The Building Blocks of Society

Annual Report 2009

GEOLOGICAL SURVEY OF DENMARK AND GREENLAND
MINISTRY OF CLIMATE AND ENERGY

GEUS

A hectic COP 15

2009 was all about the Copenhagen climate summit

The year 2009 was all about the climate summit, and the Geological Survey of Denmark and Greenland (GEUS) was heavily involved in many activities before and during COP15 to present to the global audience the research world's contribution to the understanding of climate changes and to illustrate the consequences and possibilities of climate change adaptation. The development of solutions was also part of GEUS' presentations.

GEUS contributed with material for two climate-related teaching portals which were launched well before the summit. These include the portal, Climateminds.dk, produced by the Danish Experimentarium in collaboration with the Danish energy industry, and the portal Klimaundervisning.dk, developed by Danish Science Communication and the Danish Ministry of Education.

During the climate summit, GEUS also participated in several activities inside and outside Bella Center. At the official Danish booth in Bella Center, GEUS contributed to the theme 'Meet the Danes', with topics about the Danish monitoring of the Greenland ice sheet and Danish efforts to safeguard our drinking water. In addition, researchers from GEUS presented their work on water resources and climate change in the developing countries, as part of a Dutch and Danish concurrent event.

Outside Bella Center, GEUS was involved in several parallel events. At the North Atlantic Quay in Christianshavn (Copenhagen), GEUS contributed to the 'Arctic Venue' of the Danish Energy Agency, which presented the significance of Arctic research to the international community, as well as 'In the Eye of Climate Change', organised by the Greenland Self Government, which informed about Greenland's climate challenges. GEUS presented a wide spectrum of activities through lectures, exhibitions and school events, ranging from climate tourism to hydroelectric power production and monitoring the ice sheet, changes in the sea ice of the Arctic Ocean and climate developments in the North Atlantic Ocean.

Furthermore, at the City Hall Square, during the Childrens' Climate Summit, GEUS researchers talked about the possibility of exploiting geothermal energy (heat) from the subsurface and storage of the greenhouse gas, CO_2, in the ground; solutions which may help reduce global warming. Finally, GEUS collaborated on the film 'One degree matters' which world-premiered at Stærekassen (the Royal Danish Theatre) in Copenhagen and which was organised by the European Environment Agency.

Preface

GEUS had a good and productive year in 2009, where the goals set for the year, to a very high extent, were met, and where GEUS succeeded in obtaining research and advisory tasks to realise these goals. GEUS also managed to obtain a positive financial result for the year, while also securing a substantial portfolio of projects, reaching into 2010.

With COP15 in Copenhagen and GEUS' affiliation to the Ministry of Climate and Energy, GEUS' research and advisory services within climate and energy became the focal point of the 2009 activities. GEUS mainly participated in a wide range of information activities.

Geological knowledge is a central part of tackling the climate challenge. It provides understanding of the causes of climate change, and it helps evaluate the impacts of climate change and the possibility of neutralising or adjusting to these changes. In connection with development of renewable energy sources, geology has become more important than many people realise. Climate challenges must be tackled whilst also ensuring adequate energy sources for society. In this regard, fossil energy sources continue to play a dominant role, while providing a considerable contribution to the economy. GEUS' research and assignments have never been more important to society than in recent years.

Geothermal energy has attracted strong and increasing interest, and in 2009 GEUS made a new assessment of the geothermal potential in collaboration with the Danish Energy Agency. The conclusion was that large parts of Denmark have the potential for heat supply with hot water from the subsurface. Storage of CO_2 in the subsurface is another instrument, which can reduce greenhouse gas emissions and which is highly prioritised in Europe. In the course of the year, GEUS, together with European cooperation partners, completed a number of large EU projects including mapping the potential for CO_2 storage at European level.

In June 2009, Greenland obtained self government, which meant that effective from 1 January 2010, Greenland has taken over the management of minerals via the Greenland Mineral Resources Act. As the basis for continued collaboration, an advisory services agreement between Denmark and Greenland about GEUS' work in this area should be concluded according to the Greenland Self Government Act. The agreement was made in December 2009 and marks a new milestone in the collaboration on making mineral extraction a leading industry in Greenland. Meanwhile, mining and oil companies have shown great interest in the possibilities of exploration, and this looks promising for a good and fruitful cooperation between GEUS and the Bureau of Minerals and Petroleum in Nuuk in future years.

For the Continental Shelf Project, 2009 was the most active year ever, with numerous expeditions, including LOMROG II to the North Pole area. The first claims for an area north of the Faeroe Islands were also submitted to the UN.

In the water and nature areas, GEUS focused on groundwater mapping and monitoring, including adaptation of the assignments to accord with the municipal reform. It has been decided to continue the Warning System for Pesticides ('Varslingssystem for Pesticider'), and in 2009, GEUS developed its own advanced, national, hydrological models, which make it possible to make the necessary calculations for water management. In the past year, GEUS saw increasing demands for hydrological knowledge from municipalities, including queries about infrastructure design, seen in the light of a changed and wetter climate.

GEUS has successfully obtained many strategic projects within central areas of its research, and accordingly, GEUS has proven competitive, at national as well as international levels. However, this is taking up increasing proportions of GEUS' basic funding for co-financing. Academically, GEUS is well-positioned for the new tasks required by society where geological knowledge is of importance.

We look forward to ensuring that GEUS' knowledge will continue to benefit Denmark and Greenland in 2010.

Per Buch Andreasen
Chairman

Johnny Fredericia
Managing director

Databanks and

Storage, quality assurance and presentation of geological knowledge and data

Explore Ilulissat Icefjord

In 2004, Ilulissat Icefjord was admitted to the UNESCO World Heritage List, and since then, this beautiful Greenland area has been a very popular destination for tourists. At the same destination, ministers from all over the world gathered to discuss how to best reach an international agreement on reducing greenhouse gas emissions. This was a Danish initiative started in the summer of 2005, and it was the kick-off for a number of informal meetings, named the Greenland Dialogue. In 2009, GEUS added a new section to the English language part of the GEUS website with the title: 'Explore Ilulissat Icefjord' (see: www.geus.dk/voii), revealing fascinating stories about this unique part of Greenland nature for tourists and other interested parties. The webpages comprise easy-to-read material about the ice sheet and the climate, a portrait of the Icefjord at Ilulissat, a section about animal and plant life, as well as the history of the icefjord people. The pages are abundantly illustrated with area maps, colour photographs and graphics, and visitors can experience nature through video footage, animations and slideshows. The content is based on the original nomination document to UNESCO produced by GEUS in 2002.

Invaluable data about the subsurface of Denmark

GEUS receives and delivers data from and to the national subsurface database, SAMBA. The database is operated in collaboration with the Danish Energy Agency and is an important element in obtaining subsurface data, which can be utilised by society in connection with continued oil and gas research and exploration, as well as surveys of the possibilities of exploiting geothermal energy and storing CO_2 in the subsurface. SAMBA encompasses a wealth of information from deep boreholes and geophysics, collected through many years of exploration and production of oil and gas, as well as other uses of the subsurface. Accordingly, SAMBA includes information from several hundred thousand kilometres of seismic lines, as well as geological information and log data from numerous boreholes, which have cost billions of DKK to collect. Here, the authorities can find information about oil production and yields from wells, as well as licence information and reports from the activities in the North Sea. Finally, SAMBA acts as the registration system for drill cores and other geological material in the GEUS core sample storage, which includes more than 60 000 core boxes. Many data in SAMBA are confidential, but a selection of geological and geophysical data is available at the GEUS website, and in 2009, a new map-based search engine was completed, making it easier for users to collect data.

information

More user-friendly access to geophysical data

In 2009, the national database for close-to-surface geophysics, GERDA, acquired a new user interface and a more powerful server, making it easier for users to find data on the website of the database. GERDA includes geophysical data, which mainly derives from mapping areas with special drinking water interests. Since 2007, this responsibility has been with the environment centres. Logging data, collected by GEUS and advisory engineering companies in connection with inspection borings and water supply borings, are also being reported to the database. The geophysical data in GERDA comprises geoelectrical and electro-magnetic data, seismic data and borehole logs. Both measurement data and interpretations in the form of geophysical models in the database are being stored. GERDA plays an important role in the management of water resources and mineral resources, and the database will continue to be an important tool and library for groundwater mapping by the environment centres, as well as for other mapping activities that require geological and geophysical data. During 2009, especially SkyTEM data collected by helicopter in connection with the groundwater mapping have flowed in. GERDA is headed by GEUS and financed by the environment centres, and it is being developed constantly by a work group consisting of representatives from the environment centres, the regions, Aarhus University and consultancy firms.

Geosciene magazine (Geoviden) popular in schools

The Geoviden magazine is popular in Danish high-schools. Since the beginning of 2005, subscriptions have increased from 3500 to 5200. In the COP15 year of 2009, Geoviden focused on the climate in several articles. This is especially true for an issue on the significance of climate change for the water cycle in Denmark, and another issue on monitoring of the Greenland ice sheet. The magazine also described research in the Danish Wadden Sea, and a final issue focused on Darwin and the reception of his theory in the Danish scientific and cultural arena, as 2009 was the 200th anniversary of Darwin's birth. In particular, the issue on the climate and Danish water resources attracted much media attention, and gave rise to many articles in newspapers, as well as interviews on radio and on TV with researchers from GEUS. The magazine, Geoviden - Geology and Geography, is published by Geocenter Denmark four times a year, in print and electronically.

Water resources

Procuring knowledge to permit optimal management of Danish water resources

New methods for restoration of lakes

GEUS is participating in the research centre, CLEAR, which works to develop better methods for restoration of lakes. This work includes surveys on how different types of interventions affect internal processes in the lakes, e.g. chemical restoration, biomanipulation or physical interventions. The natural inflow of water with nutrients to the lakes and the corresponding outflow are important parameters. Together with the Department of Geography and Geology at the University of Copenhagen, GEUS has listed the water balance for five Danish lakes. This work comprises descriptions of the groundwater flows in and out of the lakes, and the accompanying addition of nutrients. Groundwater flows are strongly dependent on geological conditions under the lakes, which are usually not that well known. Therefore, this work has also included measurements with georadar from the surface of the lake to gain a better image of how the geology underneath the lakes is structured. The CLEAR centre is financed by the Villum Kann Rasmussen foundation, and consists of a cross-scientific team of research groups from the University of Southern Denmark, the University of Copenhagen, the National Environmental Research Institute and GEUS. The management of the centre is headed by the Institute of Biology at the University of Southern Denmark.

Updated platform for national assessment of water resources

In 2009, GEUS concluded extensive updating of its national water resources model, the so-called DK-model, which in 2003 was used for the most recent national estimation of exploitable water resources for water supply. This update was carried out according to the national programme for monitoring the aquatic environment and nature, NOVANA. The work included updating the model with data from the counties' mapping of areas with special drinking water interests, as well as details about the physical description and input data. The updating has ensured coherent model interpretation across previous and existing administrative borders. The DK-model is a large-scale model, which calculates the overall water balance and the extent of the groundwater resource and rate of exploitation, taking into account the climate, land use and the water abstraction strategy. The updating has created a better basis for a more uniform management of Denmark's water resources, and GEUS' vision for development of the model is that it should be a common reference framework for national work on mapping, monitoring and management of Danish water resources. The model describes both the groundwater flows and the surface water, and it also supports the work on implementing the EU Water Framework Directive, which requires groundwater and surface water to be managed together.

Mapping Denmark's groundwater

The national groundwater mapping is in full swing in the environment centres of Denmark. The work comprises mapping areas with special drinking water interests (OSD) and mapping catchment zones for waterworks outside such OSDs. As a specialised datacentre, GEUS assists the Danish Agency for Spatial and Environmental Planning and the environment centres with specialist coordination and advisory services, to ensure that the national groundwater mapping is performed as uniformly as possible in situations with comparable problems. A large part of the mapping is based on geophysical methods, and in 2009, Aarhus University collaborated with GEUS on further development of geophysical interpretation methods, and preparation of guidelines on how to conduct geophysical measurements, and on how to interpret and store such measurements in the national geophysical database, GERDA. In addition, several GEO guidelines have been published on geochemical mapping, potential mapping and methods for identifying nitrate-vulnerable zones. Furthermore, a new report on mapping of buried valleys in the subsurface, where previously unknown groundwater resources are often found, was published. These publications are available at the website, Grundvandskortlaegning.dk together with information on meetings, courses and theme days, which GEUS regularly holds for its staff at the environment centres and its collaboration partners.

The warning system for pesticide leaching (VAP) is secured up to 2016

With adoption of the government's Green Growth Plan, funding of the VAP has been secured up to the end of 2015. The VAP is a unique and extensive monitoring programme that investigates whether approved pesticides or their degradation products are leached into young groundwater in concentrations above the limit value. Via the VAP, a quick assessment and a removal of otherwise approved pesticides from the market are made possible, if they prove able to leach into the groundwater during normal use under Danish conditions. The VAP was established in 1999 and today consists of five test fields, all run using normal, correct agricultural practices. The fields represent the varying soil and climate conditions in Denmark, and are instrumental in monitoring the destiny of pesticides and their degradation products from the surface, through the soil column and until they end in drains and groundwater. The risk of leaching has so far been assessed for about 40 pesticides and 40 degradation products. The results of the VAP monitoring are being sent to the Danish Environmental Protection Agency, which utilises these data in its work on regulating or possibly banning the use of approved pesticides with unwanted properties in the environment. The VAP is a collaboration between GEUS, the Danish Environmental Protection Agency, as well as the Faculty of Agricultural Sciences and NERI - both from Aarhus University.

Energy resources

Procuring knowledge for continuing exploration and exploitation of energy resources in Denmark and Greenland

Great interest in Arctic oil resources

There is a great interest in Arctic oil resources, and in 2009, no less than 13 oil companies submitted applications for pre-qualification for the licensing round in 2010 in offshore areas in Baffin Bay. In this connection GEUS has worked on interpreting seismic data and acquiring data from the area in GIS file format. Another major activity was carried out in North-East Greenland, where GEUS wants to update and expand understanding of the oil geological potential of the area. The research project is being realised in collaboration with the oil industry, and in 2009 a digital comparison of an enormous data volume and surveys of the area were concluded, after having collected information about stratigraphy, type of source rock and geophysics. As part of the field work, extensive stratigraphical and petroleum geological surveys of the area were carried out between Hold with Hope and Store Koldewey, and in Wollason Forland, a core drilling was carried out to document occurrences of source rock type in the Upper Jurassic strata. The results of the surveys in North-East Greenland were presented to the oil industry through workshops held over the past year. This work is helping mature North-East Greenland for any licensing rounds in 2011-2013 that the Bureau of Minerals and Petroleum in Nuuk might have in the pipeline.

Full steam ahead on the work to delimit the continental shelf

In 2004, Denmark ratified the United Nations Convention on the Law of the Sea, which opens for opportunities to claim subsurface and seabed resources outside the 200 nautical mile limit. Any claims have to be documented, primarily with information about sea depths and sedimentation thicknesses. Five areas are in play; one area in the Arctic Ocean, two areas north-east and south of Greenland, and two areas north-east and south-west of the Faroe Islands. In 2009, the activity level was very high in Greenland with several large expeditions, and the first claims were made to the UN for the area north-east of the Faroe Islands. GEUS collaborated with the Canadian Continental Shelf Project on acquiring bathymetric and gravimetric data from the sea ice north of Greenland, and gravimetric and magnetic data were acquired by aircraft. The area north of Greenland was also in focus, when researchers measured the seabed and acquired seismic data and gravity data during the LOMROG II expedition with the Swedish icebreaker, Oden. These activities were carried out in collaboration with the Swedish Polar Research Secretariat and the Canadian Continental Shelf Project. Refraction seismic data were acquired in collaboration with the Canadian project in the area off South Greenland. Depth data in the area were supplemented in collaboration with the Alfred-Wegener-Institut für Polar- und Meeresforschung in Germany in connection with a marine geological expedition. The Continental Shelf Project is being funded by the Danish Ministry of Science, Technology and Development, with contributions from the Faroese government, and work is being carried out as a collaboration between GEUS and other institutions from Denmark, the Faroe Islands and Greenland.

New assessment of geothermal energy

Together with the Danish Energy Agency, GEUS has made a new assessment of the geothermal potential in Denmark. Several elements constitute the basis of this reassessment. Climate change calls for new energy solutions which can reduce emissions of CO_2 into the atmosphere. Heat from the subsurface in the form of geothermal energy is one of the energy sources available. In recent years, new geological data have been collected, and the experience from the latest geothermal installation on Amager has been useful. Also, in the beginning of 2009, the Copenhagen geothermal cooperation published a report, in which the geothermal reserve in Greater Copenhagen has been reassessed to be much larger than was previously thought. The new assessment covering the whole country concludes that the subsurface in large parts of Denmark consists of deep sedimentary basins with sandy rock reservoirs containing hot water, which can be used for heating. Results show that the subsurface of Denmark has substantial geothermal resources, and that geothermal energy will be able to contribute to heat supply for several hundreds of years.

Geological storage of CO_2

For several years, Europe has focused on storage of CO_2 in the subsurface - a method which can be used to limit greenhouse gas emissions to the atmosphere. In 2009, as project manager, GEUS held a well-attended conference, which concluded the EU project, Geocapacity. The project has assessed the storage potential of CO_2 in Europe, and has established a comprehensive European GIS file database with information on CO_2 point sources and storage options. Work with a similar database covering China was also concluded as part of the EU project, COACH, which is aimed at transferring competences within geological storage of CO_2 from the EU to China. Knowledge from the research projects will be brought into play in international fora in which GEUS is represented. One of these is CO_2GeoNet, a European 'Network of Excellence' which aims at enhancing Europe's scientific and technological position within CO_2 storage through the concentration of resources and expertise. On the home front, GEUS has worked on analysing how reservoir rock and cap rock respond when CO_2 is pumped into the subsurface. This project, which includes lab tests, where reservoir rock is exposed to long-term impacts of CO_2, is being financed by the energy technology EUDP programme of the Danish Ministry of Climate and Energy, with support from the energy companies, DONG Energy and Vattenfall.

Important mineral resources for building and construction

In Denmark, mineral resources are mainly excavated onshore for building and construction. This increasing onshore extraction in some areas conflicts with the wish to preserve landscapes and nature, and GEUS is therefore working to find suitable mineral resources offshore which can be exploited sustainably. This applies to the inner Danish waters and the North Sea. In 2009, GEUS produced a map of the sediments in the seabed covering the entire North Sea, and work on developing a national database for marine geological data has been launched. The database is an important tool for management of the mineral resources of the sea, and it also holds important data for the protection of marine habitats. 2009 was also the year when a new Mineral Resources Act was adopted, and in this connection, GEUS has assisted the Danish Agency for Spatial and Environmental Planning with preparing an executive order on reporting mineral resources data to the authorities. GEUS has also concluded a desktop study on possible occurrences of mineral resources which may be used during building of the Fehmarn Belt connection. Finally, mapping of sand and gravel deposits in the North Sea and in the inner Danish waters was carried out for private enterprises. Onshore surveys have been conducted near Ølst for Central Denmark Region (Region Midtjylland) to look for clay for production of leca rocks, and on Mors, moler surveys have been carried out. Moler is used for cat litter and as an additive for chemical fertiliser and feeding stuff, as well as in the pharmaceutical industry.

New geochemical data from South-East Greenland

In summer 2009, GEUS made geological reconnaissance and geochemical surveys in a large area of South-East Greenland between 62°N and 67°N. The area, which is concentrated around the settlement, Skjoldungen, is one of the least surveyed areas in Greenland and only scarce geological information exists, such as geochemical and geophysical data. This type of knowledge is entirely necessary for commercial mineral resources exploration, and it is important to have when setting up modern geological models. The work during the summer included collection of stream sediments and water samples, which can reveal how the geochemistry in the terrain is composed, as well as samples of glacier deposits, which will be analysed for indicator minerals for diamonds. This work will continue in 2010, and is the start of a detailed geological survey and assessment of the region's mineral resources, and the project is being financed by the Greenland Bureau of Minerals and Petroleum in Nuuk.

Mineral resources

Creating the scientific basis for targeted and environment-friendly exploitation of mineral deposits in Greenland and Denmark

New mineral finds

In recent years, GEUS has been working intensively on assessing the mineral potential in West Greenland, and in 2009, this work concentrated on the Fiskenæsset region and in the area between Frederikshåb Isblink and the fjord Sermiligaarsuk. The geological field work during the summer was aimed at modernising the existing 1:100 000 atlas. In parallel with this work, geological-ore surveys have been carried out in order to assess the prospects of finding new mineral deposits. The activities have focused on Pre-Cambrian supra-crystalline rocks, which may contain mineralisations of precious and base metals. The work over the summer was extremely successful, and geologists found several new mineralisations of gold, silver, copper, and platinum group minerals. The geological mapping has been carried out in a collaboration between GEUS and a number of universities from the UK, Sweden and Canada. The activities have been funded by the Greenland Bureau of Minerals and Petroleum.

Servicing the mining industry

Easy access to data and publications is one of the services offered to the industry, which GEUS and the Bureau of Minerals and Petroleum have emphasised in their many years of marketing Greenland mineral resources. In 2009, work on the DODEX database was completed. The database is targeted at specialists in the international exploration and mining industry. The database provides online access to publicly available company reports and, to a certain extent, geoscientific publications and data. The data base also gives access to the web-facility GMOM (Greenland Mineral Occurrence Map), which contains hundreds of mineral occurrences in Greenland, and which can display the occurrences together with the main geological settings, or with physiographic data or other data, such as airborne geophysical measurements and geochemical data. In 2009, GMOM was expanded with data from the area around Godthåbsfjorden and from South Greenland. Finally, GEUS published the bulletin: 'Greenland from Archaean to Quaternary', which is a new and updated publication providing an overview of the geological development of the whole of Greenland. The publication is a description of the 1:2 500 000 geological map of Greenland. The bulletin comprises a comprehensive index register and an extended reference list of the most recent publications.

Nature and climate

Identifying processes leading to today's climate and environmental conditions in Denmark and the North Atlantic in particular

Ice and climate surveys

The melting of the Greenland ice sheet is now significantly contributing to the rise of the global sea level. In the past decade, the losses from the great ice cover have doubled. The losses derive from a major melting and calving of icebergs from the ice sheet. In 2009, GEUS collected sediment cores from the Sermilik fjord in South-East Greenland to illustrate the correlation between variations in the climate, the sea ice and changes in the ice sheet. Helheimgletscher (glacier) flows into the Sermilik fjord. The glacier is one of many calving ice tongues in Greenland, which have begun to move more quickly in recent years, while the ice front has withdrawn, and the surveys from Sermilik will illustrate which processes are at work. This work is part of the Geocenter Denmark project, SEDIMICE.

Assessment of the safety of long-term storage of radioactive waste

In 2009, GEUS participated in surveys of the flow and chemistry of groundwater in the fractured and partly frozen bedrock near the rim of the ice sheet at Kangerlussuaq in West Greenland. This work aims at assessing the safety aspects of storing radioactive waste in deep-lying deposits in Scandinavia or Canada. The project GAP (Greenland Analogue Project) is being financed by the institutions, SKB, Posivia and NWMO, which are responsible for storage of radioactive waste in Sweden, Finland and Canada, respectively. The Swedish rules for storage include requirements that repositories are safe for 100 000 years. An analysis of the safety of the repositories must therefore also include what will happen to them, if Scandinavia is again covered with ice, and surveys in Greenland are part of this ice-age scenario. The field work during the summer also included deep drilling through the bedrock at the ice front, and measurements of the ice melting to examine whether deep flows of groundwater may affect a potential waste repository, and to assess how a leakage from a facility will spread in unfrozen parts of the otherwise permafrozen fractured rock. This project is being carried out in a collaboration with universities from the US, Canada, the UK and Sweden.

Geological maps for planning and land management

Geological maps are an important tool in spatial planning and management, and they are used in connection with many technical assignments. GEUS regularly carries out geological mapping in different parts of Denmark. The areas are selected based on society's needs for geological data, e.g. in connection with groundwater extraction, mineral resources extraction, afforestation and assessment of soil quality. In 2009, the field work comprised mapping on Lolland, starting around Mariager fiord. The 1:50 000 geological maps, Nykøbing Falster and Rømø, were completed and digitalised, and are expected to be printed in 2010, and finally, the mapping of Mors has been completed. All new mapping results are regularly digitalised and stored in GEUS' map database, and in 2010, a CD-ROM was published with a new and updated digital version of the national soil map on a scale of 1:25 000. The soil map does not yet cover the entire country, but mapping now covers about 86% of Denmark.

Online data from the Greenland ice sheet

At the end of 2009, 12 fully automatic monitoring stations on the ice sheet were operational and sending measurements of melting, the climate and ice movements back to GEUS in Copenhagen via satellite. The measurements are part of the PROMICE programme, which monitors the great ice mass of Greenland. The programme is being headed by GEUS and focuses on what is happening along the rim of the ice sheet with the mass loss from melting and calving of icebergs. In 2009, the database was opened and data from the stations are found at Promice.dk. The website presents information about temperature, wind, radiation, snow depth, etc. Glaciologists are supplementing the measurements on the surface with measurements from aircraft and satellites. In cooperation with the Technical University of Denmark, the edge of the ice is being measured from aircraft all the way around Greenland, and the movement of the ice is being monitored by satellite. The website was expanded to include extensive material explaining how glaciologists determine whether the ice sheet is growing or shrinking. Danish monitoring is being supplemented by several foreign stations on the ice. In future, the overall international efforts will provide a far more accurate idea of how much ice is melting. The project PROMICE is being funded by DANCEA programme under the Danish Ministry of Climate and Energy.



Prominent Russian visit at GEUS

In February, the Danish Parliament received an official visit from the Russian Federation Council, headed by Chairman Sergey Mironov. During the meetings, the Danish-Russian cooperation was discussed, and Sergey Mironov also visited GEUS. Here Sergey Mironov, who is a geologist, was given a presentation of the Danish continental shelf project, which is headed by GEUS, and he was shown the lab facilities for mineral analyses, as well as a collection of selected Greenlandic minerals. For many years, GEUS has had good cooperation with Russian researchers. One of the areas of cooperation is analyses of minerals in the drill cores from the Skaerggard intrusion in East Greenland, which holds many special minerals. In one of the drill cores, the Russian geologist, Nikolay Rudashevsky, in 2002 found a new mineral, which was named Nielsenit, after the Danish geologist, Troels Nielsen from GEUS. Mironov received a sample from the drill core containing Nielsenit from managing director, Johnny Fredericia at GEUS, as a gift and a symbol of the successful Danish-Russian research cooperation.



Young Elite Researcher's Award for GEUS researcher

In January 2009, Steno scholar, Camilla Snowman Andresen from GEUS received the Young Elite Researcher's Award of DKK 200 000 from the Free Research Council. Camilla S. Andresen is heading the Geocenter Denmark project, SEDIMICE, which is investigating the interaction of the ice sheet with the climate near the Sermilik fjord in South-East Greenland. The researcher's award is given as extra funding for research performed by talented researchers, and Camilla was able to speed up her climate surveys.

The Geocenter Denmark trainee programme

In 2009, with a view to increasing recruitment to the geoscience, GEUS started a new trainee programme together with its partners in Geocenter Denmark. Practical training is offered for one week each spring and one week each autumn. The students work at GEUS for two days, go on a field trip for one day and also have one day at the Geological Museum and at the Institute for Geology and Geography.

Glimpses of the year

Popular school activities

Researchers from GEUS were in great demand at the events: the Research Day and the Danish Science Festival for which schools could book a researcher to give a talk. GEUS participated in both events with various lectures all over Denmark, where students could hear about climate, ice, energy, minerals, earthquakes, pollution and water, etc. All lectures were booked just one week after they were announced by the organisers. School classes also visited GEUS to learn about geology and resources. GEUS also had a visit from Greenland when an HTX (higher technical examination) class from a high school in Sisimiut was able to dabble in how geologists search for gold and other minerals, and they could see how the work with three-dimensional models in oil geology is being carried out.

Danish geological prize

In March, GEUS awarded the Danish Geology Prize 2008 to professor, Minik Thorleif Rosing from the Geological Museum at the University of Copenhagen. The prize of DKK 25 000 was given for his extraordinary surveys of some of the worlds' oldest rocks at Isua in Greenland which has led to breakthrough documentation of and theories on the early stages of the Earth's development. The prize was recommended by the Geological Society of Denmark and presented by Flemming Getreuer Christiansen, deputy director of GEUS. From an international perspective, Minik Rosing is an important researcher and one of Denmark's most quoted scientific authors, which makes him a born member of several commissions and scientific councils. His work ranges from science to the world of arts and its interchange with geology; most recently, in the book 'Verdensbillede - Geologi og Kunst' (Picture of the World - Geology and Art), co-authored with Per Kirkeby, the Danish painter. At the presentation, Flemming Getreuer Christiansen said, "Minik Rosing has made unique use of his extensive knowledge about Greenland for international top-level research, for international research collaboration and for popular dissemination. He is an outstanding ambassador for Greenland geology and for geology in general".





New research centre for sustainable small-scale mining operations

A new research centre (SASMin) under Geocenter Denmark was inaugurated in 2009. It studies the conditions for millions of poor Africans living wholly or partly off small-scale mining. Primarily the extraction of gold and precious stones provides many jobs in small communities, but also small-scale production of concrete stones, salt and fertilizer minerals is the livelihood for many people. The small-scale production form often has large negative environmental, social and health implications, but the sector also holds significant development potential for individual workers and their families and for the country. With participation of researchers from GEUS and the Department of Geography and Geology, the University of Copenhagen, the SASMin is examining small-scale mining in Ghana and Tanzania, its influence on the surrounding community, how the products are sold, and the opportunities of improving the production form, and in particular how to minimise the use of mercury. In Ghana, surveys were made of small-scale mining for materials for building and construction and salt production, and surveys were made of gold extraction in Tanzania. The centre also held an international seminar about the problems associated with this type of mining operation.

Developing the water sector in Zambia

For several years, the Danida water sector programme in Zambia has been working to promote effective and sustainable exploitation of the country's water resources. This is being done specifically by improving peoples' access to clean drinking water and by developing knowledge in relevant institutions in Zambia. GEUS is heading a sub-project in the programme which aims at supporting and developing teaching and research competences in the water sector of the country. The project, which a cooperation with the University of Zambia and the Technical University of Denmark, is currently training PhD and MSc students in hydrological and hydrogeological issues. Training is through participation in two specific research projects. These include a water resource project in Western Provence, and a project examining environmental problems in copper mines in the northern part of the country. In 2009, a Diploma programme in Integrated Water Resource Management (IWRM) at the University of Zambia was established to train students in optimum and holistic management of water resources. In the course of the year, candidates for the programme were selected.

GEUS around the world

The climate, water resources and agriculture in Tanzania

The fourth IPCC report from the international climate panel emphasises Tanzania as one of the countries that is most sensitive to climate change. Climate predictions show that great variations in many climate conditions are expected, especially precipitation, which is of great importance to agriculture and general conditions of life. At the end of 2009, a five-year climate-oriented project began in Tanzania which is to expand knowledge and capacity in Tanzanian institutions through research and development, so that the country can better adjust to the climate of the future. The project, CLIVET, which is being headed by GEUS, will comprise climate surveys and hydrological calculations of climate scenarios in the great river basin, Ruaha River Basin, where agriculture has suffered from recurring periods of drought for several years. Water resource surveys must create a better foundation for composing new strategies for how Tanzania can best adjust its agricultural activity to the new climate conditions. New data and training are on the programme for the new project. This work will form the basis for state-of-the-art knowledge about the impacts of future climate changes in one of the largest river basins of Tanzania. Several African students will be receiving training in climate-related disciplines at Master and PhD level. In this project, GEUS is cooperating with the Department of Geography and Geology, the University of Copenhagen, Denmark's Climate Center, Denmark's Meteorological Institute, the Institute of Resources Assessment and the Faculty of Engineering, both the University of Dar es Salaam and Tanzania Meteorological Agency. The project is being funded by Danida.

Theatre to ban mercury in Tanzania

Suffering for beauty is a harsh reality in a number of African countries south of the Sahara. Here, women use mercury soaps to wash themselves, in order to get paler skin, which is an ideal of beauty in that part of the world. The toxic mercury in the soaps penetrates the skin and reduces the pigmentation of the women. It is a great challenge to prevent the use of these soaps, as the women are unaware of how much damage mercury can cause. Geologists from GEUS were put onto the problem whilst working on a project in Tanzania, where mercury consumption in the local gold mining industry was examined, and since then GEUS has been working on several projects aimed at keeping the Africans from using the toxic soaps. In 2009, a campaign was carried out in Tanzania, funded by the Danish embassy in Dar es Salaam. Inspired by HIV campaigns, a local theatre group has toured around the country and performed a play which activates the audience and talks about the problem with using toxic mercury soap. "We are trying to teach women that using the toxic soap is very unhealthy, and we are trying to teach the men that black women are beautiful too", says Peter Appel, geologist at GEUS, who is behind the theatrical performance.

Key figures 2009

More detailed key figures for GEUS' activities can be found in Årsrapport 2009 (Report and Accounts 2009) and in 'GEUS' virksomhed i 2009 - Faglige resultater' (GEUS activities in 2009 - scientific results), the latter in Danish only, available on request from GEUS or at www.geus.dk.

Number of employees: **319**
Number of scientific projects: approx. **600**

ACCOUNTS 2009

Amounts in million DKK	
Revenue:	**327.2**
Net figure (appropriation):	141.4
Operating income:	185.8
Expenditure:	**320.1**
Salaries	161.6
Other operating expenditure:	158.5

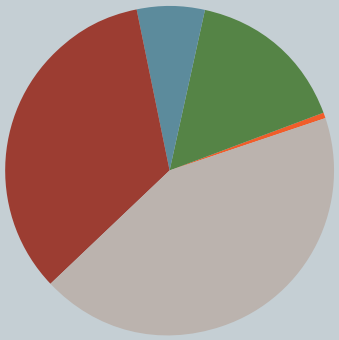
PRESENTATION ACTIVITIES

Long-term knowledge building	
Articles in international scientific journals/publications	112
Articles in GEUS' own scientific series	24
Other scientific publications	4
Ongoing scientific task solution consultancy and presentation	
Publicly available reports	72
Confidential reports	61
Memoranda, opinions, expositions, etc.	52
General presentation	
Institution reports (annual report, etc.)	4
General and popular-science presentations	140
- including popular-science lectures	63

Researcher training

Current PhD students with GEUS tutors	54
Completed PhD degrees at GEUS	13

Revenue broken down by source of revenue:



Amounts in million DKK

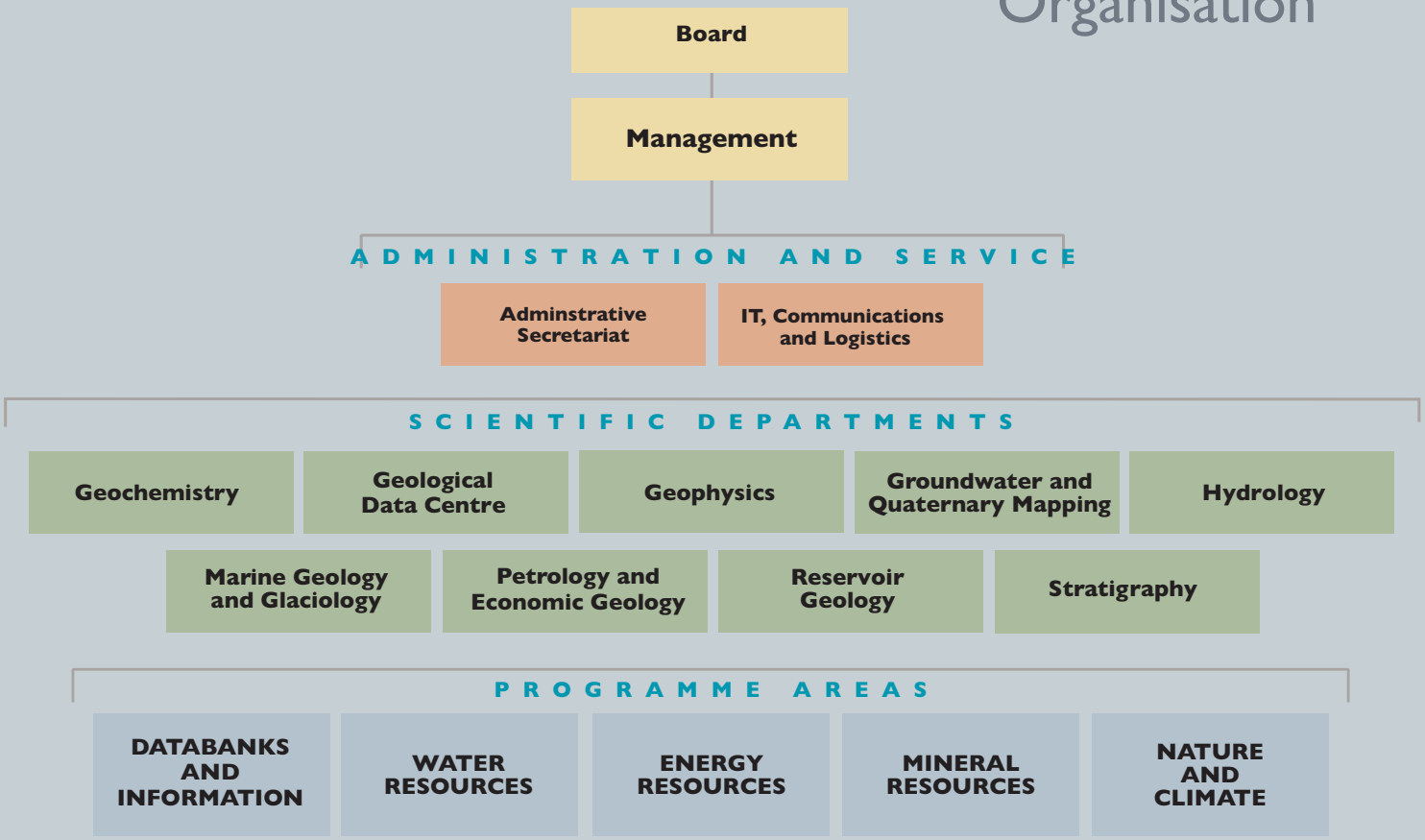
Budget appropriation:	141.4
Programme and external resources:	111.2
Other co-financed contract research:	21.6
Commercial contracts and sale of data:	52.0
Other revenue:	1.0

Expenditure broken down by programme area:

Amounts in million DKK

Databanks and information:	47.0
Water resources:	62.8
Energy resources:	114.6
Mineral resources:	55.0
Nature and climate:	40.7

Organisation



In the course of 2009, the GEUS structure was adjusted to better carry out the tasks of the institution, and to give clout to the professional environment for the Greenlandic mineral resources area. Some employees have thus changed departments and the two former departments of geological mapping and ore geology merged into a new department named: Department of Petrology and Economic Geology. Thus, at the end of 2009, GEUS had nine research departments and two administrative/service departments. Academic work is being done in five programme areas, where tasks are carried out in project groups in a matrix structure.

PROGRAMME AREA:
DATABANKS AND INFORMATION
Archiving and data processing in connection with statutory reporting of geodata to GEUS. The aim is to establish a level of quality of data and sample collections which helps work on monitoring, emergency management, advisory services and research. In addition, the programme area comprises IT-tasks, which ensure efficient and modern IT-tools at GEUS, as well as information to the scientific community and the public.

PROGRAMME AREA:
WATER RESOURCES
Providing the necessary basis for management of water resources. Activities are directed at the water cycle, the extent and quality of water resources, and transport and decomposition of xenobiotic substances in the aquatic environment, focusing mainly on the groundwater. The activities also form the basis for advisory services to authorities, regions and municipalities.

PROGRAMME AREA:
ENERGY RESOURCES
Providing and contributing the basis for continued exploration and sustainable exploitation of the energy resources of the Realm. This work comprises own research projects and international co-operation within oil/gas and renewable energy. The collected knowledge forms the basis for GEUS' advisory services to authorities in Denmark and Greenland, and also for projects carried out for the industry.

PROGRAMME AREA:
MINERALS
Providing the scientific basis for targeted and environment-friendly exploitation of raw materials and mineral deposits in Greenland and Denmark. This work includes geological mapping and mineral exploration in Greenland, as well as official processing and advisory services for the Greenland Self Government. In addition, surveys are carried out in connection with raw materials and construction work in Denmark and internationally.

PROGRAMME AREA:
NATURE AND THE CLIMATE
Examining processes in Denmark and the North Atlantic area which have led to the current climate and environment conditions. The objective is to improve the prospects of distinguishing between natural and human-induced climate changes. The programme area also includes a mapping of onshore and offshore geological conditions, as well as earthquake research and monitoring.

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