ORKUSTOFNUN
NATIONAL ENERGY AUTHORITY
GEOTHERMAL DIVISION

Gunnar Thorbergsson
Ingvar Thór Magnússon
Gudmundur Pálmason

GRAVITY DATA AND A GRAVITY MAP OF ICELAND

OS-93027/JHD-07
Reykjavík, May 1993

ORKUSTOFNUN - National Energy Authority
Geothermal Division

Gunnar Thorbergsson
Ingvar Thór Magnússon
Gudmundur Pálmason

GRAVITY DATA AND A GRAVITY MAP OF ICELAND

OS-93027/JHD-07
Reykjavík, May 1993

Translation of Orkustofnun report OS-90001/JHD-01 - July 1990

ISBN-9979-827-29-7

SUMMARY

The report describes gravity surveys carried out in Iceland during the period 1967–1985 with the purpose of producing an improved gravity map of the country and its surrounding insular shelf, with as uniform coverage of gravity stations as possible. The survey work was accomplished through a very close collaboration between the U.S. Defense Mapping Agency, Washington D.C. on one hand, and Orkustofnun and Sjómælingar Íslands in Reykjavík on the other. The gravity surveys were mostly funded by the USDMA through contracts with Orkustofnun. The Icelandic government provided funds for renting ships for the marine surveys. The computer processing of the data has been performed both at DMA and Orkustofnun.

In 1968 the Defense Mapping Agency and Orkustofnun established a Gravity Base Station Network with about 40 stations throughout Iceland and a few stations in Reykjavík. On the basis of gravity observations by the DMA, the network was adjusted independently by the DMA and Orkustofnun. The gravity reference thus obtained is named Potsdam/V73 in this report.

In the years 1967–1971 Orkustofnun determined the location, elevation and gravity of 1610 gravity stations, about 10 km apart, throughout Iceland. This number includes 150 stations established in 1967, when plans for the whole country did not yet exist, and 35 stations on Vatnajökull in 1971, but no measurements were made on other ice caps at that time.

In the summers of 1972 and 1973 a marine gravity survey around the coast of the country was carried out by the DMA, Sjómælingar Íslands (Icelandic Hydrographic Service) and Orkustofnun. Over 8400 recordings were made at sea with 10 minutes sailing between recordings.

In the summer of 1985 a densification gravity survey was made in the eastern part of Iceland at DMA's request. A team of NEA surveyors used conventional survey methods for part of the survey, establishing 213 gravity stations at various locations. A second team with surveyors from ITECH (International Technology Limited), Orkustofnun and DMA used inertial survey equipment for the rest of the survey, establishing 450 specified gravity stations (and 130 other stations). Both teams used helicopters.

In the spring of 1985 a few additional gravity measurements were made by DMA in order to strengthen the base station network. Also a gravity tie, from the U.S.A. through Iceland to Norway, was undertaken, linking Iceland to the international network, IGSN71. Afterwards the base station network was readjusted by the DMA, resulting in a new gravity reference named IGSN71/V85. (In the meantime a third reference, IGSN71/V80 had been used at Orkustofnun).

Most of the processing at NEA following gravity surveys on land was carried out in computers, but corrections for the terrain nearest to the stations were made by hand in the conventional manner. These corrections were time consuming. The processing of gravity measurements at sea was mostly by computer.

The gravity data is kept in the VAX 11/750 computer and on diskettes, as well as on tapes for the HP 9000/840 computer at Orkustofnun. A program for computing gravity anomalies and printing results from the list of gravity stations is available for each computer.

A gravity map in scale 1:1,000,000 is a part of this report, and the gravity stations used are shown on the map.

A sample listing of a few of the gravity stations from 1985, for which terrain corrections have been made, is given in an appendix.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

The Defense Mapping Agency, DMA in Washington D. C., and Orkustofnun, the National Energy Authority, NEA in Reykjavík, jointly carried out a survey of the gravity field in Iceland from 1968 to 1973. The Geothermal Division of NEA was responsible for the collaboration and communication with DMA and the overall organization, but the field work was delegated to the Geodetic Subdivision of Orkustofnun.

All parties involved were interested in this undertaking, the Geothermal Division because of the use of the gravity data in geothermal exploration and research studies of the crust underlying the country, the Geodetic Subdivision because the data can be used for the computation of the geoid, and the DMA because of its use in navigation and geodesy.

The first discussions of this undertaking took place in 1965, and in early 1966 the Geothermal Division borrowed a LaCoste and Romberg gravity meter from the DMA to replace a Worden gravity meter owned by the division. After some discussion between the parties concerned, the first proposal, for work in the Reykjanesskagi area, was made in a letter dated 27 April 1967. No field work was done in the summer of 1967, but detailed planning was made for the following year.

In May 1968 observations started in a National Base Station Network. The number of base stations reached 45 (and 4 secondary stations). These observations have been described in a report in Jökull (Gudmundur Pálmason et al. 1973).

The first contract between Orkustofnun and DMA (then named Army Map Service) was signed by Jakob Gíslason on behalf of Orkustofnun in June 1968. This contract covered 410 gravity stations, but the number of surveyed stations became 615 that year. The next year a contract for 349 stations was agreed on, but the surveyed stations became 380. At this stage it was apparent that the DMA was satisfied with the work and wished to have it brought to a full conclusion. In all, five contracts between DMA and Orkustoun were agreed on, and the work covering the whole country including a part of the ice cap Vatnajökull was completed in 1971.

In October 1969 Mr. Ostreim, the DMA representative in this undertaking, was inquired if the DMA would be interested in sponsoring gravity measurements at sea on the insular shelf surrounding the country. This had an interest from the point of view of Icelandic scientists as the main features of the gravity field reach far out from the country. Mr. Ostreim found that there was indeed interest at the DMA (now named US Topographic Command) for this proposal. Special equipment needed for the sea observations was not available in 1970, but preparations of this work were started at that time.

As gravity observations at sea were not possible without a ship, an interest arose among the members of the Insular Shelf Committee (Landgrunnsnefnd) to use the opportunity and broaden the scope of the marine survey. The Icelandic Government provided funds for the hire of a survey ship and it was decided to observe the depth, the magnetic field and, to some extent, the thickness of sedimentary layers with equipment owned by the National Research Council.

The ship sailed along lines with 10 km spacing as planned with respect to the gravity measurements. The survey area reached 100 – 150 km from the coast. The Defense Mapping Agency provided Raydist equipment for positioning the ship. In each survey area the distances from the ship to two land stations were measured with the Raydist equipment. The DMA also provided a LaCoste and Romberg gravity meter constructed for measurements at sea together with personnel for attending the survey instruments aboard the ship. The National Energy Authority surveyed the land station sites in advance of the marine survey, and set up and manned the land stations during the survey.

The marine survey was begun in the summer of 1972 and that year the area off the Reykjanes peninsula and the fjords Faxaflói and Breiðafjörður was surveyed. The following year the areas along the south and the north coast were surveyed as planned, and the area along the east coast was partly surveyed as planned. It turned out that the Naval Oceanographic Office (NAVOCEANO) possessed some gravity measurements from off the east coast of Iceland. The number of measurements in this area was therefore reduced.

A final report presenting the results of the observations on the insular shelf was delivered to Orkustofnun in February 1974 (DMA 1974). Thereby a six year cooperation on gravity measurements in Iceland between NEA and DMA (TOPOCOM) was concluded.

These new results were a major step forward on the road to knowledge of the gravity field in Iceland. From our point of view, they should prove useful in geothermal explorations and investigation of the sea bottom as well as for geological investigations in general.

The results also make possible the computation of the geoid, a reference surface for height measurements, and are therefore of fundamental importance for surveying and mapping in Iceland.

The total payment to Orkustofnun for the work carried out during this six year period was US$248,000. The shere of the cost of the marine survey paid by the DMA, i.e. for the operation of the sea gravimeter and computers has been estimated at US$450,000. If other costs paid by the DMA for the gravity survey on land are included in the estimate, the total cost of these six years project amounts to US$800,000. The Icelandic government mainly paid for the survey ships in the marine survey.

The present report was almost ready in 1984, but before it was published the DMA stated its interest in a densification survey to be conducted mainly in the northeast of Iceland and on the ice cap Vatnajökull.

Early in 1985 a few surveyors from the DMA together with NEA surveyors and other NEA personnel at Orkustofnun worked on preparing the densification survey. A number of programs from DMA were installed on the VAX computer at Orkustofnun for processing the observations as soon as they would be available, but an organizational survay plan was also worked out. In the meantime the granting of a formal permission by the Foreign Ministry to conduct the survey was awaited.

At a meeting with DMA personnel in Orkustofnun, NEA surveyors proposed to undertake a part of the survey with conventional methods for a fixed price per gravity station, and this was accepted.

In addition it was planned that two survey teams would work alternatively, using one helicopter, one gravity meter and inertial survey equipment, provided and operated by the US firm Inertial Technology Limited (ITECH). The gravity observations were to be performed by NEA surveyors.

According to a contract between the Defense Mapping Agency and Orkustofnun, signed on 20 May 1985, Orkustofnun became a contractor to the DMA with ITECH and the Helicopter Service of Albina Thordarson as subcontractors. A part of the work was to be done by DMA personnel:

(A) ITECH, NEA and DMA were to to observe gravity at 452 specified sites positioned by inertial methods in lines between existing triangulation points surveyed by NEA.
(B) NEA was to mark the triangulation points before the survey.
(C) NEA was to observe gravity at 175 specified sites with conventional methods.
(D) DMA was to recompute the National Gravity Base Station Network using the results of observations made in the network in 1968 and 1970 togeather with new observational gravity data.

The new gravity observations were partly additional ties between existing stations in Iceland for strengthening the National Gravity Base Station Network, and partly observations in the USA, Iceland and Norway made by the DMA in May 1985 (not in the contract between the DMA and Orkustofnun) in order to connect the Icelandic network to the International Gravity Standardization Net from 1971 (IGSN71).

Although the weather was not favorable in Northeast Iceland, where most of the densification work was done, the estimated cost of US$1,400,000 was not exceeded. The total number of gravity stations surveyed exceeded the specified number.

During the next few years terrain corrections were made for the new stations as time permitted at Orkustofnun. A map showing Bouguer anomalies in the surveyed area was compiled in scale 1:1,000,000 and published in a report in 1990 (Gunnar Thorbergsson et al. 1990). This is an English translation of that report.

2. BASE STATIONS

In 1968 a Gravity Base Station Network with 46 stations was measured. Information on the base stations was published in Jökull in 1973 (Gudmundur Pálmason et al. 1973). In the following text this gravity reference will be designated "Potsdam/V73".

The international gravity standard IGSN71 (International Gravity Standardization Net 1971) came into effect after the measurements in the Icelandic network took place. This standard is now used internationally instead of the previous Potsdam reference (Torge 1980).

In the IGSN71 report (Morelli et al. 1974) 11 stations in Iceland are included. More than half of these are a part of the Icelandic Gravity Base Station Network, including stations Reykjavík A (21941 A) and Keflavík K (21941 K).

The Honkasalo correction is included in the gravity values in the IGSN71 report, and such gravity values are called "mean gravity". We will use the designation "IGSN71/V74" for the gravity values in the IGSN71 report.

According to a resolution made in Canberra in 1979, the values in the IGSN71 report shall be changed by removing the Honkasalo term, thus introducing "non-tidal gravity" (Uotila 1980). We will use "IGSN71/V79" to denote such values.

The last two references (IGSN71/V74 and IGSN/V79) have not been in use at Orkustofnun, but in work done at the institution between 1980 and 1984, and in at least one report, Potsdam values (i. e. values from the report in Jökull in 1973) corrected by -14 mgal have been used. This "gravity reference" will be identified by "IGSN71/V80" (see section 5.3 and chapter 7).

In May 1985 DMA survey teams carried out observations with 4 gravity meters at the stations Boston A, Reykjavík A, Reykjavík AA, Oslo A and Tromsö S and at the same stations in the reverse order on the way back to the U .S. A. These observations (and no others) were used for connecting Iceland with the rest of the world in the recomputation of the Icelandic Gravity Base Station Network made by DMA following the densification survey in 1985.

In addition to the observations in the U. S. A., Iceland and Norway mentioned above and observations in the Icelandic Gravity Base Station Network in 1968 and 1970 (with erroneous observations removed), observations by DMA personnel with two gravity meters in three observation trips were used:

- Reykjavík AA, Kirkjubæjarklaustur 5213, Hornafjördur near 5219, Hornafjördur 7307, Egilsstadir 5228, Egilsstadir 7144.
- Reykjavík AA, Búdardalur, Akureyri, Egilsstadir 5228, Egilsstadir 7144.
- Reykjavík AA, Akureyri, Thórshöfn.

The results of the readjustment of the Icelandic Gravity Base Station Network by DMA are given in a report (DMA 1986). Gravity values based on these results are identified by "IGSN71/V85" in the present report.

Gravity values in mgal for stations Reykjavík A and Keflavík K are shown for various gravity references in table 1.

TABLE 1. Different gravity references

Reykjavík A	Keflavík K	Gravity
Gravity in mgal		reference
982279.86	982274.31	Potsdam/V73
(982264.96	982259.43	IGSN71/V74)
(982264.91	982259.38	IGSN71/V79)
982265.86	982260.31	IGSN71/V80
982264.96	982259.41	IGSN71/V85

As can be seen in this table, the values observed in the IGSN71 campaign (IGSN71/V74) are nearly the same as the 1985 results (IGSN71/V85), but "mean gravity" and "non-tidal gravity" are used respectively.

Gravity values in the Icelandic Gravity Base Station Network, with gravity reference IGSN71/V85, are given in table 2.

TABLE 2			BASE STATIONS				IGSN71/V85
National grid number & name		Latit. (° ')	Long. (° ')	Elev. (m)	Grav. (mgal)	Base stat. number and description	
5473	RVIK A	64 08.4	21 57.0	8.	982264.96	01 Háskóli Íslands	
5473	RVIK A	64 08.4	21 57.0	8.	982264.959 ± .010	02 Háskóli Íslands	
5450	RVIK AA	64 08.4	21 57.4	10.2	982264.785 ± .010	03 Raunvísindas. OS5450	
5451	RVIK B	64 08.6	21 55.6	36.8	982258.785 ± .013	04 Skólavarda OS5451	
0081	RVIK CH	64 08.8	21 56.9	22.0	982262.460 ± .012	05 Kathólska kirkjan (G)	
5452	RVIK J	64 09.2	21 56.4	2.4	982266.346 ± .013	06 Ægisgardur OS5452 (G)	
5453	RVIK L	64 07.9	21 56.8	13.7	982263.321 ± .010	07 Reykjavík (F) (L) OS5453	
5472	RVIK M	63 58.4	22 35.4	51.	982259.376 ± .015	09 Keflavík (F)	
5471	RVIK K	63 58.4	22 35.4	50.	982259.407 ± .014	10 Keflavík (F)	
5211	OS-5211	63 50.2	20 24.3	27.9	982241.944 ± .021	11 Hellubrú	
5212	OS-5212	63 31.8	19 30.2	62.	982222.546 ± .020	12 Héradsskólinn Skógum	
5213	OS-5213	63 47.4	18 03.0	25.5	982221.382 ± .015	13 Kirkjubæjarklaustur (G)	
7427	OS-7427	63 47.4	18 03.3	25.	982221.564	13 Kirkjubæjarklaustur P&S	
5214	OS-5214	63 52.6	16 38.4	14.7	982232.071 ± .017	14 Fagurhólsmýri	
5215	OS-5215	64 46.5	22 18.2	15.	982307.821 ± .023	15 Snorrastadir (G)	
5216	OS-5216	64 54.1	23 56.1	10.	982328.163 ± .024	16 Lóranstödin Sandi	
5217	OS-5217	65 06.5	21 45.9	22.	982313.204 ± .014	17 Búdardalur (L)	
5218	OS-5218	65 39.1	18 04.3	5.	982337.467 ± .011	18 Akureyri (F)	
5219	OS-5219	64 18.3	15 14.2	10.	982270.768 ± .017	19 Hornafjördur (G)	
5220	OS-5220	65 44.7	19 38.5	15.	982356.006 ± .020	20 Saudárkrókur (F)	
5304	OS-5304	65 33.2	19 26.9	29.6	982317.51	20 Varmahlíd (from 20)	
5221	OS-5221	64 42.0	21 07.2	58.0	982263.738 ± .018	21 Refsstadir (G)	
5222	OS-5222	65 18.7	20 54.4	32.8	982320.604 ± .021	22 Melstadarkirkja	
5223	OS-5223	65 39.6	20 18.1	12.	982361.841 ± .024	23 Hótel Blönduós	
5224	OS-5224	65 57.8	17 24.6	12.	982370.993 ± .019	24 Húsavík (G)	
7426	OS-7426	65 57.7	17 25.2	12.	982370.648	24 Adaldalsflugvöllur	
5225	OS-5225	66 18.1	16 26.8	5.0	982419.717 ± .024	25 Kópasker	
5226	OS-5226	66 15.1	15 15.7	5.	982405.310 ± .018	26 Thórshöfn (F)	
5227	OS-5227	65 45.2	14 49.8	20.	982368.881 ± .019	27 Vopnafjördur (F)	
5228	OS-5228	65 16.7	14 24.6	24.3	982317.403 ± .012	28 Egilsstadir (F) (L)	
5229	OS-5229	66 07.8	18 55.4	17.	982398.216 ± .025	29 Siglufjördur	
5230	OS-5230	65 59.4	21 19.3	15.	982376.179 ± .027	30 Gjögur (F)	

TABLE 2 (cont.)					BASE STATIONS	IGSN71/V85
National grid number & name		Latit. (° ')	Long. (° ')	Elev. (m)	Grav. (mgal)	Base stat. number and description
5231	OS-5231	64 15.1	21 07.7	101.6	982233.807 ± .021	31 Thingvellir
1152	LÍ-1152	64 33.9	21 46.0	17.7	982298.941 ± .019	32 Hvanneyrarkirkja
5180	OS-5180	64 42.0	20 58.6	122.6	982250.70	32 Barnafossar (from 32)
5470	OS-5470	65 16.2	16 06.2	466.0	982207.236 ± .023	33 Grafarlönd
5469	OS-5469	64 19.7	20 07.5	210.5	982200.791 ± .023	34 Gullfoss
5258	OS-5258	64 11.1	19 25.1	307.	982176.585 ± .031	35 Hald
5260	OS-5260	64 25.3	18 39.2	590.	982115.489 ± .043	36 Illugaver
5267	OS-5267	64 53.6	18 03.8	750.	982096.317 ± .049	37 Fjórdungsvatn
5268	OS-5268	64 52.1	19 33.7	640.6	982131.564 ± .058	38 Hveravellir (L)
5269	OS-5269	65 28.3	21 55.7	35.1	982330.284 ± .018	39 Króksfjardarnes (F)
5270	OS-5270	65 55.6	22 25.7	9.6	982366.512 ± .023	40 Reykjanesskóli
5271	OS-5271	66 03.3	23 09.0	5.	982374.382 ± .022	41 Ísafjördur (F)(G)
5272	OS-5272	65 33.2	23 57.4	3.4	982350.112 ± .020	42 Patreksfjördur (F)(G)
5273	OS-5273	64 39.4	14 16.8	6.1	982284.750 ± .017	43 Djúpivogur (L)
5274	OS-5274	65 08.1	13 44.1	2.2	982307.864 ± .016	44 Neskaupstadur (F)
5275	OS-5275	63 25.5	20 16.3	100.	982195.760 ± .026	45 Vestmannaeyjar (G)
5276	OS-5276	65 38.8	16 54.9	285.	982282.145 ± .017	46 Reykjahlíd (L)
5277	OS-5277	65 38.6	16 07.2	390.	982260.872 ± .019	47 Grímsstadir
5278	OS-5278	65 01.1	14 58.8	35.	982280.072 ± .021	48 Valthjófsstadur (L)
9905		65 12.0	19 40.0	458.	982203.024	49 Sandá (from 38) (G)
5307	OS-5307	65 01.7	18 19.8	744.7	982120.636	50 Laugafell (from 37)
5449	OS-5449	65 42.4	21 40.2	20.	982354.632	51 Hólmavík (from 30,39,40)
5467	OS-5467	64 24.4	17 16.0	1721.6	981850.491	52 Grímsfjall (from 13)
7144	OS-7144	65 16.7	14 24.6	24.3	982317.418 ± .020	53 Egilsstadir (F)
7307	OS-7307	64 18.2	15 13.4	10.	982271.280 ± .020	54 Hornafjördur (F)

The station at the University of Iceland has two base station numbers. The first (01) is used in all references before 1967 (even if the connection to this station is indirect).

A few extra stations were established in the years 1968−71. Each station was very carefully connected to a base station. Some of these stations have their own base station number and others use the number of the base station to which they were connected. Mean errors were not computed.

The following abbreviations are used in table 2:

- (F) station at airport
- (G) station is lost
- (L) station mark is lost, but the location can be found by use of the point description.

Point descriptions for four stations established after 1973 are given in figure 1 on page 12. Descriptions in English of other base stations are given in the previously mentioned report in Jökull (Gudmundur Pálmason et al. 1973).

DESCRIPTION			Station name: OS7144
Abbr. info.: BF	Abbrev. name:	Locality: Egilsstaðaflugvöllur	
Type of station: Gravity base station		Region: Egilsstadir	
Type of marker: Bolt/plate		Engraving on marker: OS-1982-7144	
Established by institution: Orkustofnun		Estab. year/month: 1982	Estab. by: GÞ

Description

In the building containing the control tower at the airfield at Egilsstadir.

The marker is set vertically in a concrete porch outside the third window from south on the east wall of the building. The porch is 1.0x3.7 m in size and the marker is 10 cm from the concrete column between windows.

Drive road 1 from Akureyri to the bridge on river Lagarfljót, just west of Egilsstadir. Cross the river and drive a few hundred meters and turn left to the airfield. You can usually park near the control tower.

This station replaces station OS5228.

N NNE NE ENE E ESE SE SSE (S)	Blocking angle in degrees (if it exceeds ten degrees)	
S SSW SW WSW W WNW NW NNW (N)		Max blocking angle < degrees
Photo of station	Map/coord. read unless otherwise stated: 6222 I C762	

Latitude (approx.)	Longitude (approx.)	Elevation (approx.)	Described by
65°16.67'	14°24.67'	24 m	GÞ,ÁG

DESCRIPTION			Station name: OS7307
Abbr. info.: B	Abbrev. name:	Locality: Hafnarflugvöllur	
Type of station: Gravity base station		Region: Hornafjördur	
Type of marker: Bolt/plate		Engraving on marker: OS-1985-7307	
Established by institution: Orkustofnun		Estab. year/month: 1985	Estab. by: GÞ

Description

At the entrance on the west side of the terminal building at the airfield near Höfn in Hornafjördur. The marker is set vertically in the concrete porch 6.5 m north of the control tower, 0.2 m outside a door and 0.1 m south of a concrete pillar 0.4x1.0 m in size.

Drive road 1 along the east coast of Iceland to Hornafjördur. The road to the airport is on the right hand side 2.6 km before you come to road 99 about 5 km north of the small town Höfn.

This station replaces station OS5219.

N NNE NE ENE E ESE SE SSE (S)	Blocking angle in degrees (if it exceeds ten degrees)	
S SSW SW WSW W WNW NW NNW (N)		Max blocking angle < degrees
Photo of station	Map/coord. read unless otherwise stated: 6119 I C762	

Latitude (approx.)	Longitude (approx.)	Elevation (approx.)	Described by
64°18.17'	15°13.33'	10 m	GÞ,ÁG

DESCRIPTION			Station name: OS7426
Abbr. info.: B	Abbrev. name:	Locality: Adaldalsflugvöllur	
Type of station: Gravity base station		Region: Northeast Iceland	
Type of marker: Bolt/plate		Engraving on marker: OS-1986-7426	
Established by institution: Orkustofnun		Estab. year/month: 1986	Estab. by: IÞM

Description

In a new terminal building at the airfield in Adaldalur (Husavik Airport).

The marker is set vertically in a concrete porch at the east side if the building. The porch is opposite the road up to the building, 9 m north of the main entrance and 15 m from the north end of the building. The marker is in the southwest corner of the porch 25 cm from a wall and 15 cm from a concrete column. Drive road 1 east from Akureyri and turn north onto road 85 and drive about 35 km towards Húsavík. The road to the airfield is south from the main road a short distance west of a brigde on river Laxá.

This station replaces station OS5224.

N NNE NE ENE E ESE SE SSE (S)	Blocking angle in degrees (if it exceeds ten degrees)	
S SSW SW WSW W WNW NW NNW (N)		Max blocking angle < degrees
Photo of station	Map/coord. read unless otherwise stated: 2016 I C762	

Latitude (approx.)	Longitude (approx.)	Elevation (approx.)	Described by
65°57.67'	17°25.16'	12 m	IÞM

DESCRIPTION			Station name: OS7427
Abbr. info.: B	Abbrev. name:	Locality: Kirkjubæjarklaustur	
Type of station: Gravity base station		Region: South Iceland	
Type of marker: Bolt/plate		Engraving on marker: OS-1986-7427	
Established by institution: Orkustofnun		Estab. year/month: 1986	Estab. by: IÞM

Description

At the post office at Kirkjubæjarklaustur.

The post office is in a building at the side of the road towards the village Kirkjubæjar-klaustur 480 m west of road 1. The bench mark is in the stairway at the main entrance on the south side of the building. The marker is at the northwest corner of the top step of the concrete stairway 10 cm from the wall and 10 cm from a concrete column. Drive road 1 east along the south coast of Iceland. Cross the bridge on river Skaftá 0,5 km east of village Kirkjubæjarklaustur and drive 480 m to the post office along the road to the village.

This station replaces station OS5213.

N NNE NE ENE E ESE SE SSE (S)	Blocking angle in degrees (if it exceeds ten degrees)	
S SSW SW WSW W WNW NW NNW (N)		Max blocking angle < degrees
Photo of station	Map/coord. read unless otherwise stated: 5818 II C762	

Latitude (approx.)	Longitude (approx.)	Elevation (approx.)	Described by
63°47.33'	18°03.34'	25 m	IÞM

FIGURE 1. Description of base stations established after 1973

3. GRAVITY OBSERVATIONS ON LAND

3.1 Gravity observations before 1967

Gravity observations by Icelanders started in 1950 in cooperation with French scientists. This was followed by Dr. Trausti Einarsson's gravity studies in the years 1950–1954. The National Energy Authority bought a gravity meter (Worden no. 68) early in 1951, which Dr. Einarsson used to observe at 900 stations in various parts of the country, most densely in the Southwest. The results were published in 1954 by Vísindafélag Íslendinga (Societas Scientiarum Islandica) in a report named "A Survey of Gravity in Iceland". These observations gave the first overall view of the gravity field in Iceland and showed in particular the characteristic deep low of the Bouguer gravity field. The observations were sponsored by the Geothermal Division of the National Energy Authority, the National Research Council and the National Almanac Fund. In his report Dr. Einarsson tells of gravity measurements in Iceland by foreign scientists starting at the beginning of the century.

TABLE 3	Observers
01	M. Munck
02	A. Josef
03	Trausti Einarsson
04	Sveinbjörn Björnsson
05	Hörður Lárusson
06	Ingvar Ásmundsson
07	Egill Egilsson
08	Ásmundur Jakobsson
09	Jón Hafsteinn Jónsson
10	Gunnar Thorbergsson
11	Kristinn Thorbergsson
12	Sven Th. Sigurðsson
13	T. H. Nilsen
14	Survey ship Ms. Albert
15	Survey ship Ms. Ísborg
16	Gunnar V. Johnsen
17	Ingvar Thór Magnússon

In the years 1955–1966 local gravity observations were made in connection with geothermal heat explorations and investigations of the changes of glaciers. Results of these measurements were published in reports of the National Energy Authority or in scientific periodicals (Gudmundur Pálmason 1964).

Tables 3, 4 and 5 give the names of observers, the instruments used and information on publication of the results of gravity observations in Iceland.

TABLE 4	Gravity meters
01	Western Geophysical Co. Gravimeter No. 42
02	Western Geodetic Gravity Meter No. 68
03	LaCoste and Romberg Gravimeter G 10
04	LaCoste and Romberg Gravimeter G 137
05	LaCoste and Romberg Gravimeter G 144
06	LaCoste and Romberg Gravimeter G 445
07	Gravity meter on board Ms. Albert
08	Gravity meter on board Ms. Ísborg
09	LaCoste and Romberg Gravimeter G 269
10	LaCoste and Romberg Gravimeter G 220A
11	LaCoste and Romberg Gravimeter G L126

3.2 Gravity measurements in the Blanda area in 1967

Surveyors of the National Energy Authority surveyed in the Blanda area in the summer of 1967 for the purpose of hydro power development. In the beginning of July they started using new distance measuring instruments (Tellurometer MRA-101) and in the middle of that month the helicopter TF-DIV landed at their quarters at Sandá. This marked the beginning of its use in land surveying during summers for many years.

The gravity meter owned by the Geothermal Division (Worden no. 68) was part of the surveying campaign. Gravity observations were made in 150 triangulation points and ground control points. These gravity stations were later given numbers 2705–2864, with a few numbers omitted. The survey area in 1967 is shown in figure 2.

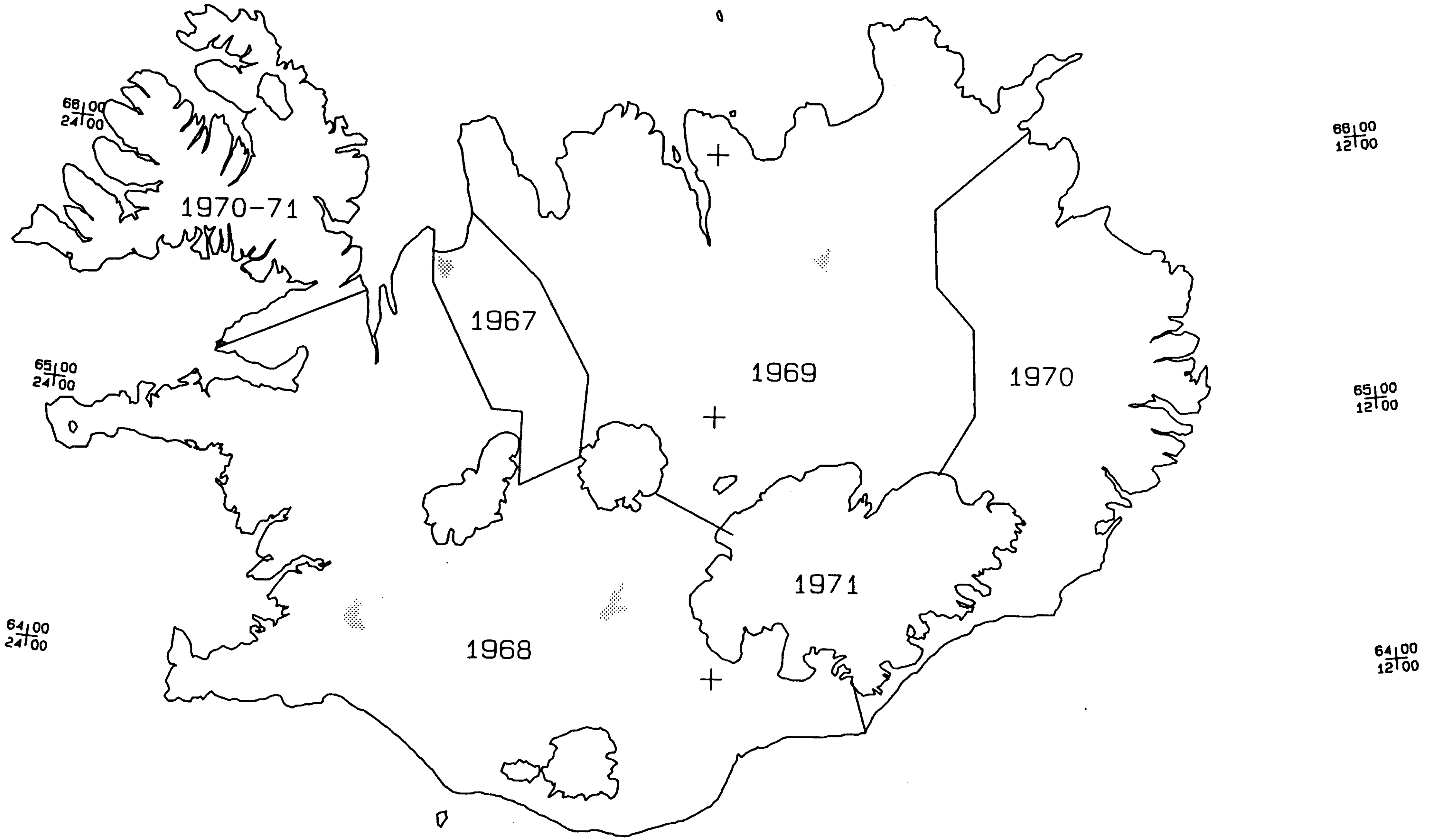

FIGURE 2. Survey areas on land 1967-71

TABLE 5	Publications
01	Tr. Einarsson, Th. Sigurgeirsson and G. Bödvarsson: A Report on the French Icelandic Gravity Measurements in Southern Iceland in 1950. Vís. Ísl. Greinar III, 1.
02	Tr. Einarsson: A Survey of Gravity in Iceland. Vís. Ísl. XXX. A typed copy of the manuscript is kept at the Geothermal Division.
03	The original results are to be found together with item 02 at the Geothermal Division. As far as known they have not geen published.
04	Sveinbjörn Björnsson: Gravity Observations on Skeidarársandur in April 1966 (in Icelandic). Report published at NEA in August 1966.
05	The original results are kept in the Geothermal Division, but they have not been published. See drawings FNR-7308 and 7730 at NEA.
06	The original results are kept at the Geothermal Division, but they have not been published. See drawings FNR-7685 and 7686 at NEA. Report of the Geodetic Division: Measurements of elevations at Hengill in June 1966 (in Icelandic). Compiled in July 1966.
07	The original results are kept at the Geothermal Division. Egill Egilsson: Report on gravity observations in the Krísuvík area in the summer of 1967 (in Icelandic). Published by NEA, August 1967. Report of the Geodetic Division: Surveying in connection with the gravity observations in Krísuvík (in Icelandic). NEA, July 1967.
08	The original results are kept at the Geothermal Division.
09	Gravity Survey of Southwestern Iceland 1968. Report of the Geodetic Division of NEA. NEA, April 1970.
10	Gravity Survey of Northern Iceland 1969. Report of the Geodetic Division of NEA. NEA, March 1970.
11	Gravity Survey of Eastern Iceland 1970. Report of the Geodetic Division of NEA. NEA, December 1970.
12	Gravity Survey of Northwestern Iceland 1970 – 1971. Report of the Geodetic Division of NEA. NEA, November 1971.
13	Gravity Survey of Vatnajökull 1971. Report of the Geodetic Division of NEA. NEA, November 1971.
14	Gravity Base Station Network in Iceland 1968 – 1970, Jökull 23, 1973.
15	Gravity observations in Reykjavík in 1975 (in Icelandic). The results are kept at the Geodetic Division of NEA.
16	Gravity observations at sea in 1972 and 1973. The results are kept at the Geodetic Division of NEA.
17	Gunnar Thorbergsson et al.: Surveying and gravity observations in The Hengill area in 1982 and 1983 (in Icelandic). OS-84003/VOD-03 B. January 1984.
18	Gunnar Thorbergsson, Ingvar Thór Magnússon, Gudmundur Pálmason: Gravity data and a gravity map of Iceland (in Icelandic). OS-90001/JHD-01. July 1990. The Icelandic version of this report.

3.3 Gravity measurements throughout the country 1968 – 1971

The Geothermal Division of the National Energy Authority undertook to carry out gravity measurements for the Army Map Service (later named Defense Mapping Agency), Washington, D. C. in Southern and Southwestern Iceland in the summer of 1968. This work was delegated to the Geodetic Division, a subdivision of the Hydro Power Division of the National Energy Authority. The results were to be delivered the following winter.

The project was carried out according to plan and the contract between DMA and NEA renewed yearly for the next three years. Reports were delivered following the measurements each summer (Gunnar Thorbergsson 1969–1971). The surveyed areas are shown in figure 2. Gravity meter LaCoste and Romberg, Model G, No. 137 was used in all the surveys.

3.3.1 Southern and Southwestern Iceland 1968

In the summer of 1968 observations were made at gravity stations 3001–3615 and the measurements were processed the following winter. The 150 gravity stations in the Blanda area from the summer of 1967 were also processed. A report was ready in April 1969.

A workday in the field usually went somewhat like this: In the morning one or two hours were spent in preparation, mostly refueling and preflight inspection of the helicopter. Then a two man team with a theodolite and a Tellurometer MRA-101 were transported in the helicopter to a triangulation point as planned. If a landing was attempted, as was usually the case, the two men were left behind at the point ("pole") and the helicopter went back to transport two more members of the surveying team to points pre-selected where gravity stations were established.

The distance between the pole and the gravity station was measured with the Tellurometers (measurements at both ends), an horizontal angle was observed at the pole to determine the direction to the gravity station, and the zenith angles at both stations were observed simultaneously (to reduce the effect of refraction). Often one or both instruments were eccentric at the pole (if a cairn was there) and measurements of eccentricity were then made according to fixed rules.

The use of eccentric measurements when needed, sighting on spotlights powered by 12 V acid batteries, the use of light transmitters for communication and the use of the helicopter, were all important for speedy operation. Soon after the surveying started the helicopter pilot began assisting in the measurement routine. After that only one surveyor and the pilot manned the helicopter in flights between gravity stations.

To this description from the 1969 report may be added, that in the following summers we no longer had a two man team at the pole and the observers started writing the field books themselves. Thus two surveyors and a helicopter pilot did the same work as a 5 man team did in the first year. For reasons of safety a fourth man took part in the survey establishing communication with the other members from a car with a transmitter.

3.3.2 Northern Iceland 1969

Gravity stations 3616–3995 were surveyed in the summer of 1969 and a report was made in March 1970. The surveying started on June 1st and ended on October 12th. The experience gained in the previous summer payed off and the field work went very well, except for one day when a car broke down, a surveyor strained an ankle and a serious fault was discovered in the helicopter. The surveying had to be postponed for one month because of delay in obtaining spare parts.

3.3.3 Eastern Iceland 1970

Early in the spring of 1970 surveying started in Northwestern Iceland. A fault in the helicopter during flight caused an emergency landing. Again it took a long time to obtain spare parts. In the meantime surveying started in Eastern Iceland, where 235 gravity stations numbered 4201–4435 were established. A report was delivered in December 1970.

3.3.4 Northwestern Iceland 1970–1971

The measurements in Northwestern Iceland could not be concluded after the surveying in Eastern Iceland in 1970. In the spring of 1971 the last 28 stations in the Northwest were established. The number of stations became 195. The stations were numbered 3996–4190. The report was made in November 1971.

3.3.5 Vatnajökull 1971

At the end of May six men on three snowmobiles went on an expedition onto Vatnajökull. When we arrived at Grímsfjall, a blizzard started and we waited three days in the hut of the Icelandic Glaciological Society on Grímsfjall. On the first of July the sky suddenly cleared and remained like that during the following week.

Gravity measurements were made at stations in lines as follows:

- between Grænafjall and Bárðarbunga
- between Örðfajökull and Kverkfjöll
- over Breiðabunga towards Grendill
- a short line east – west crossing the other lines east of Grímsvötn

A helicopter was used for measurements between Grænafjall and Grímsvötn and on Grímsfjall and at a base station at Kirkjubæjarklaustur. Later a short line of gravity stations was measured south of Síðujökull using the helicopter. The gravity stations got the numbers 4436 – 4471. The last report to the Defense Mapping Agency was delivered in November 1971.

3.4 Other measurements on land

In the years 1970 – 1971 German geodesists carried out extensive gravity measurements between Eyjafjörður and Vopnafjörður. The results were to be published in 1974, but in September 1973 gravity values at 1021 stations together with a gravity map were made available to the Geothermal Division. These data were kept at the Geodetic Division (see chapter 7).

In 1975 the Geodetic Division surveyed at 189 gravity station, number 4501 – 4689, in Reykjavík. A gravity map of Reykjavík (with Potsdam reference) was plotted the following year. The map has not been published but it has been used at the Geothermal Division for geophysical investigations (Ólafur G. Flóvenz 1979).

Gravity measurements were made in the Hengill area in 1982 and 1983. The stations were numbered 4700 – 4999 and 7460 – 7474. A report in Icelandic was prepared in 1984 (Gunnar Thorbergsson et al. 1984).

3.5 Densification survey in 1985

The following is an extract from a report to the Defense Mapping Agency in Washington on Part C (survey by conventional methods by NEA) of the Iceland Gravity Densification Survey in 1985.

Measurements were made in various parts of the country. The plan called for 181 points to be established in an inertial survey. To get the same coverage 213 stations were surveyed by the same methods as in 1968 – 71, but now two surveyors with all their equipment could be transported at the same time in the helicopter (Hughes 500 D).

The error in elevation was estimated within 1 m except in 8 points on glaciers where it was estimated within 2 m. The largest residue in gravity observations was 0.05 mgal and the largest drift in a gravity field trip was 0.0005 mgal/h. The gravity stations established in part C are listed on pages 37 – 41. They are numbered 7481 – 7693.

The National Energy Authority subcontracted the use of a second helicopter of type Hughes 500 D for Part A of the gravity work. Surveyors from ITECH used Litton DASH II Autosurveyor for measuring the location and height of gravity stations in lines between existing triangulation points established by NEA (and six Dopler stations established in May and June). Two NEA surveyors measured gravity at 450 planned gravity stations and 130 other points where landing was necessary. The survey went on from 14 June to 6 August. The quarters of the survey teams were in Akureyri and the survey area covered most of Northeast Iceland and the west part of Vatnajökull.

The mean error of elevation at gravity stations was estimated 1.0 m relative to NEA's triangulation points (estimated error in elevation within 0.5 m) and the precision of location and gravity was also within specifications. The stations were numbered 7701 – 8280.

A detailed description of the survey in Part A of the Densification Survey is given in a report from ITECH (Bomblies 1985), but the final results are in a report from the Defense Mapping Agency (DMA 1986). The gravity stations are shown in figure 3.

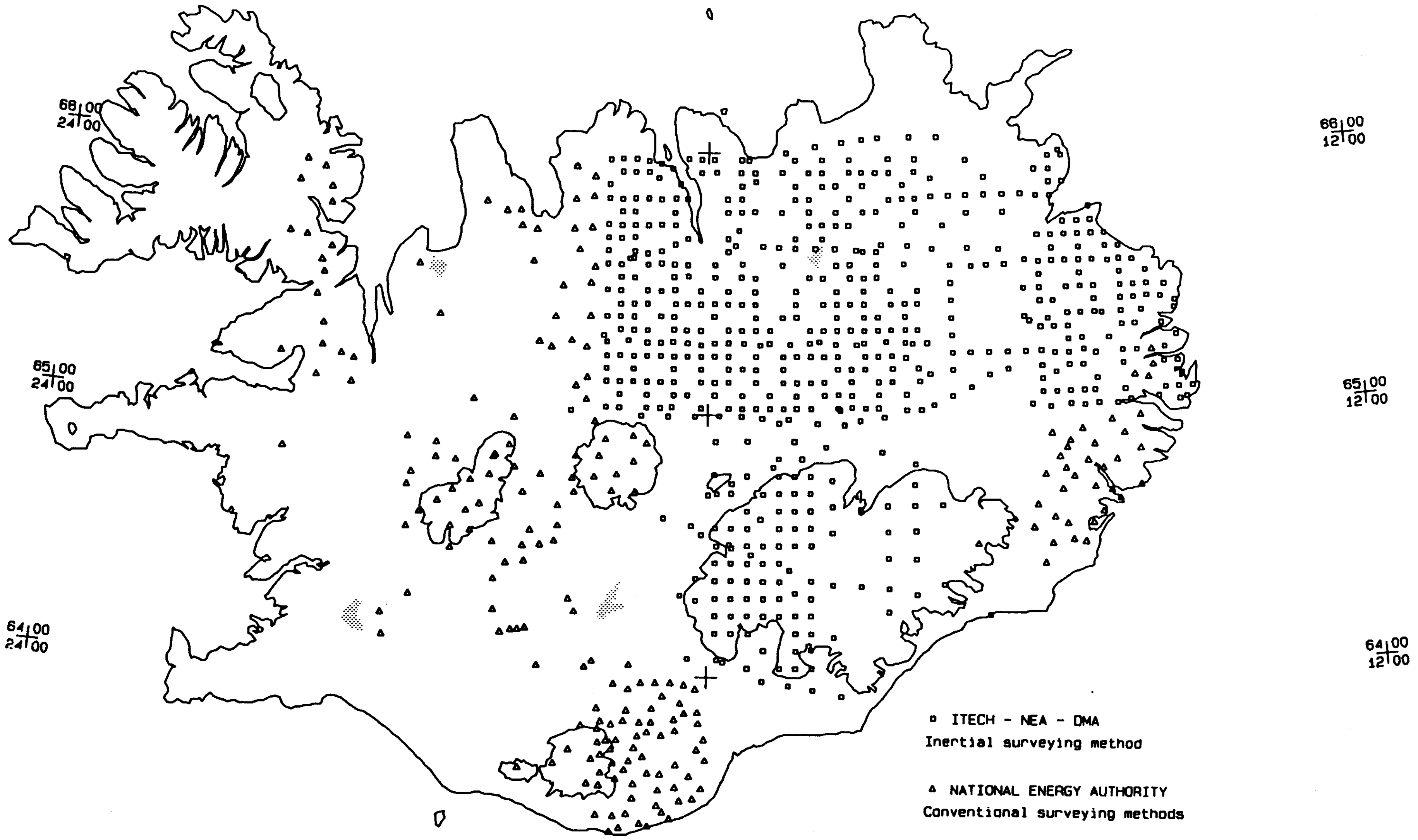

FIGURE 3. Gravity stations in 1985

4. GRAVITY OBSERVATIONS AT SEA 1972-1973

Following the gravity measurements on land in 1968–1971, the Defense Mapping Agency, Washington D. C. and the National Energy Authority (Orkustofnun), on behalf of the Government of Iceland, reached an agreement on gravity surveys on the insular shelf around Iceland.

Measurements of the magnetic field, of the sea depth, and some measurements of the thickness of the sedimental layer on the sea bottom, were made in conjunction with the gravity measurements. Personnel from the Defense Mapping Agency, the National Energy Authority and the Icelandic Hydrographic Survey took part in the survey at sea. The Survey Ships were Ms. Albert in 1972 and Ms. Ísborg, which was chartered the following year.

4.1 Land stations

The Geodetic Section of NEA established two land stations at each survey area and Raydist antennas were erected before the survey started in each of them. The survey areas and the land stations are shown in figure 4.

The boundary of each survey area is an arc of the circle from which the segment between the land stations is seen under an angle of 30°. The land stations were positioned with radial measurements from triangulation points in June and September 1972 and April 1973, and the computations followed. A report was prepared later (Gunnar Thorbergsson 1974). A ground marker with the station number was used at most station sites and the position, where later a 15–30 m high antenna was erected, was clearly but not permanently marked.

4.2 Sea survey in 1972

The survey started on 20 June and ended on 10 August and covered areas 5, 6, 7 and 9 in Faxaflói and Breidafjördur.

Before the measurements started in each area, gravity measurements were made at a Base Station and at the site of the ship in harbor in order to verify or correct the gravity meter on board the ship.

The readings of the Raydist equipment were initialized in a much more complicated and expensive manner: The ship sailed and crossed the line through the two land stations somewhere between the stations and then somewhere outside the segment between the two stations. This had to be kept in mind when the land station sites were planned.

The U. S. surveyors on board the ship took care of the gravity meter, the Raydist equipment and a computer for recording the measurements on tapes.

Personnel of the Icelandic Hydrographic Service were in command of the vessel and recorded the ship's position from the Raydist readings at 10 minutes interval. Each recording contained the following

- area number
- line number in area
- point number in line
- date and time
- the distances to the land stations (read in units of 45.4266 m from the Raydist)
- depth in meters

Due to equipment failures it was not possible to record the depth at all measurement sites. Over 2100 recordings were made.

4.3 Sea survey in 1973

The survey started on 18 May and ended on 22 September. Measurements were made in all areas except the previously surveyed (see figure 4). She measurements were carried out in the same way as the previous summer, and personnel of the Icelandic Hydrographic Service made over 6300 recordings.

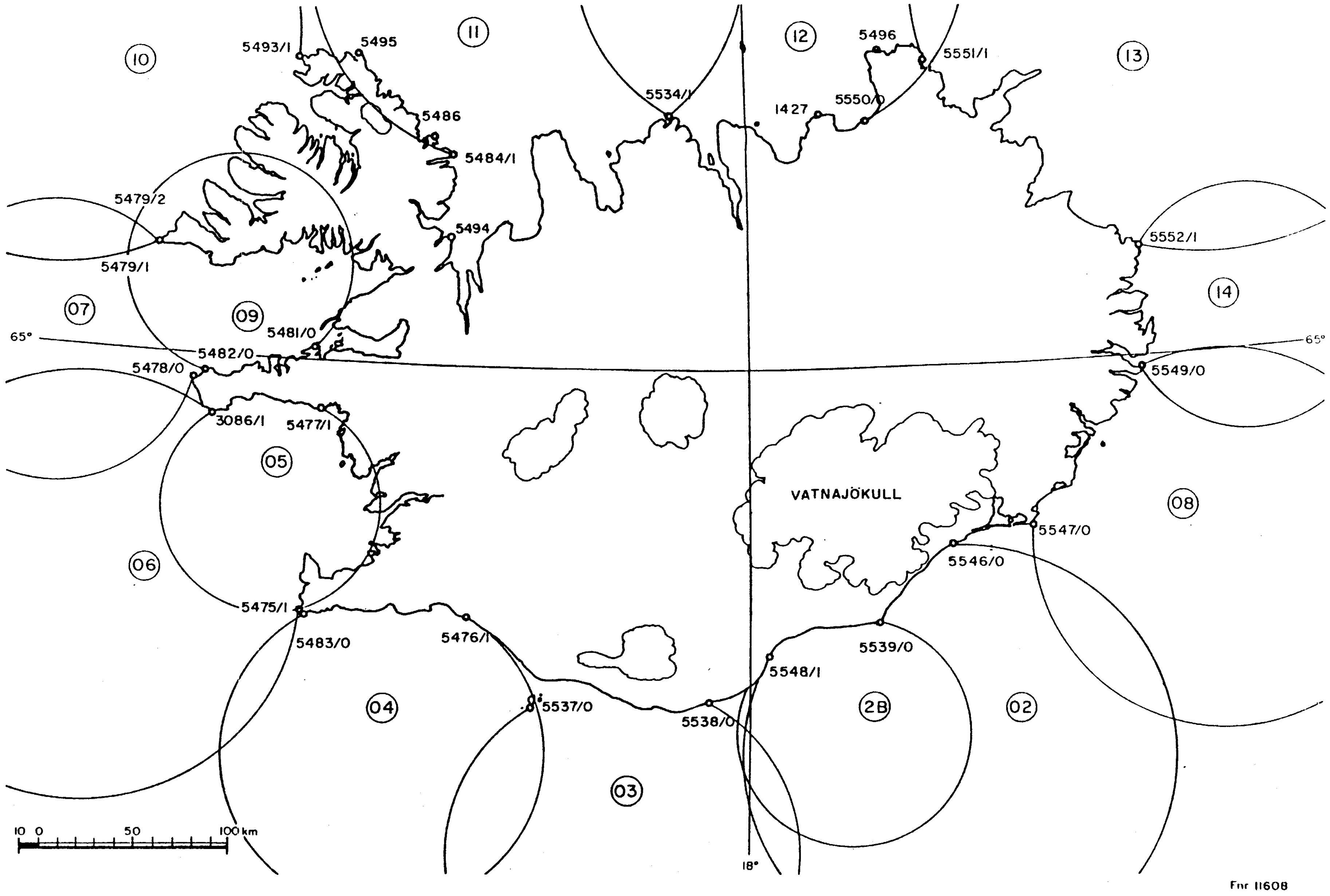

FIGURE 4. Land stations and survey areas at sea 1972-73

5. PROCESSING OF OBSERVATIONS ON LAND

5.1 Recording of gravity readings

In the summer of 1968 NEA surveyors started using a fixed form for recording gravity readings in field books. Part of the recorded matter was later punched on cards as shown in table 6 and read into a file with a name indicating the survey area and with extension .GRR (gravity reading).

TABLE 6 Form for recording gravity readings (.GRR)

Pos.	Description
01	"9" when starting new trip
02-06	field trip number
01	Blank
02-06	Station number
07	" " for ordinary station "*" for base station "/" for wait station "D" for drift station
08-11	Date (DDMM), day and month
12-15	Time (HHMM), hour and minute
17-23	Gravity reading (assumed decimal point after 4 digits)
24-28	Blank or instrument height in m

The gravity measurements are made in field trips. Each trip starts with an observation at a base station, then at a few new stations, and reobservations at some of them follow, with a final observation usually at the same (sometimes another) base station. A "wait" station is used before and after a (few hours) rest or delay between measurements. A "drift" station is established at a convenient site in order to repeat measurements there later during the same field trip without recording the drift station with the gravity stations proper. Approximate coordinates and elevation must be estimated for wait and drift stations (unless a wait station is also an ordinary station).

5.2 Method of processing

The data flow during the processing of the gravity measurements is shown in figure 5. It will be described for an imaginary survey area named "NAME". Some of the operations mentioned here are described more fully in section 5.3.

The results of land surveying are in file NAME.PNT (x and y coordinate, elevation and station number). The coordinates are in one of the following system:

- Lambert coordinates as on old maps in scale 1:20.000
- Gauss-Krüger coordinates as on the new maps in scale 1:25.000
- UTM coordinates (Universal Transverse Mercator Projection) as on maps by DMA and Iceland Geodedic Survey

One of the programs LAMGEO, GAUGEO or UTMGEO are used to transform the file into file NAME.GEO with geographic coordinates of the stations. The program GEOGRC transforms file NAME.GEO into file NAME.GRC (eastern longitude instead of western longitude etc.).

Gravity readings are in file NAME.GRR which form has been described.

File LCRG137.GRA contains table 7 on page 23. The table is used to transform the gravity readings into milligals. It is valid for gravity meter LaCoste and Romberg Model G No. 137 that was used from 1968 to 1971.

The file NAME.GRB contains part or the whole of table 2 on pages 10 − 11.

Program GRAVOS reads files .GRA, .GRB, .GRC and .GRR, changes gravity readings into milligals, corrects the readings for the attraction of the moon and the sun, uses observations and known gravity values at base stations and the reobservations to compute the gravity values at the new stations according to the method of least squares. The drift of the gravity meter as a linear function of time for each field trip is computed also. The gravity values at the new stations are recorded in the file NAME.GRS.

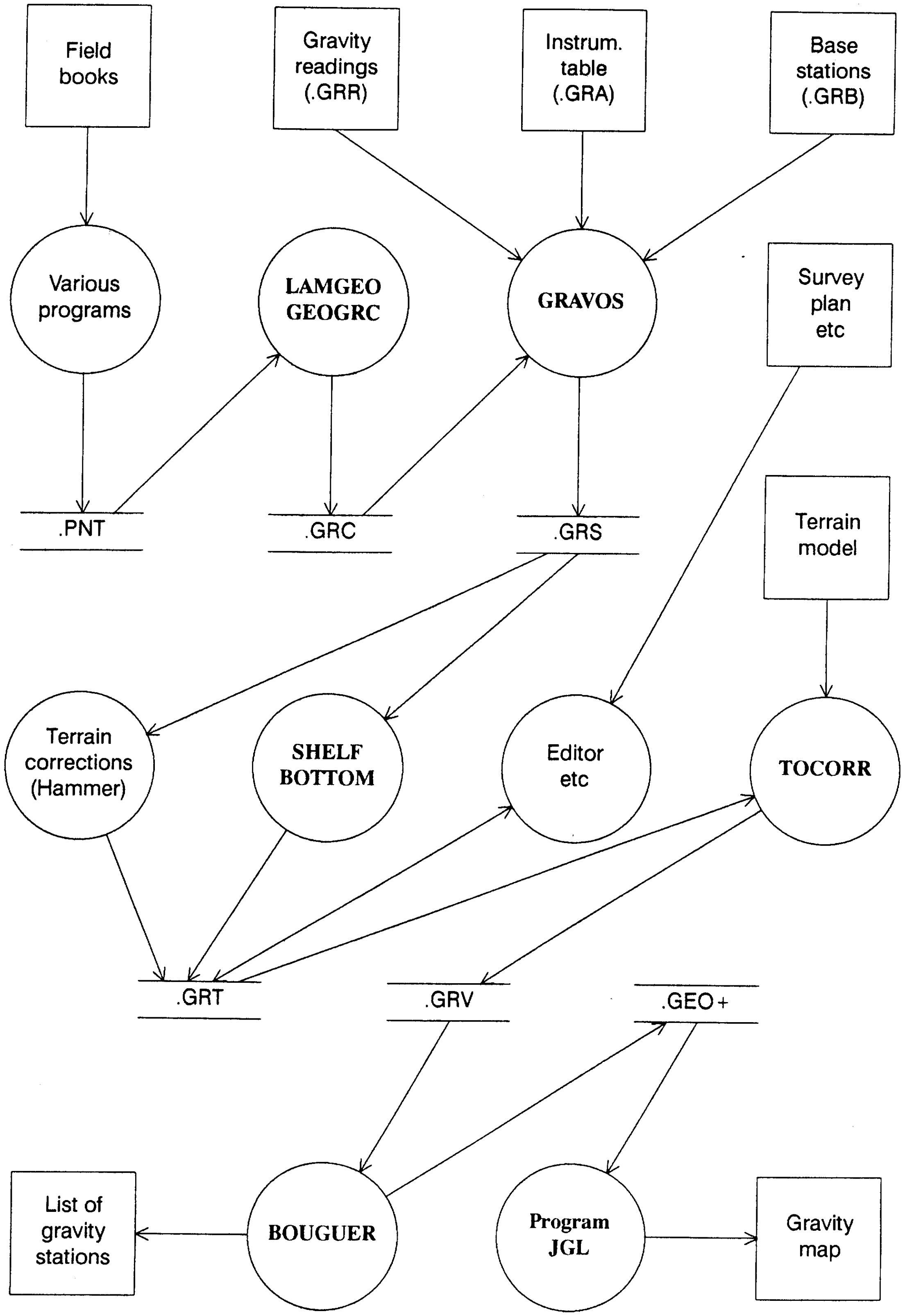

FIGURE 5. Data flow in the processing of gravity observations

TABLE 7 Calibration of Gravimeter LCR G 137 (mgal)

4000	4100	4200	4300	4400
4206.39	4311.63	4416.88	4522.12	4627.36
4500	4600	4700	4800	4900
4732.61	4837.84	4943.08	5048.31	5153.53
5000	5100	5200	5300	5400
5258.75	5363.97	5469.17	5574.37	5679.56
5500	5600	5700	5800	5900
5784.73	5889.89	5995.04	6100.17	6205.28
6000	6100	6200	6300	6400
6310.37	6415.44	6520.49	6625.51	6730.51

Terrain correction within the truncated Bouguer plate radius (see section 5.3) is appended to records in file NAME.GRS together with information on the gravity meter used, name of observer, and rating numbers for the elevation and terrain correction. The resulting file is named NAME.GRT.

Program TOCORR reads a file with the mean elevations in compartments of size 2'x 5' (latitude x longitude) near the survey area and compartments of size 6'x 15' farther from the survey area. It also reads file NAME.GRT and writes the file NAME.GRV with one quantity appended to each record: the topographic correction due to the land mass (and lack of mass at sea) outside the truncated Bouguer plate radius. The file NAME.GRV becomes part of a data base for gravity stations.

Program BOUGUER reads file NAME.GRV and prints the information in that file with "free-air" anomaly and Bouguer anomaly appended. The anomalies are computed according to a standard dating from 1979 (Moritz 1980), except that the attraction of the atmosphere is ignored.

5.3 Gravity corrections

Terrain corrections were made in Hammer zones E−H (Hammer 1939) for gravity stations observed in 1967−71. The correction is due to the deviation of the terrain from a horizontal plane through the station within distance 9903 m from the gravity station (the selected radius of the truncated Bouguer plate, Bouguer radius for short).

Elevations in compartments of size 1'x 2.5' (latitude x longitude) have been read from AMS-C762 maps in scale 1:50.000 and the sea depth from maps of the Icelandic Hydrographic Survey. These data were used to enter into files the mean elevation of land or sea bottom in compartments of size 2'x 5' (3,7 km north−south and about 3,9 km east−west) on and near land, and 6'x 15' farther from land. The area covered by the compartments is between 61° and 69° north and 8° and 30° west.

The computer program TOCORR is used for correcting for the effect of land mass above sea level and lack of mass at sea outside the Bouguer radius (spherical earth). The program was used for correcting gravity values at stations observed in 1967−71 using the Bouguer radius 9903 m. The specific mass used for terrain and topographic corrections is 2,60 g/cm^3. The topographic corrections are made for masses within 167.000 m from a gravity station.

Program BOUGUER computes the "free-air" and Bouguer anomalies for a truncated circular plate between sea level and an horizontal plane through the gravity station and with radius 9903 m. The specific mass of the plate is 2.60 g/cm^3.

Gravity corrections are also explained in the report on gravity observations in the Hengill area (Gunnar Thorbergsson et al. 1984). In that report the attraction of the atmosphere is accounted for. Those effects are < 0.05 mgal in the survey area, but reference IGSN71/V80 is used and this differs by 0.9 mgal from the IGSN71/V85 reference.

5.4 Form of gravity station records

TABLE 8 Format of gravity station records (.GRV)

```
7481            6516.56-1915.84  692.31 982155.57 09068520100918260  81-3.82J52
7482            6506.13-1912.94  706.14 982128.49 09068520100918260   7-4.20J51
7483    OS-9873 6508.11-1906.71  747.52 982126.86 09068520100918260  88-4.66J52
7484    OS-5577 6503.06-1907.07  803.10 982104.05 09068520100918260  39-5.30J41
7485    OS-9871 6515.13-1907.41  568.40 982174.42 09068520100918260  27-2.74J51
7486    OS-5542 6522.28-1905.56  227.73 982253.32 09068520100918260 162 0.66J43
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

Printed under heading (in the appendix)	Pos. in .GRV	Description
STATION NUMBER	01-05	Gravity station (running) number
STATION NAME	09-16	Station name or blank
LATITUDE	17-24	Northern latitude: Degrees, minutes with 2 decimals
LONGITUDE	25-32	Western longitude: Degrees, min. with 2 decim. (- in pos. 25)
HEIGHT	34-40	Elevation above sea level in meters
GRAVITY	42-50	Gravity at station in milligals
DATE/D M Y	52-57	Date: Day, month, year
REFERENCE/B	58-59	Base station number (see table 2)
REFERENCE/O	60-61	Observer (see table 3)
REFERENCE/I	62-63	Gravimeter (see table 4)
REFERENCE/P	64-65	Reference (see table 5)
BGER/DENS	66-68	Density of land mass: (Implied point after first digit)
CORR./TERR	69-72	Terrain correction within truncated Bouguer plate, mgals (Implied point after second digit)
CORR./TOPO	73-77	Topographic corr. outside truncated Bouguer plate, mgals
NOTES/Z	78	Name of outermost Hammer zone within Bouguer radius
NOTES/H	79	Rating number for station elevation (see table 9)
NOTES/T	80	Rating number for terrain correction (see table 9)

TABLE 9 Rating numbers for elevation (m) and terrain correction (mgal)

Rating number	Error estimate (m or mgal)
1	< 0,05
2	< 0,1
3	< 0,2
4	< 0,4
5	< 0,7
6	< 1,0
7	< 2,0
8	< 5,0
9	< 10,0
0	not estimated

In 1967 information on gravity observations were collected at the Geothermal Section of NEA, a form for their recording designed, and the data punched on cards (Sven Th. Sigurdsson 1967). Minor alterations have been made on this form. It is used for files with name extension .GRV, which is explained in table 8. Program Bouguer is used to read such files and to print the information contained therein with the gravity anomalies appended, as shown in the appendix.

6. PROCESSING OF GRAVITY OBSERVATIONS AT SEA

As previously stated the DMA surveyors on board the survey ship recorded their observations on tape, but the personnel of the Icelandic Hydrographic Service (Sjómælingar Íslands) recorded on paper the information they had access to in the bridge.

The Geodetic Section of the National Energy Authority received data from both parties and worked on unifying the data when time permitted.

6.1 Unification of SÍ data and US data

The data from the Icelandic Hydrographic Service (SÍ data) was punched on cards. We wrote a program (GTRDST) which read those cards, computed latitude and longitude from the distances from the land stations (and the land station coordinates).

The program punched "SÍ cards" with the latitude and longitude of the ship position and all the information recorded by the IHS personnel at that position, but the gravity value was lacking.

A program (GTPLAY) read the SÍ cards from one survey area and printed a "SÍ picture" of a part of the survey area showing the ship positions with line and point number affixed (we did not have a plotter at that time).

Each SÍ picture covered 1°x 1° and the resolution was 1'x 1'. These pictures gave a clear overview of the ship sailing in the survey area.

Data cards arrived from the U. S. A. with data from the DMA, "US cards", containing the ship position and the gravity value. At most positions the depth was also recorded.

The program GTPLAY was used to print "US pictures" showing the ship positions in the survey area. By comparing the SÍ and the US pictures, we could put the US cards in time order.

Finally the SÍ cards and the US cards were used together by program GTUNIT to produce "sea survey cards" with all the information recorded at 10 minute intervals by IHS personnel and with the gravity value appended. The gravity value at a SÍ recording position was found by interpolating between the two adjacent US recording positions in a line. Only a few SÍ recording positions were unused in this processing.

All this processing would have been simpler had the US cards contained the date and time !

6.2 Method of processing gravity at sea

The unification of data from the Icelandic Hydrographic Service and data from the Defense Mapping Agency, Washington D. C. culminated in the sea-survey cards. They were certainly preserved (see table 12).

Data from about each third card was selected to enter a data base of enumerated gravity stations. It was believed that this selection would avoid difficulties in plotting a gravity map from the data from surveys on land and sea. The density of recording sites on sea was now comparable with station density on land. These recording sites on sea were numbered 5001 – 7458.

The following processing was the same as for stations on land, except that the radius of the truncated Bouguer plate at sea was selected 6653 m.

The Bouguer correction is then for a circular plate between sea level and a horizontal plane through a point on the sea bottom below the recording site. The radius of this plate is 6653 m and the specific mass is 1.75 g/cm^3. The attraction of the plate is added to the gravity value but not subtracted as on land.

The program BOUGUER (see section 5.2) recognizes a point at sea by the criterion that the height is recorded as less than -5 m which is true for points on the bottom of the sea. (It may happen that gravity stations on the sea coast, observed on land, have a negative elevation).

6.3 Terrain correction at sea

TABLE 10 Terrain correction within the Bouguer plate at sea (1/100 mgal)

Point	corr.	Point	corr.	Point	corr.	Point	corr.	Point	corr.
5913	50	5969	50	6065	-50	6160	200	6233	50
5914	50	5970	100	6085	50	6173	150	6234	50
5920	50	5972	-150	6087	-200	6174	-100	6235	-50
5921	50	5984	-200	6093	-50	6175	100	6239	-50
5922	50	5985	100	6094	-200	6176	-200	6241	50
5923	50	5990	50	6095	-100	6177	150	6251	50
5924	100	5991	50	6098	50	6189	100	6252	50
5925	100	6005	-200	6100	-250	6190	-300	6253	100
5926	100	6006	50	6101	150	6191	-600	6260	100
5931	50	6007	50	6102	50	6192	-600	6261	50
5953	50	6012	50	6103	50	6193	-200	6262	100
5954	50	6013	-50	6104	50	6194	-300	7388	50
5956	-50	6029	-100	6118	150	6195	150	7389	100
5957	-200	6030	50	6119	50	6207	100	7390	50
5958	-100	6031	100	6120	50	6208	-100	7391	150
5965	-100	6036	50	6135	150	6216	50	7392	200
5966	-100	6037	50	6136	50	6218	-100	7400	50
5967	100	6038	-150	6152	100	6220	-50		
5968	50	6051	-100	6159	-100	6221	50		

Terrain corrections within the truncated Bouguer plate were made at a few recording sites at the shelf boundary southeast of the country. Two methods were used.

Where the shelf boundary was regular, the correction was according to a model in which the profile of the shelf is approximated with a step function. The model parameters are: the Bouguer radius, sea depth outside the self, thickness of the shelf, horizontal distance between the two edges, the number of steps, and the difference in specific mass between land and sea. A few models were computed with a computer program (SHELF) and the one selected for a recording site, which best approximated the sea bottom below that site.

Where the sea shelf is irregular we made the terrain correction in a manner similar to that used on land. Transparent plots with Hammer zones were laid upon IHS maps in scale 1:750.000 with 100 m contour intervals.

We used Hammer zones I and J but the circle containing zones A-H was divided in four sectors. The mean depth in each sector or zone was read and recorded and the terrain correction computed with a program (BOTTOM). This method was used at 8 recording sites at sea (6100, 6101 and 6190−6195).

The corrections due to the sea bottom terrain are given in table 10.

7. DATA SETS

TABLE 11	Data from the U. S. A.		Reference:	Potsdam/V73
Diskette	File	Description		
GRAVI01	NAVIDATA1	Box 1963/1	Not used	
	NAVIDATA2	Box 1963/2	Not used	Out of order
GRAVI02	NAVIDATA3	Box 1963/3	Not used	
	NAVIDATA4	Box 1963/5	Not used	
GRAVI03	NAVIDATA5	Box 1964/1	Not used	
	NAVIDATA6	Box 1964/2	Not used	
GRAVI04	NAVIDATA7	Box 1965/3	Not used	
	NAVIDATA8	Box 1965/4	Not used	
GRAVI05	NAVIDATA9	Box 1966/1	Not used	
	NAVIDATAA	Box 1966/2	Not used	Out of order
GRAVI06	NAVIDATAB	Box 1966/3	Not used	Out of order
GRAVI07	AREA02K1	US-cards	Area 2	Box 1
	AREA02K2	US-cards	Area 2	Box 2
GRAVI08	AREA03K1	US-cards	Area 3	Box 1
	AREA03K2	US-cards	Area 3	Box 2
GRAVI09	AREA04K1	US-cards	Area 4	Box 1
	AREA04K2	US-cards	Area 4	Box 2
GRAVI10	AREA05	US-cards	Area 5	
GRAVI11	AREA06K1	US-cards	Area 6	Box 1
	AREA06K2	US-cards	Area 6	Box 2
GRAVI12	AREA07K1	US-cards	Area 7	Box 1
	AREA07K2	US-cards	Area 7	Box 2
	AREA09	US-cards	Area 9	
GRAVI13	AREA10K1	US-cards	Area 10	Box 1
	AREA10K2	US-cards	Area 10	Box 2
GRAVI14	AREA11K1	US-cards	Area 11	Box 1
	AREA11K2	US-cards	Area 11	
GRAVI15	AREA12K1	US-cards	Area 12	Box 1
	AREA12K2	US-cards	Area 12	Box 2
GRAVI16	AREA13K1	US-cards	Area 13	Box 1
	AREA13K2	US-cards	Area 13	Box 2
	AREA14	US-cards	Area 14	
GRAVI17	AREA08	US-cards	Area 08	

Early in 1981 various gravity data were transferred onto diskettes which could be read by the VAX11/750 computer at the National Energy Authority.

Table 11 is a directory of data files received from the U. S. A. in 1974. Data on the first six diskettes have not been used.

TABLE 12 Various data related to gravity observations Reference IGSN71/V80

Diskette	File	Description
GRAVI18	REITIR	Compartments (2' x 5' og 6' x 15')
GRAVI19	MREITIR	Smallest compartments (1' x 2,5')
GRAVI20	SMS03	Sea survey cards: Area 03
	SMS04	Sea survey cards: Area 04
	SMS05	Sea survey cards: Area 05
	SMS06	Sea survey cards: Area 06
	SMS07	Sea survey cards: Area 07
	SMS09	Sea survey cards: Area 09
GRAVI21	SMS10	Sea survey cards: Area 10
	SMS11	Sea survey cards: Area 11
	SMS12	Sea survey cards: Area 12
	SMS13	Sea survey cards: Area 13
	SMS14	Sea survey cards: Area 14
	SMS08	Sea survey cards: Area 08
	SMS02	Sea survey cards: Area 02
GRAVI22	Various	Sea survey cards with every third point
GRAVI23	GRAVISEA	Output from program TOCORR (Wrong numbers)
GRAVI24	Various	Gravity observations 1967–1969 (Gravity-cards 1)
GRAVI25	Various	Gravity observations 1969–1971 (Gravity-cards 1)
GRAVI26	GRAVI66	Gravity observations 1950–1967 (Gravity-cards 2)
	GRAVI6771	Gravity observations 1967–1971 (Gravity-cards 2)
	INPTOCORR	Gravity observations 1967–1971 (Inntak TOCORR)
GRAVI27	OUTTOCORR	Output TOCORR 1967–1971 9903 m to 167000 m
	SEATOCORR	Output TOCORR 1972–1973 6653 m to 167000 m
	SEATOCORR2	(continued) Wrong numbers of points at sea
	HANNOVER	Gravity results from Germany Not used
	BASTAFLA	Table of gravity base stations
GRAVI28	RVIKINPTC	Input TOCORR: Reykjavík Bouger radius 2615 m
GRAVRES	BASTAFLA	Gravity base stations
	GRAVLAND	Results: 1967–1971 9903 m to 167000 m
	GRAVSEA	Results: 1972–1973 6653 m to 167000 m
	HENGILL	Results: 1982–1983 2615 m to 50000 m

Table 12 is a directory of data files including some gravity station files in form .GRV, except that the name of the outermost Hammer zone, for which terrain corrections were made, is not in the records in these files.

An older version of program BOUGUER asks for both the inner and outer boundary of the area in which topographic corrections were made. Each of these gravity station files were processed separately in the VAX11/750 computer.

TABLE 13	Base station network and densification 1985	
Filename	Description	Diskette
IBN1.GRR	Gravity readings in the base network 1968	V85DAT
IBN2.GRR	-	-
IBN3.GRR	-	-
IBN4.GRR	-	-
IBN5.GRR	Gravity readings in the base network 1970	-
IBN.NAM	Skort and full numbers and names in the base network	-
IBN.DAT	Observations in the base network 1968 and 1970	-
HORN.DAT	Tying stations 5219 and 7307 at Hornafjördur airport	-
ICELAND.DAT	Observations in the base network in July 1985	-
ICETIER.DAT	Tying Iceland to IGSN71 in May 1985	-
GRADJ.DAT	Observations in Part A in 1985	-
DATASHEET.LIS	Results for Part A (DMA 1986)	-
GMETERS.DAT	Instrument tables and constants: G-137, G-269, G-445	-

TABLE 14		List of data sets of gravity stations			IGSN71/V85
Station numbers	Inter-val (km)	Bouguer-radius (km)	Outer radius (km)	Survey area and year	Filename on diskette V85RES
2705–2864	2–8	9.903	167	Blanda 1967	GRAVLAND.V85
3001–3615	10	-	-	South and SW Iceland 1968	-
3616–3995	-	-	-	North Iceland 1969	-
3996–4190	-	-	-	Northwest Iceland 1970-1971	-
4201–4435	-	-	-	East Iceland 1970	-
4436–4471	-	-	-	Vatnajökull 1971	-
4501–4689	1.5	2.615	50	Reykjavík 1975	RVIK.V85
4700–4999	1.5	2.615	50	Hengill 1982-1983	HENGILL.V85
5001–7458	10	6.653	167	Observations at sea 1972-1973	GRAVSEA.V85
7460–7474	1.5	2.615	50	Hengill 1982-1983	HENGILL.V85
7481–7693	8	6.653	167	Part C 1985	PARTC.V85
7701–8280	8	6.653	167	Part A 1985	PARTA.V85

Table 13 is a list of files containing observation data in the Gravity Base Station Network 1968, 1970 and 1985 as well as observation data from Part A of the Densification Survey in 1985 together with one file containing information on gravity meters.

Table 14 is an overview of gravity stations established 1967–1985. The names of gravity station files (form .GRV) using reference IGSN71/V85 are given in the table.

Program BOUGUER can be used in the HP 9000/840 computer at the National Energy Authority for computing the gravity anomalies for stations in these files. The program asks for the outer boundary for topographic corrections, but the inner boundary, i. e. the name of the outermost Hammer zone, is given in the records in these files. Part of Fortran program BOUGUER is shown in figure 6 on page 30. All the data listed in tables 11–14 have been transferred to the HP 9000/840 computer and recorded on tapes.

```
SUBROUTINE BOUGAN( MINR,AT,H,G,RHOB,TERR,TOPO,ANOMA,ANOMB )
!-------------------------------------------------------------
! Routine for computing gravity anomalies.
! February 1989. Gunnar Thorbergsson
!-------------------------------------------------------------
IMPLICIT NONE
INTEGER          MINR
REAL             AT,H,RHOB,TERR,TOPO,ANOMA,ANOMB,PI2G
DOUBLE PRECISION  G
REAL             X,FACTOR
PARAMETER       ( PI2G = 3.1415926*2.0*0.006672 )
!
!  GEODETIC REFERENCE SYSTEM 1980 (CANBERRA):
!  Moritz, H.  1980: Geodetic reference system 1980.
!  Bulletin Géodésique, 54 no3, 395-405.
DOUBLE PRECISION  AXISA, FLAT, E12, GEQ, CK
PARAMETER( AXISA = 6378137.D0 , FLAT = 1.D0/298.257222101D0 )
PARAMETER( E12 = FLAT*(2.D0 - FLAT) )
PARAMETER( GEQ = 978032.67715D0 , CK  = 1.931851353D-3 )

X=SIN(AT/57.29578)**2    ! AT is station latitude in degrees

!  Compute the free-air anomaly, ANOMA.
!  Note:  Stations are on land if H > -5 meters,
!  then H is the elevation of the station, else
!  the station is at zero elevation and the sea
!  bottom has elevation H (negative).

IF( H.GT.-5 )THEN
  ANOMA=G-GEQ*(1+CK*X)/SQRT(1-E12*X)  +  0.30855*H
ELSE
  ANOMA=G-GEQ*(1+CK*X)/SQRT(1-E12*X)
END IF

!  Compute the Bouguer anomaly, ANOMB, for a truncated
!  circular plate of radius MINR and thickness ABS(H).
!  The terrain correction is TERR and the topographic
!  correction (outside the circular plate) is TOPO.

FACTOR  =  -PI2G*H*(1 - ABS(H)/(MINR+SQRT(MINR**2+H**2)))
IF( RHOB.EQ.0. )THEN
  STOP ' Rock density RHOB is undefined'
ELSE IF( H.GT.-5 )THEN
  ANOMB  =  ANOMA  +  TERR  +  TOPO  +  FACTOR*RHOB
ELSE
  ANOMB  =  ANOMA  +  TERR  +  TOPO  +  FACTOR*(RHOB-1.03)
END IF
RETURN
END
```

FIGURE 6. Part of program BOUGUER for the HP-computer

8. GRAVITY MAP

The first gravity map of Iceland was published with the previously mentioned report by Dr. Trausti Einarsson. Gravity maps in the scales 1:250.000 and 1:2.000.000 were compiled at Orkustofnun on the basis of the gravity data obtained in the surveys for the Defense Mapping Agency. Neither of these maps have been published.

A gravity map in scale 1:1.000.000 comes with this report. It is compiled from data obtained on land and at sea in the surveys during 1967–1985. Both the gravity stations on land and locations at sea are shown on the map. On land the mean distance between stations is 8–10 km, except in the Blanda area surveyed in 1967, where the station density is greater. Gravity stations on ice caps, except on Hofsjökull, are not included on the map, because the thickness of the ice is generally unknown and the Bouguer correction cannot be computed. On sea the observations were made in lines with sailing time between observations 30 minutes. Some very short lines contain only one observation site.

Gravity corrections, as described in chapters 5 and 6, have been made for all these survey points. The density of land mass (including masses under the sea) is assumed to be 2.60 g/cm^3, and topographic corrections were made for masses within 167 km from a station.

Lines of equal Bouguer anomaly (5 mgal) were plotted by a computer program (JGL, author GTH) which exists only as a prototype in the VAX computer. Maps plotted with the program have the following properties:

- The mapped value at an observation point is the observed value (with an insignificant change).
- Maximum and minimum values on the map occur only at observation points.
- Theoretically the lines are continuous and have continuous tangents (but actually they are plotted as broken lines).

Maps with these properties are suitable for showing observed data since the results are not exaggerated and without smoothing.

A prominent feature of the map is the decrease in anomaly from the map boundaries at sea towards the center of the land. At the 300 m depth curve the Bouguer anomaly is mostly between +60 and +80 mgal, but -40 mgal at the northwest corner of the ice cap Vatnajökull.

There is much variation in the gravity field off middle north Iceland. Firstly there is a high in the gravity field running north–south over Kolbeinseyjarhryggur, and secondly a deep low with an east–westerly direction at the mouth of the fjord Eyjafjördur with its east end at the island Flatey.

The next observation point northwest of the point in Flatey is at a distance of nearly 25 km. Here we have the one and only example of human interference with the plotting of the program. An extra interpolated point was introduced (and mistakenly shown on the map) midway between the two observation points, else the map would have shown two lows in this area.

Strikingly many lines converge at the northern half of the ice cap Mýrdalsjökull. A few observation points are located on the ice cap and it will be interesting, at a later date, to use a map of the ground surface under the ice cap when computing gravity anomalies in the area of the ice cap.

An existing map of the ground surface under the ice cap Hofsjökull (Helgi Björnsson 1988) has been used to compute gravity anomalies in that area.

A blank spot, 40 km in diameter, can be seen southeast of Lónsvík (on the southeast coast of Iceland) in survey area 08 (see figure 4). This is where the surveys at sea were concluded late in September 1973. The final report by the Defense Mapping Agency comments on the survey in this area: "Some problems were experienced with the Raydist equipment and also with masking of the Raydist signal due to the land station positions. Much of the southern, nearshore area had to be eliminated due to this masking problem".

REFERENCES

Bomblies, K. H 1985: *Project Report. Inertial Positioning of Gravity Stations on a Project of the Defence Mapping Agency of the USA and the National Energy Authority of Iceland.* For NEA. Inertial Technology Limited. Report at NEA, 24+14 p.

Defence Mapping Agency, Topographic Center 1974: *Final report. Iceland Marine Gravity Survey 1972–1973.* Report at NEA. 154 p.

Defence Mapping Agency, Hydrographic/Topographic Center, Geodetic Survey Squadron 1986: *Iceland Gravity Densification Survey.* Report at NEA, 30+26 p.

Gudmundur Pálmason 1964: Gravity Measurements in the Grímsvötn Area. *Jökull, 14:* 61–66.

Gudmundur Pálmason, Tor H. Nilsen and Gunnar Thorbergsson 1973: Gravity base station network in Iceland 1968-1970. *Jökull, 23:* 70–125.

Gunnar Thorbergsson 1969: *Gravity Survey of Southwestern Iceland 1968.* NEA, 42+125+56 p.

Gunnar Thorbergsson 1970: *Gravity Survey of Northern Iceland 1969.* NEA, 25+89 p.

Gunnar Thorbergsson 1970: *Gravity Survey of Eastern Iceland 1970.* NEA, 18+55 p.

Gunnar Thorbergsson 1971: *Gravity Survey of Northwestern Iceland 1970–71.* NEA, 16+43 p.

Gunnar Thorbergsson 1971: *Gravity Survey of Vatnajökull in Southeastern Iceland 1971.* NEA, 13+21 p.

Gunnar Thorbergsson 1974: *Iceland Marine Gravity Survey (1972–73). Geodetic surveys for positioning of RAYDIST land stations.* NEA, 63 p.

Gunnar Thorbergsson, Ingvar Thór Magnússon, Ásgeir Gunnarsson, Gunnar V. Johnsen, Axel Björnsson 1984: *Surveying and Gravity Observations in Hengill area 1982-83.* (In Icelandic). NEA, OS-84003/VOD-03 B, 58 p.

Gunnar Thorbergsson, Ingvar Thór Magnússon, Gudmundur Pálmason 1990: *Gravity data and a gravity map of Iceland.* (In Icelandic). NEA, OS-90001/JHD-01. 50 p.

Hammer, S. 1939: Terrain corrections for gravimeter stations. *Geophysics, 4:* 184–194.

Helgi Björnsson 1988: *Hydrology of ice caps in volcanic regions.* Vísindafélag Íslendinga, rit XLV, 139 p. + 21 maps.

Morelli, C., Gantar, C., Honkasalo, T., McConnell, R. K., Tanner, J. G., Szabo, B., Uotila, U., Whalen, C. T., 1974: *The International Gravity Standardization Net 1971 (IGSN71), Special Publication No. 4.* International Association of Geodesy, Paris.

Moritz, H. 1980: Geodetic reference system 1980. *Bulletin Géodésique, 54 no3:* 395–405.

Ólafur G. Flóvenz 1979: *Jarðsveiflumælingar á höfuðborgarsvæðinu 1976. Dýpi á lag 3.* (Seismic observations in the Reykjavík area. Depth to layer 3). NEA, OS-790039/JHD-17, 68 p.

Sven Th. Sigurdsson 1967: Manuscript at NEA's Geothermal Division.

Torge, W. 1980: *Geodesy.* Walter de Gruyter, Berlin. 254 p.

Trausti Einarsson 1954: *A Gravity Survey of Iceland.* Societas Scientiarum Islandica, no. XXX, 22 p.

Uotila, U. A. 1980: Note to the users of International Gravity Standardization Net 1971. *Bulletin Géodésique, 54 no3:* 407–408.

ÁGRIP (Summary in Icelandic)

Samvinna Orkustofnunar og Kortadeildar Bandaríkjahers (Defence Mapping Agency, DMA) um þyngdarmælingar stóð samfellt árin 1968 til 1973, og hófst með mælingu grunnstöðvanets með um 40 stöðvum víða um land, auk nokkurra stöðva í Reykjavík.

Þyngdir í netinu voru miðaðar við þyngdargildi í Potsdam, en skömmu eftir að netið var mælt var víða erlendis tekin í notkun ný viðmiðun (IGSN71). Á Orkustofnun hafa alls þrjár viðmiðanir þyngda verið notaðar, og eru þær nefndar Potsdam/V73, IGSN71/V80 og IGSN71/V85 í þessari skýrslu.

Á árunum 1967 – 1971 mældi Orkustofnun legu, hæð og þyngd í 1610 þyngdarmælistöðvum, víðast með um 10 km millibili, dreifðum yfir landið allt. Hér eru taldar með 150 stöðvar á Blöndusvæði 1967 (áður en mælingar á landinu öllu voru ákveðnar) og 35 stöðvar á Vatnajökli 1971.

Sumurin 1972 og 1973 höfðu DMA, Orkustofnun, Sjómælingar Íslands og fleiri aðilar samvinnu um þyngdarmælingar á sjó umhverfis allt landið. Sjómælingar Íslands skráðu mælingar á yfir 8400 stöðum.

Vorið 1985 lét DMA þyngdarmæla í nokkrum grunnstöðvum hér á landi til að styrkja grunnstöðvanetið. Einnig var farin sérstök mæliferð frá Bandaríkjunum um Ísland til Noregs og til baka, til að tengja íslenska grunnstöðvanetið við alþjóðlega þyngdarnetið IGSN71. Að mælingunum loknum var grunnstöðvanetið endurreiknað.

Sumarið 1985 voru þyngdarmælipunktar á austanverðu landinu þéttir á kostnað DMA. Mæliflokkur frá Orkustofnun notaði hefðbundnar aðferðir við hluta verksins, en annar mæliflokkur með starfsmönnum ITECH (International Technology Limited), Orkustofnunar og DMA notuðu tregðuleiðsögutæki í stað hefðbundina landmælitækja. Báðir flokkarnir ferðuðust á þyrlum.

Úrvinnsla þyngdarmælinga á landi fór að miklu leyti fram í tölvum, en leiðrétting þyngdar vegna landslags næst stöð var unnin á venjulegan hátt. Landslagsleiðréttingar eru tímafrekar. Úrvinnsla þyngdarmælinga á sjó fór að mestu leyti fram í tölvum.

Þyngdarmæligögnin eru geymd í VAX 11/750-tölvu og á disklingum, sem hún les og skrifar, og nýlega hafa gögnin verið flutt yfir í HP 9000/840-tölvu og á segulbönd. Forrit til að reikna þyngdarfrávik stöðva og prenta stöðvalista er til staðar í báðum tölvunum.

Þyngdarkort í mælikvarða 1:1.000.000 fylgir þessari skýrslu, og eru mælistöðvar, notaðar við gerð kortsins, sýndar á því.

Í viðauka er listi yfir þær þyngdarmælistöðvar, sem mældar voru 1985, og þar sem þyngd hefur verið leiðrétt fyrir áhrifum landslags.

APPENDIX: Gravity stations observed in 1985 (extract)

The appendix in the Icelandic report contains a list on 14 pages of those gravity stations observed in 1985 for which terrain corrections have been made. Only the first two pages are given here. In both versions of the report, the Icelandic and the English, this listing is in English.

STATION NUMBER	STATION NAME	LATITUDE DEG MIN	LONGITUDE DEG MIN	HEIGHT METERS	GRAVITY MGALS	DATE D M Y	REFERENCE B O	I P	BGER DENS	CORRECTION TERR	TOPO	NOTES Z H T	ANOMALIES FAIR	BGER
7481		65°16.56'	19°15.84'	692.31	982155.57	090685	2010	0918	2.60	.81	-3.82	J 5 2	61.0	-13.5
7482		65°06.13'	19°12.94'	706.14	982128.49	090685	2010	0918	2.60	.07	-4.20	J 5 1	50.3	-26.8
7483	OS-9873	65°08.11'	19°06.71'	747.52	982126.86	090685	2010	0918	2.60	.88	-4.66	J 5 2	59.1	-21.6
7484	OS-5577	65°03.06'	19°07.07'	803.10	982104.05	090685	2010	0918	2.60	.39	-5.30	J 4 1	59.3	-27.9
7485	OS-9871	65°15.13'	19°07.41'	568.40	982174.42	090685	2010	0918	2.60	.27	-2.74	J 5 1	43.3	-18.5
7486	OS-5542	65°22.28'	19°05.56'	227.73	982253.32	090685	2010	0918	2.60	1.62	.66	J 4 3	8.9	-13.2
7487		65°14.92'	19°26.86'	610.45	982174.29	100685	2010	0918	2.60	.27	-3.15	J 5 1	56.4	-10.0
7488		65°16.11'	19°33.56'	542.55	982193.86	100685	2010	0918	2.60	.08	-2.54	J 5 1	53.6	-5.5
7489		65°02.27'	20°08.29'	712.98	982134.93	100685	2010	0918	2.60	.01	-4.07	J 5 1	63.3	-14.3
7490		65°33.57'	19°03.55'	1088.81	982092.63	110685	2010	0918	2.60	4.02	-7.36	J 5 4	101.0	-11.4
7491		65°29.87'	19°05.62'	1187.11	982065.41	110685	2010	0918	2.60	3.46	-7.67	J 5 4	108.3	-13.8
7492		65°37.44'	19°12.42'	1129.03	982101.81	110685	2010	0918	2.60	4.39	-6.23	J 5 4	118.2	3.6
7493	OS-5544	65°29.09'	19°20.98'	202.68	982272.10	110685	2010	0918	2.60	1.86	.54	J 4 3	12.1	-7.2
7494		65°21.95'	19°24.91'	753.66	982155.50	110685	2010	0918	2.60	3.56	-3.92	J 5 4	73.7	-4.1
7495		65°34.46'	19°37.77'	803.32	982169.65	110685	2010	0918	2.60	4.86	-3.25	J 6 4	88.9	8.2
7496		65°41.71'	19°36.50'	37.64	982347.80	110685	2010	0918	2.60	1.48	.75	J 5 3	22.6	20.7
7497		65°46.01'	19°45.75'	607.80	982231.56	110685	2010	0918	2.60	8.46	-1.70	J 5 5	77.4	20.9
7498		65°47.76'	20°04.86'	512.57	982263.41	110685	2010	0918	2.60	2.99	-1.32	J 6 4	77.8	25.8
7499		65°45.73'	19°53.49'	544.48	982252.98	110685	2010	0918	2.60	2.25	-1.68	J 5 3	79.6	23.2
7500		65°42.43'	19°44.85'	373.86	982287.74	110685	2010	0918	2.60	1.79	-.83	J 5 3	65.4	26.8
7501		65°48.89'	19°15.17'	947.41	982154.30	130685	2010	0918	2.60	14.11	-3.69	J 5 7	101.6	16.1
7502	LI-0149	65°56.38'	19°15.08'	775.61	982212.07	130685	2010	0918	2.60	3.07	-2.36	J 5 4	97.9	19.0
7503		65°54.18'	19°04.43'	984.22	982168.91	130685	2010	0918	2.60	5.41	-4.83	J 5 5	121.6	22.8
7504		65°49.66'	19°04.89'	972.97	982161.87	130685	2010	0918	2.60	6.11	-5.03	J 5 5	116.2	19.0
7505		65°42.15'	19°15.60'	958.59	982149.75	130685	2010	0918	2.60	5.40	-4.09	J 5 5	108.2	12.5
7506		65°42.58'	19°05.62'	181.70	982302.08	130685	2010	0918	2.60	5.36	1.71	J 5 5	20.3	7.8
7507		65°21.48'	20°28.50'	912.22	982142.00	130685	2010	0918	2.60	4.06	-3.47	J 5 4	109.7	17.6
7508		65°32.85'	20°41.34'	427.56	982267.55	130685	2010	0918	2.60	4.11	-.79	J 5 4	72.7	30.9
7509		65°50.26'	21°51.27'	475.97	982275.88	130685	5110	0918	2.60	1.05	-1.38	J 5 2	76.2	25.8
7510	OS-5657	65°55.12'	21°47.71'	545.06	982267.80	130685	5110	0918	2.60	.92	-1.65	J 4 2	83.9	26.2
7511		65°53.58'	21°37.48'	498.70	982272.72	130685	5110	0918	2.60	.85	-1.26	J 5 2	76.3	23.6
7512		65°49.08'	21°33.13'	401.72	982290.77	130685	5110	0918	2.60	.83	-.79	J 5 2	69.5	27.1
7513		65°45.44'	21°32.79'	245.80	982316.55	130685	5110	0918	2.60	.70	-.27	J 5 2	51.3	25.4
7514		63°47.54'	18°16.02'	400.89	982147.90	190685	1310	0918	2.60	1.57	-.60	J 5 3	68.0	26.6
7515		63°50.11'	18°16.70'	374.67	982153.69	190685	1310	0918	2.60	.44	-.64	J 5 1	62.6	22.7
7516		63°49.46'	18°28.76'	322.08	982161.36	190685	1310	0918	2.60	.21	-.38	J 5 1	54.8	20.4
7517		63°46.47'	18°23.37'	497.51	982122.80	190685	1310	0918	2.60	1.94	-1.01	J 5 3	74.0	22.7
7518		63°49.27'	18°03.89'	181.47	982189.38	200685	1310	0918	2.60	1.60	.27	J 5 3	39.7	22.1
7519		63°51.78'	18°04.42'	352.03	982157.90	200685	1310	0918	2.60	1.33	-.47	J 5 2	57.8	21.4
7520		63°45.60'	18°00.93'	41.27	982217.30	200685	1310	0918	2.60	.00	.53	J 5 1	28.8	24.8
7521		63°43.27'	18°04.50'	42.31	982218.71	200685	1310	0918	2.60	.00	.51	J 5 1	33.3	29.2
7522		63°40.87'	18°00.19'	27.88	982222.03	220685	1310	0918	2.60	.00	.48	J 5 1	35.0	32.5
7523		63°31.42'	18°13.29'	13.64	982227.76	220685	1310	0918	2.60	.00	.68	J 5 1	47.8	47.0
7524		63°34.51'	18°15.88'	20.35	982225.08	220685	1310	0918	2.60	.00	.62	J 5 1	43.4	41.8

THE 1980 (CANBERRA) GRAVITY FORMULA IS USED WITH IGSN71/V85 ICELAND GRAVITY DATUM AND HJÖRSEY 1956 GEODETIC DATUM.
TERRAIN CORRECTION INSIDE CIRCLE OF RADIUS 6653 M (HAMMER ZONE J) AND TOPOGRAPHIC CORRECTION FROM THERE TO 167 KM.

STATION NUMBER	STATION NAME	LATITUDE DEG MIN	LONGITUDE DEG MIN	HEIGHT METERS	GRAVITY MGALS	DATE D M Y	REFERENCE B O I P	BGER DENS	CORRECTION TERR	CORRECTION TOPO	NOTES Z H T	ANOMALIES FAIR	ANOMALIES BGER
7525		63°32.03'	18°06.44'	11.64	982228.93	220685	1310 0918	2.60	.00	.66	J 5 1	47.6	47.0
7526		63°37.13'	18°08.34'	21.99	982223.39	230685	1310 0918	2.60	.00	.55	J 5 1	39.1	37.2
7527		63°34.35'	18°02.07'	9.97	982227.78	230685	1310 0918	2.60	.00	.60	J 5 1	43.1	42.6
7528		63°30.28'	18°25.25'	28.24	982225.57	240685	1310 0918	2.60	.00	.77	J 5 1	51.5	49.2
7529		63°33.86'	18°24.71'	40.65	982219.58	240685	1310 0918	2.60	.00	.68	J 5 1	45.0	41.2
7530		63°28.79'	18°22.27'	19.73	982227.78	240685	1310 0918	2.60	.00	.80	J 5 1	52.8	51.5
7531		63°27.33'	18°18.52'	14.68	982231.31	240685	1310 0918	2.60	.00	.85	J 5 1	56.6	55.8
7532		63°39.75'	18°15.67'	57.49	982213.97	250685	1310 0918	2.60	.00	.53	J 5 1	37.5	31.8
7533		63°37.81'	18°30.35'	85.61	982207.93	250685	1310 0918	2.60	.07	.67	J 5 1	42.4	33.9
7534		63°31.97'	18°38.04'	85.28	982209.66	250685	1310 0918	2.60	.00	.91	J 5 1	51.1	42.8
7535		63°37.59'	18°23.85'	51.89	982217.07	250685	1310 0918	2.60	.00	.62	J 5 1	41.4	36.4
7536	LI-0035	63°25.06'	18°44.66'	221.70	982175.67	270685	1310 0918	2.60	4.99	1.14	J 5 4	67.6	49.9
7537		63°25.54'	18°29.86'	5.50	982231.13	270685	1310 0918	2.60	.00	.97	J 5 1	55.7	56.1
7538		63°27.95'	18°56.99'	335.36	982149.22	270685	1310 0918	2.60	3.56	.93	J 5 4	72.7	41.5
7539		63°27.81'	18°48.11'	68.47	982210.44	270685	1310 0918	2.60	.04	1.22	J 5 1	51.7	45.6
7540		63°28.26'	18°41.07'	43.50	982214.90	270685	1310 0918	2.60	.00	1.04	J 5 1	47.9	44.3
7541		63°26.16'	18°34.00'	12.30	982228.02	270685	1310 0918	2.60	.00	1.00	J 5 1	54.0	53.6
7542		63°24.15'	18°49.58'	6.24	982225.49	270685	1310 0918	2.60	.01	1.27	J 5 1	52.0	52.6
7543	OS-M30	63°45.29'	18°47.01'	480.09	982120.96	280685	1310 0918	2.60	1.16	-.90	J 5 2	68.2	18.0
7544		63°52.07'	18°42.09'	641.66	982077.84	280685	1310 0918	2.60	1.52	-2.61	J 5 3	66.8	-.9
7545		63°52.45'	18°57.71'	931.20	982014.09	280685	1310 0918	2.60	6.20	-5.56	J 5 5	91.9	-1.8
7546		63°49.53'	18°55.52'	667.80	982069.62	280685	1310 0918	2.60	1.08	-2.80	J 5 2	69.7	-1.2
7548		63°48.84'	18°49.88'	516.20	982104.76	280685	1310 0918	2.60	.12	-1.40	J 5 1	58.9	3.5
7549		63°52.53'	18°28.65'	364.13	982149.75	280685	1310 0918	2.60	.18	-.69	J 5 1	52.5	13.4
7550		63°55.42'	18°23.09'	416.31	982140.20	280685	1310 0918	2.60	.00	-1.09	J 5 1	55.6	10.6
7551		63°58.44'	18°26.81'	460.81	982127.17	280685	1310 0918	2.60	.03	-1.46	J 5 1	52.7	2.8
7552		63°58.42'	18°18.82'	467.37	982130.22	280685	1310 0918	2.60	.06	-1.51	J 5 1	57.8	7.2
7553		63°57.99'	18°11.61'	526.45	982123.52	280685	1310 0918	2.60	.00	-1.91	J 5 1	69.9	12.8
7554		63°57.05'	18°05.59'	596.01	982109.30	280685	1310 0918	2.60	.79	-2.22	J 5 2	78.2	14.7
7555		63°53.83'	18°13.52'	431.34	982142.78	280685	1310 0918	2.60	.05	-1.11	J 5 1	64.7	18.2
7556	OS-M27	63°41.52'	18°32.98'	266.85	982173.10	290685	1310 0918	2.60	1.28	.12	J 5 2	59.1	32.0
7559		63°38.46'	18°42.55'	171.40	982195.50	300685	1310 0918	2.60	.01	.93	J 5 1	55.7	38.2
7560		63°40.53'	18°40.27'	268.17	982173.50	300685	1310 0918	2.60	.82	.31	J 5 2	61.1	33.6
7566		63°51.56'	18°11.19'	457.18	982137.24	020785	1310 0918	2.60	.99	-1.07	J 5 2	69.9	21.7
7567		63°43.55'	18°37.59'	298.80	982166.65	020785	1310 0918	2.60	1.42	.03	J 5 3	60.0	29.7
7568		63°46.23'	18°36.00'	230.49	982177.29	020785	1310 0918	2.60	.24	.28	J 5 1	46.4	22.2
7569		63°47.19'	18°30.93'	232.60	982179.96	020785	1310 0918	2.60	.47	.15	J 5 1	48.6	24.3
7570		63°49.37'	18°35.00'	374.47	982146.05	020785	1310 0918	2.60	.53	-.61	J 5 1	55.8	16.1
7571		63°49.70'	18°43.60'	536.20	982103.37	020785	1310 0918	2.60	.28	-1.66	J 5 1	62.6	5.2
7573		63°35.21'	18°37.63'	112.99	982202.04	020785	1310 0918	2.60	.05	.82	J 5 1	48.1	36.8
7574	OS-M22	63°58.37'	18°34.56'	667.10	982083.03	030785	1310 0918	2.60	2.80	-3.18	J 5 4	72.3	2.9
7575	OS-5294	63°56.93'	18°41.21'	744.64	982064.64	030785	1310 0918	2.60	2.74	-3.82	J 4 4	79.6	1.9
7576	LV-6367	64°02.49'	18°41.23'	624.24	982097.08	030785	1310 0918	2.60	.33	-3.01	J 4 1	68.2	.7
7577		64°03.20'	19°01.03'	586.94	982099.38	030785	1310 0918	2.60	.14	-2.64	J 5 1	58.2	-5.5

THE 1980 (CANBERRA) GRAVITY FORMULA IS USED WITH IGSN71/V85 ICELAND GRAVITY DATUM AND HJÖRSEY 1956 GEODETIC DATUM.
TERRAIN CORRECTION INSIDE CIRCLE OF RADIUS 6653 M (HAMMER ZONE J) AND TOPOGRAPHIC CORRECTION FROM THERE TO 167 KM.

ÞYNGDARKORT AF ÍSLANDI

GRAVITY MAP OF ICELAND

Kortið sýnir Bouguer frávik þyngdarsviðs með 5 mgal milli jafngildislína. Þyngdarmælistöðvar eru sýndar sem svartir plúsar og mínusar og hvítir punktar. Þyngdarformúla frá árinu 1980 er notuð, viðmiðunarkerfi þyngdar IGSN71/V85 og eðlismassi bergs 2,60 g/cm^3. Lega stöðva er í landsneti (Hjörsey 1955) og hæðir stöðva yfir meðalsjávarborði. Strandlínur og útlínur jökla eru hnitaðar af kortum Landmælinga Íslands, dýptarlínur af kortum Sjómælinga Íslands. Vörpun er hornsönn keiluvörpun Lamberts. Mælt, reiknað og teiknað af Orkustofnun. Prentað í Prentsmiðjunni Odda hf.

The contour lines show Bouguer anomalies with intervals of 5 mgals between lines. A gravity station is shown on the map as black plus or minus or white point. Geodetic Reference System 1980 is used, Gravity Reference System IGSN71/V85 and Bouguer density 2.60 g/cm^3. Horizontal datum is "Hjörsey 1955" and station heights are above mean sea level. Coastlines and boundaries of lakes and glaciers are digitized from maps of the Iceland Geodetic Survey, depth curves from maps of the Icelandic Hydrographic Service. Projection is Lambert's conical conformal. Surveyed, processed and plotted by Orkustofnun (National Energy Authority). Printed at Prentsmiðjan Oddi hf.