

# The year in focus, 1999

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In 1999 field activities in Greenland by the Geological Survey of Denmark and Greenland (GEUS) were at a slightly lower level than in 1998, but still involved 85 persons including 27 from the Danish Lithosphere Centre (DLC); these figures include guest scientists from within and outside Denmark. Of the Survey's total normal staff of 356, 87 were focused on Greenland-related activities. The key statistics of human and financial resources for the years 1998 and 1999 are summarised in Table 1.

The prime source for funding of the Survey is a Finance Law grant. The systematic and continuous reductions in this primary grant over the past few years and in the future will clearly be reflected in the level of activities that can be maintained by the Survey. Thus the allocation from the Finance Law grant spent on Greenland activities fell from 35 to 33 million kroner from 1998 to 1999. This reduced primary support is counterbalanced to some extent by external public funding, which is focused on specific programmes. The main sources are:

1. The Bureau of Mines and Petroleum (BMP), Government of Greenland, Nuuk – funding of onshore mineral resource investigations and hydrocarbon exploration projects.
2. The Danish Energy Research Programme – funding of petroleum-related activities.
3. The Danish National Research Foundation – support to the Danish Lithosphere Centre.

In addition general scientific activities are made possible by funding from a variety of sources: the Danish Natural Science Research Council (SNF), the Carlsberg Foundation, the Commission for Scientific Research in Greenland, the European Union and the Government of Greenland. In 1999 support to certain DLC activities came from the United States National Science Foundation, and funding for onshore work in South-East Greenland and marine work in Disko Bugt, West Greenland from

the United Kingdom Natural Environment Research Council. Thus, despite cut-backs, funding for earth science activities in Greenland is in a healthy state.

Field activities in Greenland are often cooperative ventures between the Survey and Danish and international universities and research institutions. In 1999 the Greenlandic institutions of the Greenland National Museum and Greenland Field Investigations (ASIAQ) again participated in the Survey's scientific activities. This is in keeping with the importance the Survey gives towards attracting Greenland students to science curricula at secondary school and introductory university levels.

The Government of Greenland is directly involved in setting priorities for the Survey's activities through its representative on the Board of GEUS. Two GEUS geol-

Table 1. Key statistics on Survey resources

RESOURCES	1999	1998
HUMAN RESOURCES		
Permanent staff (man-years)		
GEUS personnel*	356	359
Allocated to Greenland work	87	98
Greenland field work (persons)		
Total number of participants†	85	112
DLC staff and guests	27	23
FINANCIAL RESOURCES (million DKK)		
GEUS finance law grant	135	141
Of this spent on Greenland activities	33	35
GEUS external funding‡	78	78
Of this spent on Greenland activities	28	33
DLC spending on Greenland activities	18	16
Total expenditure on Greenland activities	79	84

\* excludes DLC staff resource of c. 20.

† includes DLC and external scientists.

‡ excludes DLC funds.



Fig. 1. Map showing the regions in which Survey field activities were carried out in 1999: frames **A-M**. **Letters underlined below** indicate those regions for which articles are presented in this volume; **numbers** 1–11 in parentheses refer to the articles as listed in the *Contents* and on the adjoining index map (pages 4 and 5).

- A**: Kane Basin 1999, regional geology and economic assessment, Palaeoproterozoic to Quaternary (1, 2, 3).
- B**: Nioghalvfjærdssjorden – Tobias Øer, reconnaissance of recently discovered islands, Quaternary.
- C**: Renland, Scoresby Sund, structural geology and geochronology, Proterozoic tectono-thermal events (4).
- D**: Lindenow Fjord – Kap Farvel, regional geology, Palaeoproterozoic (5).
- E**: Kap Farvel – Nanortalik, limnological studies and coring, lake ecosystems, Holocene (6).
- F**: Igaliku Fjord region, offshore seismic and onshore investigations, climatic change, Norse settlements.
- G**: *Isua Multidisciplinary Research Project*, Isukasia region, regional geology and geochronology, early life, Archaean (7).
- H**: *Aeromag 1999*, low-level airborne survey of Palaeoproterozoic orogen (8).
- I**: *IMERSUAQ* project, Tasersiaq basin, hydrological studies, ground/airborne, meltwater from Inland Ice.
- J**: Sisimiut – Kangerdlussuaq, limnological studies and coring, lake ecosystems, Holocene (9, 10).
- K**: *ARKVA-2* project, Tasersuaq basin, hydrological studies, snowmelt and runoff modelling.
- L**: Disko Bugt, marine seismic and coring, palaeo-oceanography, Holocene sea-level variations.
- M**: Svartehuk Halvø region, petroleum geology studies, sedimentology and palynology (11).

ogists were seconded to the BMP in Nuuk throughout 1999 to assist in its work concerning mineral and oil exploration. This support is aimed at fulfilling the ambition of the Greenland Home Rule authorities to make the exploitation of Greenland's natural resources a significant element of the Greenland economic base. BMP and GEUS continue jointly to support initiatives to inform the international oil and mineral industries about opportunities in Greenland through publication of newsletters directed towards the mining industry (*Greenland MINEX News*) and the oil industry (*Ghexis Newsletter*), and through participation in conferences in Europe and North America with publicity stands, lectures and posters.

## Regional geology and mapping

The first 1:500 000 scale geological map of part of West Greenland was published in 1971. Previous regional mapping projects had primarily been directed towards publication of more detailed 1:100 000 geological maps. For the past 30 years emphasis has been aimed at completion of the national map sheet coverage at 1:500 000, although 1:100 000 maps have continued to be produced (at a reduced rate) for selected regions. The *Kane Basin 1999* project completed the field mapping for the last remaining 1:500 000 geological map sheet (sheet 6, Kane Basin; Fig. 1, **A**). Of the three sheets not yet published, compilation is complete for sheet 9 (Lambert

Land) which will be printed in the year 2000, while sheet 11 (Kong Oscar Fjord) is scheduled for printing in 2001, and sheet 6 (Kane Basin) in 2002 (see Fig. 3 on page 102 of this volume).

The *Kane Basin 1999* field party to north-western Greenland comprised 30 persons, of whom the main group from the Survey was concerned with bedrock investigations including economic geology investigations, while eight persons dealing with surficial geology, archaeology and botany were sponsored by the Danish Polar Center and research foundations; base-camp and aircraft personnel completed the group. The main Survey work was concentrated on the Palaeoproterozoic Inglefield mobile belt and the Palaeozoic Franklinian Basin. The work included rock sampling on a traverse line extending into Ellesmere Island, Canada.

In central East Greenland a two-man team visited the Renland area of the Scoresby Sund region (Fig. 1, **C**), with the objective of finding convincing structural and isotopic evidence for Grenvillian (~ 930–1000 Ma old) tectono-thermal activity within the southern part of the East Greenland Caledonian orogen. This was a follow-up of similar studies undertaken during the Survey's 1997–1998 expeditions to the Kong Oscar Fjord region immediately to the north.

Field work in the Palaeoproterozoic Ketilidian orogen of South and South-East Greenland (Fig. 1, **D**) was continued by an international group of five geologists, in 1999 mainly funded by the Natural Environment Research Council, UK. Studies were concentrated on structural geology and the genesis of the rapakivi granite suite.

The Archaean Isua greenstone belt to the north-east of Nuuk, southern West Greenland (Fig. 1, **G**), has again been the focus of studies by two multinational and multidisciplinary groups: 25 researchers supported by the Commission for Scientific Research in Greenland and the Danish Natural Science Research Council, and another group of ten persons from the Danish Lithosphere Centre.

## Mineral resources investigations

The acquisition of airborne geophysical data from Greenland was continued with project *Aeromag 1999*, funded by BMP, and covering a broad region between latitudes 65°40'N and 68°20'N in southern West Greenland (Fig. 1, **H**). The contractor, Sander Geophysics Ltd., Ottawa, Canada, acquired a total of 141 000 line km of data. With completion of this programme, government-

financed projects have now made available a total of 445 000 line km of regional high-resolution magnetic data and approximately 75 000 line km of detailed multiparameter data (electromagnetic, magnetic and partly radiometric data) from Greenland.

Economic investigations within the scope of the *Kane Basin 1999* project included mineral prospecting and sampling of newly discovered and previously known mineralisations in both the Precambrian crystalline rocks and Cambro-Ordovician carbonates of the Franklinian Basin (Fig. 1, **A**). Investigations of geochemical gold anomalies in shield lithologies outlined by previous studies did not lead to location of a source, but anomalous gold abundances associated with copper were located in a 70 km long NE–SW-trending belt that coincides with an aeromagnetic lineament and is considered a promising exploration target.

## Petroleum geology

Field activities in 1999 specifically concerned with petroleum geology were concentrated in the Svartenhuk Halvø region in central West Greenland (Fig. 1, **M**). Although outcrops of sedimentary rocks are few in the region, they are important for interpretation of the evolution of the Cretaceous–Palaeogene Nuussuaq Basin. The search for oil seeps in the Palaeogene basalts continued, with interesting new finds, and an approximate northern limit for the oil seepage province can now be defined. Extensive sampling of basalts was carried out for palaeogeomagnetic studies.

Offshore the drilling of the first exploration well on one of the spectacular structures in the Fylla area is planned for the year 2000, and is eagerly awaited. The Survey continued reinterpretation of seismic data from the Palaeogene basalt area west of the island of Disko (Fig. 1), a study extended into Canadian waters. As a preparation for the coming licensing round in 2001, several new interpretation projects were initiated to reassess the exploration potential offshore central West Greenland; these include reprocessing and reinterpretation of the many seismic data sets, and reanalysis of material from the five offshore wells from the 1970s. These projects are supported by the Danish Energy Research Programme and administered by the Danish Energy Agency (DEA).

In 1999 a new exploration strategy for West Greenland undertaken with the BMP and DEA was completed, and was approved by the joint Greenlandic/Danish parliamentary committee.

## General scientific activities

With the help of the polar research vessel R/V *Polarstern* from the German Alfred Wegener Institute, Bremen, measuring instruments and data were collected from the floating ice tongue filling Nioghalvfjærdsfjorden in north-eastern Greenland (Fig. 1, **B**), which has been the subject of intense ice dynamic studies over the past few years. Opportunity was also taken to visit the recently discovered small group of islands some 80 km east of the ice tongue filling Nioghalvfjærdsfjorden, the Tobias Øer, in Greenlandic Tupperp qeqertai. These islands proved to comprise low-lying accumulations of loose glacial till, and a small stratified ice cap rising to about 10 m above sea level.

Further studies were carried out on lake ecosystems and sediments in the Kangerlussuaq area of southern West Greenland (Fig. 1, **J**) and the Kap Farvel area of South Greenland (Fig. 1, **E**). These studies are supported by the European Union and the Carlsberg Foundation, and objectives include investigation of the rapid and large climatic changes at the transition from the last ice age to the Holocene.

In south-western Greenland investigations of the possible causes for the disappearance of the Norse settlements were continued (Fig. 1, **F**). This work included acquisition of seismic data in Igaliku Fjord off the main Norse settlements of Gardar and Hvalsey. Pilot studies of aeolian sand layers in soil profiles close to some Norse farms were also conducted in an attempt to define whether these layers are indicative of climate change or are a result of soil erosion caused by Norse farming activities. The field work was supported by funding from the Government of Greenland.

In southern West Greenland hydrological studies were carried out in two areas. In the Tasersuaq basin, south of Kangerlussuaq (Fig. 1, **I**) the first year of the 3-year *IMERSUAQ* project was carried out in cooperation with Greenland Field Investigations (ASIAQ), the National Survey and Cadastre (KMS), the Danish Center for Remote Sensing (DCRS) and Aarhus University, Denmark (AAU). The main aim of the ground and airborne work is a more precise assessment of the meltwater quantity derived from the Inland Ice. The project is funded by the Danish Natural Science Research Council (SNF). Snow hydrological studies (ARKVA-2 project) were continued in the Tasersuaq basin, a potential hydropower basin north-east of Sisimiut (Fig. 1, **K**). The studies, undertaken in association with ASIAQ, were in 1999 mainly tracer experiments focused on gaining knowledge of percolation and storage of water through cold snow.

Marine geological investigations were carried out in Disko Bugt (Fig. 1, **L**) as part of a project financed by the Natural Environmental Research Council, UK, and in cooperation with the University of Durham, UK and University of Copenhagen. The work addresses the dynamics of the ice margin and regional palaeo-oceanography since the last glacial maximum. The August cruise in R/V *Porsild* involved seismic acquisition and coring. The investigations showed the presence of large postglacial sedimentary basins in south-eastern Disko Bugt and a major submarine fan east of Disko.

## Publications

Four issues in the *Geology of Greenland Survey Bulletin* were published in 1999 (nos. 181–184). Bulletin 181 comprises 14 articles on the Precambrian geology of the Disko Bugt region, West Greenland, and is accompanied by a (previously published) 1:250 000 coloured geological map. Bulletin 182 on vertebrate remains from the Upper Silurian to Lower Devonian beds of North Greenland is the first palaeontological monograph released since the formation of the new Survey organisation (GEUS). Bulletin 183 is the annual Review of Greenland activities for 1998, comprising 10 articles, and Bulletin 184 is a collection of research articles on palaeontology, geochronology and geochemistry.

Geophysical maps at 1:250 000 and 1:50 000 scale resulting from airborne surveys carried out in 1998 (*Aeromag 1998* and *AEM Greenland 1998*) were released in 1999. These comprise magnetic maps from the Nuuk–Maniitsoq region of southern West Greenland and the Disko Bugt region of central West Greenland, and electromagnetic maps from Washington Land – Daugaard-Jensen Land in western North Greenland and J.C. Christensen Land in eastern North Greenland (see Fig. 1 on page 73 of this volume).

In the series *Danmarks og Grønlands Geologiske Undersøgelse Rapport*, 14 issues with a Greenland scientific content were published. Two issues of the newsletter directed towards the oil industry (*Ghexis Newsletter* 15 and 16) and two issues of the newsletter directed at the mining industry (*Greenland MINEX News* 16 and 17) were published in 1999. The Survey's activities in Greenland, including those of DLC, have resulted in the publication of 29 papers in international scientific outlets.

A review of publications of the Geological Survey of Denmark and Greenland, with a listing of 1999 issues on Greenland, conclude this volume on pages 97–105.