

Review of Survey activities 2016

Edited by

Adam A. Garde and Ole Bennike

Keywords

Geological Survey of Denmark and Greenland, survey organisations, current research, Denmark, Greenland.

Cover photographs from left to right

1. The traditional spear auger remains a principal tool in mapping Danish quaternary deposits, but can now be combined with short-range electromagnetic methods for specific purposes such as 3D delineation of contaminated landfill sites. Photograph: Jakob Laurtrup
2. Elevation map around the stream of Hagens Møllebæk in north-west Jylland with the positions of measuring stations to determine the nitrate runoff from agricultural fields at different times of the year.
3. The monitoring of the surface conditions of the Greenland ice sheet by GEUS is an important tool for understanding global climate change. Photograph: Baptiste Vandecrux.
4. Rescuing primary seismic data from the North Sea obtained by private exploration companies to a national electronic database at GEUS. Photograph: Peter Warna-Moors.

Frontispiece: facing page

Surface of Qagssimiut ice lobe ablation area, southern Greenland ice sheet, after a period of extended clear sky conditions that enabled a strong dark ice algal bloom registered in satellite imagery presented in Box *et al.* (2017, this volume). Aerial oblique photo near 61°11.006'N, 46°42.333'W, 820 m elevation. Photo: Jason E. Box, 23 August 2014.

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Illustrations: Benny M. Scharck, Allan Lindy, Stefan Sølberg and Susanne Rømer

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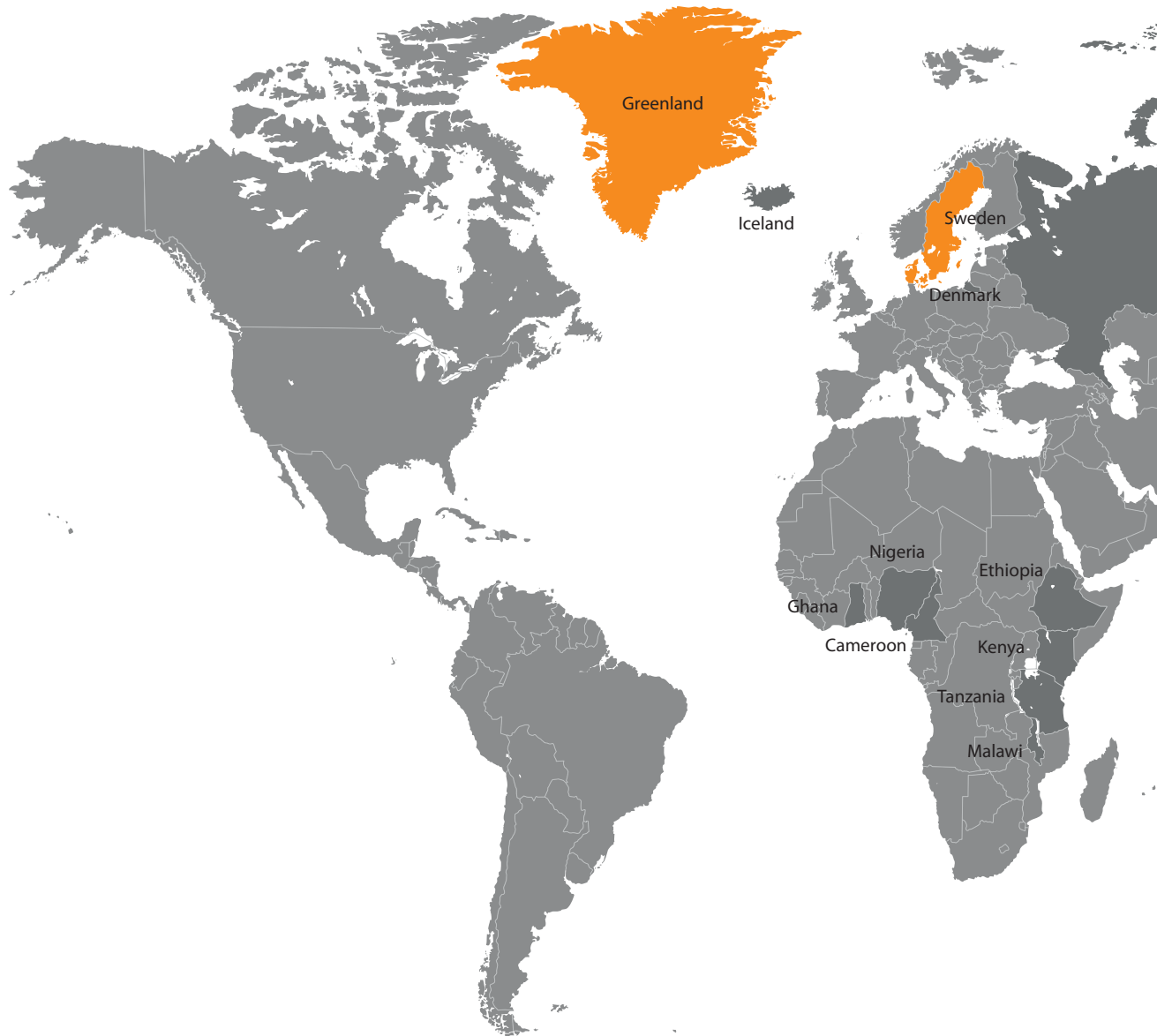
Geological Survey of Denmark and Greenland (GEUS), Øster Voldgade 10, DK-1350 Copenhagen K, Denmark

Phone: +45 38 14 20 00, fax: +45 38 14 20 50, e-mail: geus@geus.dk and at www.geus.dk/publications/bull

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Review of Survey activities 2016

Flemming G. Christiansen

Deputy Director

2016 was a year of transition in the international geological society. Like previous years, it was still a period with lots of reorganisation and cut-backs in the energy and mineral industry but also with obvious signs of an even more complex business pattern where well-organised geological data and easy access to geological knowledge will be strongly needed. Compared to the industry, and also to some of the authorities that are regulating the use of natural resources, GEUS has a high degree of continuity of both activities and personnel; in these years with strong focus on key strategic goals. This creates and develops a corporate memory that can be easily applied even with sudden shifts of a political or business agenda. This also establishes GEUS as the starting point for getting access to geological information from Denmark and Greenland, and makes GEUS a natural collaboration partner nationally as well as internationally.

Publication of results, both internationally and in our own series is a key factor for keeping a high scientific standard and for documentation of this towards society, authorities and industry. This issue of GEUS' Review of Survey activities shows like in previous years a broad spectrum with a total of 17 papers covering many different activities. The papers give a good overview in their own right but with systematic references to background reports and other papers, they also provide an easy way to dig deep into the important work that GEUS is carrying out. Eight papers are on Denmark, six on Greenland and three on other themes.

Activities in Denmark

GEUS works on many different – and often closely interrelated – topics in Denmark such as the use of water, energy, and mineral resources, protection of nature under significant climatic changes, and by making up-to-date geological and geophysical data and information easily available for all sorts of purposes.

The use of groundwater is very important for Denmark, and GEUS carries out many studies on water resources and their protection in connection with climate changes, environmental impact and domestic use. Systematic geo-

logical and geophysical studies provide not only specific water data, but also give a much better understanding of the geological models that can be used to predict resources and regulate their use. One paper with a case study from Samsø describes how traditional geological mapping can be optimised by using high-resolution electromagnetic induction data. Another paper gives an overview of buried valleys in Denmark, their geological architecture and very significant length, which has great implications for the groundwater resources in many parts of Denmark. A third paper gives a detailed description of nitrate transport pathways in one catchment area in northern Jylland where results from year-around monitoring can be used for planning and regulating to meet the demands of the EU Water Framework Directive.

In many areas in Denmark, chalk and limestone are directly exposed or found near terrain surface with only a thin cover of Quaternary deposits. Such deposits are important as a mineral resource for many different purposes and due to their groundwater resources and they may also control structures in overlying sediments. One paper documents the structures and stratigraphy of Danian limestone on eastern Sjælland, whereas another study uses GIS and digital terrain models to map karst sinkholes in areas of Jylland and to interpret the geological and climatic conditions and anthropogenic activities that influence their development.

Denmark has a large potential for subsurface geothermal energy and for heat and energy storage. Following the recent launching of the Geothermal WebGIS portal with all geological and geophysical data relevant for geothermal exploration, GEUS has continued with more detailed studies of specific areas and on specific parameters. One paper gives a summary of a EUDP-supported project on the planning of exploration in urban areas of Copenhagen by targeting on shallower reservoirs in the Gassum Formation and by using smaller drilling rigs. Another paper has focus on the porosity and permeability variation of the Bunter Sandstone Formation that is a potential geothermal reservoir in large onshore areas of southern Denmark.

Shale-gas production has been a major game changer in the energy sector for quite some years, and we have seen

many studies of the resource potential and some exploration in Europe, including Denmark and southern Sweden. One paper gives a detailed description of the gas composition and discuss biogenic versus thermogenic origin of gas in Lower Palaeozoic shales from scientific core holes in southern Sweden.

Activities in Greenland

Once again there was a high level of geological and glaciological activities in Greenland in 2016, both traditional studies with focus on the mineral and petroleum potential and exploration studies as well as monitoring and research related to climate changes and their effect.

GEUS has been active with regional mapping and research in South-East Greenland for quite some years, and some of the geo-datasets are important for identifying exploration targets. One paper argues for the possibility of orogenic gold deposits by using aeromagnetic and stream sediment geochemistry data in a minerals systems model. A large number of data and proxies maps have been applied to construct a final prospectivity map pointing towards the most interesting possibilities in the Tasiilaq area.

The Nuussuaq Basin in West Greenland has served as an analogue geological model for offshore petroleum exploration for decades but there may also be an onshore potential. As preparation for both off- and onshore licensing rounds, GEUS has compiled key data in a GIS model and re-studied especially the large-scale structures in more detail using photogrammetric mapping. One paper describes a very large inversion anticline on central Nuussuaq that could be an interesting drilling target. A revised migration pathway model is proposed; this could explain distribution of both oil and gas seeps outside the traditional area with common seepage. Another paper describes the reservoir properties of quite a number of sedimentary and volcanic successions of Aptian to Paleocene age in the Nuussuaq basin.

Monitoring programmes of the Greenland ice sheet and research based on local ground truth data from stations on

the ice – and from fjords and nearby offshore areas – are very important contributions from GEUS to global climate models. One paper gives an example of albedo grids measured from satellite and checked with local data to give a much better de-noising and bias correlation. Another paper outlines a new climate monitoring and radar mapping programme in the Camp Century area in northern Greenland that will be managed by GEUS; some historical information and background models are also presented. A third paper describes the ice-sheet development along the central East Greenland margin in late Miocene to recent time where thick and different types of glacial deposits are interpreted using seismic data.

Other themes

As the national geological data center GEUS has a strong obligation to make all data available to authorities, educational and research institutes and to private enterprises. The ever accelerating changes in technology make this a great challenge in terms of competence, capacity and economic resources, both for collection and quality control of the actual data and for the database and distribution systems. The value for society is, however, very high and there is a strong focus on digitalisation strategy in Denmark these years.

One paper describes the tremendous effort that was made to rescue most of the seismic field data from exploration activities in the 1980s and 1990s in the Danish North Sea and how successfully this worked in collaboration with the operators. Another paper introduces Jupiter, the integrated public database for geology, groundwater and drinking water in Denmark, and describes the data systems, agreements and management behind it.

Finally, the last paper presents the early history of earthquake monitoring in Denmark and Greenland, and discusses how this was as geopolitically important more than a century ago as it is today.