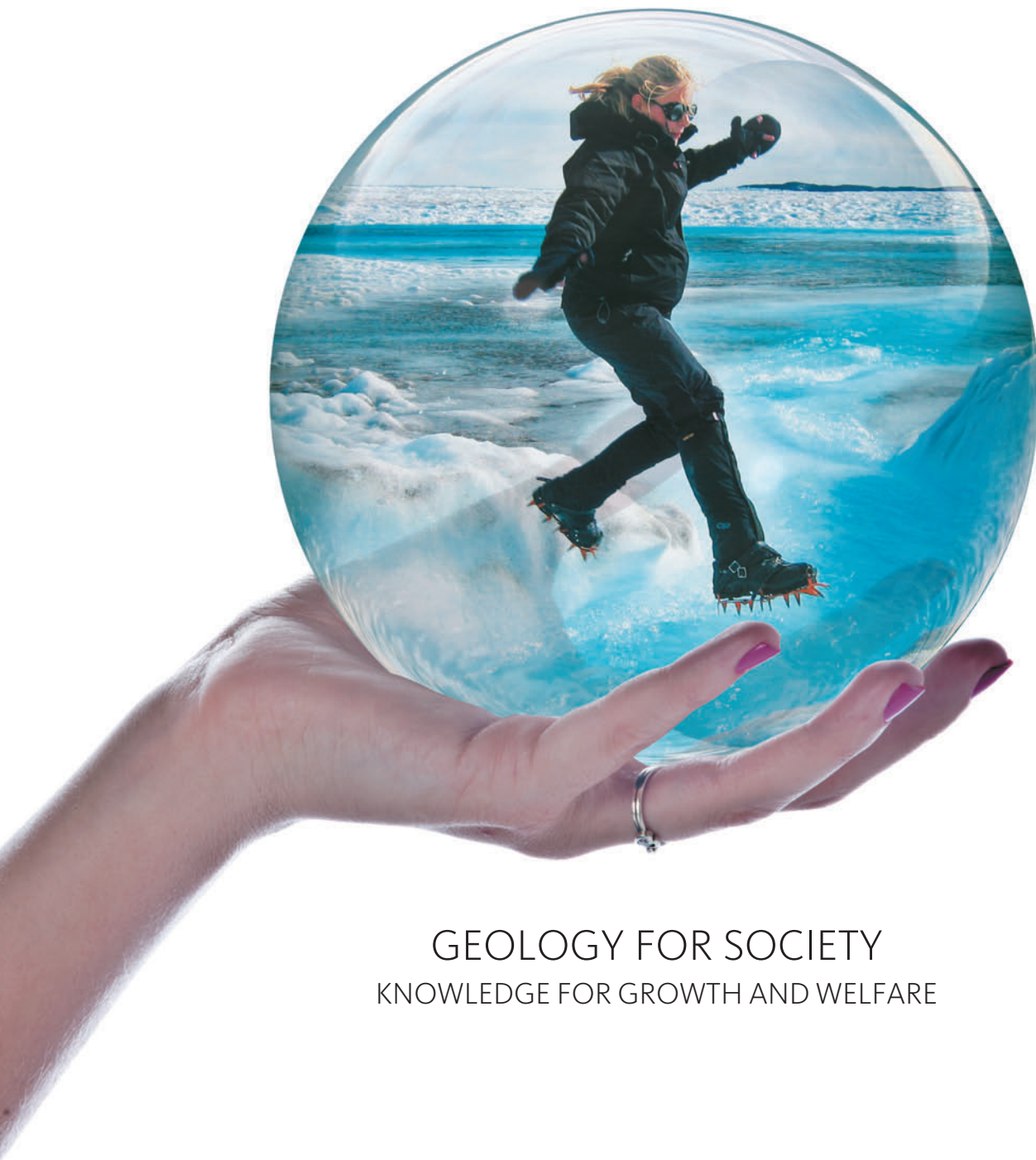


# GEUS STRATEGY 2012

BASIS FOR PERFORMANCE CONTRACT  
2012–2015



GEOLOGY FOR SOCIETY  
KNOWLEDGE FOR GROWTH AND WELFARE









## Contents

Foreword	4
Introduction	5
The framework of the strategy	6
The building blocks of the strategy	6
Targets for GEUS for the strategy period 2012–2020	7
Strategy factors	8
Framework conditions, challenges and opportunities	8
External trends – the broad perspective	10
Specific central development trends and driving forces	10
Strategic topics	14
Dissemination of digital data and knowledge	15
Water resources under pressure	16
Oil and gas as the foundation for supply and transition to green energy	17
Geothermal energy and underground storage	18
Geology and health	19
Minerals – basic and critical resources	20
Geology across land and sea	21
Past and future climate	22
Geology in the public arena	23
Resources and employees	24
Employees and management	24
The organisation	26
The infrastructure	26

## Foreword

This strategy 2012 was prepared by the GEUS board of directors and the management between June 2010 and September 2011. The strategy covers eight years and it forms the strategic basis for GEUS' performance contract with the Ministry of Climate, Energy and Building for the period 2012–2015. The eight-year strategy is therefore to be translated into two four-year performance contracts, and the strategy will be renewed or revised every four years. The current strategy has therefore been established as an extension of *GEUS' strategier – Grundlag for Resultatkontrakt 2008–2011* (GEUS' strategies – basis for performance contract 2008–2011).

The strategy has been prepared in close dialogue between the GEUS management and board of directors, between management and department heads, and between general management and employees. Seminars have been held and working groups and analysis groups have been set up within management. Furthermore, experience and strategies from international sister organisations have been incorporated; in part through visits to these organisations.

Employees have been involved through seven personnel strategy meetings, and they have contributed with a large number of written suggestions. The employee representation committee has also been involved at overall level and supports the specific personnel and organisational parts of the strategy.

The strategy has been discussed by the management at Geocenter Denmark to allow the strategy to contribute positively to developing the close, integrated and coordinated collaboration within Geocenter Denmark.

The strategy has been subject to a consultation process with primary stakeholders at the Ministry of Climate, Energy and Building: the Minister's Department, the Danish Energy Agency and the Danish North Sea Fund, and at the Danish Ministry of the Environment: the Danish Nature Agency and the Danish Environmental Protection Agency, as well as at the Bureau of Minerals and Petroleum under the Greenland Self-Government. Views from this process have been incorporated in the preparation of the strategy.

The strategy was adopted by the GEUS board of directors on 27 September 2011.



Per Buch Andreasen  
Chairman of the board



Johnny Fredericia  
Managing Director

## Introduction

The Geological Survey of Denmark and Greenland (GEUS) is an autonomous and independent research institution under the Ministry of Climate, Energy and Building. GEUS is a state organisation with its own legislation; Act no. 536 of 6 June 2007. The objective and activities of GEUS are stipulated in this act with the associated Executive Orders, as well as a number of other acts in which GEUS is appointed to specific tasks.

GEUS' board of directors sets the general guidelines for GEUS' organisation, long-term activities and development. Thus the board of directors sets and approves the strategic basis for GEUS.

In contrast to the previous strategy for 2008–2011, this strategy is described in a more general form and based on requirements and expectations for GEUS. These are in turn based on assessments of external trends which are especially relevant for GEUS' fields of activity.

GEUS' objectives and activities are stated in general terms in GEUS' *Mission*, which is a summary of the relevant provisions in the GEUS Act. GEUS' *Vision* is described in nine statements: 'Geology for a changing society' (see [www.geus.dk/geuspage-uk.htm](http://www.geus.dk/geuspage-uk.htm)). The vision has a longer time perspective than this strategy and is a description of the long-term goals for the institution.

After the Mission and Vision, this strategy constitutes the highest level in GEUS management chain. The specific realisation of the topics described in this strategy is in the form of strategic focus areas, which have been included in the 2012–2015 performance contract for GEUS. A strategic focus area is a measurable effort for which targets have been set in a selected field of work requiring special attention. The strategic action is to be implemented through projects, many of which will be won in competition, while others will be initiated by GEUS itself. The project portfolio can for obvious reasons be best described for the first years of the strategy, but the strategy will determine the tasks GEUS chooses to seek funding for in the future.



### GEUS' Mission

- GEUS is responsible for the scientific exploration of the geology of Denmark and Greenland with associated continental shelf areas.
- GEUS is to carry out research at the highest international level into matters of significance for exploitation and protection of geological natural assets and conduct mapping, monitoring, data collection, data management and dissemination of these.
- GEUS is to provide consultancy services to authorities and the private sector and to carry out tasks for the authorities within its core areas.
- GEUS is a national geological data centre.

# THE FRAMEWORK OF THE STRATEGY

## Building blocks of the strategy

On the basis of an analysis of the relevant *strategy factors*, a number of *strategic targets* and a number of *scientific topics* have been established. These factors cover GEUS' internal and external *framework conditions* as well as external *development trends*, including the driving forces and opportunities that these provide GEUS. The strategic targets are long-term, general and functional targets, which GEUS will follow so as to best complete its mission, while the topics are scientific, dealing with the subjects and overall objectives at which GEUS will direct its activities strategically for the benefit of society. GEUS' *resources and employees* deals with strategic initiatives to support GEUS' activities.



## Targets for GEUS for the strategy period 2012–2020

- GEUS will retain its role as the primary advisor for the authorities on issues in which geology has great significance in society.
- GEUS will focus on contributing to secure energy supply, water management, climate-change adaptation and exploitation of natural resources crucial for the Danish and Greenlandic societies.
- GEUS will extend its participation in international research and consultancy work, take part in international division of labour, and increase applications for international funding of its activities.
- GEUS will raise the level of its research and its contributions to innovation as well as its international competitiveness.
- GEUS will improve the accessibility and the value content of its data and knowledge, and, through modernised services, improve the use and social benefits of its information and knowledge.
- GEUS will promote collaboration and partnerships with the business community in order to help enable GEUS' knowledge and know-how to form the best possible basis for growth in Denmark, Greenland and internationally, and thereby contribute to solve important resources and environmental problems.
- GEUS seeks to be the preferred collaboration partner within geosciences, and will expand collaboration with universities, and consolidate Geocenter Denmark.
- GEUS will improve visibility of the significance of geology in modern society and of GEUS itself in the public arena.
- GEUS wishes to be an attractive workplace in which ethical standards and social values are central to the corporate culture and to be among the leading state institutions in meeting social responsibility and HR policy targets.





# THE FRAMEWORK OF THE STRATEGY

## Strategy factors



The external and internal strategy factors determine GEUS' possibilities of implementing the strategy. The *external factors* include framework conditions such as legislation, appropriations, fluctuations in the economic cycle and other external conditions with which GEUS will interact to implement the strategy, but which can only be influenced to a limited extent, and which GEUS therefore has to accept and adapt to. The *internal strategy factors* involve GEUS' own capacity and competence, i.e. areas such as technology, technical and administrative systems, laboratory facilities, skills, recruitment opportunities and attractiveness as a workplace, management and management values, as well as competitiveness.

## Framework conditions, challenges and opportunities

The strategy is based on a number of framework conditions and an assessment of how these will change over the course of the strategy. Such changes will define part of the assumptions behind the strategy.

At the end of the period, GEUS is likely to be facing reductions in the level of activity in a number of areas, because some governmental ventures will be finalised or will change in nature, significantly affecting GEUS' current basis for revenues and work portfolio.

Therefore, GEUS will focus on extending collaboration and developing business models to carry out tasks based on the knowledge and the comprehensive data collections built up during the projects to be finalised in the strategy period, and GEUS will document the necessity of governmental appropriation in a number of areas in which there are no alternatives to fulfil the needs and contribute to the benefits of society.

In some areas, including minerals in Greenland and the nature and environmental monitoring programme NOVANA, GEUS expects more competition, but also possibilities for more work as GEUS has the relevant competences.

The institutional landscape surrounding GEUS is being reorganised as a result of the Greenland Self-Government, the new Water Sector Act, mergers between the government agencies closest to GEUS, new roles for municipalities and, finally, mergers between a number of government research institutes and universities and the subsequent closure of GEUS' 'sister organisations'.

Larger projects which will be phased out, change in nature, or be renewed include the following:

- Groundwater mapping for the Danish Nature Agency will be finalised at the end of 2015.
- The Continental Shelf Project will end in its current form at the end of 2014, after which it is expected that the project will continue at a much lower level of activity for follow-up and consultancy.



- The first five-year agreement period with the Greenland Self-Government terminates at the end of 2015, but it is expected that a new agreement will be established so that cooperation with the Greenland Self-Government throughout the period of the strategy is firmly anchored in the Self-Government Act and the Mineral Resources Act for Greenland.
- The new nature and environmental monitoring programme NOVANA was launched at the start of 2011 and will be revised in 2016. GEUS' role as specialist data centre will remain central, as GEUS will be providing scientific input to the programme.
- GEUS' 'globalisation funding' for research will end in 2013. However, GEUS anticipates that it will be reinstituted in one form or another, as research and new knowledge are considered important parameters for growth, and because limited government funding will reduce the possibilities for research funding from the EU, which is a strategic priority for the government.



Strategically, these challenges will require reorganising of resources within the relevant areas, as well as increasing the focus on the human resource capacity management up to 2015, at which point we will have a clearer picture of the consequences of changes in GEUS' activities.

A positive aspect, both economically and in terms of new activities, is that high priority is being given to research areas that coincide with GEUS' core competences, namely, energy, water and climate, and, in an international and Greenlandic context, critical minerals. The EU's upcoming programme for research and technological development, Horizon 2020, is expected to give priority to climate and energy as well as to critical minerals. Other national funding also focuses on water and technologies with potential for new services and products. This includes funding from the Danish Council for Technology and Innovation, the Danish Environmental Protection Agency's eco-technology initiatives and the Danish National Advanced Technology Foundation. It is therefore likely that there will be considerable demands and opportunities in the fields in which GEUS has knowledge and data. This may provide sufficient support for a growth strategy based on innovation and new product and service development.

International collaboration and projects are considered vital if GEUS is to retain and develop its significance in Danish society. International collaboration and international projects will provide GEUS with the opportunity to harvest new knowledge and gain access to facilities, as well as to promote innovation in Denmark and a national strategy for growth directed towards international markets. We can see the outline of a clearer European agenda for cooperation between the European geological surveys within the EU. It seems that national and EU funding for research are merging to an ever greater extent in initiatives such as ESFRI and JPI. GEUS aims to take part in this development.

# THE FRAMEWORK OF THE STRATEGY



## External trends – the broad perspective

Following several years of growth, the economic crisis and the emergence of new growth economies, which are demanding welfare and living standards similar to those in the West, are putting pressure on the world's natural resources such as energy, minerals and water, which in turn is affecting food production. This new growth has also intensified pressure on the environment and impacts on the climate.

Scarcity of natural resources and adaptation to changes in natural conditions, e.g. through technology development, will make winners of countries which adapt most quickly and most effectively and which gain access to new resources or invent new solutions. These countries will solve their own problems effectively, while also providing competitive solutions to new markets.

NB!

GEUS possesses competences in a number of important areas and can therefore assist in assessing as well as in managing and protecting resources outside Denmark, and in line with Danish interests. Furthermore, other external development trends can be observed which have an influence on GEUS' choices. In some cases, these trends will be reflected in strategies, directives, and national legislation etc. formulated by GEUS' contracting authorities, either directly by the authorities or indirectly through private cooperation partners.

The same political awareness of trends will not necessarily be present in other areas, and here GEUS will draw upon its own assessment of the knowledge and tools which society needs in the geoscientific field. Often research will identify a problem or an opportunity, which will subsequently call for political or societal initiatives. Projects and research from GEUS will come before, during as well as after political initiatives (strategies, action plans, legislation, etc.) in different areas.

All in all, the framework conditions support a growth strategy for GEUS; growth which entails adaptation, setting new priorities and which improves efficiency.

## Specific central development trends and driving forces

In the strategy period up to 2020, the following important development trends and driving forces can be identified, which will influence GEUS' choices and priorities.

### Transformation of energy supply

The transformation from oil/gas and coal to green energy technologies is a global trend, which Denmark is implementing with its Energy Strategy 2050. The driving forces behind this development are partly economic, stemming from the perceived market potential in developing new energy technologies, and partly political, dictated by the political goals of security of supply and reduced carbon emissions.

### Climate change adaptation

Climate change adaptation covers initiatives that will or could be necessary if infrastructure and production, as well as environmental and economic assets, are to be preserved. To cope with the climatic changes that are happening already, as well as those that are on the way, society will have to adapt in many ways. The government's climate change adaptation strategy from 2007 pointed out this necessity, which since then has only been more strongly confirmed, e.g. in the work by IPCC and the Danish Commission on Climate Change Policy. The driving force is primarily economic, dictated by the political need to reduce the extent of undesirable effects on (and their related socio-economic costs) infrastructure, production, the environment and societal development in general.

### Scarcity of raw materials

The need for a continued supply of raw materials for production has gone up considerably as a result of increasing demand in the emerging growth economies. This has led to concerns about the security of supply of a number of minerals. These include, in particular, critical minerals, e.g. used in the production of high-tech products. However, also other minerals and basic raw materials used in infrastructure, buildings and installations are in high demand.

### Keeping water resources under control

Pressure on freshwater resources and stakeholder competition (households, agriculture, industry, nature, recreational interests, etc.) are increasing. The driving force is the necessity to provide water for all purposes in order to ensure welfare and growth, in other words, water is considered a (scarce) commodity. There is also an economic incentive to develop model system solutions and new technology for water management for the international market. Finally, the impact of climate change on the water cycle adds to existing problems: for infrastructure in the form of flooding; and for water utilities in the form of water scarcity due to drought and the need to ensure the quality of water for different purposes.

### Geology and health

In a Danish context, geology and health have so far not been given much attention. However, human health and how human health is affected by nature and the environment are now given a more central position. There is great international focus on how geological conditions, the exploitation of mineral resources, the natural quality of water and the significance of geology on human exposure to anthropogenic substances affect human health. It is anticipated that the emerging new scientific research field 'medical geology' will get increasing attention, also in Denmark. The driving force is a human desire to be healthy, as well as society's need to protect human and animal life and limit expenditure on disease and the environment.





# THE FRAMEWORK OF THE STRATEGY



## Urbanisation

The increasing urbanisation taking place in Third World countries, in particular, is creating new challenges for the countries themselves, as well as for international aid and international collaboration. In GEUS' field of operation, the specific issues relate to securing water, sanitation, infrastructure, energy and recreational opportunities. Centralisation of people and societal functions brings about new demands for resource management and logistics.

## Nature as recreational space

Increased concentration of people in the cities intensifies the need for recreational opportunities. Nature is becoming a recreational space, where people seek peace and quiet, and which offers valuable 'natural' experiences. The more estranged we become from nature, the more exotic nature seems. Nature becomes a commodity to be commercialised, and which acts as an economic driving force for the development of various products and services.

## Digitalisation

The information society has fostered a demand for rapid information and communication, making data transmission and response rates in communications a competition parameter. Digital solutions are efficient if they can minimise human time consumption and thereby enhance competitiveness and profitability. Digitalisation of communication, as well as digitally managed production, promotes the international division of labour. To retain jobs in 'expensive western countries', they will have to exploit the digital potential as much as possible, in public administration as well as in production, and they will have to exploit it intelligently and before everyone else.









# THE STRATEGIC TOPICS

## The strategic topics



In addition to the targets, GEUS' strategy consists of a number of scientific topics, as well as structural initiatives to support these, which GEUS will be addressing during the strategy period.

These topics are based on the 2008–2011 strategy. The topics will be translated into a performance contract with the Ministry of Climate, Energy and Building, and the specific projects to implement the strategy will be set out in the annual work programmes which GEUS' board of directors approves, as well as in the projects and tenders that GEUS is able to win in order to implement the strategy.

Descriptions of the topics include their strategic background and context, the issues involved and the overall subjects of which the topic consists; and the types of potential services to be delivered to fulfil the objectives of the strategy.





## Dissemination of digital data and knowledge

Like other western countries, Denmark is spotlighting digital society, digital solutions and the enhanced accessibility these provide. Digitalisation is an important lever for growth and welfare in that it creates competitiveness and greater efficiency in public administration. Realising this, the government regularly prepares new digitalisation strategies and policies.

Although GEUS' field of work is not as central as the large administrative areas, within its field GEUS is playing an important role in the digitalisation efforts. This is true, especially in areas where accessible, usable, and quality-assured data are important to users, including professional users such as companies and authorities. However, data are more than just the data themselves. Data are carriers of knowledge, and the value of data is often increased when the data are processed further. It is essential to couple the understanding and knowledge of the data creation processes, and the concept behind the data, to the usability of the data, in other words what it can or cannot be used for. It is therefore vital that GEUS' specialist data-centre function, and its statutory role as the national geological data centre, is maintained. This will ensure the greatest benefits from common public solutions, such as the Danish Nature and Environment Portal (Miljøportalen) and map services, in which GEUS takes part, and for which there are expectations that GEUS will contribute as the primary supplier. Data are not merely individual sets of data but also compiled data sets and maps that together make up syntheses.

Internationally and within the EU system, there is also more focus on digitalisation and making data more accessible. In GEUS' area, the INSPIRE Directive has played an important role, along with EU harmonisation and the build-up of databases at European and global levels such as OneGeology-Europe and OneGeology (Global). The EU and European society as such are increasingly expecting to be able to draw on relevant harmonised databases covering an array of geological topics and data types. Similarly, in the European Research Area (ERA), the spotlight has been directed at establishing increased access to research data across users and countries. This greater accessibility is being implemented as part of the establishment of a common European research infrastructure (ESFRI). GEUS will participate in several of these initiatives.



## Strategic goals

'Everything digital' is the long-term goal for GEUS with regard to data and knowledge, wherever this is relevant. To meet and stay abreast of the demands and expectations of the surrounding world, GEUS will work towards the following strategic goals:

- GEUS will modernise the existing data deliveries, keep databases as up-to-date as possible and increase the integration of data from different sources, so that quality, flexibility and usability are enhanced.
- GEUS will make new types of data available in a quality-assured, up-to-date and processed form, making them usable for a broad spectrum of GEUS users.
- GEUS will develop new data services on the basis of GEUS databases and include new mobile digital platforms for dissemination of knowledge and data.
- GEUS will test new payment models in selected areas, so that increased data application and accessibility can be combined with the delivery of knowledge-intensive services.
- GEUS will take part in the international build-up of harmonised databases for administrations as well as for a wide spectrum of users in connection with the establishment of a common European research infrastructure.
- GEUS will develop deliveries of digital 3D models, which can become reference models for a variety of uses.
- GEUS will develop and improve the efficiency of data capture in the field in laboratories and from external sources.

## Water resources under pressure

### Strategic goals

In the strategy period GEUS will work towards the following strategic goals:

- GEUS will maintain and develop its role within Danish water management. This includes efforts to make the results of groundwater mapping, groundwater monitoring, etc. useful for authorities and other stakeholders in the water sector.
- GEUS will develop and apply models that integrate chemistry, hydrology, geology and climate effects, and which can provide information about water quality and water resources, as well as constitute the basis for water management in Denmark under changed climatic conditions.
- GEUS will contribute to innovative solutions to manage water cycles in urban settings.
- GEUS will continue its analysis of the fate of natural and anthropogenic substances and microbial factors in the soil and in the water cycle, which affect the environment, human health and the climate, and which affect efforts to meet quality requirements for water for different purposes.
- GEUS will seek to find a central place for itself within water research at European level.
- GEUS will contribute knowledge and technology to solve international water issues, as well as to strengthen Denmark's position in the international market for system solutions for the water sector.

Managing water resources has been high on the political agenda for some years, which is also evident in the extensive national legislation and EU directives in the area. GEUS is part of a context in which there is a need for consultancy about conditions which call for political action, and which subsequently require active involvement in order to achieve and document the regulatory goals.

Anthropogenic impact and effects on the water cycle and water resources are increasing, and the growing effects of climate change on groundwater and surface water, quantity and quality, make extremely high demands on building a knowledge base to manage problems in the water sector. Denmark's domestic problems share similarities with problems in the EU, and GEUS is a leading player in a number of areas. Therefore it is possible for GEUS to take part in research and assessments in other European countries in partnerships with e.g. its sister organisations, and to provide consultancy to individual countries as well as the EU.

Internationally, water resources are also under high pressure. Scarcity of water is a problem in many places, along with managing the effects of climate change, including flooding of large urban areas. These problems are associated with significant health problems and they have enormous consequences for feeding a steeply increasing population. In addition, there is pressure from changes in land-use, e.g. the shift of production to biomass for energy purposes.



## Oil and gas supply and transition to green energy

= põlevkivi (Eesti kontekstis)

For a long transition period oil and gas will be crucial globally for continued economic growth and security of energy supply, while the proportion of energy from renewable sources will gradually grow and become cost-effective. Oil and gas from the Danish fields are also part of the government's Energy Strategy 2050.

Costs of exploration, production and transport of oil and gas continue to rise. Irrespective of changes in oil prices, for many years to come there will be a need for knowledge and data to enable authorities to plan optimally and establish a foundation to attract industrial investments for new exploration and enhanced recovery. At the same time, changes in prices and the degree of success of exploration activities will be decisive for the level of activity.

This applies both for Denmark, where oil revenues have been economically vital for many years, and for Greenland, where it is possible that future oil revenues will contribute significantly to Greenland becoming increasingly economically independent of Denmark. An important requirement for optimum exploitation is an assessment of the possible size of a resource.

In mature oil regions like the Central Graben in the North Sea, GEUS will work on models for how it will be possible to produce efficiently an ever larger proportion of the known resources in existing fields and contribute with easily accessible data and new knowledge about the potential for new oil and gas discoveries in deeper-lying layers, especially in areas with an existing infrastructure. There will be special focus on chalk and on the potential for deep discoveries, especially in the Jura layers.

In areas where there has been, or still is, limited activity, without yet making a commercial discovery, by comparing new data, GEUS will contribute with a continuous assessment of exploration opportunities. In this way GEUS will advise authorities on new activities and assist in the marketing of these. In frontier areas like Baffin Bay and North-East Greenland, where only preliminary oil exploration without drilling has taken place so far, GEUS will combine broad research efforts within sedimentology, stratigraphy and geochemistry with geophysical interpretation. On the basis of increasing geological knowledge, and by setting up models and assessing the risks, GEUS will contribute to providing the industry with the knowledge and incentives necessary to make the considerable investments. In this context, GEUS will also be involved in large regional projects with international partners to establish the best possible regional correlation studies.



### Strategic goals

In the strategy period GEUS will work towards the following strategic goals:

- GEUS will maintain and develop its role as the most important advisor for Danish and Greenlandic authorities. GEUS will enter into close cooperation with the oil industry about research and consultancy that can provide an incentive to further investments in exploration and production.
- GEUS will utilise the results and data from many decades of oil and gas exploration in Denmark and Greenland.
- GEUS will utilise the knowledge from its own research through new types of products, projects and evaluations of potentials, and thus help in marketing efforts towards new companies.
- GEUS will retain and expand its large and unique chalk expertise.
- GEUS will concentrate more intensively on deep oil and gas resources on the basis of its knowledge about petroleum systems.
- GEUS will work with both conventional and unconventional resources in Denmark and internationally.
- GEUS will contribute to innovative solutions, particularly in connection with developing new analytical methods and laboratory expansion, for example CO<sub>2</sub> Enhanced Oil Recovery (EOR) and petroleum systems.



### Geothermal energy and underground storage

With a strong political wish to reduce carbon emissions and at the same time retain high security of energy supply, there is sharp focus on domestic renewable energy sources and the interaction between the many different types of energy for heating and transport.

#### Strategic goals

In the strategy period GEUS will work towards the following strategic goals:

- GEUS will retain and extend its role as the central advisor for Danish authorities and it will establish close collaboration with the many different stakeholders acting in this part of the energy sector in order to minimise costs and risks and thereby increase competitiveness compared with conventional types of energy.
- GEUS will compile results and data from many decades of oil and gas exploration in Denmark and from GEUS' own research, **to increase awareness of the use and exploitation of the subsurface for storage and geothermal exploitation;** thereby supporting the Energy Strategy 2050.
- GEUS will contribute to innovative solutions, in particular with development of new analytical methods and laboratory expansion, for example when it comes to understanding the properties of reservoirs.

**Geothermal energy and the use of heat from shallow geothermal wells as well as groundwater cooling and energy storage are some of the methods which may be incorporated in future energy supply to a much higher degree than today.** Increased use of these methods requires knowledge and technology in order to bring down the costs and risks so that the methods are competitive compared with more conventional types of energy. Authorities will also have a greater need for knowledge to set priorities in the use of the subsurface in relation to a number of other uses (Carbon Capture and Storage (CCS), oil and gas exploration, storage, groundwater extraction, etc.).

Through broad research initiatives, GEUS will continue to acquire the knowledge necessary about the geological parameters needed for establishing geothermal installations. This applies for both traditional installations and new types of installation in the shallow part of the subsurface, i.e. in the layers that are primarily made up of sediments from the Quaternary Period, including the upper strata. Heat pumps and drillholes are typical methods to extract heat or establish cooling. In addition to new knowledge and systematic comparison of data and integration into 3D models, easy access to such information in modern digital form is necessary in order to ensure a flexible and rapid decision-making process for authorities and stakeholders in the energy sector.



## Geology and health

There is an increasing attention in society on public health in general. There is focus on the individual human being due to increasing population growth and concentration of people in large urban metropolises.

In the geological field this has given rise to a relatively new area: medical geology. This covers the branch of geosciences related to the effects of geological conditions on human health. A number of naturally occurring substances and minerals in too high or too low concentrations affect health. The influence can be direct, through exposure to soil or water, or through evaporation from these media, or indirect through consumption of water and food which have been affected by the content of these substances in nature. Well known examples in Denmark are radon in buildings and arsenic, nickel, fluorine and iodine in drinking water. Other examples are naturally formed organic substances in the soil environment, e.g. PAH compounds in humus complexes and chloroform. Internationally, in a number of cases a connection has been established between geological factors and diseases such as between child diabetes and lack of zinc in drinking water, or schizophrenia and lithium deficiency.

In addition to naturally occurring substances, there is now also focus on a number of new anthropogenic substances because of their potential harmful effects, including estrogenic substances, pharmaceutical residues, antibiotics, as well as various micro-organisms.

This area also includes effects harmful to health from tailings, auxiliary substances etc. in connection with exploitation of natural resources, both through conventional mining operations and in connection with the special health problems associated with small-scale mining in the Third World. Efforts in this area require extensive collaboration with other specialist areas, not least within medical/pharmaceutical disciplines.

### Strategic goals

In the strategy period GEUS will work towards the following strategic goals:

- GEUS will examine the occurrence, transport, degradation, bioaccessibility and potential human exposure of inorganic and organic substances harmful to human health in the soil and aquatic environment, including the development of reactive models, analyses and sensors to determine the different states of the substances.
- GEUS will describe the occurrence of substances harmful to health and the processes which are important for human exposure in connection with exploitation of natural resources.
- GEUS will work with epidemiologists to examine the statistical relationship between selected geological parameters and specific diseases.





## Minerals – basic and critical resources

International developments, in particular with continued high economic growth in the East, but also in western countries, with declared strategies for growth, will result in high demand for mineral resources, and the US, EU and Nordic countries have increased their focus on this area. This includes basic materials for construction (sand, gravel, chalk) and metals for infrastructure projects (iron, copper, zinc, chromium, manganese, molybdenum, etc.). Furthermore, continued developments in high technology will give rise to increased demand for the special metals used in cars, aircraft, mobile phones and other electronics, at the moment rare-earth elements and platinum-group metals in particular, but also niobium, tantalum, tungsten, etc. With regard to these metals and their use within the arms industry and high technology, there may be critical or strategic problems, if global reserves are concentrated in just a few countries; especially in China and countries in Africa.

A crucial condition for optimal planning and exploitation is an assessment of the size and accessibility of resources. This applies for basic materials for construction projects in Denmark and in connection with mineral resources in Greenland, where there are interesting exploration opportunities, which in a few years could lead to mining operations for iron, zinc, molybdenum, rare-earth elements, etc.

In Denmark, GEUS is contributing to systematic mapping and data compilation of the resources necessary for large building and construction projects. There is special focus on the offshore areas where it is necessary to prioritise the use in relation to other large construction projects such as offshore wind farms and oil installations, and where there are special environmental considerations.

In the areas of Greenland from which data are relatively limited, GEUS will increase understanding of the regional geology through various types of geological, geophysical and geochemical mapping, with focus on the processes forming the different types of mineralisation.

In connection with marketing of exploration opportunities in Greenland, GEUS will conduct systematic compilation and marketing of specific commodities in line with changes in international demand. Moreover, GEUS will take part in an overall resource evaluation of selected commodities with external partners.

### Strategic goals

In the strategy period GEUS will work towards the following strategic goals:

- GEUS will retain and expand its role as the central advisor for the Greenland Self-Government, but it will also use its experience to advise other countries.
- GEUS will establish close collaboration with the mining industry on research and consultancy, which could create incentives for further investments in exploration and mining operations.
- GEUS will utilise results and data from current and previous mineral exploration and its own research in Greenland, and GEUS will participate in resource evaluations which, together with new data compilation and models, can contribute to increasing exploration activity.
- GEUS will take part in international work with the assessment of critical minerals in order to promote Greenland's potential.
- GEUS will contribute to mapping basic resources in Denmark to plan large infrastructure projects and prioritising land use.
- GEUS will contribute to innovative solutions, especially in connection with development of new analytical methods and laboratory expansion, for example new methods to analyse magmatic, metamorphic and sedimentary rocks for minerals.



## Geology across land and sea

The soil beneath our feet forms the foundation for human activity and the natural resources available for exploitation as the building blocks in modern society. Our understanding and perception of the landscape is important for this exploitation and for how we set priorities for the protection of geological amenity values and the landscape as a place to live for people and animals.

Through legislation and directives, society seeks to regulate and balance the various interests. This balancing should be based on factual knowledge and understanding of the internal structure of the landscape, the nature of the different strata, and their interplay with the hydrosphere and biosphere. One requirement for this is a systematic foundation in the form of geological mapping and knowledge about what lies beneath the landscape we see.

In many cases, human exploitation and use of the sea are determined by the geology of the seabed. The geology is often connected across the coastal lines, although the geological, physical and biological processes are very different, depending on whether they are onshore, in the coastal zone or at the seabed. This gives rise to new issues and calls for new knowledge and new collaboration.

Exploitation of the sea is also subject to legislation, but in this context understanding the interaction with the geology, and thus the significance of the geosphere, is less well established, and implementation of a number of plans is directing increased focus on acquiring the geological foundation in the form of knowledge and data about the seabed.

The coast is a special zone in which land and sea interact and the natural processes which dominate each domain are acting simultaneously. Coastal areas are under ever growing pressure because of urbanisation, exploitation of resources, recreational needs and tourism. The significance of the geology is only just beginning to be recognised, but in addition to the traditional issues, the climate agenda will raise many new questions which can only, or most appropriately, be answered on the basis of new knowledge and new data in which geology is integrated across the land and the sea.

In order to meet the known and the new requirements strategically, GEUS will address the issues on the basis of the idea that geology on land and at sea should not be treated separately, but rather in combination – across land and sea. Similarly, geology, which is three dimensional, will best be able to contribute when the large amounts of data from different sources are considered in combination and synthesised into three-dimensional digital models, which make up the best estimate of total knowledge about an area at a given time.



## Strategic goals

In the strategy period GEUS will work towards the following strategic goals:

- GEUS will map the strata and landscape as well as the composition of the seabed and will increase understanding of both the visible and sea-covered landscape.
- GEUS will develop prototypes of 3D geological models for broad and general application within geology onshore as well as offshore.
- GEUS will focus on conditions especially relevant for the interaction between land and sea and compare the geological maps and models.
- GEUS will work to acquire knowledge as a basis for future legislation or strategies and their realisation, including securing data and access to geological data collected and established by other players.
- GEUS will establish understanding and information about geological values so that they can be protected and enjoyed, and so that they can be incorporated sustainably in the development of tourism and the leisure industry.
- GEUS will take part in partnerships to contribute to international marine and coastal tasks requiring geological knowledge.

## Past and future climate

### Strategic goals

In the strategy period GEUS will work towards the following strategic goals:

- GEUS will retain and develop its role as an important player in Greenland with monitoring of the ice sheet and glaciers.
- GEUS will elucidate the extent of sea ice and the stability of the ice sheet over long periods of time and elucidate the interaction of the ice with climate change and ocean currents.
- GEUS will develop methods to assess and analyse past climate change, including development of proxies to describe future climate scenarios.
- GEUS will develop and apply models which can predict the effects of climate change on the water cycle, including hydrological models to manage local water resources and water quality, as well as to assess run-off and flooding.
- GEUS will contribute to climate-change adaptation in order to be able to better manage the water cycle in connection with urban development, infrastructure, supply, etc. and GEUS will produce knowledge about changes in the degradation and transport of substances in geological environments.
- GEUS will continue to take part in research collaboration on climate-change adaptation, in which knowledge about past climate change and its impact will be an important validation tool for estimating and quantifying future climate change.

There is an increasing need to predict climate change and its effects on natural resources in the shorter and longer terms and to identify solutions of how society should adapt to climate change. There is also a strong need to monitor how the Greenland ice sheet is melting, as this has consequences for both the regional climate and global sea levels. The current monitoring provides a check of the models in the short term and an insight into the rate at which the ice is melting and the possible feedback processes, as well as a basis for improving forecasts.

The past can act as a reference framework for predicting the effects of climate change and variation on nature and the environment. Knowledge-building about the climate system, with related models, depends on a basis of verification in order to ensure reliability; a basis which is especially accessible in the geological strata column and in ice cores. Similarly, geological strata contain information which, in the shape of proxies, can identify the environmental effects on marine, limnological and terrestrial systems, while changes in the landscape in themselves provide an indication of large-scale changes during different climate conditions. The future effects, both long-term and short-term, can be assessed, and in the best case modelled, on the basis of proxy data.

Climate models predict major changes in the water cycle, which are important for water extraction, flooding and droughts. In cities, too much rain over a too short time is a special challenge for the infrastructure, while agriculture, for example, is affected by too much and too little rain. Changing flow patterns and a wish to get rid of rain water as fast as possible – without runoff to sewers – to either groundwater or surface water, also affect water quality.

There are special challenges along coasts, where higher sea levels will lead to increased salt-water intrusion farther inshore. Increased precipitation is also expected to give more water periodically in watercourses, which will run out into the sea and therefore coastal areas with estuaries will have an especially high risk of flooding. Furthermore coasts near estuaries are often the most densely populated areas both in Denmark and abroad.



## Geology in the public arena

Dissemination of knowledge about exploitation and protection of geological resources in Denmark and Greenland is part of the statutory work described in the Geological Survey of Denmark and Greenland Act. Geological resources are vital for modern society, both functionally and economically, but this is not generally recognised by the public, and the coupling between value creation and the tasks and research carried out by GEUS has yet to be hammered home.

Similarly, geology is rarely the primary asset in the public use of nature, in developing recreational areas, or to attract tourism, although the geology is there as an integrated and exciting part of the landscape. However, there is a growing interest in including geology more in the public perception of nature and more focus on preserving and marketing geological values. This is apparent in heritage work, in work on national parks and geo-sites, as well as internationally with geoparks. Also, new and modern exhibitions and museums focus on geological story-telling.

To encourage broader understanding of the societal issues which can be solved with important contributions from geological knowledge, GEUS has to communicate to a wide range of users and stakeholders. Communication should aim at achieving the largest possible effect for society.

Dissemination of research results from GEUS will be through high-profile, international journals and through GEUS' own relevant publications. Publication of research results is vital for professional credibility and thus for the quality of consultancy services from GEUS.

Broader communication will take place via the Internet and new media such as Facebook and Twitter. Phone apps could also be a new channel for popular communication. Through these channels GEUS can meet younger generations and help arouse interest which could positively influence recruitment to the field.

Geoviden, a popular periodical, which makes up a cornerstone in Geocenter Denmark's communication and is an important contribution to teaching in schools and high schools, will continue, but it will also be supplemented by internet-based teaching materials, developed in collaboration with e.g. high schools.

In order to improve the understanding of the societal significance of geology, communication targeted at the press and decision-makers is to be developed and regular evaluations will be made of GEUS' position in the media to assess the visibility of GEUS.

Finally, GEUS will contribute actively to communicating geological knowledge about Danish landscapes and to the many nature and communication projects already established or in the pipeline. In this context, GEUS' role will be to make its knowledge available with due respect for the fact that initiatives are to be anchored locally.



## Strategic goals

GEUS has the following strategic goals:

- GEUS will publish its research in high-profile international journals and in its own series; in so doing contributing to improving research quality.
- GEUS will involve the communication aspect in all projects, where this is relevant.
- GEUS will communicate popular science via the Internet, new media and its own popular publications, and GEUS will contribute to teaching materials and develop these in collaboration with high schools.
- GEUS will improve communication to decision-makers and the press.
- GEUS will make its knowledge available to nature projects with geological relevance and contribute to communication of these.



## Resources and employees



GEUS' resources consists of financial resources and employees with their knowledge and skills. GEUS' data, experience and publications together with employees comprise GEUS' knowledge capital. GEUS' resources also include GEUS' infrastructure, which is made up of its IT hardware and software and administrative systems as well as data, samples, laboratories, etc. In addition to these resources are intangible assets such as the organisation's experience, brand, network and goodwill.

The financial foundation of GEUS includes funds which GEUS receives via the Danish Appropriation Act and grants and revenues which GEUS acquires from a wide range of funding sources, collaboration partners and customers. The financial foundation is dealt with in the section on framework conditions.

Employees, including management, comprise GEUS' human resources. Implementation of GEUS' strategy requires that employees and management have the necessary competences and that the necessary infrastructure is in place and regularly adjusted to meet demands.

## GEUS' values

- Professional commitment and creativity.
- Freedom with responsibility.
- Cross-cutting openness and collaboration.
- Community and mutual respect.

GEUS has the following overall personnel and organisational goals:

- GEUS will be a visible, attractive and developing workplace, which forms the framework for a high level of professionalism, creativity and commitment, and a good cooperative environment.
- GEUS will be a modern project-oriented, professionally led research institution.
- GEUS will constantly develop its organisation, management and employees to support GEUS strategies and visions.

## Employees and management

GEUS is a research institution and, being a knowledge-based entity, employees and their knowledge are the most important resource. Therefore, GEUS constantly works to develop the competences of its employees and to develop an attractive and exciting workplace which can retain and recruit skilled employees.

GEUS' values-based personnel policy and GEUS' common management foundation *Ét GEUS* (One GEUS) are the foundation for management practice in GEUS.

To implement this strategy, the results of the development projects implemented as per strategy 2008–2011 are to be retained. Not least, focus will be on enhancement and development of the project work platform and competences to manage projects. However, there is also a need for new competences and tools.

Competence development at GEUS is strategic because this relates to the competences already possessed by the organisation and the individual employees, and it



relates to the competences to be developed to meet the challenges GEUS will be facing in the future.

Competence development encompasses both what the individual employee should be able to do, and what the organisation should be able to do in terms of ability to carry out tasks collaboratively.

GEUS is responsible for ensuring that employees and managers receive the competence development necessary, while employees and managers are also responsible for acquiring competences which meet GEUS' needs, as well as those of their own development; and in so doing securing the market value of employees.

There is focus on the requirement to improve *professionalism*, and this stems from the strategic targets and their focus on internationalisation and partnerships, more cooperation with the business community and an increased need to win contracts, including achieving funding for research and consultancy in an environment with increasing competition. This involves:

- Higher research quality by researchers and in the organisation through improved research planning, a targeted publishing strategy, mentorships and recruitment of employees, incl. professors. The quality of research and evaluation of GEUS' level will continue to take place through peer reviews of articles and evaluations of research.
- Improved competence in financial understanding, planning, management and forecasting, as well as better competences in business models, including contracts, customer relationship management and interplay with the authorities. More efficient work and QC processes.
- More awareness and greater ability to communicate with the outside world, including dealing with the press.
- Better cultural understanding and exploitation of existing cross-cultural competences at GEUS, as well as focus on the social aspects of recruiting employees from abroad.
- Better linguistic skills.
- Continued development of management competences within the management group.

Recruitment of new employees requires a recruitment basis; a goal that will be met through maintaining an attractive, family-friendly workplace with a good working environment and high job satisfaction, as well as a significant number of PhDs and thesis students.



## GEUS' RESOURCES



It is extremely important that knowledge is retained and shared in GEUS, and therefore focus is on further developing initiatives on systematic knowledge sharing and recruitment, and ensuring overlap between new and leaving employees as well as schemes for older employees.

Finally, equal opportunities – between genders as well as ethnic backgrounds – continue to be in focus at GEUS.

### The organisation

Organisational development is based on GEUS' values and management foundation. Involvement of employees in decisions as well as their influence on their own work are the key to understanding GEUS' success. Therefore, these will be retained in the continued development of GEUS as a dynamic workplace.

GEUS' matrix structure comprises the basic organisation of the institution, and project organisation is applied when performing tasks. Organisationally, GEUS will improve and make more efficient the necessary work processes and systems which support task performance. GEUS will also develop business models and methods for portfolio management, and through balancing the composition of tasks ensure a solid foundation for resource management. Forecasting and winning projects, including financial aspects and success rates, will be developed in order to secure a timely overview of GEUS' situation. Finally, systematic knowledge sharing and the cultural approach to knowledge sharing will be further developed.

Establishment of partnerships and networks will be the central tools in securing GEUS' position and access to larger projects and in creating understanding for GEUS' organisation. There will also be focus on establishing and developing networks and contacts to a wide spectrum of managers and employees to maintain important collaborative relationships.

GEUS will develop the organisation to optimise its benefit from the international division of labour and from the establishment of common platforms and facilities, where this is beneficial for society, and in a form which ensures that GEUS can perform its core tasks.

### The infrastructure

The infrastructure is to be under constant development, and access to the necessary facilities will be ensured, both to the widely used tools and systems, and to laboratories etc. There will be regular assessments of whether GEUS itself should establish and develop these facilities, or whether in the future it would be beneficial for GEUS to share facilities with other institutions, nationally and internationally. Finally, there will be continuous assessments of the use and relevance of our facilities.









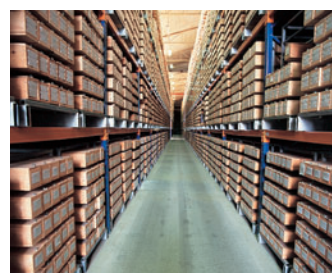
The Geological Survey of Denmark and Greenland (GEUS) is an independent research institution under the Ministry of Climate, Energy and Building and a part of Geocenter Denmark. GEUS carries out research and advises public authorities and the private sector within nature, environment, energy and mineral resources. GEUS is responsible for scientific exploration of the geology in Denmark and Greenland, including the continental shelf areas. GEUS maps, monitors and collects data, communicates about geological matters and is the geological data centre for Denmark and Greenland.



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