The year in focus, 2000

Kai Sørensen
Director

The year 2000 was unusual in that it lacked major field activity directly involved with the systematic geological mapping of Greenland. However, field activities were again many and varied, including a successful high-resolution seismic survey offshore central West Greenland, and a joint Geological Survey of Denmark and Greenland (GEUS) – Danish Lithosphere Centre (DLC) project centred on Kangerlussuaq in southern East Greenland. Of the Survey's 354 personnel, 93 were allocated to Greenland-related activities (Table 1). The Greenland level of activity in 2000, both in Copenhagen and in the field, thus compared favourably with that of 1999.

The Survey is obliged to spend a fixed percentage of its Finance Law grant on Greenland-related activities. These activities are planned each year by the Survey in consultation with the Greenland authorities, in particular the Bureau of Minerals and Petroleum (BMP). The activities, as described in the annual work programme, are approved by the Board of GEUS, on which the BMP is represented. In addition to the Finance Law grant, funding of Greenland activities comes from the BMP, the Danish Energy Research Programme and the Danish National Research Foundation; the last named institution funds the DLC, as well as a number of other research centres in Denmark. Funding for specific research projects in 2000 included grants from the Carlsberg Foundation, the Danish Natural Science Research Council, the Commission for Scientific Research in Greenland and the European Union (EU).

During parts of the year 2000, several geologists from GEUS were seconded to the BMP in Nuuk, Greenland, to assist in work concerning both mineral and oil exploration. Together with BMP, GEUS continues to inform the international oil and mining industries on exploration possibilities in Greenland, both through participation in conferences in Europe and North America, and through publication of the newsletters *Greenland MINEX News* (directed towards the mining industry) and *Ghexis Newsletter* (directed towards the oil industry).

Regional geology and mapping

Field work for the long-term mapping project aimed at the publication of 1:500 000 geological maps of the land areas of Greenland was completed in 1999. One sheet was printed in 2000, and compilation of the final two map sheets in the 14-map series is underway with printing planned for 2001 and 2002 respectively (see also publications review, page 11). Geological maps in the 1:100 000 series continue to be published, currently with about one new sheet annually.

A multinational field party continued studies in the very Early Archaean greenstone belt at Isua, north-east of Nuuk (Fig. 1, **A**). This was planned to be the last year of field activities for the *Isua Multidisciplinary Research*

Table 1. Key statistics on Survey resources

RESOURCES	2000	1999
HUMAN RESOURCES		
Permanent staff (man-years)		
GEUS personnel*	354	356
Allocated to Greenland work	93	87
Greenland field work (persons)		
Total number of participants†	92	85
DLC persons involved	21	27
FINANCIAL RESOURCES (million DKK)		
GEUS Finance Law grant	138	135
Of this spent on Greenland activities	32	33
GEUS external funding‡	77	78
Of this spent on Greenland activities	22	28
DLC spending on Greenland activities	14	18
Total expenditure on Greenland activities	68	79

* excludes DLC staff resource of *c.* 20.
† includes DLC and external scientists.
‡ excludes DLC funds.
From: Annual Accounts 1999/2000 and internal/external sources.

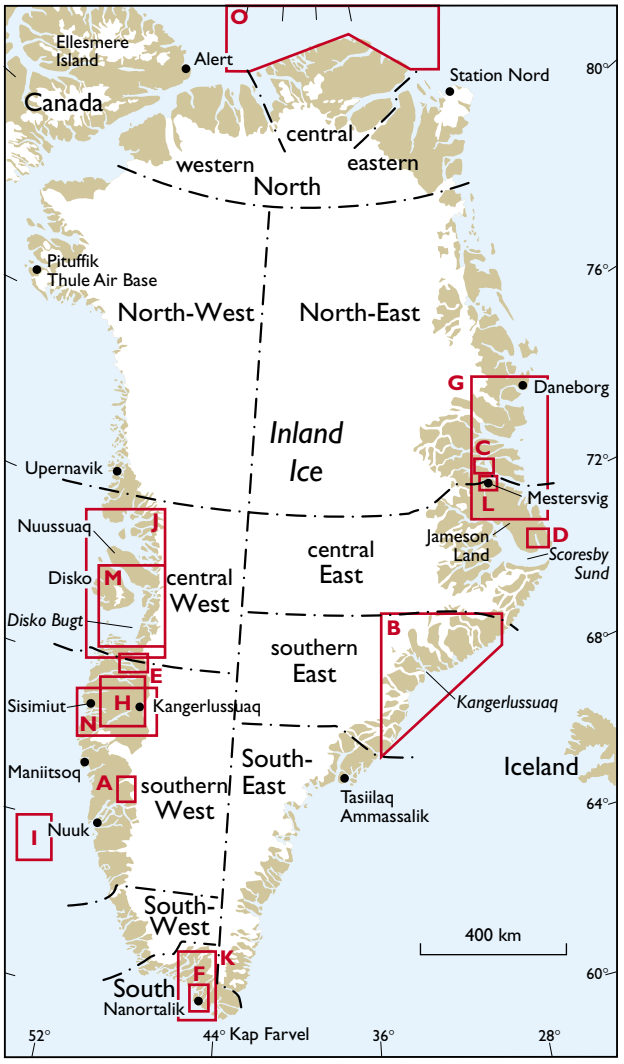

Fig. 1. Map showing the regions in which Survey field activities were carried out in 2000: frames **A–O**. **Letters** underlined below indicate those regions for which articles are presented in this volume; **numbers** 1–15 in parentheses refer to the articles as listed in the Contents and on the adjoining index map (pages 4 and 5).

A: *Isua Multidisciplinary Research Project*, Isukasia region, regional geology and geochronology, early Archaean life.

B: *EG 2000*, Kangerlussuaq area, Cretaceous–Palaeogene sedimentology, investigation of Palaeogene basalt formations and intrusive complexes (9, 10, 11).

C: Ella Ø, Vendian – Lower Ordovician stratigraphy and palaeontology (12).

D: Jameson Land Basin, sedimentological research.

E: *Ussuit 1:100 000 map sheet*, geological mapping.

F: *Nalunaq gold prospect*, Nanortalik area, mining geology and feasibility studies (8).

G: *MINEO* and *HyperGreen* projects, hyperspectral and remote sensing research (14).

H: *Kimberlite Project*, Kangerlussuaq–Sisimiut area, kimberlite survey and exploration.

I: Offshore exploration drilling, Fylla offshore area, drilling of exploration well Qulleq-1 (1).

J: Nuussuaq Basin geophysical survey, high resolution seismics (2).

K: Holocene environment, palaeoclimate studies around former Norse settlements (7).

L: Mestersvig, solifluction and mass-wasting experimental sites revisited (13).

M: Disko Bugt, palaeo-oceanographic research, marine sample coring (3).

N: Søndre Strømfjord, palaeoclimatic research, investigations of lake sediments and airborne pollutants (4, 5, 6).

O: *GRASP* initiatives, North Greenland shelf area, sea-ice observations and satellite data comparison (15).

Project, but due to poor weather conditions field objectives were not met, and field activities will now be carried out in 2001. The management and the Chairman of the Board of GEUS visited Isua during the field season (Fig. 2).

With combined funding from DLC and GEUS, an extensive field programme (*EG 2000*) was carried out in the Kangerlussuaq area of southern East Greenland, from a base at Sødalen close to the Skaergaard intrusion (Fig. 1, **B**). Investigations included studies of the Cretaceous–Palaeogene sedimentary basin, as well as the Palaeogene basalt formations and intrusive complexes. A special grant from the Danish Natural Science Research Council made it possible to retrieve and transport to Copenhagen 6 km of selected drillcore (weighing 20 tons), part of the 80 tons of drillcore recovered during mineral exploration of the Skaergaard intrusion in 1989–1990, and stored in the open at Sødalen. These cores provide an invaluable research archive for an anticipated extensive research programme into differentiation processes in this celebrated layered gabbro intrusion.

Field parties visited North-East and central East Greenland. One party carried out work from a base on Ella Ø (73°N; Fig. 1, **C**), collecting samples and mapping the Lower Palaeozoic carbonate succession which represents the passive margin of the Laurentian continent. A second party based at Constable Pynt (70°45′N; Fig. 1, **D**) investigated the sedimentology and biostratigraphy of the Upper Palaeozoic sediments exposed along the margin of the Jameson Land Basin.

Limited field work was carried out on the Ussuit 1:100 000 map sheet in the Nordre Strømfjord area, southern West Greenland (Fig. 1, **E**).

Fig. 2. Mr. Leo Larsen, Permanent Secretary of the Danish Ministry of Environment and Energy (left) and Dr. Per Buch Andreasen, Chairman of the board of GEUS (right), at Isua north-east of Nuuk in July 2000; some of the visitors to the multinational research group studying the very Early Archaean greenstone belt.
Photo: Johnny Fredericia.

Mineral resources

As part of the southern East Greenland activity reported on above, a field party investigated the mineralisation adjacent to Palaeogene intrusives in the Amdrup Fjord area (68°N; Fig. 1, **B**) and sampled extensively for analytical work.

Survey representatives carried out a courtesy inspection visit to the site of the Nalunaq gold mineralisation (60°N; Fig. 1, **F**) in the Ketilidian supracrustal rocks of South Greenland. In the summer of 2000 the consortium holding the Nalunaq licence carried out test mining as part of a feasibility study with respect to future mining to extract the gold.

The *SUPRASYD* project was concluded with the publication of a CD-ROM with systematic presentations of comprehensive geodata sets collected in the Proterozoic rocks of South Greenland. This is accessible to users in a format allowing GIS-manipulation.

As a part of an EU-funded remote-sensing project (*MINEO*), collection of hyperspectral data was carried out over an area including the abandoned lead-zinc mine at Mestersvig in central East Greenland (Fig. 1, **G**). The project had a double aim of testing the method both for use in environmental monitoring as well as for exploration purposes. Hyperspectral data acquisition in the same region was extended with project *HyperGreen*, a mineral exploration project financed by BMP (Fig. 1, **G**).

Research had also been planned in the kimberlite province to the west of Kangerlussuaq airport in southern West Greenland, but the work accomplished was limited because of logistic problems (Fig. 1, **H**).

Petroleum geology

Drilling of the offshore Qulleq-1 well, some 150 km west of Nuuk, was carried out in the summer of 2000 in the Statoil-operated Fylla licence (Fig. 1, **I**). To the disappointment of all, the well did not encounter hydrocarbons in the tilted fault-block of the Fylla structural complex which it tested. It bottomed out in a reservoir sequence of Santonian age, so that the possible occurrence of Cenomanian–Turonian source rocks in the West Greenland offshore basins remains conjectural.

In preparation for the licensing round planned for late 2001, a comprehensive reassessment of the West Greenland offshore basins has been undertaken, with the aim of identifying potential plays within the area to be included in the licensing round.

In order to obtain a more detailed understanding of the Nuussuaq Basin of central West Greenland, a high-resolution seismic survey was carried out in the waters north and south of the Nuussuaq peninsula using the research vessel R/V *Dana* (Fig. 1, **J**). Data acquisition was carried out over a period of 18 days, with recovery of 2743 line km of high-quality data. Spectacular reservoir sections of Late Cretaceous and Palaeogene age are exposed onshore, and the occurrence of oil seeps in basalts and shows in wells in this basin have demonstrated that the Nuussuaq Basin has exploration potential. The additional seismic data are expected to encourage exploration interest by the petroleum industry.

Below the basalts of southern East Greenland sediments of Cretaceous and Palaeogene age are preserved in the Kangerlussuaq Basin. These sediments provide analogues of interest for exploration on the eastern

Atlantic margin and an important data point in the reconstruction of the regional palaeogeography; a field party from the petroleum industry visited the region during 2000, utilising the field base at Sødalen (Fig. 1, **B**).

General scientific activities

Aspects of the marine and onshore Holocene development of Greenland were in focus in a number of field investigations during the year. Thus, a visit to localities of the former Norse settlements in South Greenland focused on acquisition of palaeoclimatic evidence (Fig. 1, **K**), while a revisit to localities around Mestersvig, central East Greenland (Fig. 1, **L**), established during extensive short-term solifluction studies in the 1950s, permitted long-term conclusions and comparisons.

Following the programme of acquisition of seismic data around Nuussuaq by R/V *Dana,* advantage was taken by marine geologists of GEUS and colleague institutions to use the ship to acquire piston cores, assisted by shallow sub-bottom seismic (chirp) profiling in the Egedesminde Dyb and outside the mouth of Jakobshavn Isfjord, in the Disko Bugt region (Fig. 1, **M**). The cruise constituted a follow-up to the marine geological investigations carried out in 1999 with the smaller research vessel R/V *Porsild*. With R/V *Dana* as a platform it was possible to collect longer cores in the eastern part of Disko Bugt, where sediment accumulation features allow mapping of potential palaeo-oceanographic variations and studies of the dynamic history of the ice margin. Meltwater from the Inland Ice through the Disko Bugt region may have contributed significantly to the deep-water formation in the Labrador Sea.

Palaeolimnological investigations were continued in 2000, with additional sampling and measurements in the water column of inland lakes near Søndre Strømfjord (Fig. 1, **N**); sampling of the lake sediments was also carried out. Palaeoclimate studies are ongoing and measurements of airborne pollutants have been initiated.

In order to investigate the feasibility of establishing data collection from the sea ice to the north of Greenland, observations were made from flights with a C-130 aircraft for comparison with satellite images (Fig. 1, **O**).

Publications

The Survey published four issues in the peer-reviewed *Geology of Greenland Survey Bulletin* series in 2000, as well as a range of other publications including map sheets and compilations of data on CD-ROM. The Survey's 2000 publications dealing with Greenland, including papers published by Survey members and colleagues in international scientific outlets, are reviewed in the following pages (pp. 11–23).

Author's address

Geological Survey of Denmark and Greenland, Thoravej 8, DK-2400 Copenhagen NV, Denmark. E-mail: *ks@geus.dk*