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Review of Survey activities 2014

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Cover photographs from left to right
1 Fractured granite on the island of Bornholm. Photograph: Merete Binderup.
2 The Swedish ice-breaker *Oden* in the Arctic Ocean. Photograph: Martin Jakobssen.
3 A geologist enjoying the magnificent view over the landscape in South-East Greenland. Photograph: Jakob Lautrup.
4 A geologist crossing a local ice cap on Nuussuaq peninsula in West Greenland. Photograph: Jason Briner.

Frontispiece: facing page
Ice conditions in the area north of Greenland during the GEUS LOMROG 2012 cruise with the Swedish ice-breaker *Oden*. See paper by C. Marcussen *et al*. in this issue. Photograph: Thomas Funck.

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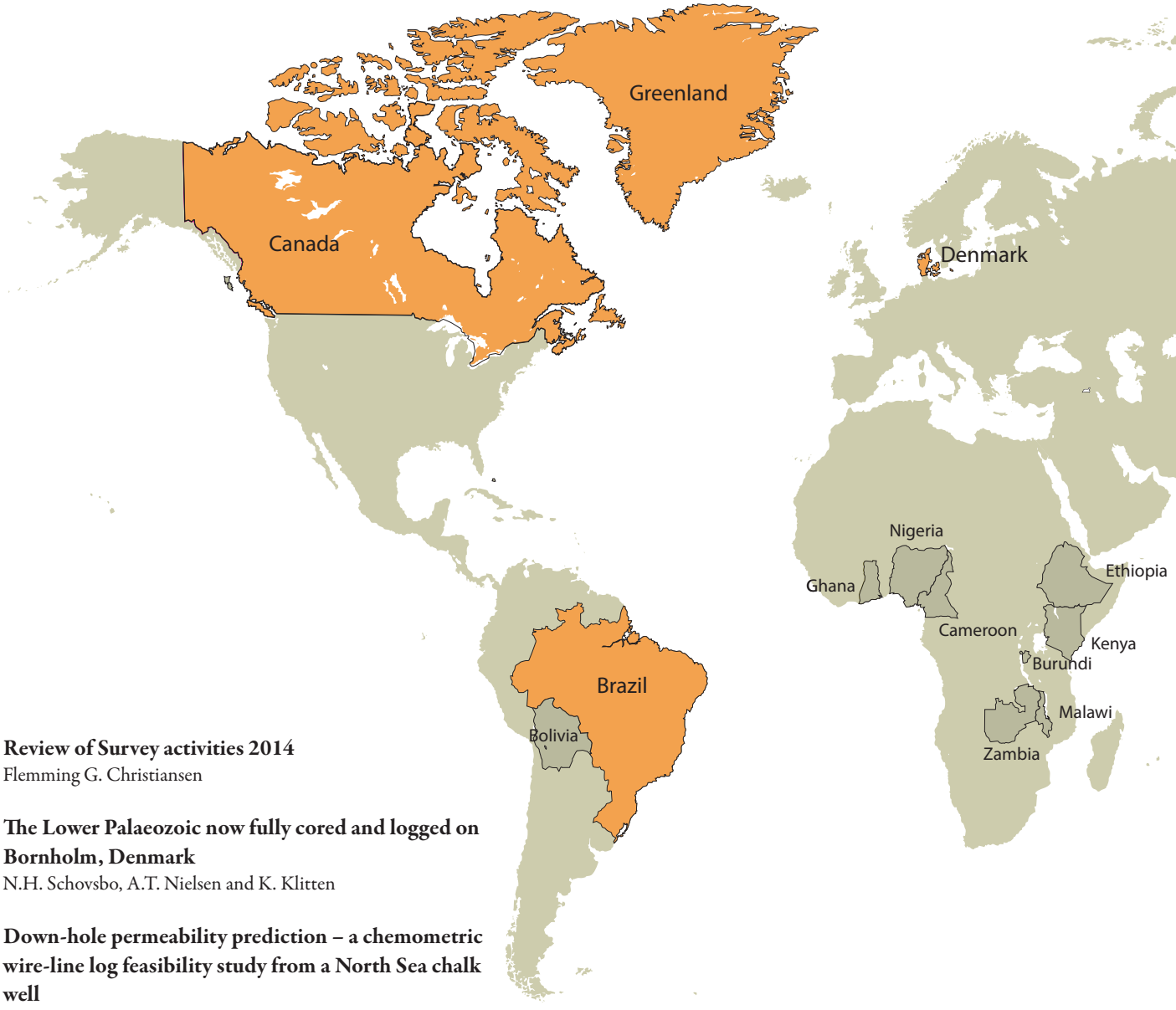
ODEN



Grey indicates countries where GEUS had projects in 2014
Orange indicates countries with GEUS projects decribed in this volume.

Review of Survey activities 2014

Flemming G. Christiansen
Deputy Director

Over the past decades the Geological Survey of Denmark and Greenland (GEUS) has gradually changed from an organisation that focussed on basic mapping and research to one that provides knowledge for discussions and decisions within society and the political system in Denmark and Greenland. Knowing the importance – and in some cases controversy – of many of these decisions, it is of the utmost importance that such input is based on high-quality and well-documented research that is objective, transparent and easily accessible.

Such input to important public and political discussion is also reflected in this issue of the Review of Survey activities that contains a total of 20 four-page papers, eight on Denmark, eighth on Greenland and four on broader themes.

In addition to many classical research summary papers, there are also examples of activities giving input to important political decisions on energy such as shale gas and carbon capture and storage technology, use of and exploration for mineral resources in Denmark and Greenland, climate (monitoring of the Greenland ice sheet) and foreign policy (international boundaries).

Activities in Denmark

The activities and research in Denmark of GEUS cover a wide range of topics within our main programme areas: data, water, energy, mineral resources as well as nature and climate.

The island of Bornholm has a different geological history from the rest of Denmark; a dominance of outcropping basement rocks and Palaeozoic sedimentary rocks gives special research possibilities. One paper summarises information on the Lower Palaeozoic from scientific wells. This succession is now fully cored and logged, thereby providing important data for correlation to other regions for assessing resources in Denmark and Scandinavia and for local use of water supplies.

Chalk is a very important rock type for Denmark as it hosts more than 90% of the Danish petroleum reserves in the North Sea. One paper discusses one of the main challenges, namely prediction of permeability, which is a very critical parameter for production performance.

GEUS is involved in many studies of Quaternary and recent geological processes. One paper describes thrust-fault architecture of glacio-tectonic complexes using 3D geological models based on integrated photo-data from cliff sections with high resolution seismic data.

GEUS records seismological events at many locations in Denmark and Greenland, data that are useful for many different purposes. One paper applies seismological, geological and geodetic data to discuss the consistency of postglacial geodynamics (especially uplift) in the Kattegat region. Another paper provides examples of shock waves from thunder and fireballs that have been detected on seismograms.

The use of groundwater is very important for the Danish society, and GEUS carries out many studies on water resources and possible future scenarios due to changes in climate and use. One paper uses the comprehensive and constantly updated DK-model in the process of developing a hydrological early-warning system for Denmark that can be important for water plans for emergency managers. Another paper describes the relationship between groundwater chemistry and the weathering of Precambrian basement rocks on eastern Bornholm.

The Center for Minerals and Materials (MiMa) at GEUS was established to identify and study important raw material chains from source to use, with the goal of enhancing our knowledge of the risk of resource scarcity and the ensuing vulnerability of the Danish society. One paper gives an assessment of the mineral resource potential of the on- and offshore areas in Denmark with focus on methods and the main results. Denmark has a high potential for aggregates, various clays, chalk and lime, salt and granite – but there are also many conflicting interests on the use of land and seabed where detailed planning and regulations are required.

Activities in Greenland

Once again there was a high level of activity in and concerning Greenland in 2014. Many large and small projects were carried out, studies that are important for evaluating and marketing the resource potential in Greenland. The level of activity in both oil and mineral exploration is rather low at present, but it is very important to prepare for a future when

prices of the most important commodities will rise again. Monitoring of ice and predicting climate changes are also important GEUS activities.

The work on the Continental Shelf Project reached a new culmination point, when the 5th submission concerning a very large area north of Greenland, with great international media coverage, was sent jointly to the Commission on the Limits of the Continental Shelf by the Government of the Kingdom of Denmark and the Government of Greenland in December 2014. One paper gives a status for the recent work on the project and mentions some of the issues for the coming years where data and results will be presented and used in negotiations, maintainance and hopefully supplemented by additional scientific data.

Several papers focus on mapping and evaluation of the mineral potential in Greenland. One paper gives snapshots of the magmatic history in south-eastern Greenland with examples of magma mixing, mingling and hybridisation at different crustal levels. A second paper gives details of mineralisation in the Skjoldungen area, South-East Greenland, where tungsten- and molybdenum-bearing minerals have been discovered within veins in amphibolites. A third paper follows up on the annual Ujarassiorit public mineral hunt in South-East Greenland where a number of interesting samples have been found by local stone collectors (e.g. corundum, precious and base metals), and where considerable time during field work was used for outreach activities in several small settlements.

Studies and monitoring of the Greenland ice sheet and local glaciers provide a significant contribution to models for global sea-level rise. The important monitoring programme of the Greenland Ice Sheet (PROMICE) that was initiated in 2007 continuously supplies crucial data that are used in a number of subsequent projects and in key publications. Three papers in this issue use such data from PROMICE. One discusses the ice-sheet melt area, where data from MODIS (NASA's Moderate-resolution Imaging Spectroradiometer) are validated against PROMICE data. A second is on the observed melt-season snowpack evolution of the Greenland ice sheet. A third paper gives a technical description of the automatic weather stations that have been developed for basic and applied research. A fourth paper addresses applied glaciological challenges of proglacial mining, which may be important in Greenland where several potential mining sites are located very close to the margin of the ice sheet.

Broader thematic activities

Internationally GEUS also works in many different countries with a variety of projects and is involved in broader thematic studies. The first of these thematic papers describes how digital outcrop models can be made based on images from a handheld camera, with examples from land, sea and ice. A second paper gives details of a so-called provenance study in Labrador, Canada, using detailed analytical data on zircon, rutile and titanite that can be applied to map out boundaries between major orogenic terrains. Another provenance study of heavy minerals from northern Brazil is also presented, in this case with focus on titanium placer deposits.

The challenge of climate change demands reduction in global CO_2 emissions. One of the most promising technical solutions is to use carbon dioxide capture and storage (CCS). The final paper is a summary of the CO_2StoP project, which has designed a database on storage capacity in 27 European countries and identified important gaps in our knowledge.