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Marine geophysical investigations offshore East Greenland

H. C. Larsen

During August and September 1982 a marine geophysical survey was conducted on the East Greenland Shelf. The survey was part of the ongoing regional project NAD (Larsen & Andersen, 1982; Andersen *et al.*, 1981; Risum, 1980; Larsen & Thorning, 1980). In all 2794 km of 30-fold multi-channel seismic data and marine gravity and magnetic data were acquired (fig. 33).

The object of the NAD programme is to acquire regional coverage of aeromagnetic, multi-channel seismic reflection, seismic refraction (sonobuoy), marine gravity and magnetic data of the East Greenland Shelf between latitudes 60°N and 78°N. Aeromagnetic data comprising 63 000 line kilometres were acquired in 1979 (Larsen & Thorning, 1980) and 5000 km of marine geophysical data were acquired in 1980 and 1981 (Larsen & Andersen, 1982; Andersen *et al.*, 1981).

This year the final data for the project were collected. Thus, a total of 7800 km of multi-channel reflection seismic data and 50 sonobuoy refraction seismic profiles of 20 to 70 km length have been acquired (fig. 33). In addition, marine gravity and magnetics were run at most lines.

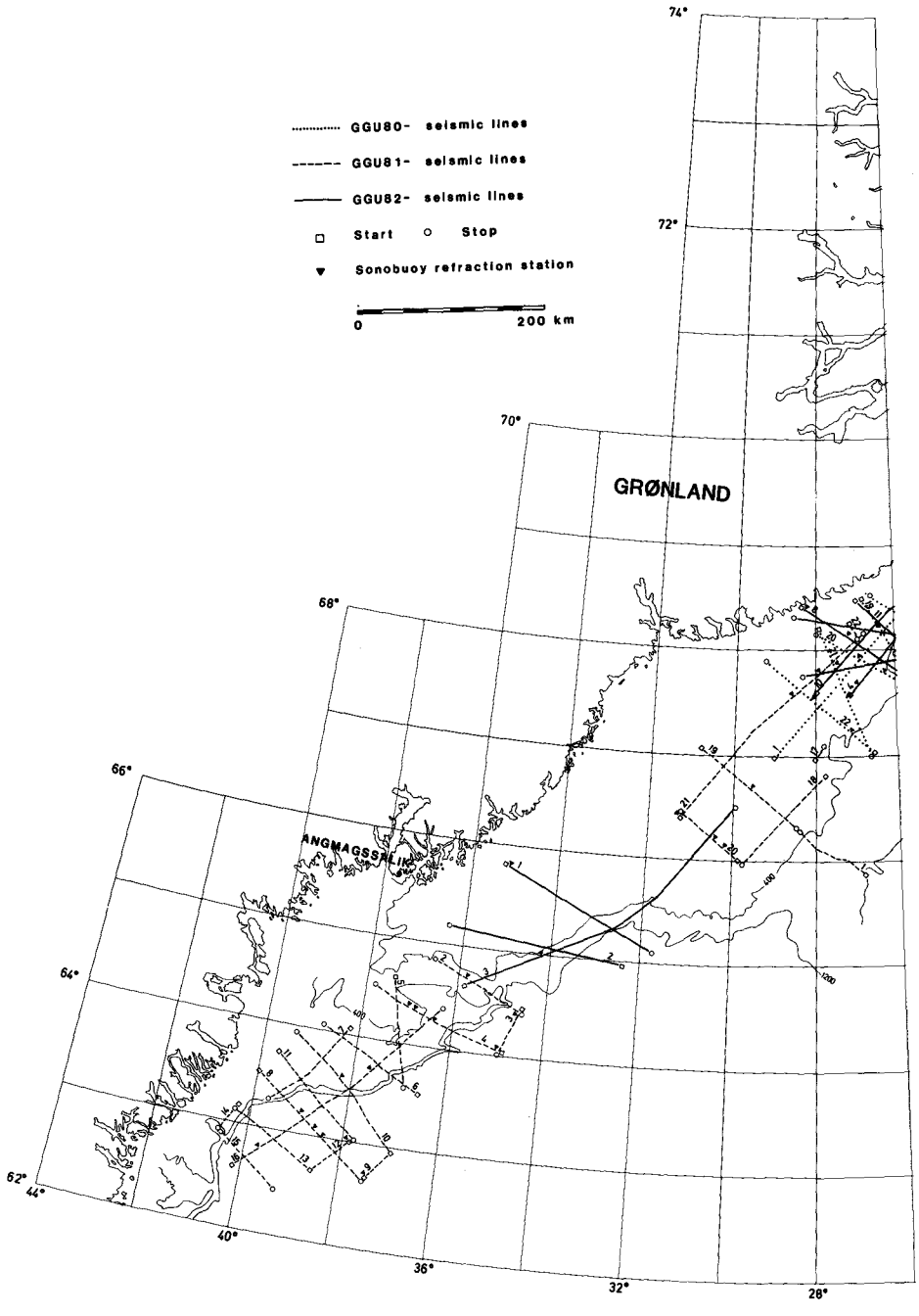

Fig. 33. Seismic lines acquired during the years 1980, 1981 and 1982 (NAD project). This year's profiles in solid lines.

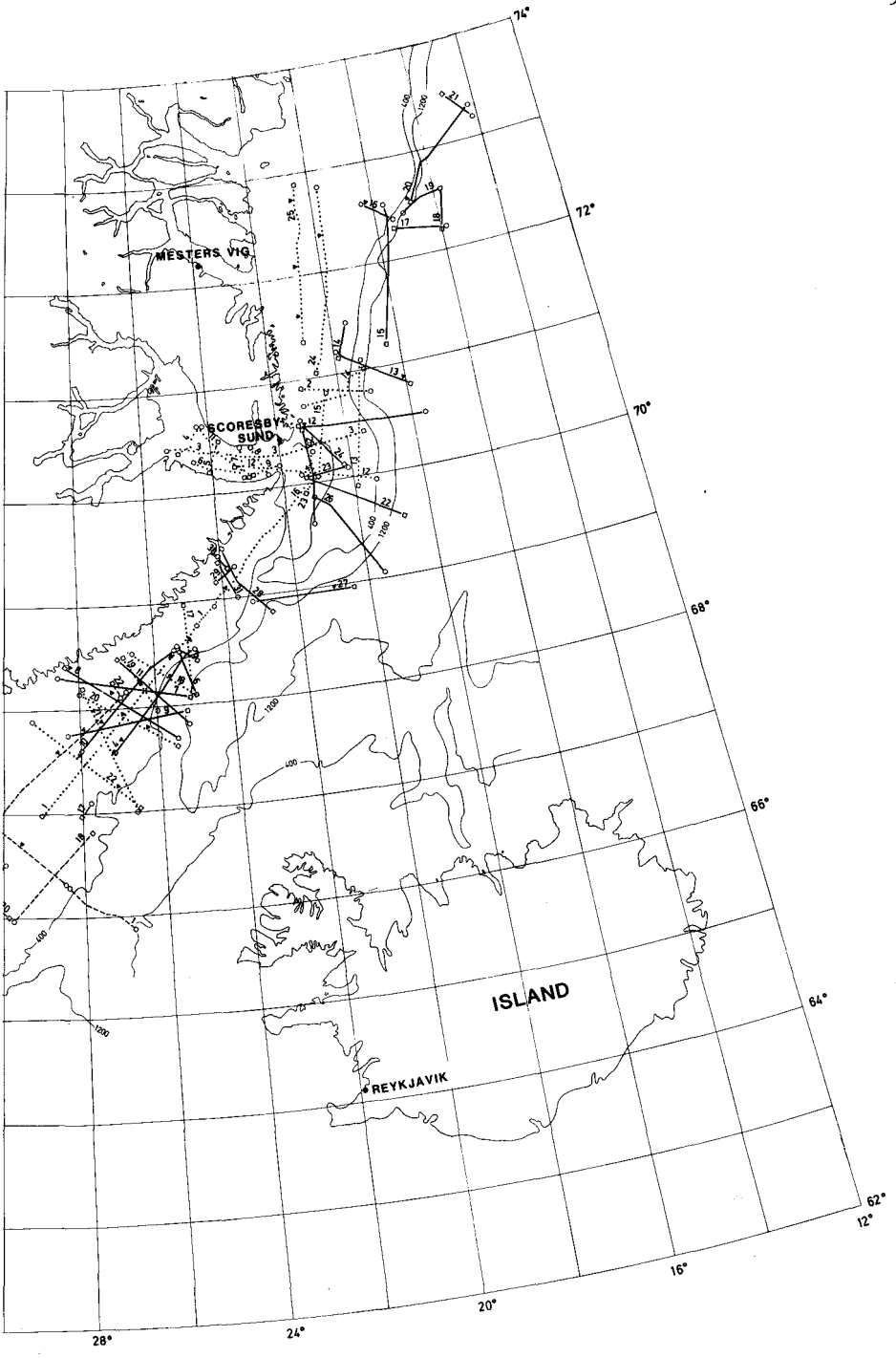
MESTERS VIG
SCORESBY SUND
ISLAND
REYKJAVIK
74°
72°
70°
68°
66°
64°
62°
28°
24°
20°
16°
12°

Fig. 33 cont.

Survey vessel and instrumentation

Western Geophysical Company of America, London, were contracted for the 1982 survey. The 1600 ton seismic vessel R/V *Western Arctic* equipped with a DFS V seismic recording system, a 3000 m Litton streamer, and a 1600 cubic inch (5000 PSI) extended airgun array was used for the survey operations. Coverage was 30 fold (60 trace recording) with 50 m shot point intervals during the whole survey, allowing an average shooting speed of 6.2 knots.

Gravity and total field magnetic data were obtained using a LaCoste Romberg marine gravity meter and a Geometrics G803 marine magnetometer. The integrated use of Loran-C, NavSat and sonar-doppler provided the necessary positioning throughout the survey, although Loran-C was not very useful south of latitude 66°N.

The Danish Hydraulic Institute (DHI) was contracted to provide real time information on the regional ice pattern. This was obtained from satellite images and special ice reconnaissance flights from Reykjavik during August and September. This information, together with ice data and special weather forecasts, were transmitted to the survey vessel by facsimile from various stations in Greenland, Iceland and Denmark. A Hughes 500D helicopter was carried onboard to provide short range, detailed ice information. The helicopter was chartered from Bergquist Helikopterservice A/S, Ringsted, through Greenlandair Charter A/S.

The survey

The survey vessel embarked from Reykjavik on 22nd August and returned to Reykjavik after completion of the survey on 16th September. No port calls were made during this period.

The weather in general was very favourable for marine data collection. The mean wind force was <4> (Beaufort) during the survey (fig. 33). The good weather together with the excellent technical performance of the geophysical equipment made a high production rate possible.

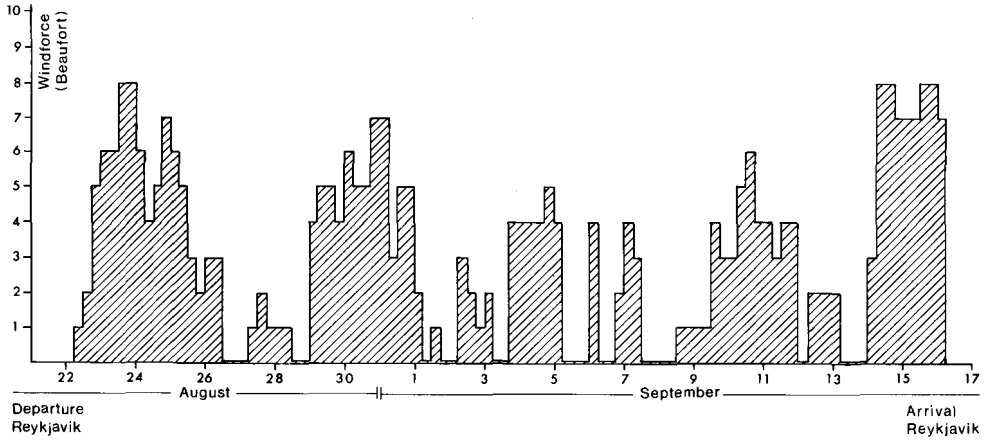

Fig. 34. The windforce in Beaufort scale during the survey operations.

No serious technical problem was encountered during the survey. Occasional problems with the depth control of the streamer because of rapid changes in sea water temperature and freezing of the airguns in very cold water (–1°C to –2°C) caused no delay to the operations. Almost all the airgun maintenance was carried out during line changes.

The only limiting factors in the operation were ice, and the time used for steaming because of the very large distances involved. The ice conditions off central and North-East Greenland were close to the average between the very good ice-year of 1980 and the very bad ice-year in 1981, and probably also very close to a more long-term average for the region.

Some ice covered part of the shelf between latitude 68°30'N and 70°N, but otherwise open water was found to about latitude 70°40'N. North of this position, the ice remained packed in heavy concentrations against the coast, but part of the outer shelf was accessible to about latitude 74°N. The possibility of outer shelf operations in this northern region was restricted to very short-lived embayments and channels along the outer ice edge. Owing to the very good weather and extensive helicopter use, a number of successful operations were carried out under very difficult conditions allowing data acquisition as far north as latitude 73°30'N. The ship was manoeuvred most skilfully during these difficult operations.

Attempts were made twice to enter Scoresby Sund, but they were abandoned due to pack-ice and later, new ice forming at a high rate. In fact, for the first time in the three years marine survey programme, widespread new ice was met within substantial amounts.

Work was stopped and towed equipment recovered on 14th September as a consequence of strongly increasing wind which was not forecast. The ship was kept in position while awaiting the next weather forecast but an extended period of strong wind was forecast and the decision to demobilize was made. The survey was terminated in Reykjavik on 16th September following 30 hours steaming in stormy conditions.

Survey programme

A three to four weeks programme was planned in order to complete the NAD acquisition programme. The acquisition of approximately 2100 km of marine data was anticipated, but a flexible and much larger 'catalogue' of lines was planned in order to meet different survey conditions, such as ice, weather, etc.

The main targets of the 1982 programme were to tie-up the data obtained in 1980 and 1981, to provide increased data coverage over a deep basin between approximately 67°N and 69°N, and if possible to expand the area of seismic coverage to the north. Good results were obtained in all three aspects of the programme. The tie-up programme, mainly covering the regions latitude 65°N to 67°N and latitude 68°30'N to 70°N, was all carried out. Although the seismic work was made difficult owing to the presence of pack ice and new ice, some success was also obtained in expanding the area of seismic coverage to the north, but only on the outer shelf and slope.

Marine gravity measurements were run at all lines and marine magnetics on most relatively ice-free lines.

In addition to the reflection seismic programme ten sonobuoy refraction profiles were made. Profile length varied from 30 to 70 km. The refraction seismic programme was mainly designed to provide deep crustal information and less emphasis was laid on velocity stratigraphy than in the two previous years. The airgun volume of 1600 cubic inch at 5000 PSI and good sonobuoy transmission allowed recording of the Moho discontinuity on some

profiles. All the refraction profiles are single profiles, but with some control of regional dip to be obtained from the reflection seismic data shot concurrently with the sonobuoy profile.

Data quality and processing

Quality control during the survey was exercised on behalf of GGU by Exploration Consultants Ltd. in co-operation with a GGU geophysicist.

The quality of data acquired in 1982 is generally believed to be very good. All the data have been acquired within tight specifications. Rarely shooting took place with less than 95 per cent of full airgun volume. The streamer was kept very straight and all sixty channels were operative most of the time. Air pressure (5000 PSI) did not drop during the entire survey, nor were air-leaks encountered. Misfiring due to bad synchronization occurred, but infrequently.

By far the most serious and continuous data problem was caused by sea-bed multiples. This was also seen in the 1980 and 1981 data (Larsen & Andersen, 1982; Larsen, 1981) and it can now be concluded that the multiple problem has to be considered seriously, both on the acquisition side and the processing side in any future seismic operation off East Greenland. This year, an extended, 89 m long airgun array was applied during acquisition and one, or more, multiple attenuation tools will be applied to the data in addition to the standard processing. Owing mainly to multiple generated noise in the data, velocity picking for the

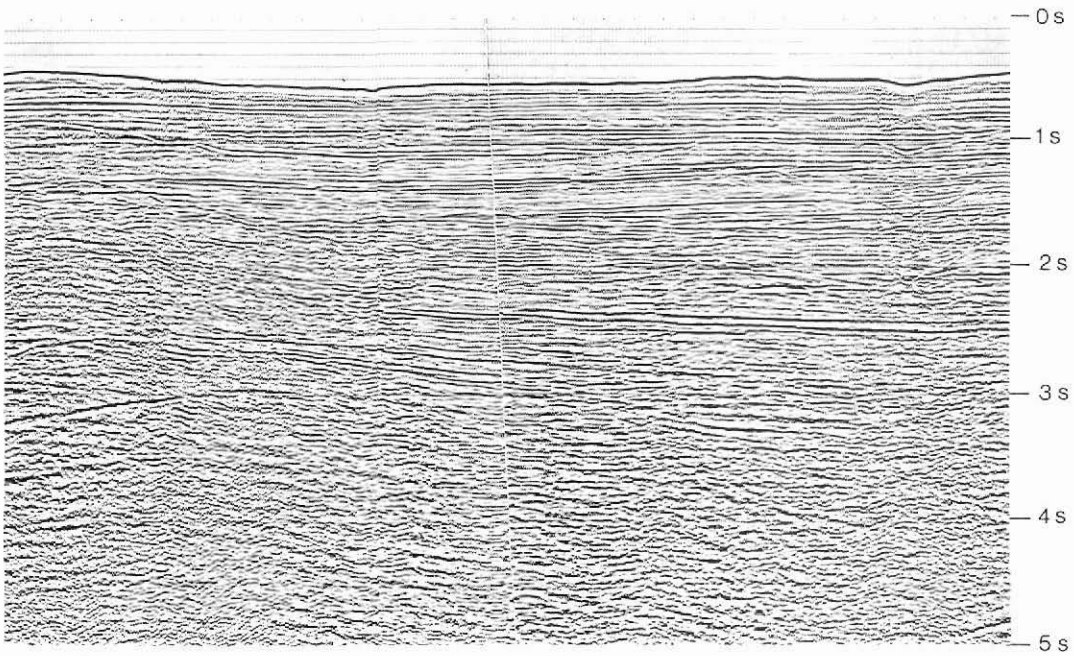

Fig. 35. Part of seismic line GGU80–24 (southern end). Profile length 20 km. Two-way travel time in seconds. 3000% initial stack with adjacent shot gun and receiver-array simulation (1:2:1 trace mix). Note the presence of strong water-bottom multiples. Input data: air-gun data recorded 60 fold.

NMO correction of data can be very difficult and will require continuous constant velocity stacks in certain regions, and expanded velocity analysis in less difficult regions.

Reprocessing

About 700 km of the 1980 reflection seismic data have been reprocessed in 1982. About 200 km, comprising four test panels, have been reprocessed by various contractors. The remaining 500 km of data comprise five profiles reprocessed by a number of oil companies. Important improvements of data quality can be seen on many of the 1980 seismic data (fig. 35, 36) and a further 1400 km of 1980 data will be reprocessed along with the processing of the new 1982 data. Thus, at the end of the project most of the reflection seismic data will be processed to a high level.

Interpretation and release of data

Preliminary depth-to-magnetic, depth-to-acoustic basement maps and a regional bouguer gravity map have been compiled for the whole region. It will take a year to interpret and compile the new data and to complete the final interpretation. Release of data will start in late 1983.

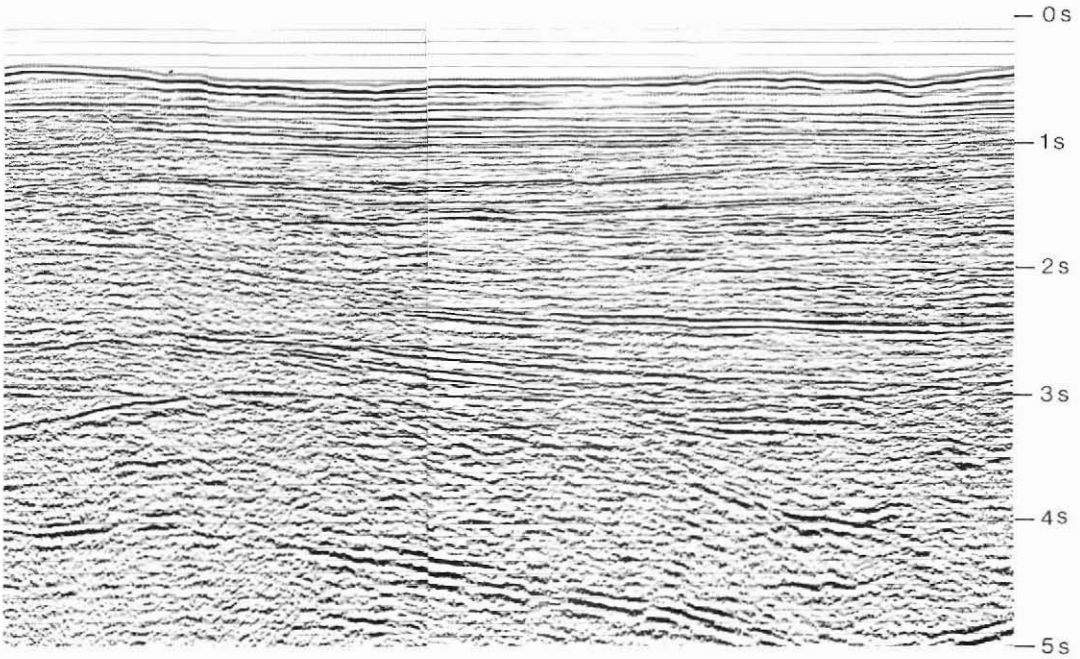

Fig. 36. Same panel as above after reprocessing. 6000% stack (weighted) with multiple attenuation through wave equation method. Improved velocities from constant velocity stacks. Tertiary sediments down to approximately 2.5 seconds. Mesozoic and older (Palaeozoic to Precambrian?) rocks below.

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Glaciology related to potential hydroelectric power for Greenland towns

Anker Weidick and Henrik Højmark Thomsen

There is increasing interest in the possibility of supplying towns with hydroelectric power from neighbouring basins. To meet this interest the project 'Vandkraftundersøgelser for bynære bassiner' was carried out at the localities listed in Table 4 and shown in figure 37. The project has been in operation since 1980 as a joint project of Greenland Fisheries Investigations and the Greenland Technical Organization; in 1982 GGU commenced glaciological work on the project. The project is due to terminate in March 1984.

The effect of glaciers upon the discharge from the individual basins must vary greatly according to glacier cover but it can rarely be neglected and is of paramount importance for basins receiving meltwater from the Inland Ice.

The objective of the investigation is the determination of the relations between local climatic conditions, mass balance, and variations in the discharge of the individual glaciers. The basic requirement therefore is to list glacier areas, elevations and types, together with information on recent changes in their extent and form. An inventory of all the basins with this information, together with a review of current base maps, has been made. The subsequent steps in the determination of the individual mass balance conditions on the basis of snow line altitudes and the data transferred from meteorological and glaciological stations is in progress. For the glaciological work the results are based on measurements at selected glaciers (Johan Dahl Land, Taseq, Qamanârssûp sermia, Qapiarfiup sermia and Tasersiaq) the locations of which are shown in figure 37. In the light of the geographical spread of the