005 builds on a long Danish tradition back in the 20th century. The interdisciplinary nature of the research area is a scientific strength, but also makes the discipline vulnerable in periods of financial cuts by falling between several institutions area of responsibility.

The strategy shift 2003/2004 caused a strong reaction by the international palaeoecological research community with support for continued research at GEUS within research theme.

6. Evaluation of individual working groups: status and recommendations

Land geology and ice

Observations made during interviews and presentations:

- The working group sees itself as interdisciplinary with open structure, great personal commitment, but with no formal leader. 'Climate impact, past, present and future' represents a general research theme for the group.
- The mapping programmes have priority at GEUS, and the present map production meets the long term planning of GEUS.
- In addition to the basic geological and glaciological mapping programme, applied and thematic mapping programmes are in progress. Land use planning for instance, needs detailed insight in occurrences of raw materials and ground water aquifers. There is no plan for additional mapping activities when the present mapping activity is finished.
- Much time is spent writing research proposals.
- When funding for a project is obtained, the infrastructure (laboratories, databases, etc.) at GEUS is considered highly professional and efficient.
- The working group regards the Geocenter as a means of establishing a higher degree of co-operation with other geoscientists in Copenhagen. At the moment, the relatively low number of M.Sc. students within certain areas of geoscience at Danish universities is a drawback for full exploitation of this potential.

- There is concern for future activities within glaciology in Greenland.

Scientific output

The output in peer reviewed scientific publications has varied strongly during the period under evaluation. There is a tendency towards a decreasing number of publications over the last three years, apparently reflecting the reduction in personnel during the evaluation period and the movement of GEUS into new buildings. Because of the delay from research to publication the effect of this development may not yet be fully visible in the publication record.

In the list below, the first column indicates the year of publication, the second column number of publications, and the third column the number of citations according to 'Web of science' (values supplied by GEUS). The decline in citations with time is to be expected because of short international exposure time for the most recent publications:

2000	05	(10)
2001	10	(17)
2002	10	(59)
2003	03	(00)
2004	11	(03)
2005	02	(00)

Several publications focus on issues relating to Quaternary Geology and Palaeoclimate. Many publications are related to Greenland, reflecting the ongoing research activity of glaciologists and Quaternary geologists in this country. From a publication point of view coastal geomorphology has mainly been restricted to activities in Denmark.

Recommendations:

Having legitimate research interests and -activities in both Denmark and Greenland, GEUS as a scientific institution is in a unique position to investigate marine and terrestrial geoscientific issues on both sides of the North Atlantic. This is today becoming an even more advantageous position from a strategic point of view, given the current widespread interest in the relation between regional and global climatic change in the North Atlantic area in general, and the mass balance of the Greenlandic Ice Sheet in particular.

The Evaluation Panel recommends that

- *Current mapping activities and documentation techniques should be continued and developed.*
- *Current research activities in Greenland should be upheld and enforced. This especially applies to glaciological activities in Greenland.*
- *The working group should maintain and initiate relevant baseline studies.*

- *A research initiative on mapping, dating and monitoring various slope processes around settlements in Greenland should be considered. The growing awareness of climate change induced changes in permafrost, snow avalanches, mudflows, etc., may in the near future prompt Greenlandic authorities to approach GEUS for advice on issues relating to local risk/hazard assessments at existing settlements. The coming International Polar Year (IPY; 2007-2008) may add to the potential importance of such an initiative.*

Research carried out by the working group on the character and distribution of different sediments in Denmark is important, both from a classic research point of view as well as when seen from a directly applied perspective. As one example, acquiring knowledge on the different structural and sedimentological characteristics of tills and glaciofluvial sediments are important input values for hydraulic models, in order to model fluid migrations in different types of sediments.

The Evaluation Panel recommends that

- *Current research on structural and sedimentological characteristics of tills and other sediments should be continued. The research on fracture geometry and – frequency in tills represent such an area where GEUS has the potential to obtain a leading international research role.*
- *Development of new mapping techniques using ground penetrating radar and other geophysical methods should be continued.*

The working group has an uneven publication profile, with some members of staff having an excellent record of peer-reviewed international publications, while other member of staff have been significantly less active in this respect.

The Evaluation Panel recommends that

- *The programme area management should actively encourage researchers to submit research results for publication in peer-reviewed international journals and to participate actively in international meetings, to exploit the possibilities for enhanced scientific co-operation with other geoscientists at Geocenter Copenhagen and at the University of Aarhus.*

Marine Geology

Observations made during interviews and presentations:

- The research is carried out in the field of offshore raw materials and applied geology in climate related fields.
- Studies are carried out in the field of dynamic processes of the sea bed in relation with the morphology and habitat

- For stratigraphic correlations expertise on foraminifera is missing.
- In contradiction with the research agenda no development of seismic methods or systems is carried out.
- Partnership in EU-projects is possible and required to obtain funding for more research.
- In contradiction with the programme management with project crossing over the borders of the departments, there are economic boundaries between the departments because of the external funding targets of each department.
- Applied research in the field of submarine hazards like the occurrences of shallow gas in the top layers is not only restricted to the shelf seas around Denmark but also applies to deep water work in the North Atlantic and Greenlandic waters.
- GEUS is equipped with survey and coring equipment for shelf research.
- The number of publications is high. Research is often carried out in an international framework.
- The working group has a strong international network as can be read from the large number of publications in co-operation with foreign institutes, and the co-operation at sea on board survey vessels with foreign institutes.
- External co-operation in Denmark takes place with the Hydraulic Institute, Technical Institute and with the Universities in Århus and Copenhagen.
- The lack of ship time for marine research is a problem caused by high costs.

Mapping:

The mapping activities of the marine Geology Groups have been split into research in the North Sea and the Inner Danish Waters. Their main activities comprise:

- Raw material administration and EU related activities.

The research on raw materials is carried out per licence area: Bathymetry, seabed geology, seabed morphology and the observations (seismic and sampling locations) are available. Registration of the extraction of marine aggregates is done for each extraction area (figures are presented between 1996 and 2000 are available). Seabed sediment mapping covers the Inner Danish waters, and the coastal zone of the Danish part of the North Sea (partly the German part). In co-operation with the other Baltic States a seabed sediment map has been prepared of the entire Baltic Sea.

Concerning the habitat directive for the Inner Danish waters a habitat map is produced where sandbanks and stone reefs are indicated. With advanced techniques as side scan sonar and multibeam pilot studies have been carried out showing a detailed seabed morphology and bathymetry. Diver observations complete the tools available for habitat mapping.

Applied research:

- Infrastructure projects (bridges)

- Raw materials (marine aggregates (sand and gravel), geological setting, exploitation potential, and environmental assessment)
- Windmill parks
- Harbours
- Beach nourishment
- Submarine pipeline and cable route surveys
- Rig site surveys
- Deep water slope instability

Of applied research for windmill parks, beach nourishment, submarine pipelines and cables no publications or reports were available for the auditors. This was explained by the group as a result of the confidentiality of the data reported.

Scientific output:

The output in peer reviewed scientific publications of the working group has varied over the period under review:

2000	08	(26)
2001	10	(33)
2002	16	(55)
2003	04	(12)
2004	09	(21)
2005	10	(03)

The publications represent a wide range of marine subjects; including seabed dynamics, morphology, biostratigraphy, (neo)tectonics, ocean currents, water mass exchange, climate change, environmental issues, and reflect a strong international co-operation as in 2002 as a result of joint ocean research in the North Atlantic and the Baltic Sea. Marine research in the North Sea was mainly restricted to the coastal zone (morphology, seabed sediments and glaciotectonics. A strong position in biostratigraphic issues is reflected by the large number of publications in this field. The methods and equipments used belong to the standard devices, and latest developments (multibeam)

Recommendations:

The mapping programme of the North Sea is restricted to seabed sediments at a large scale. The classification is very general compared to maps available from the Baltic Sea.

The Evaluation Panel recommends that

- *A North Sea mapping programme is initiated at a smaller scale (1:250.000 or smaller), including the Holocene and Pleistocene geology.*
- *The working group should maintain and initiate relevant baseline studies.*

Ship time is limited because of the high daily rate of survey vessels. Much of the research is carried out in co-operation with ship owning partners, and for that reason the research options are not always entirely controlled by GEUS. This results in research in areas of common interest.

The Evaluation Panel recommends that

- *Funding is made available for ship time in order to start a reconnaissance mapping programme and other marine geological work and studies Presumably the management at GEUS would have to make a joint effort with other Danish research institutions and universities for improving availability of ship time at a national scale.*
- *More emphasis is put into marine geological investigations in Greenlandic and Artic waters focusing on the effect and impact of the climate change, e.g. melt water discharge, sea ice reduction on Atlantic circulation and global climate.*

The marine biostratigraphic support is strongly reduced by retirements during the evaluation period.

The Evaluation Panel recommends that

- *Young scientists are attracted to continue the biostratigraphic support. This knowledge is essential for the mapping programmes.*

Most of the marine surveying and sampling equipment is standard, including the multibeam.

The Evaluation Panel recommends that

- *GEUS join international research studies in the field of seabed classification techniques and methods.*

Palaeovegetation and forests

Observations during interviews and presentations

- The working group regards dynamics of Holocene landscape development and environment in Denmark to be the main focus for current research.
- The working group already has good contacts with other groups at the Geocenter, Copenhagen, but would like to expand that collaboration and also extend collaboration to other institutions outside GEUS.
- It is a desire to include more young scientists in the group.
- Members of the group have good time for research and spend little time on administration except for EU applications.

- This group feels that palaeoecology faces a great challenge for local/regional as well as continental scales. They regard that their scientific results are at the cutting edge of this research area.
- The financial and staff cut-backs has been very hard for this group and this has led to a collective concern about the future. However, there is optimism about their scientific capacity for further development of the area.

Research on environmental history is today characterised by a paradigm shift, a development from a descriptive to a quantitative discipline, applying modelling to describe processes which is of relevance for understanding future changes of ecosystems and landscapes. The scientists at GEUS contributing to this theme have played a leading role in this development which is reflected in the international collaboration. The research over the evaluation period is of high international standard and of great importance for Danish-Greenlandic authorities in their work related to environment protection and management as well as forestry and agriculture. The working group has developed the discipline methodologically and has an impressive publication record generated as a result of team work between permanent staff, research students and guest scientists.

The original composition of the research group combining expertise on terrestrial and limnic biota, palynology, diatoms, and macrofossils has provided a unique base for understanding natural and human impacts on environment and climate in the terrestrial realm. The group contributed considerably to international, particularly Nordic and European, research programmes and have been successful in obtaining external funding for its research while contact to other national governmental institutions such as the Danish Forest and Nature Agency appear to be less strongly developed. This group, even though being reduced in strength during the evaluation period, still have the potential of being an excellent platform for continued, and expanded, research of high international standard within the field of Holocene environmental history and its applications in society.

Scientific output

The output in peer reviewed scientific publications, related to terrestrial and limnic environments, has been very good over the whole period. The citation record (numbers in brackets) is also very good, although as expected decreasing for the most recent publications. The high number of citations for the years 2000-2002 is related to the time when the group included several top scientists. As there is typically a delay from research to publication the effect of the cut may only be evident in the publication record for 2006 and onwards. All members of the working group have contributed to the high productivity and by international standard the output for individual members of the group is good and publications are in journals of good international standing. Many of the publications are results of international, particularly EU collaboration, and it is worth noting that members of the working group are often the leading scientists in these joint projects with many first author publications. A measure for international recognition is also a number of review papers in international journals. In addition to international publications, results are also published in report series and national media.

2000	16	(207)
2001	14	(60)
2002	12	(44)
2003	12	(42)
2004	11	(16)
2005	22	(04)

Recommendations:

The working group have been reduced in size during the period under review, but still represents a unique resource for Denmark and Greenland and has the potential for becoming leading internationally if new resources are allocated to the area.

The Evaluation Panel recommends that

- *GEUS should with urgency reconstruct the group so that manpower is kept above the critical level.*
- *Research within this group should include terrestrial as well as limnic/brackish palaeoecology.*
- *GEUS should consider integrating also marine palaeoecology into this theme.*
- *The working group should respond to requirements of society for knowledge-based decision making on issues related to long-term environmental changes in Denmark-Greenland and besides this document cultural and natural heritage.*
- *The working group should maintain and initiate relevant baseline studies.*
- *Nordic and European research integration should be further developed and supported.*
- *The unique competence of the working group for monitoring forest dynamics should be maintained and used to support the Draved field station.*

7. General consequences of the strategic aims of GEUS: some general recommendations

While the above recommendations focus on the individual working groups within programme area 5, the evaluation panel has chosen also to address some issues of more general relevance for the programme area when seen from an overall GEUS strategic point of view. From interviews with staff from different working groups under Programme 5 the evaluation panel appreciates that the overall GEUS strategy is generally well established, and this represents an inherent strength of high importance for GEUS. A number of researchers, however, also expressed concern over unclear long-term priorities and visions

and that this uncertainty might negatively affect creativity and enthusiasm at GEUS.

The general comments and recommendations given below have been viewed in the context of the strategic statements as specified previously in the present report. The evaluation panel has chosen first to identify the items, which are considered to be necessary for achieving the goals defined in the strategy of GEUS, followed by an evaluation of the status of each of these elements. The evaluation panel emphasises that the sequence of the items as given below should not be read as a list of priority.

Safeguarding high quality research skills at GEUS

In order to achieve the strategic goals for research (Appendix 3), GEUS must be safeguarding its high quality research skills and encourage its scientists to play an actively role in setting the research agenda at the international level by engagement in relevant scientific fora. GEUS places emphasis on maintaining personnel with excellent fieldwork skills. This is relevant for Denmark in general, but perhaps particularly relevant in the light of the high interest in climatic issues related to Greenland and the Greenlandic Ice Sheet behaviour, as well as the oil-gas exploration potential in the Greenland region. In addition, having a competent staff with excellent fieldwork skills also represents a generic strength of GEUS with respect to acquisition of high-quality geoscience data.

On this background the Evaluation Panel recommends that

- *GEUS should clearly define research issues that the programme area “Nature and Environment” is supposed to address.*
- *GEUS should make resources available to support and encourage staff to participate actively on the international scientific scene.*
- *The scientific staff of GEUS should in particular exploit the possibilities for scientific co-operation within Geocenter Copenhagen and with the University of Aarhus.*
- *GEUS should define a publication strategy for all members of staff in order to maintain and enhance their individual research profile. Long unpublished texts or extensive reports should not be prepared unless specifically requested by project sponsors.*
- *GEUS should allow its researchers to interact over departmental boundaries to fully exploit its potential of generating new research ideas.*
- *Dynamic modelling of subsoil as a response of processes of groundwater table lowering, landscape degradation and overall environmental change should be introduced at GEUS.*
- *GEUS should consider developing new baseline studies relevant to conservation issues, landscape use, agriculture, seabed use, and for the documentation of climate change in general. This also in order to meet new EU-directives.*

In a rapid changing scientific environment and where new needs from society may arise with short notice it is important that GEUS has the capacity to anticipate new developments.

On this background the Evaluation Panel recommends that

- *GEUS should ensure that relevant geoscientific knowledge is at hand in Denmark when need arises with short notice, by maintaining its present policy of securing research areas without sufficient funding by investing surplus from other areas of research.*
- *One person within the programme area is designated to assist the head of department in the overall knowledge management regarding future demands from the European Union, industry and society.*
- *This person should also assist the head of department as scientific coordinator by focusing research activities within the department, but should have no formal hierarchal function.*

During the evaluation process it could barely escape the evaluation panel that programme area 5 at the moment has a highly male-dominated profile.

The Evaluation Panel recommends that

- *The potential weaknesses of the present gender imbalance should be taken into consideration when future recruitment strategy is planned for the working groups under programme area 5.*

GEUS activities in the third world

Researchers within the programme area are involved in several projects providing assistance to third world countries.

The Evaluation Panel recommends that

- *GEUS should find funding for further third world activities, particularly related to consequences of natural hazards, sea level changes and other environmental changes.*

Laboratory and administration facilities at GEUS

GEUS has several well-equipped laboratories at its disposal, which must be seen as pre-requisites for much high-quality research. In addition, the laboratories may be important in

future collaboration with other research organisations, and in attracting high-quality scientists. The Draved field station is of national and international importance as part of a European network.

The Evaluation Panel recommends that

- *Focus on good laboratory facilities should be maintained.*
- *Adequate resources should be ensured for the Draved field station in southern Jutland to maintain long-term monitoring of forest dynamics.*
- *Handling of EU applications should be further supported in order to unload the scientists.*

GIS, databases and other archives at GEUS

To advise Danish, Greenlandic and other authorities in geoscience matters, the evaluation panel would like to stress the importance of an efficient Geographical Information System (GIS), its associated databases and archives of geoscience data presently found at GEUS. Of particular importance for Programme area 5 and research related to baseline studies for natural and human impact on environment and climate are the palaeoecological databases organized within the European framework. In general, this represents a robust foundation for geological documentation of national as well as global value. Simultaneously, the database provides a background on which high quality applied research programmes can be developed and maintained.

The Evaluation Panel recommends that

- *High priority is maintained on the maintenance of the present GIS-system at GEUS with associated databases and other types of archives.*
- *GEUS should take long-term responsibility for maintaining Danish geoscientific data and make the data available for the European and international scientific community.*
- *GEUS should promote more effectively its role in society as the national geoscience centre for databases and archives related to environmental change across short- and long time ranges.*

8. Conclusions

GEUS has a long tradition of research and occupies a prominent position in the Danish geoscience community. GEUS aims at strengthening its research capabilities to become international leading in selected research disciplines.

Having a strong research profile is not by necessity a matter for an advisory/consultancy institution like GEUS with numerous mandatory, strategic and applied research tasks to fulfil obligations towards governmental authorities. In fact, several comparable institutions in Europe have given lower priority to research, compared to the present situation at GEUS. The evaluation panel believes that the strategy formulated by GEUS will not only strengthen the research efforts, but also strongly benefit consultancy tasks and thus the Danish and Greenlandic societies in general. This will enable GEUS to be a heavy scientific operator on the international scene also in the future.

The programme area 5 “Nature and Environment” has contributed significantly to the status of GEUS being recognised as an important research institution. With the increasing public concern over geoscientific climate change effects, and other environmental issues, research within programme area 5 is highly relevant to a modern society.

Considered in the context of GEUS’s overall mission and tasks as stated previously in chapter 4, programme area 5 at GEUS is presently fulfilling its obligations as to strategic research and ability to advice on applied matters. Given the strength of the researchers, the unique data available at GEUS for baseline studies, and the responsibility for geological mapping and monitoring environmental changes in regions of high relevance to global climatic change, the research groups within programme area 5 have a clear potential to take an internationally leading role in different environmental studies. In our view this potential and the present positive working morale within programme area 5 should be fully acknowledged by GEUS.

In the present review we have attempted to identify areas of particular strength within programme area 5. We have also identified certain issues that might restrict a dynamic development of the programme area. There is sometimes a need to improve coordination between various research groups/projects within the programme area. We recommend GEUS to consider the various specific recommendations stated previously in this report (chapter 6 and 7), and from this to develop strategies to enforce, revive and strengthen the programme area.

As examples of general issues where future changes might be considered within programme area 5 the evaluation panel would have noted that:

- *Acquisition of projects consumes much time for staff.*
- *International peer reviewed publication activity is complicated by the fact that publication of data collected for third parties often are allowed only after several years of confidentiality.*

As examples of general issues where programme area 5 has a particularly strong standing the evaluation panel would have noted that:

- *The scientific staff at programme area 5 generally feels that they have influence on developments, which contributes to the present positive working morale.*
- *Given the strength of the researchers and the unique data available at GEUS, programme area 5 have a clear potential to take an internationally leading role in different environmental studies.*

Based on this, the evaluation panel recommends that formulating an overall research objective for the programme area might be considered:

- *Taking all scientific activities within programme area 5 into account, a common research objective might be the linking of terrestrial (incl. glaciological) and marine processes and environments, past and present, in and around Denmark and Greenland. This would represent an example of how to perform useful, modern baseline studies. In addition, this would augment GEUS's role as a leading geoscientific research institution within the North Atlantic context.*

An initiative like the above should clearly be co-ordinated within the bigger Geocenter Copenhagen, and would add to both the internal strength of the programme area and the overall capability of GEUS to advice on issues relating to the landscape effect of ongoing and future climatic changes.

Finally, the evaluation would like to appreciate that

- *GEUS over the evaluation period has attempted to secure the existence of relevant geoscientific knowledge, by investing surplus from some research areas to other areas without sufficient funding for the time being. It is important that this modus operandi should be continued by GEUS to ensure that relevant knowledge always is at hand in Denmark when need arises with short notice.*

Appendix 1

The review panel

Professor **Ole Humlum**, Oslo University. *Before taking up his present position at the Institute of Geoscience in Oslo in 2003, he served as professor of Physical Geography at the University Centre in Svalbard (UNIS) 1999-2003. From 1985 to 1999 he was appointed as Associate Professor at the Institute of Geography, University of Copenhagen. For three years (1983-1985) he was Scientific Director for the Arctic Research Station in Greenland. He has been a scientific guest at the University of St. Andrews, Scotland, and at the Museum of Natural History in Tórshavn, Faroe Islands, in 1997 and 1998, respectively. Since 1998 he has been one of two co-chairs for the international working group 'Periglacial processes, landforms and climate' under the International Permafrost Association (IPA). Main research focus are glacial- and periglacial geomorphology, with emphasis on climatic controls on glacial, periglacial and permafrost processes in cold-climate, high-relief areas, past and present. In addition, he is also active within mapping, monitoring and numerical modelling of natural cold-climate hazards.*

Professor emeritus **Björn E. Berglund**, Lund University. *During the period 1971-2000 he served as professor in Quaternary Geology and Head of the Department of Quaternary Geology, since 2000 he is active as independent scientist at the Department of Geology/Quaternary Geology, GeoBiosphere Centre, also at Lund University. He has acted as member of several research committees at the Swedish Natural Science Research Council and the Royal Swedish Academy of Sciences, and as coordinator for European projects and conferences on Holocene palaeoecology. His main research interests are Lateglacial and Holocene vegetation history in relation to climate and human impact, in recent years with focus on long-term cultural landscape dynamics. Another research field is the Baltic Sea history with focus on Littorina Sea transgressions in relation to climate changes. One application of this basic research has been nature management and conservancy.*

Dr **Cees Laban**, of TNO Built Environment and Geosciences - Geological Survey of The Netherlands-, *was head of the Marine Geology department between 1990 and 2004, and head of the Business Unit Geology (land and marine) till September 2005. At the moment he is director of the starting TNO company "Marine sampling services", and responsible for marine project development of the institute. He has a longstanding experience in marine research, and has been involved in a large number of national and international projects and programmes in the North Sea, Baltic Sea, Atlantic Ocean, the Caribbean Sea, the Antarctic, Svalbard, Persian Gulf, and Western Greenland. His thesis was on the Pleistocene glaciations in the Dutch sector of the North Sea - a synthesis of sedimentary and seismic data-.*

Professor **Else Marie Friis**, Naturhistoriska Riksmuseet, Stockholm. *Since 1987 professor in palaeobotany and head of the Department of Palaeobotany at the Swedish Museum of Natural History and presently associate director of science for the Science Division at the museum. Has served on the board of directors for the Geological Survey of Denmark, for the Geological Surveys of Denmark and Greenland, as member of several Danish and foreign research committees such as the Danish Natural Science Research Council (including position as chairman for the committees Biodiversity and Man, Cultural Landscape, and Polar research), and on the board of directors for the Danish Research Foundation. Main research interest is the early evolution and diversification of flowering plants and major vegetational changes through the latest Mesozoic and early Cainozoic.*

Appendix 2

General terms of reference for the evaluation of programme area 5 at GEUS, Nature and Environment:

The mandate and objectives of the committee was defined in a letter of 2. November 2005, stating that the panel shall undertake an evaluation of research activities within the programme area 'Nature and Environment', constituted by

- Research and development activities within the areas of palaeoclimate, palaeoecology, marine geology and glaciology, with respect to the Quaternary in Denmark and Greenland
- Research and development activities with respect to the environment and climate change in Denmark and the northern hemisphere; and geological mapping in Denmark

Within programme area 5 the evaluation panel was asked to focus on:

- Identifying areas of high quality research
- Identifying areas where the research of GEUS should be strengthened in order to meet GEUS vision and strategies.
- Identifying areas which should be strengthened in order for GEUS to expand GEUS' ability to provide assistance to third world countries with the broad area of nature and environment
- Providing comments and proposals as to strategic changes, amendments, and improvements to GEUS' work within the programme area, in order to improve GEUS' ability to fulfil its main mission within the programme area put into perspective of the surveys statutes and general mission

The panel was asked to base its evaluation on:

- Publications from programme area 5 spanning the time interval 2000-2005
- One main visit at GEUS in Copenhagen, interviewing scientists, and visiting laboratories and work-facilities at the GEUS premises.
- A supplementary second visit aimed also for presenting the initial findings of the panel.

Appendix 3

Vision for GEUS: Geology for a changing society

GEUS is the Geological Survey of Denmark and Greenland and by pursuing its vision it contributes to the development of society

GEUS is to be an internationally recognised and in selected areas a leading research and consultancy institution in the fields of environmental geology, water resources, energy and mineral resources.

GEUS is to be the primary consultancy institution for Danish and Greenland authorities in all questions concerning important geological conditions.

GEUS is to be the national geological data centre, on the forefront internationally, which presents reliable and independent information to benefit the public and industry.

GEUS is to be an attractive workplace where ethical standards and social values are the mainstay of the business culture.

GEUS is to play an active part in developing the periphery fields of geology.

GEUS is to set the trend by developing partnerships with other research institutions, industry and international organisations.

GEUS, including its associates in Geocenter Copenhagen, is to be an internationally distinguished research centre attracting visiting researchers and PhD students.

GEUS is to be a visible player in international development assistance concerning the exploitation and protection of natural geological resources.

GEUS is to be visible in society and present geological information to the public in an accessible way.

Appendix 4

The general government budget for GEUS 2000-2009

Mio. kr.	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Budget appropriation...	136,8	138,1	145,6	137,7	148,8	127,3	129,5	127,5	126,0	127,5
Expenditures.....	227,7	244,2	222,0	229,4	269,7	218,3	265,7	261,2	248,2	231,7
Operating revenue.....	91,0	106,1	76,4	91,7	120,9	91,0	136,2	133,7	122,2	104,2

Mio. kr. in 2006 prices	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1. Research and advisory activities										
1.1. Water resources....	31,6	46,9	42,3	42,3	40,3	42,3	36,8	36,2	35,4	36,5
1.2. Energy resources...	40,9	36,4	40,2	55,7	38,5	56,3	90,3	87,4	76,7	58,7
1.3. Mineral resources..	40,8	46,4	30,7	29,5	24,5	27,6	29,7	28,9	28,6	29,4
1.4. Nature and environment	16,4	18,0	16,7	17,5	14,9	15,5	16,8	16,2	16,2	16,5
1.5. DLC.....	30,9	33,8	12,2	12,5	12,9	0,0	0,0	0,0	0,0	0,0
2. Databank.....	22,0	24,1	20,2	25,2	17,3	17,0	18,2	18,3	18,5	19,4
3. Help functions.....	36,4	34,1	36,4	26,5	47,1	43,2	46,1	46,4	45,8	44,6
4. Administration.....	34,8	33,6	42,8	27,1	21,2	20,1	27,8	27,8	27,0	26,6
% of total.....	14%	12%	18%	11%	10%	9%	10%	11%	11%	11%
Total.....	253,8	273,3	241,5	236,3	216,7	222,0	265,7	261,2	248,2	231,7

Personel (in man-years)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total Man-years	354	349	341	319	295	303	271	269	266	266

Source: The Finance Act, Ministry of Finance, www.fm.dk

Appendix 5

Programme area 5, Nature and environment:

Percentage of time used for research and advising 2000 – 2005

	2000	2001	2002	2003	2004	2005	
Research	77	70	68	68	84	73	79
Advising	23	30	32	32	16	27	21

Appendix 6

Programme area 5, Nature and environment: Publications 2000-2005

GEUS researchers have during 2000-2005 published the scientific results in 96 different journals and books. The list below shows that 32 journals have printed articles between 2 and 13 times, while 64 journals have published 1 article.

The researchers have the permission to choose the journal they want and as they find convenient for the subject of the paper. The different research areas are demonstrated by the diverse characters and types of the journals.

List of journals where the papers are published and the numbers of papers.

Journal	Number of papers
The Holocene	13
Marine Geology	10
Boreas	9
J. of Quaternary Science	6
Bull. Geol. Soc. Denmark	6
Quaternary Science Reviews	5
J. of Paleolimnology	5
Freshwater Biology	5
Quaternary Research	4
Quaternary International	4
Palaeogeography, Palaeoclimatology, Palaeoecology	4
Geoscience	4
Geology	3
Forest ecology and Management	3
J. of Ecology	3
Geologie en Mijnbouw	3
Period Biology	3
Global and Planetary Change	2
Canadian J. of Forest Research	2
J. of Marine Systems	2
Review of Paleobotany and Palynology	2
Annals of Glaciology	2
Arctic, Antarctic and Alpine Research	2
Archive für Hydrobiologie	2
Limnology and Oceanography	2
J. of Glaciology	2
Geografiska Annaler	2
Earth and Planetary Science Letters	2
Mitteilungen Pollichia	2
Marine Micropaleontology	2
Geol. Soc. London Sp. Publ.	2
Marine and Petroleum Geology	2
64 different journals (incl. Nature)	1

Appendix 7

Publication statistics for programme area 5 at GEUS 2000-2005

Year	2000	2001	2002	2003	2004	2005
Peer reviewed scientific papers	29	33	38	19	31	35
Citations from above papers	243	110	158	54	40	7*
Peer reviewed GEUS series	4	7	2	0	7	3*
TOTAL peer reviewed	33	40	40	19	38	38*
Theses	0	3	0	2	4	0*
Other	139	113	94	88	90	33*
TOTAL productivity	172	156	134	109	132	71*

* Values for 2005 updated to early December 2005

Appendix 8

First panel meeting on evaluation of research activities on Nature and Environment.

Copenhagen, November 23-24, 2005

Timetable (1. revision)

Date	Time	Activity	Responsible	Place
Tuesday 22/11				
		Arrival to Copenhagen		Comfort Hotel Østerport A/S Adress: Oslo Plads 5 2100 København Ø Phone: +45 3311 2266 www.choicehot els.dk
Wednesda y 23/11				
	08.45	Arrival and registration	Klaus Pedersen	GEUS reception
	09.00	Welcome to GEUS	Vice director Johnny Fredericia	OWC Conference room, GEUS
	09.15	Introduction to the research areas within Nature and Environment	Head of department Peter Gravesen	OWC Conference room, GEUS
	09.30	Brief presentation (25 min.) by senior researchers, followed by Q&A	Knud Erik Klint Jørgen Bo Jensen Antoon Kuijpers Richard Bradshaw	OWC Conference room, GEUS
	12.00	Lunch break	Panel	Cantine, Geocenter
	13.00	Discussions with various relevant researchers	Head of department Peter Gravesen	GEUS
	16.00	Planning of evaluation End of session	Panel	OWC Conference room, GEUS

	19.15	Dinner at Restaurant "Copenhagen Corner"		Adress: Rådhuspladse n Vesterbrogade 1A 1620 København V Phone: +45 33 91 45 45
Thursday 24/11				
	09.00	Publications are presented - copies made upon request	Head of department Peter Gravesen	OWC Conference room, GEUS
	12.00	Lunch break	Panel	Cantine, Geocenter
	13.00	Coordination within the panel – the coming evaluation is planned	Panel	OWC Conference room, GEUS
	16.00	End of meeting		

Questions can be forwarded to:

Vice director Johnny Fredericia (jfr@geus.dk, tel: +45 38142130) or
Klaus Ljørring Pedersen (klp@geus.dk, tel: +45 38142132).

Appendix 9

Second panel meeting on evaluation of research activities on Environment and Nature.

Copenhagen, February 23-24, 2006

Timetable

Date	Time	Activity	Responsible	Place
Wednesday 22/2				
		Arrival to Copenhagen	Hanne Hende	Comfort Hotel Østerport A/S Address: Oslo Plads 5 2100 København Ø Phone: +45 70 12 46 46 www.choicehot els.dk
Thursday 23/2				
	08.45	Arrival		GEUS reception
	09.00	Presentation of the evaluation to programme area 5	Professor Ole Humlum & the panel	OWC Conference room, GEUS
	12.00	Lunch break	Panel, Peter Gravesen & Johnny Fredericia	Cantine, Geocenter
	13.00 - ?	Writing of the report	Panel	OWC Conference room, GEUS
	19.00	Dinner at a restaurant in Copenhagen	Panel, Peter Gravesen & Johnny Fredericia	To be decided
Friday 24/2				
	09.00	Writing of the report	Panel	OWC Conference room, GEUS
	12.00	Lunch break	Panel	Cantine, Geocenter
	13.00 - ?	Writing of the report Printing of the report	Panel	OWC Conference room, GEUS
		End of meeting		

Questions can be forwarded to:

Klaus Ljørring Pedersen (klp@geus.dk, tel: +45 38142132).

He can be contacted, if any practical problems arises.