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A new gravity data set from Svalbard and the adjacent sea areas: Processing report

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REPORT

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Title:
A new gravity data set from Svalbard and the adjacent sea areas: Processing report

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Summary:

Gravity maps that cover the Svalbard Archipelago and the adjacent offshore areas are presented. The maps are based on a compilation of several different data sets. Most of these data are previously unpublished. This report describes the data compilation, quality control and the terrain corrections. Two photographic reproductions of coloured gravity maps are included. Maps at the scale of 1:1 million can be purchased from the Geological Survey of Norway.

Keywords:		
Geofysikk		
Gravimetri		Fagrapport

LIST OF CONTENTS

Page

FIGURES

1 INTRODUCTION

In this report we present Bouguer and Free-air anomaly maps of Svalbard and the adjacent off-shore areas. The data that are presented here include (to our knowledge) all the available gravity data in digital from the land area of Svalbard. This is also the first gravity map to be compiled that covers the whole of Svalbard.

The data have been corrected for obvious errors in location (x,y), height or depth (z), and value (mGal). Levelling has been performed to minimize cross-over errors at ship track intersections, and finally the data have been merged into one digital data file. This has enabled us to experiment with different densities in the Bouguer and terrain correction procedure. Because the rugged terrain on Spitsbergen (thus the name **Spitsbergen**) requires terrain corrections, a complete Bouguer correction of the gravity data on land has been performed. Digital elevation data was employed in performing the terrain corrections. A perspective view of Spitsbergen is shown in Fig. 1. The image was created using the digital elevation data.

The data sets used are those reviewed below. The gravity data are presented in map form, and the processing procedure is described.

2 DATA SETS

This section describes the integration of the different data sets into one consistent, digital data set. Several different data sets were used in constructing the digital data file.

The reference net ties a survey to the measured value of absolute gravity. Two reference networks were encountered in this compilation. These were the European Calibration System of 1962 (ECS 62) and the International Gravity Standardisation Net (IGSN 71). The latter was chosen as the basis for this compilation because modern surveys are referenced to it. A value of normal gravity is produced at any given latitude by the International Gravity Formula of 1967, which was used in this compilation.

The distribution of the gravity stations on Svalbard, and of the ship tracks from the shelf areas surrounding Svalbard, is shown in Fig. 2.

2.1 Land data

The majority of the gravity stations in the interior of the land areas were measured by Statens Kartverk (SK, Norwegian Mapping Authority) in 1980, 1981, 1985 and 1986. The stations were set out using helicopter transportation. All stations which were located directly on the glaciers have been omitted from the data sets because they give local negative Bouguer anomalies. The thickness of the ice cover is not known, and because of this, we cannot correct for the mass deficiency represented by the ice.

A few spurious values were encountered in the data set. When possible, these were corrected. The remaining erroneous data were taken out of the data set. Gravity measurements located close to the shorelines on Svalbard were carried out by the University of Oslo between 1974 and 1977 (the project was run by G. Grønlie). These data are generally in quite good shape.

2.2 Ship tracks

Statens Kartverk, in a joint project with the U.S. Defence Mapping Agency, carried out shipborne gravity measurements in Storfjorden and north of Svalbard in 1986. The data are of excellent quality. After 0-order levelling (constant corrections to each individual whole line), cross-over errors at track intersections show a mean value of 0.04 Mgal, and the standard deviation is 0.55 Mgal (the errors have positive and negative signs).

Gravity measurements along lines from the 1987 'Mobil Search' deep reflection seismic cruise have been included (Austegaard, 1989; Sundvor and Austegaard, 1990). These data were made available by the University of Bergen. These line data were adjusted (constant corrections to individual lines) in order to minimise differences at line intersections.

3 PROCESSING

3.1 Terrain corrections

The method used for terrain corrections is described in Mathisen (1976). Three circles were drawn around each gravity station (with radii equal to 0.5 km, 1 km and 2 km). Eight elevations were read at each circle, evenly distributed along the circle and starting at north. For integration of distant topography (zones), a digital elevation model (DEM) has been incorporated. The DEM was constructed by the University of Oslo in the late seventies. It consists of elevation values on a 1 km by 1 km grid (see Fig. 5). In addition, mean heights of 5' by 10' areas have been used, enabling the terrain correction to be taken out to 166.7 km (Mathisen, 1976).

3.2 Description of the error analysis

All gravity stations were plotted on topographic maps that are available from Norsk Polarinstitutt (at scales 1:50,000 and 1:100,000). For each station, original field notes (made available from Statens Kartverk) were inspected for values of x,y, elevation, gravity value and name of station (usually name of mountain peak etc.). These field notes were checked against the map information. In cases of discrepancies, Statens kartverk was contacted. Some errors were sorted out. In 29 cases, the original (correct) data values were not found. Also, a few spurious values were detected on preliminary versions of the gravity map. Accuracy of station heights is critical to the gravity data. One metre in error is equivalent to a 0.1967 Mgal error (error in the terrain correction not taken into account). Statens Kartverk used precision barometers to establish and control elevation on maps. The barometers were well monitored, and the errors in barometric heights are believed to vary from one to five m in this survey.

Altogether 1038 gravity stations have been kept (out of 1067). No original field maps or field books were made available from the University of Oslo. However, these data were quality checked by G. Grønlie (pers. comm., 1991), and are apparently in good shape.

4 RESULTS

Two gravity maps in colour at the scale 1:1 million were made. Photographic reproductions at the scale 1:3.16 million are included in this report. The first consists of terrain-corrected Bouguer anomalies on land and Free-air anomalies in the sea areas (Fig. 3). The second map is produced from a compilation of terrain-corrected Bouguer anomalies on land and Bouguer anomalies at sea (Fig. 4). A density of 2.67 (tons/m^3) was used for the complete Bouguer correction on land, and for the Bouguer correction over the sea areas. The fit between the data sets is good at the land-sea transition.

The areal extent of the anomalies found within the map areas (Figs. 3 & 4) depends on the spacing of the gravity lines and the distribution of the gravity stations on land (see Fig 2). The line spacing and orientation is variable. Only a few lines exist to the west of Svalbard. In this area, anomalies either may escape detection altogether, or they are not completely resolved. However, the few lines are very useful because they are helpful in mapping the regional gravity field. Elsewhere on the map, it is probable that anomalies with a 'strike length' of at least 40-50 km are revealed.

5 ACKNOWLEDGEMENTS

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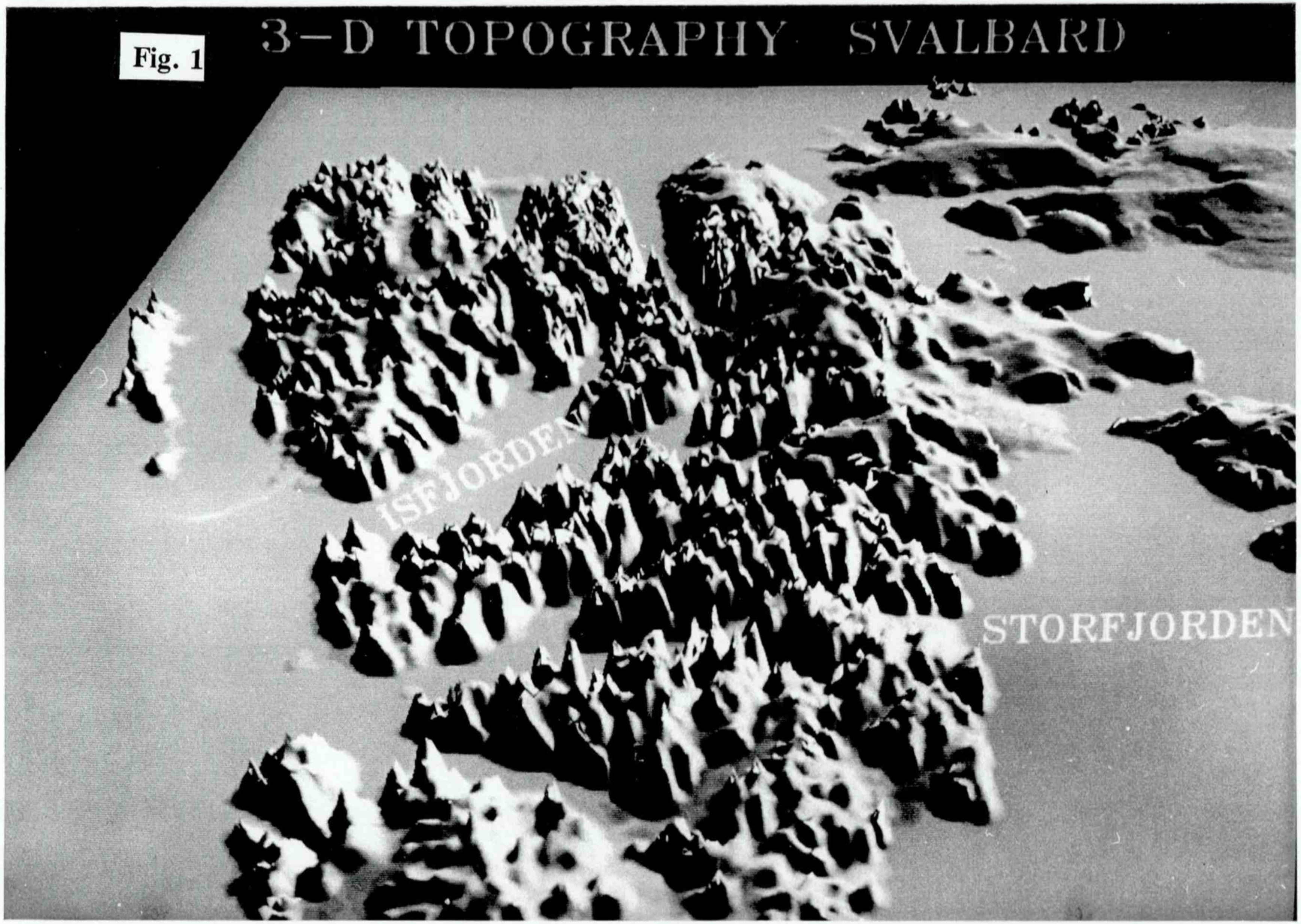
Fig. 1
3-D TOPOGRAPHY SVALBARD
ISFJORDEN
STORFJORDEN

Fig. 2: Location of gravity lines and stations used to create gravity data on a grid.

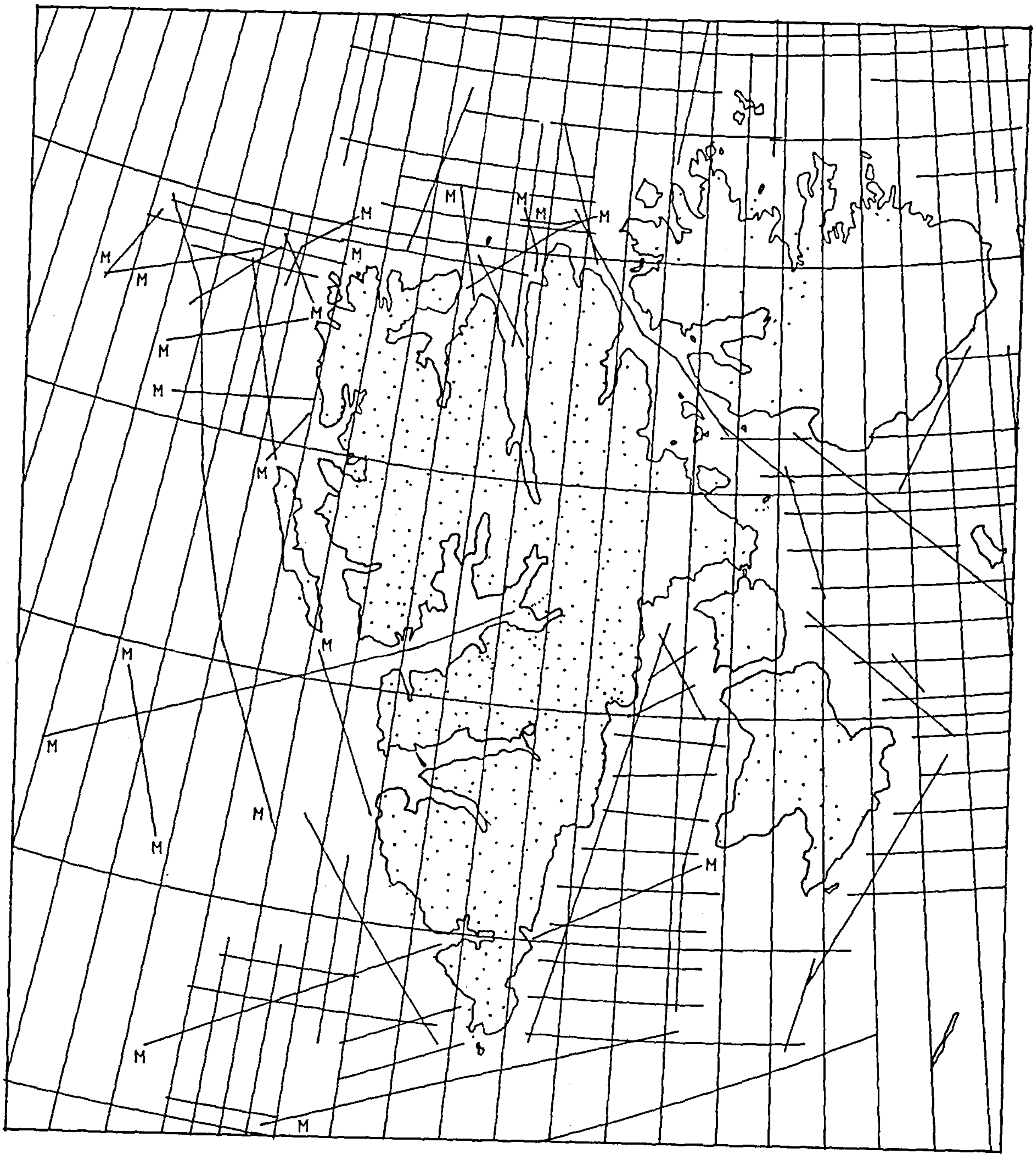

Fig. 3: Gravity map SVALBARD FREE-AIR AND BOUGUER ANOMALIES

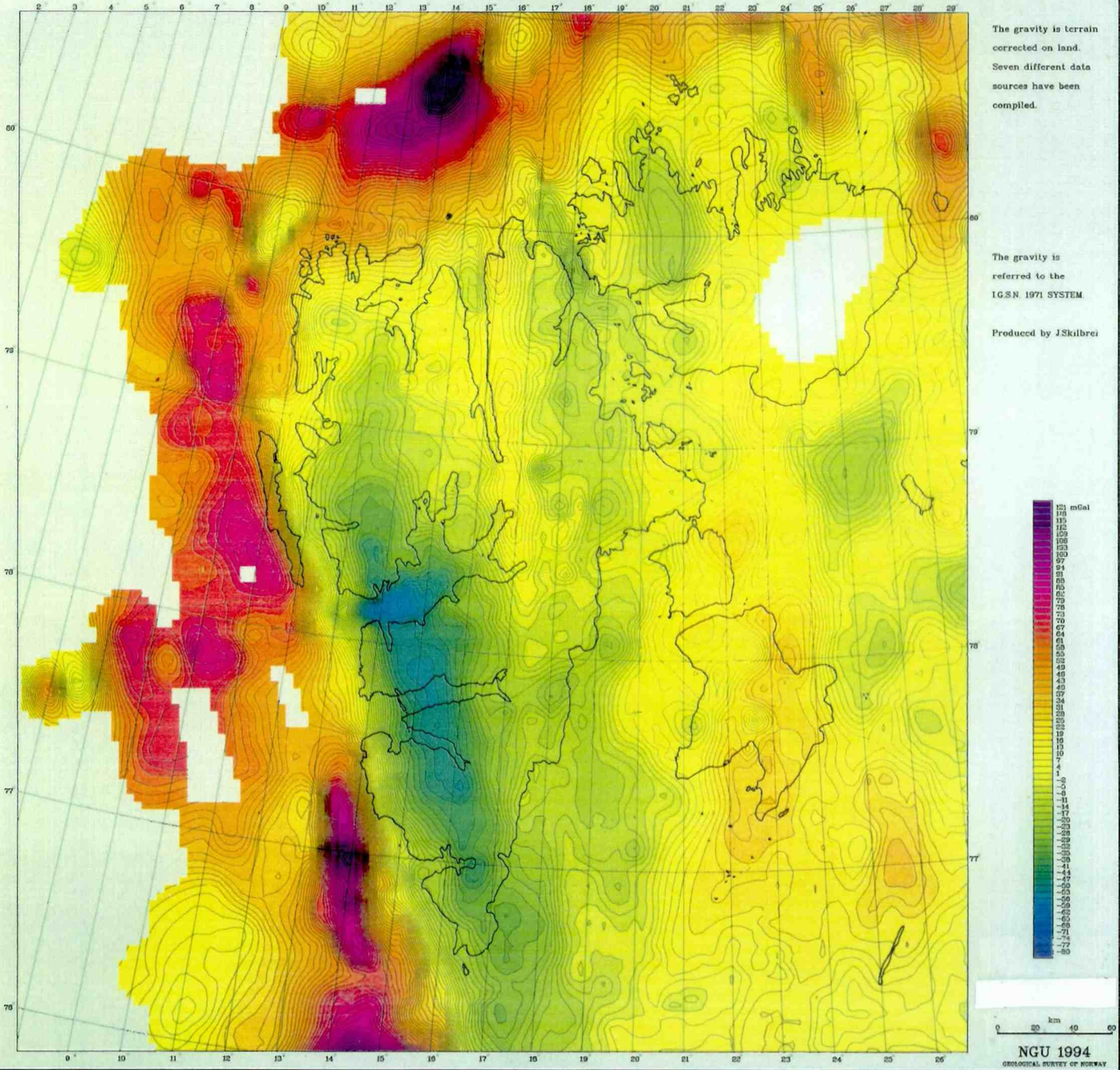

Fig. 4: Bouguer anomaly map.

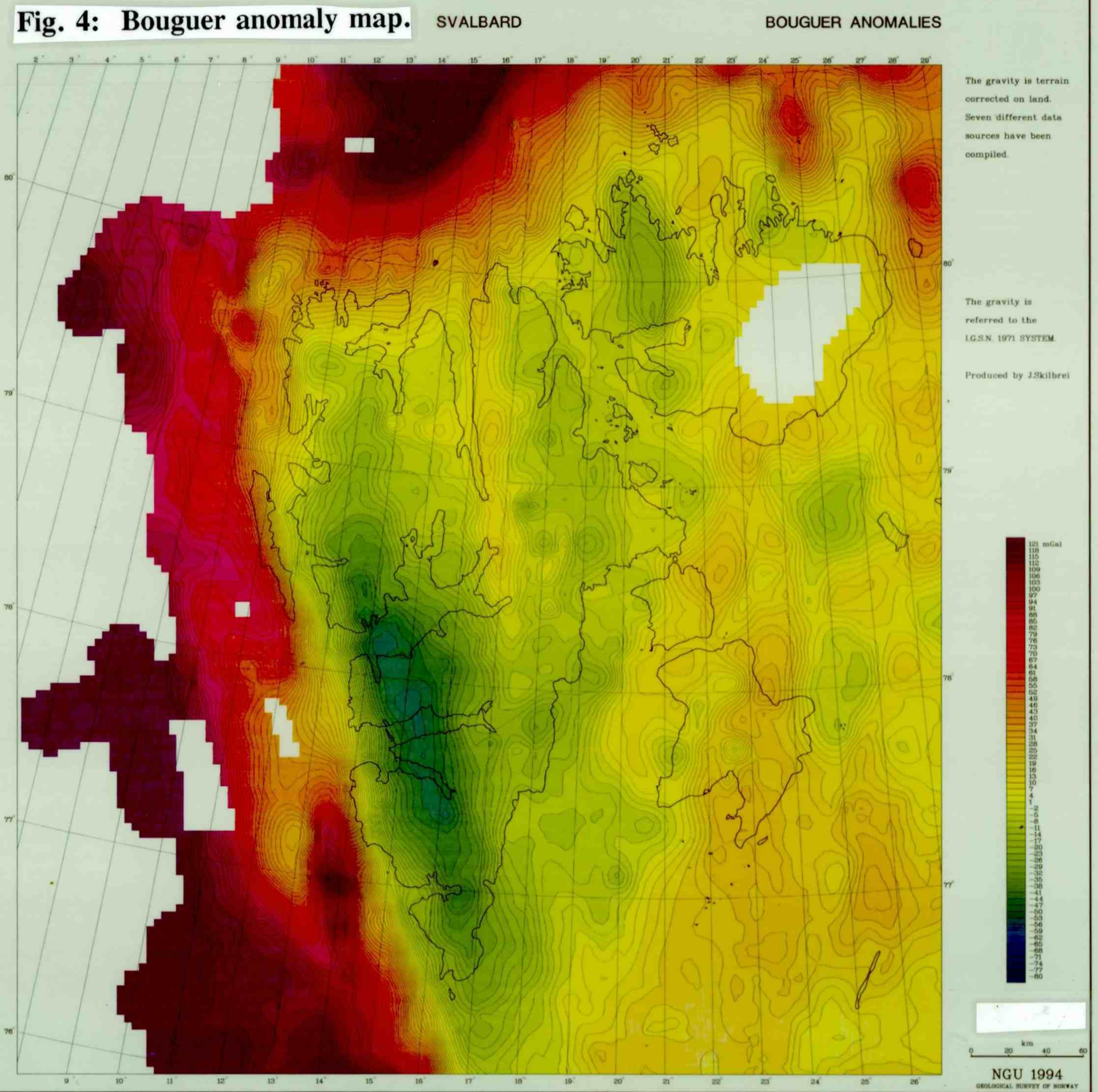

Fig. 5: Shaded relief version of topography