

Review of Survey activities 2015

Edited by

Adam A. Garde, Ole Bennike, Kristine Thrane and W. Stuart Watt

Keywords

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

Cover photographs from left to right

- 1 3D anthropogenic model of urban infrastructure with buildings and pipes for combination with geological data.
- 2 Elevated plain (c. 800 m a.s.l.) across Precambrian basement cut by a deep valley, Torngat Mountains, Labrador, Canada. Source: Google Earth.
- 3 The geothermal energy potential in Denmark is substantial and a WebGIS portal for exploration of deep geothermal energy based on geological and geophysical data has been launched. An interactive 3D tool in the portal gives an intuitive overview of the variations of subsurface topography.
- 4 After drilling two or more overlapping holes in the sea ice, a so-called Kajak core with seabed sediments is retrieved for investigations of past climate. Photo: Jesper Hoffmann.

Frontispiece: facing page

Field investigations at the Sulugssut intrusive complex in the alpine terrain of East Greenland. The rocks formed during the initial stages of the opening of the North Atlantic Ocean at c. 55 Ma. The field camp in the background was pitched on top of a glacier. Photo: Thomas F. Kokfelt.

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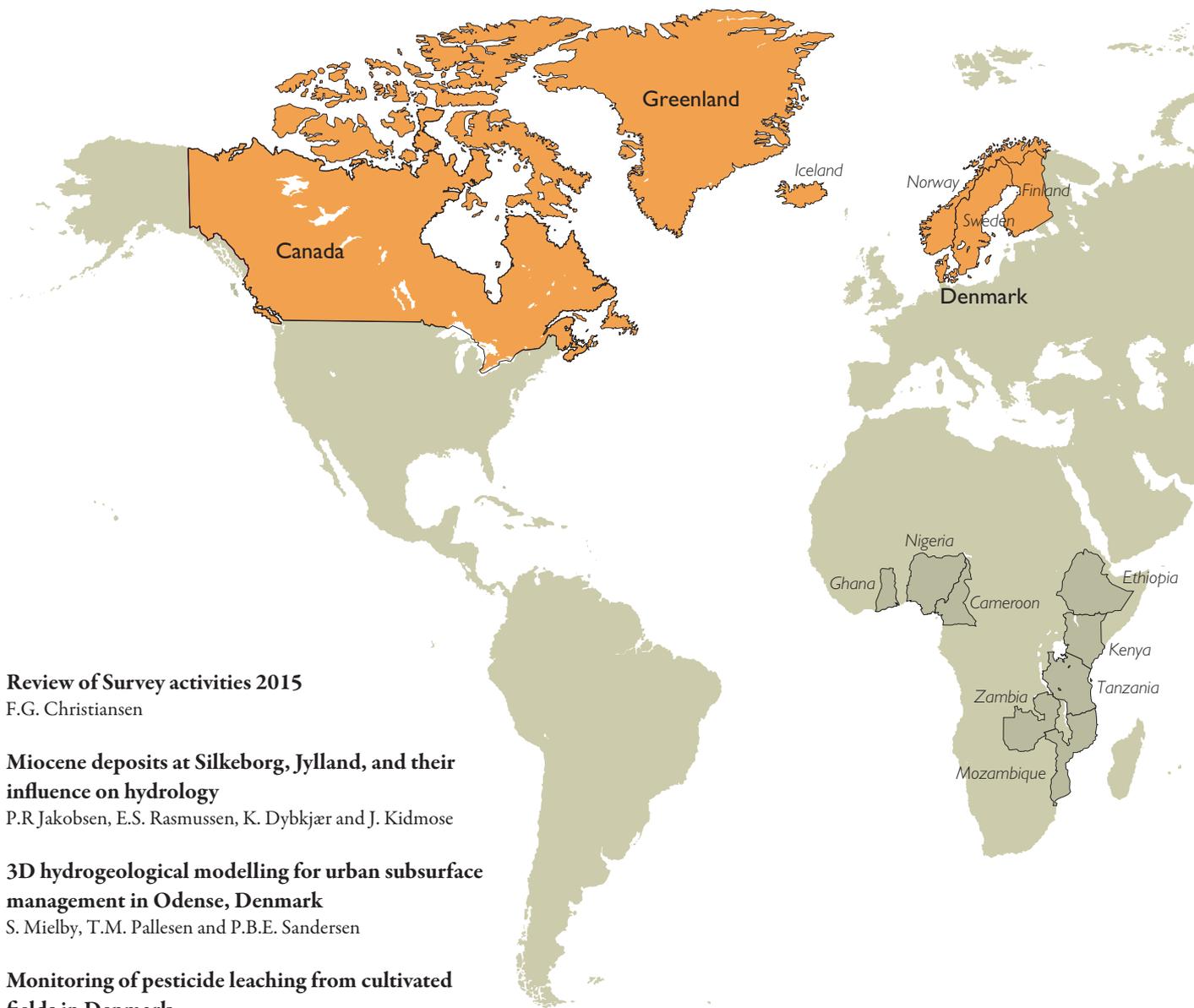
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Review of Survey activities 2015

Flemming G. Christiansen

Deputy Director

2015 was a tough year for many geologists around the World, and the years to come may be even tougher. Low prices of oil, gas and other energy sources, and also of many mineral commodities have led to a significantly lower level of investments in exploration and production than seen in previous years. Both society and industry suffer from much lower income, so cost reduction is the new buzzword; and many geologists have lost their jobs – also in Denmark and at GEUS. Investments in data, projects and knowledge – including many typical products from the Geological Survey of Denmark and Greenland (GEUS) – are worryingly low and will eventually reduce the level of knowledge for decision makers in both the private and public sectors.

Commodity prices are, however, cyclic by nature, and it is very important for GEUS to continue to collect and compile new data, build up new knowledge and models based on research projects – and prepare for a future that will still rely on traditional resources but with a strong focus on a transition towards new green technologies that can reduce the consumption of fossil fuels and the emission of CO₂.

This issue of GEUS' Review of Survey activities has a broader content and a total of 24 four-page articles, more than seen for several years. It reflects that GEUS works on many different subjects and is preparing for a future where geology still plays an important part in the planning of important activities in Denmark and Greenland. Eleven papers are on Denmark, eight on Greenland and five on international and general themes.

Activities in Denmark

GEUS' Danish activities and research cover a wide range of topics within our specific programme areas: data, water, energy, mineral resources and nature and climate, as well as many other basic research projects.

The use of groundwater is very important for Denmark, and GEUS carries out many studies on water resources, their protection and possible future challenges due to changes in climate and use. As a follow-up on previous studies of the Miocene sedimentary succession in Jylland, one paper focuses on deposits at Silkeborg and their influence on hydrology. Another paper describes 3D hydrogeo-

logical modelling important for the urban subsurface management in Odense. A third paper is on the monitoring of pesticide leaching from cultivated fields in Denmark, an activity that has been carried out for several decades.

Denmark has a large potential for subsurface geothermal energy. Following several regional studies and many local case stories in preparation for drilling campaigns, GEUS has developed a WebGIS portal for exploration of deep geothermal energy based on geological and geophysical data. One paper describes this portal where the relevant geological and geophysical maps, data and key information from drilling are easily accessed.

Many of the applied studies emphasise the strong need for a comprehensive national 3D geological model of Denmark. Similar models are being developed in several other European countries in order to provide the best possible background for large resource and infrastructure projects. One paper describes the strategy behind the effort that GEUS is currently putting into developing such models and gives examples of how existing data and geological models can be applied.

Sediments and rocks in Denmark generally have a low content of radioactive minerals and radon. Some of the highest levels of radioactivity on Mors and Bornholm have been studied in detail to understand their geological control and distribution in space. This is described in one paper. Another paper describes how the terrain in the Roskilde area, and in particular the Roskilde Fjord, is controlled by deeper tectonic features that are clearly recorded in subsurface maps of the Danian limestone and Paleocene chalk, marl and clay. After several studies of the Palaeozoic succession in Denmark, it is now possible to make a complete Middle–Upper Ordovician and Silurian stratigraphy and basin model for all of southern Scandinavia. This is described in another paper using wireline logs as a correlation tool.

Several methods of enhanced oil recovery, e.g. injection of 'smart' water, have the potential to significantly increase oil production, and thereby income for Danish society. To do this, a detailed understanding of different types of reservoirs is required, as shown in a paper describing the distribution and composition of primary formation water and produced water in the North Sea oilfields.

Interglacial marine deposits are fairly common in Denmark but for the first time such deposits are described from Kibæk in the Herning area, where they occur several metres above present sea level. Chalk is a very important rock for Denmark. It is the reservoir for most of the oil and gas resources in the North Sea, it is important as a groundwater reservoir in large areas onshore, and it is an important resource for cement production. One paper provides new details of geochemical stratigraphy as a tool to understand the depositional environments and their geographical correlation.

Activities in Greenland

Once again there was a high level of activity in and about Greenland in 2015. Many large and small projects were carried out, studies that are important for evaluating and marketing the resource potential in Greenland. The level of industrial activity in both oil and mineral exploration is very low at the moment, but it is important to prepare for a future when prices of the most important commodities will eventually rise again.

For the last few years GEUS has focused on mapping and mineral evaluation activities in South-East Greenland; this emphasis is now changing to West and North-West Greenland. Two papers give new information from South-East Greenland. One paper describes new geochronological data using Hf isotopes in zircon to unravel Archaean crustal accretion processes in the Skjoldungen region, and another provides entirely new insight into the fractionation processes of the world-famous Skaergaard intrusion, which has been discussed for many decades. The last paper on Greenland bedrock geology describes Palaeoproterozoic palaeovalleys underlying the Karrat Group in the Uummannaq region of West Greenland, where new field activity has started.

Studies and monitoring of the Greenland ice sheet and studies of marine sediments in the fjords around Greenland result in important contributions from GEUS to global climate models. One paper investigates past climate and sea-ice variability in the remote eastern part of North Greenland close to Station Nord. Results from the important PROMICE monitoring project with its focus on temperature sensitivity of ice sheet-ablation are presented in another paper. A third paper is on climate models based on *in situ* observations of Greenland firn.

Passive, so-called Receiver Function analysis of seismological signals from natural earthquakes around the World

can be used to information on the deep crustal structure, e.g. the depth to Moho. One paper presents results from such a study across the Nagssugtoqidian front in West Greenland where a significant change in Moho is recorded across an ancient plate boundary and subduction zone.

Systematic mapping of offshore sedimentary deposits and evaluation of the petroleum potential is crucial for planning and marketing of licensing rounds and for advice on subsequent exploration activities. After several successful licensing rounds and a relatively high level of activity, the seismic data coverage in Baffin Bay is now relatively high compared to many other regions around Greenland. Based on a systematic updated interpretation and mapping, one paper outlines some interesting possibilities for future exploration but also describes the main risks and uncertainties.

International and broader technical themes

GEUS also works overseas in many different countries with a variety of projects and is involved in broader thematic studies.

Over the years GEUS has been involved in several projects of carbon dioxide capture and storage (CCS), especially with European Union and industrial funding. One paper summarises mapping of the storage capacity of sandstone aquifers in Denmark and the Nordic Region, based on a large Nordic collaboration project. Another paper describes a preliminary study of the burial and exhumation history of the Labrador-Newfoundland margin using apatite fission track analysis and thermal maturity methods similar to previous studies on the Greenland side of the Labrador Sea.

GEUS is constantly developing databases and facilities for easier access to and use of data, as well as new methodologies and technologies to make research easier, quicker and better for our geologists. One paper describes the Greenland Mineral Resources Portal; a new version of this was launched by GEUS and the Ministry of Mineral Resources in Greenland (MMR) in April 2015. The portal is based on decades of work and re-organisation of previous databases with an ambition of securing data and making them easily accessible through the internet. Another paper is on a new app – aFieldWork – that has been designed specifically for field work in Greenland to make digital capture of data as easy and efficient as possible. The last paper presents the development of special software for evaluation of data distribution in U-Th-Pb geochronology – jAgeDisplay.