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Gravity and Height Variations Connected with the Recent Rifting Process in Northern Iceland 1975–1981

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Abstract. In 1975 rifting started in northern Iceland along the supramarine part of the constructive plate boundary. Regional gravity and height variations have been observed across the neovolcanic zone and the adjoining western and eastern Pleistocene and Tertiary basalt zones. The center of activity is in the Krafla caldera and the rifting has affected the 100 km long and 5 km wide fissure swarm associated with the central volcano. Local gravity and height variations have been investigated by annually re-observing transverse profiles in the Námafjall area (approx. 10 km south of Krafla) and in the Gjástikki area (approx. 15 km north of Krafla), and additional gravity stations in the northern part of the fissure swarm. The observations which have been performed at an accuracy level of better than $\pm 10 \times 10^{-8}$ ms^2 (= ± 0.01 mGal) and $\pm 0{,}03$ m, respectively, give significant information about vertical mass shifts during the rifting process. The recent rifting process is characterized by shifting of activity with gravity decrease and uplift at the flanks and gravity increase and subsidence at narrow central parts of the Krafla fissure swarm. The annual variations reach $\pm 100 \times 10^{-8}$ ms^{-2} and ± 0.5 m or more, respectively. Since 1978 the activity has been concentrated in the Gjástikki region with the variations decreasing in the southern and northern parts of the fissure swarm.

Key words: Iceland rift zone – Recent gravity and height variations – High precision gravity measurements

Introduction

High precision gravity measurements and technical levelings have been carried out in the axial rift zone of northeastern Iceland since 1965, in order to investigate vertical mass shift along this part of the plate boundary between the American and the Eurasian tectonic plates (e.g. Jacoby et al., 1980; Pálmason and Saemundsson, 1974). The investigations continue the pioneering work of Alfred Schleusener who in 1938 established a number of gravity stations in that area (Schleusener, 1943). As, on the average, secular gravity and height variations will not exceed a few 10^{-8} ms^{-2} (10^{-8} ms^{-2} = 1 μGal) and a few centimeters per year, respectively, high precision techniques have to be used especially in gravimetry and systematic influences have to be carefully controlled in both methods. The observations during the last 16 years fall into a non-active tectonic epoch between 1965 and 1975 (Torge and Drewes, 1977) and an active rifting episode since 1975. Preliminary results of the observation epochs 1976, 1977 and 1978 are given in Torge and Kanngieser (1980a). This report contains the final results of the investigations obtained at the recent rifting process between 1979 and 1981. The results of all observation epochs before 1979 are given by Kanngieser (1982a).

These investigations are related to other geodectic research programs, carried out by different Icelandic (see below), German and Austrian groups in nothern Iceland: Horizontal movements are controlled by the Institut für Vermessungskunde, Technische Universität Braunschweig, by a regional network based on the special geodetic network set up by Niemczyk and Emschermann in 1938 (Möller and Ritter, 1980). High precision levelings have been performed by the Institut für Markscheide- und Bergschadenkunde, Montanuniversität, Leoben (Spickernagel, 1980), while local strain and tilt measurements were carried out by the Geodätisches Institut, Universität Hannover, and the Institut für Physikalische Geodäsie, Technische Hochschule Darmstadt (Pelzer and Gerstenecker, 1980).

High Precision Gravity and Height Measurements 1979–1981

The schematic location of the gravity, and partly also height, profiles established in northeastern Iceland is shown in Fig. 1 (Kanngieser, 1982a). Repeated surveys before the rift process were carried out especially along the west-east main profile at 65° 40′ latitude. This profile crosses the neovolcanic zone and the adjoining western and eastern Pleistocene and Tertiary basalt zones. Gravity and height have been observed in 5-year intervals, 1965, 1970/71, 1975, and 1980. The small gravity increase, indicated in the axial rift zone between 1965 and 1970 (Schleusener and Torge, 1971), was confirmed in the following observation epoch 1975–1970/71 (Torge and Drewes, 1977); it resulted in a gravity change of approx. $+50 \times 10^{-8}$ ms^{-2}/10 years with respect to the western Tertiary basalt zone. The maximum horizontal gradient of gravity change (70×10^{-8} ms^{-2}/10 years) occurred across approx. 15 km in the Námafjall area south of the Krafla caldera. In today's view, this variation may have been a kind of precursor of the recent rift process.

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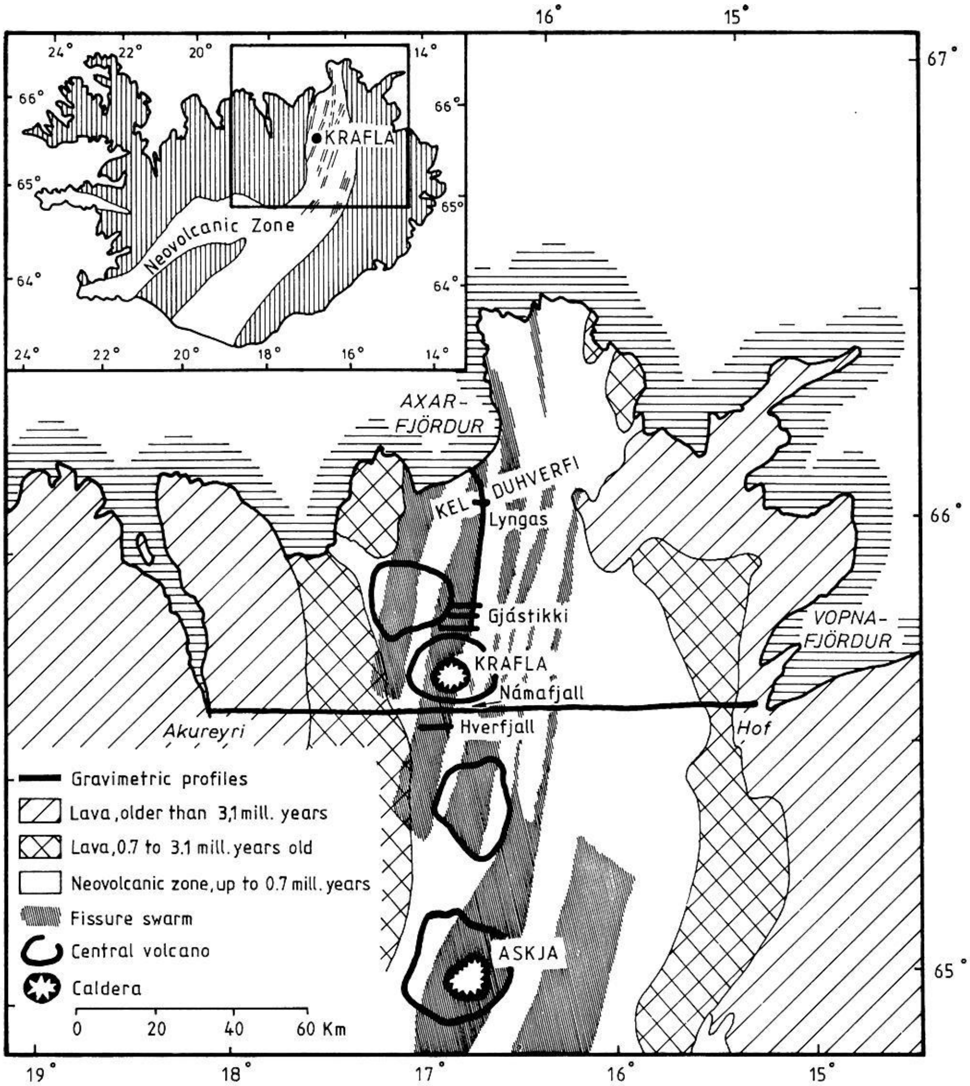

Fig. 1. Location of gravity profiles observed in northern Iceland between 1975 and 1981

Table 1. Statistics of gravity observations

Profile	Epoch	Observation period	Number of stations	LCR gravity meters	Number of observations per station
West-east main profile	1980	28.6.–30.8.	165	G79, G85	7…8
Hverfjall profile	1980	19.8.–20.8.	4	G79, G85, G298, D14	4
	1981	13.7.–22.7.	4	G79, G298, D14	4
Námafjall profile	1979	16.7.–20.7.	19	G79, G85, D14	8
	1980	9.7.– 9.8.	18	G79, G85, G298, D14	8…9
	1981	13.7.–22.7.	18	G79, G298, D14	6
Southern Gjástikki profile	1980	21.7.–24.8.	7	G79, G85, G298, D14	6
	1981	18.7.–30.7.	4	G79, G298, D14	6
Central Gjástikki profile	1979	22.7.–25.7.	14	G79, G85, D14	5
	1980	20.7.–22.8.	14	G79, G85, G298, D14	4…5
	1981	17.7.–29.7.	12	G79, G298, D14	5…6
Northern Gjástikki profile	1980	23.8.	5	G85, G298, D14	3…4
	1981	18.7.–28.7.	5	G79, G298, D14	6
Lyngás profile	1979	24.7.	6	G79, G85, D14	2…3
	1980	24.8.	5	G79, G85, G298, D14	3
	1981	21.7.–28.7.	6	G79, G298, D14	5…6
Gjástikki Kelduhverfi profile	1979	22.7.–23.7.	12	G79, G85, D14	4
	1980	24.7.–24.8.	12	G79, G298, D14	5…6
	1981	18.7.–28.7.	12	G79, G298, D14	6…7

Table 2. R.m.s. errors (10^{-8} ms^{-2}) of one observed gravity difference

Epoch	G79	G85	G298	D14
1979	±25	±21	–	±11
1980	± 8	±11	±15	±15
1981	± 9	–	±13	±12

Table 3. Calibration terms of LCR gravimeters

Instr.	Epoch	Linear factor	Quadratic factor
G79	1979	0.99959 ±15	0.00000008 ±2
	1980 1981	0.99893 ±36	0.00000013 ±3
G85	1979 1980	0.99750 ±40	0.00000044 ±4
G298	1980 1981	1.00014 ±14	0.00000007 ±1
D14	1979 1980 1981	0.99994 ±3	

Table 4. Results of the gravity connection continent (Hannover) – south-west Iceland (Reykjavik), Hannover fixed $g=$ 9.81262376 ms^{-2}

Epoch	LCR gravity meters	Number of connections	Gravity value of Reykjavik 21941 K (Keflavik) (10^{-5} ms^{-2})	R.m.s. error of the gravity value (10^{-5} ms^{-2})
1965	G79, G85	5	982 259.394	±0.036
1967	G79, G85	7	259.354	±0.024
1970	G79, G85	6	259.401	±0,015
1971	G79, G85	4	259.412	±0.013
1975	G79, G85 G87, G298	8	259.410	±0.011
1976	G79, G85	4	259.389	±0.014
1977	G298	2	259.362	±0.022
1978	G79	2	259.400	±0.013
1979	G79, G85	4	259.384	±0.011
1980	G79, G85, G298	6	259.394	±0.014
1981	G79, G298	4	259.373	±0.015
1965–1980		48	259.392	±0.007

Since December 1975, the Krafla fissure swarm has shown tectonic and volcanic activity with the Krafla caldera as the activity center. Here rapid subsidence lasting a few hours to a few days occurs, episodically interrupted by uplift intervals lasting several months. During the subsidence events brittle deformation occurs at different parts of the fissure swarm (Pálmason, 1981). These short period variations are carefully monitored by Icelandic geoscientists (Björnsson et al., 1979; Johnson et al., 1980), whereas our Institute has measured gravity and height variations at different parts of the fissure swarm in one-year intervals between 1975 and 1981 (Torge and Kanngieser, 1980a; Torge and Kanngieser, 1981; Torge, 1981). Altogether six transverse profiles (Hverfjall; Námafjall; Gjástikki south, central, north; Lyngás) crossing, and one profile (Gjástikki-Kelduhverfi) running along, the fissure zone have been established (see Fig. 1), with the observations concentrated on the Námafjall and the central Gjástikki profiles, located approx. 10 km south and 15 km north of the Krafla caldera, respectively.

Some statistics of the *gravity observations* are given in Table 1. The r.m.s. errors of single observed gravity differences have been derived from the adjustments of the different epochs and are given in Table 2. The r.m.s. errors of LaCoste-Romberg (LCR) gravity meters G79 and G85 in 1979 result mainly from reading errors caused by the optical readout system and the galvanometer. The high accuracy of LCR D14 in 1979 and of the gravimeters since 1980

Table 5. Results of the gravity connection southwest Iceland (Reykjavik) – northeast Iceland (Akureyri); Reykjavik fixed $g=$ 9.82259392 ms^{-2}

Epoch	LCR gravity meters	Number of connections	Gravity value of Akureyri 60932 (10^{-5} ms^{-2})	R.m.s. error of the gravity value (10^{-5} ms^{-2})
1965	G79	10	982 333.399	±0.028
1970	G85	2	333.423	±0.021
1971	G79, G85	4	333.405	±0.020
1975	G79, G85 G87, G298, D14	10	333.380	±0.014
1976	G79, G85, D14	5	333.387	±0.014
1977	G298, D14	2	333.395	±0.023
1978	G79, D14	4	333.365	±0.015
1979	G79, G85, D14	6	333.389	±0.014
1980	G79, G85, G298, D14	8	333.398	±0.014
1981	G79, G298, D14	6	333.405	±0.012
1965–1980		51	333.382	±0.008

Table 6. R.m.s. errors (10^{-8} ms^{-2}) of final gravity values in single observation epochs

Profile	1979	1980	1981
West-east main profile	–	±3 ... ± 8	–
Hverfjall profile	–	±6	±6
Námafjall profile	± 6 ... ±10	±3 ... ± 6	±3 ... ±7
Southern Gjástikki profile	–	±6 ... ± 7	±5 ... ±6
Central Gjástikki profile	± 8 ... ±11	±5 ... ±10	±5 ... ±7
Northern Gjástikki profile	–	±7 ... ± 8	±5 ... ±7
Lyngás profile	±10 ... ±11	±6 ... ± 9	±6 ... ±8
Gjástikki-Kelduhverfi profile	±10 ... ±13	±7 ... ± 9	±4 ... ±7

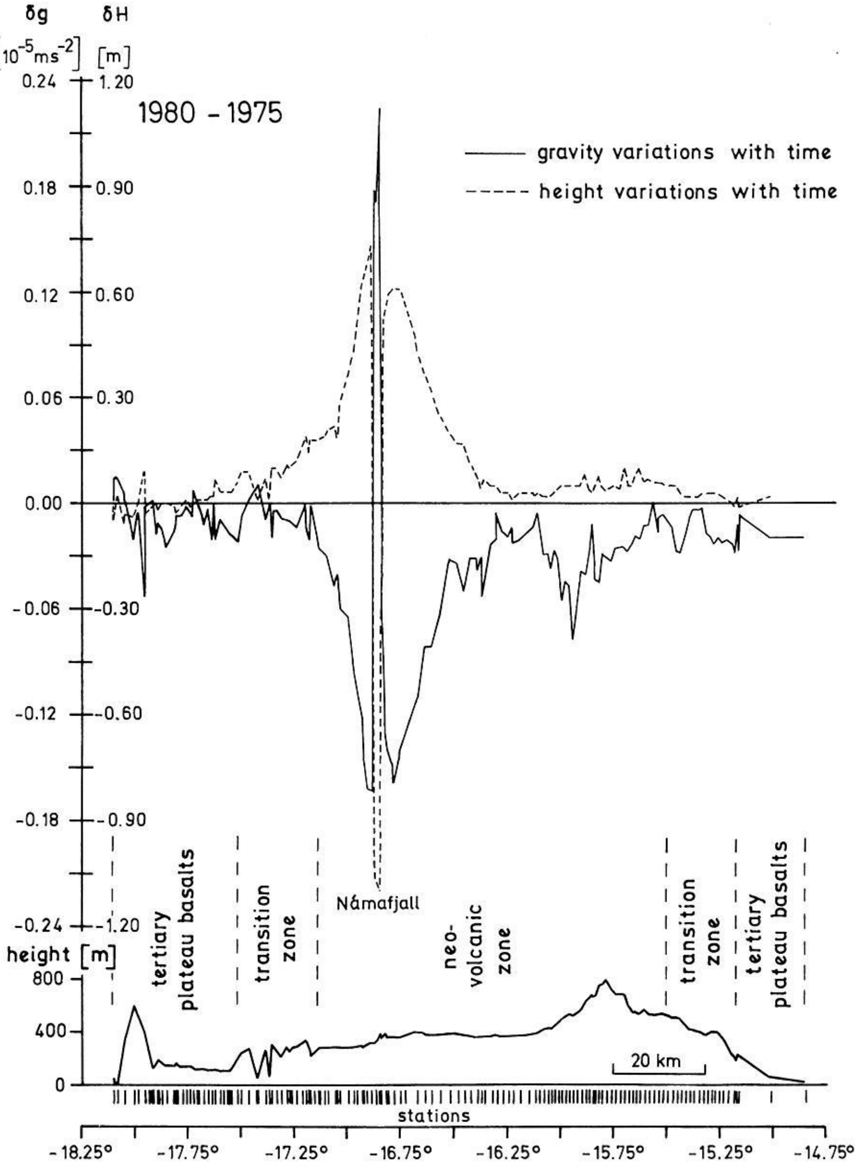

Fig. 2. West-east main profile, northern Iceland: Gravity and height variations 1980–1975

under the difficult environmental conditions in Iceland results from the following developments
- reduction of reading errors: digital voltmeter reading,
- protection against transportation shocks; shock suppressing transport case (Kanngieser, 1982b),
- protection against wind disturbance: wind shelter,
- control of instrumental drift and error accumulation within the gravity network: establishment of a base network with overlapping ties (accuracy 1980: $\pm 3 \times 10^{-8}$ ms^{-2}) and frequent connections to the base stations,
- gravimetric earth tide reduction: introduction of regional tidal parameters observed at a temporary tidal station in northern Iceland (Torge and Wenzel, 1976),
- determination of linear and quadratic calibration terms: back and forth measurements along the European absolute calibration line between Munich and Hammerfest reduce the corresponding calibration errors to $\pm 3 \times 10^{-5}$ (Kanngieser and Torge, 1981). Due to the installation of a capacitive readout system in LCR G 79 (December, 1979) the calibration changed. Quadratic calibration terms have been determined significantly for LCR D 14 on the Hannover-Harz calibration line, but not in northern Iceland. The calibration terms in Table 3 have been introduced in the adjustment,
- determination of periodic calibration terms: measurements along the 0.2, 2, 20 and 200×10^{-5} ms^{-2} (10^{-5} ms^2 = 1 mGal) calibration lines of the Hannover calibration system (accuracy $\pm 1 \times 10^{-8}$ ms^{-2}) reduce periodic errors to the $\pm 1 \times 10^{-8}$ ms^{-2} level (Torge and Kanngieser, 1980b; Kanngieser et al., 1983).

As measurements with static gravimeters give only gravity differences, the problem of the *absolute gravity reference* arises. The networks of each measuring epoch have always been tied to the gravity base station Akureyri 60932 located in the Tertiary plateau basalts at the western edge of the west-east main profile, about 60 km from the activated Krafla fissure zone. Numerous gravity connections between the continent (Hannover) and southwest Iceland (Reykjavik) and between Reykjavik and northeast Iceland (Akureyri) indicated that the gravity values of Reykjavik relative to the continent and of Akureyri relative to Reykjavik had not changed significantly between 1965 and 1981; thus sta-

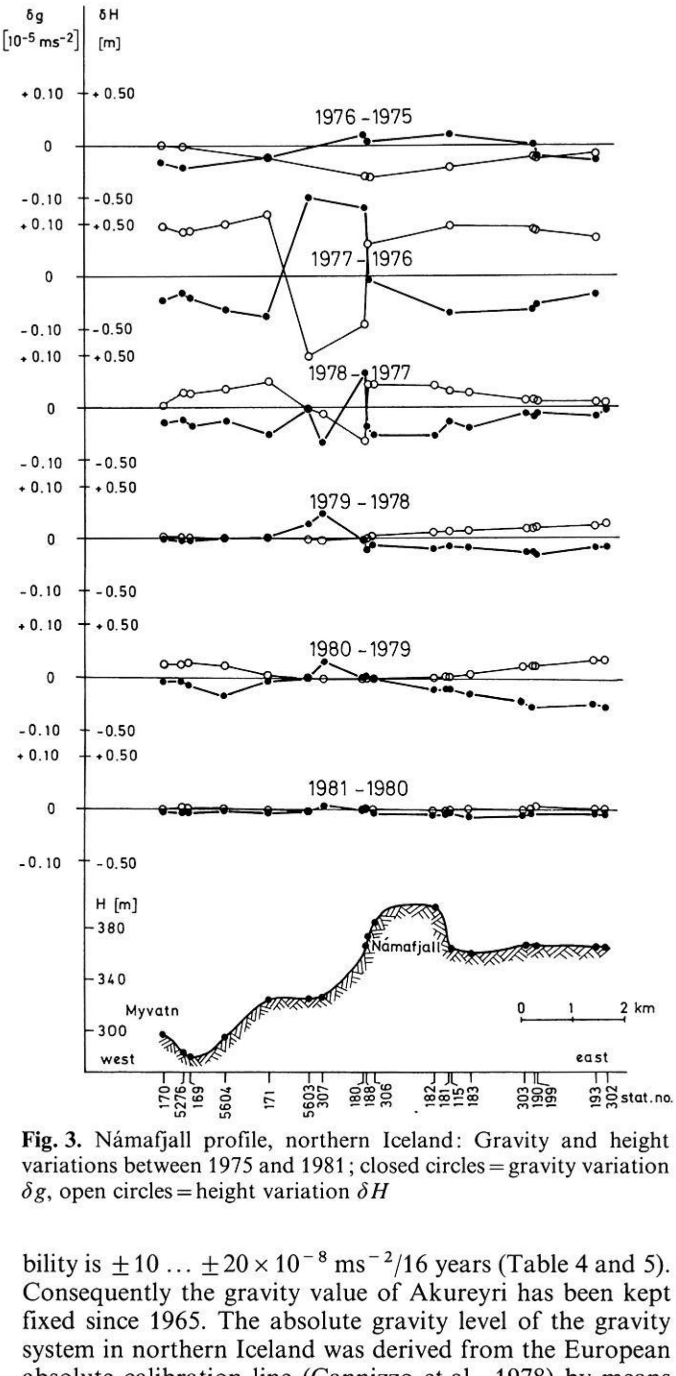

Fig. 3. Námafjall profile, northern Iceland: Gravity and height variations between 1975 and 1981; closed circles = gravity variation δg, open circles = height variation δH

bility is $\pm 10 \ldots \pm 20 \times 10^{-8}$ ms^{-2}/16 years (Table 4 and 5). Consequently the gravity value of Akureyri has been kept fixed since 1965. The absolute gravity level of the gravity system in northern Iceland was derived from the European absolute calibration line (Cannizzo et al., 1978) by means of repeated gravity connections between Akureyri and Hannover, with an accuracy of better than 10×10^{-8} ms^{-2} (Kanngieser, 1982a). The gravity system is compatible with the IGSN 71 (Morelli et al., 1974).

The *adjustment* follows the least squares method with gravity differences as observations and introduction of empirical correlations of sequential gravity differences. The gravity values at the single epochs, referring to the base station Akureyri, are given in Appendices 1–5, their r.m.s. errors are given in a generalized manner in Table 6.

Height determination was performed by technical leveling using automatic levels. From double leveling, either back and forth or by double turning points and connections to mean sea level the accuracy of the height differences is estimated to be better than $\pm 0.01 \times \sqrt{\text{distance (km)}}$ (m).

The height reference of the different epochs has been derived by leveling connections to the stable station Akureyri (west-east main profile 1980) or by using stations with small gravity changes as reference, converting significant gravity variations with the factor -0.2×10^{-5} ms^{-2}/m (Torge, 1981) into height variations (Námafjall profile 1979 and 1981, central Gjástikki profile 1979, 1980, 1981).

The *height datum* in the Námafjall profile is
– 1979: profile station no. 143, about 10 km southwest of the starting point of the Námafjall profile, connected by geometric leveling,
– 1980: base station Akureyri no. 60932, which is not affected by the recent activity; its height is given in the height system introduced by Spickernagel (1966),
– 1981: profile station no. 143, connected to the starting point of the Námafjall profile by hydrostatic leveling via the level of the lake Mývatn.

The height datum in the central Gjástikki profile is profile station no. 548 in 1979, no. 556 in 1980 and no. 704 in 1981. The accuracy of the reference height fixed by this method, has been estimated by applying the law of error propagation (Kanngieser, 1982a). For the small gravity variations used for transformation, we obtain ± 0.1 m. This value corresponds to the error, which can be suspected if the height reference is derived from leveling to the base station Akureyri. The reference height error of ± 0.1 m adds to the observation error as a systematic bias, affecting all height variations of one period in the same sense (Torge, 1981).

The results of the height measurements are given in Appendices 1–3.

Comparison of the Gravity and Height Observations 1975–1981

The gravity and height variations (δg and δH) 1980 – 1975 for the *west-east main profile* are given in Appendix 1; Fig. 2 shows the variations along the profile. The comparison contains the regional long-term effect of the recent rifting episode. An extended region of approximately 70 km width is affected by gravity decrease and correlated uplift, with a maximum of -0.16×10^{-5} ms^{-2}/5 years and $+0.7$ m/5 years, respectively, at the activated Krafla fissure zone. The central part of this zone is characterized by short-period variations, which accumulated to $+0.2 \times 10^{-5}$ ms^{-2}/5 years in gravity, and -1.1 m/5 years in elevation, respectively. The stations of this central part of the west-east main profile and some adjacent stations form the *Námafjall profile* and have been observed in one-year intervals between 1975 and 1981. The results are given in Appendix 2 and Fig. 3. We recognize a small gravity increase (20×10^{-8} ms^{-2}) and a correlated subsidence (-0.3 m) at the western edge of the Námafjall ridge and a gravity decrease (up to -50×10^{-8} ms^{-2}) at the flanks in the first observation period (1976–1975). Gravity and height variations enlarged in the next period (1977–1976). The maximum gravity increase (160×10^{-8} ms^{-2}) and subsidence (-0.8 m) concentrated in a narrow, 1.5 km wide part, slightly shifted westward. The flanks of this subsidence area are characterized by uplift ($+0.3$ to $+0.6$ m) and gravity decrease (-30 to -70×10^{-8} ms^{-2}). In the following period (1978–1977) the variations diminished, although the tendencies continued, resulting in a gravity increase (60×10^{-8} ms^{-2}) and subsidence (-0.3 m) at the central part, and gravity decrease

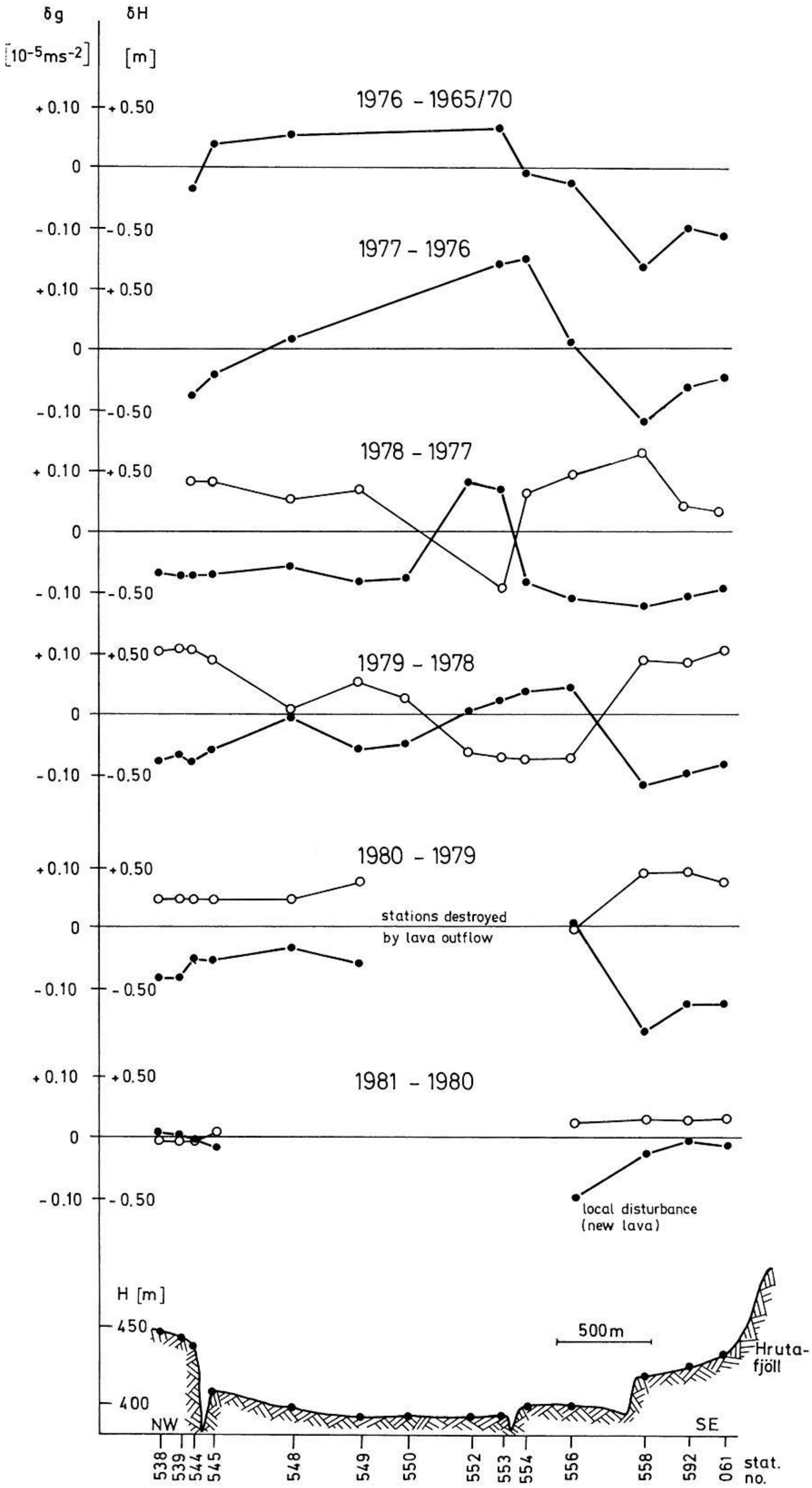

Fig. 4. Central Gjástikki profile, northern Iceland: Gravity and height variations between 1965/70 and 1981; closed circles = gravity variation δg, open circles = height variation δH.

(up to -70×10^{-8} ms^{-2}) and uplift (+0.2 m) at the flanks. West of Námafjall, an abnormal correlation between gravity and height change can be recognized, in the area of new fissure formation and thermal activity. The next two observation periods (1979–1978, 1980–1979) reveal a strongly reduced activity, with small gravity increase (20 to 40×10^{-8} ms^{-2}) and subsidence (<0.1 m) at the center and gravity decrease (up to -60×10^{-8} ms^{-2}) and uplift (<0.2 m) at the flanks. The last observation period (1981–1980) indicates the end of the activity along this profile.

For the *central Gjástikki profile* (Fig. 4), the first gravity

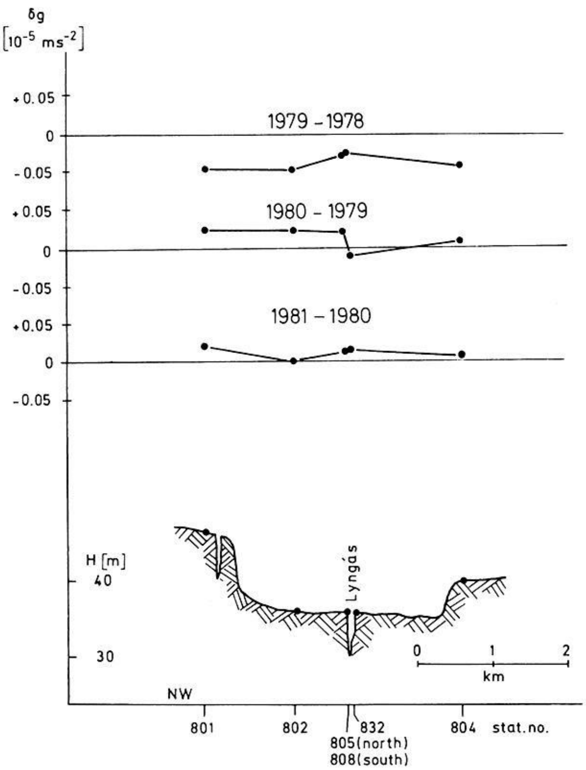

Fig. 5. Lyngás profile, northern Iceland: Gravity variations between 1978 and 1981

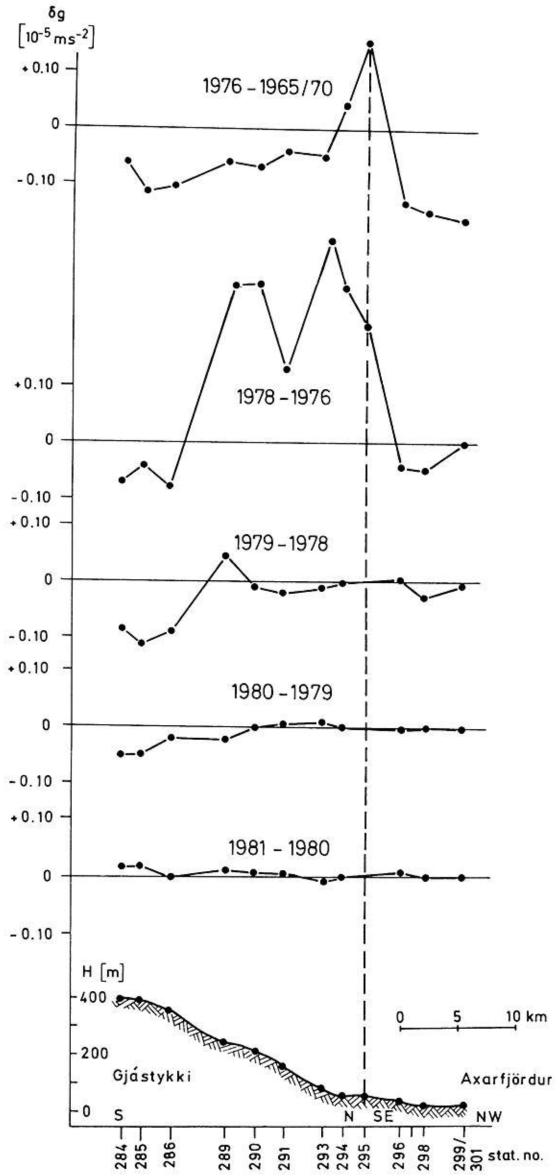

Fig. 6. Gjástikki-Kelduhverfi profile, northern Iceland: Gravity variations between 1965/70 and 1981.

reference epoch is 1965/70. We may assume that larger variations occured only after the end of 1975. The comparison 1976–1965/70 shows a gravity increase (40 to $60 \times 10^{-8}\,ms^{-2}$) in a broad central part and a decrease (up to $-160 \times 10^{-8}\,ms^{-2}$) at the flanks. In the following periods, these trends continued. In 1977–1976, the gravity increase ($>100 \times 10^{-8}\,ms^{-2}$) concentrated in a smaller area, while the decrease at the edges kept the same order as before. New stations give for the 1978–1977 period a more detailed picture of the narrow, approx. 300 m wide, central part. We find again a gravity increase ($>50 \times 10^{-8}\,ms^{-2}$) and subsidence ($-0.4$ m) in this zone and a gravity decrease (up to $-110 \times 10^{-8}\,ms^{-2}$) correlated with an uplift (up to 0.6 m) at the flanks. The period 1979–1978 is characterized by an intensified thermal activity in the central part; subsidence (-0.4 m) and gravity increase ($50 \times 10^{-8}\,ms^{-2}$) is slightly shifted to the southeast. Uplift (up to 0.6 m) and gravity decrease ($-100 \times 10^{-8}\,ms^{-2}$) at the flanks are similar as before, with a more complex picture in the northwestern part. The central part of this profile has been covered by lava flows in 1980 and more extensively in 1981. Therefore in the period (1980–1979) only the gravity decrease (up to $-180 \times 10^{-8}\,ms^{-2}$) and uplift (0.5 m) at the flanks could be determined. The variations are decreasing since 1980. Only the gravity of station no. 556 changed strongly ($-100 \times 10^{-8}\,ms^{-2}$) because of large new basalt lava masses near the station.

At the *Lyngás profile* (Fig. 5), a gravity decrease (up to $-40 \times 10^{-8}\,ms^{2}$) has been observed between 1978 and 1979. This tendency did not continue in the following periods (1980–1979, 1981–1980).

Along the *Gjástikki-Kelduhverfi profile* (Fig. 6), we may again assume that larger variations occured only after the end of 1975. The comparison 1976–1965/70 gives a significant gravity increase (up to $160 \times 10^{-8}\,ms^{-2}$) about 20 km north of Gjástikki and a gravity decrease (up to $-160 \times 10^{-8}\,ms^{-2}$) north and south of the maximum. The next period (1978–1976) is characterized by 3 minima ($-80 \times 10^{-8}\,ms^{-2}$) and 2 maxima ($<350 \times 10^{-8}\,ms^{-2}$) with wavelengths of approx. 10 km. The great variations north of Gjástikki reduced to approximately zero after 1978. The southern part of the profile (northern Gjástikki region) remained active until 1980 with gravity decrease up to $100 \times 10^{-8}\,ms^{-2}$/year.

Conclusions

From the gravity and height measurements during the recent rifting process in northern Iceland, we arrive at the following conclusions:

– an extended region (70 km) is affected by gravity decrease and correlated uplift during the rifting process;

– the areas south and north of the activity center in the Krafla-caldera show a systematic trend characterized by gravity decrease and correlated uplift at the flanks of the fissure swarm, and gravity increase and subsidence in a narrow central 'graben' with maximum values of $\pm 100 \times 10^{-8}\ \mathrm{ms}^{-2}$/year and ± 0.5 m/year, respectively;
– the observed annual variations change their magnitude with time, but generally proceed in the same sense, thus indicating the long-term behaviour of the mass shifts;
– the observations reveal the regional wandering of the swarm activity, from the north (1975/76) to the south (Námafjall 1977/78), concentrated since 1976 in the Gjástikki area;
– activated areas along the fissure swarm show large gravity variations of $200 \times 10^{-8}\ \mathrm{ms}^{-2}$/a and more;
– according to the 1981 survey, the gravity and height variations are decreasing.

These results, and hopefully also future observations, will contribute to the understanding of the mass movements in time and space which are related to the present rifting episode. For geophysical model calculations of the subsurface mass shifts, continuous time-space models of the gravity and height variations have been developed, using least squares collocation techniques (Kanngieser, 1980, 1982a, c).

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Appendix 1. Gravity and height values[a] of the west-east main profile between Akureyri and Hof, 1980, gravity and height variations 1980–1975

Station no.	ϕ (°)	λ west (°)	g(80) (10^{-5} ms^{-2})	g(80)−g(75) (10^{-5} ms^{-2})	H(80) (m)	H(80)−H(75) (m)
			982…			
60932	65.676	18.098	333.382	0.000	49.11	0.00
60936	65.680	18.098	338.267	0.013	24.00	−0.05
5218	65.655	18.079	337.431	0.015	2.11	0.02
1	65.739	18.046	281.787	0.006	350.33	−0.06
9	65.739	18.046	281.841	0.002	350.12	−0.03
2	65.732	18.003	232.608	−0.020	594.26	−0.04
3	65.737	17.983	248.882	−0.005	520.04	−0.01
18	65.733	17.952	274.847	−0.053	384.59	0.09
10	65.732	17.952	275.201	−0.001	382.32	−0.04
11	65.733	17.933	301.690	−0.001	247.21	−0.02
12	65.734	17.912	326.499	0.002	121.47	−0.01
20	65.738	17.893	317.856	−0.018	168.84	0.00
29	65.740	17.887	310.808	−0.011	198.21	−0.02
21	65.739	17.873	314.120	−0.014	173.21	0.00
22	65.734	17.849	315.626	−0.025	141.43	0.00
24	65.728	17.812	315.344	−0.015	138.25	−0.01
34	65.722	17.807	310.371	−0.008	159.06	−0.01
33	65.723	17.803	311.103	−0.007	154.19	−0.03
35	65.717	17.778	316.429	−0.007	130.86	−0.01
36	65.710	17.754	314.689	−0.002	139.22	0.01
48	65.712	17.726	314.246	−0.007	137.62	−0.02
41	65.714	17.723	314.479	0.008	132.42	0.00
43	65.705	17.708	317.648	0.000	117.67	0.01
50	65.709	17.699	316.587	−0.003	120.87	0.00
59	65.711	17.699	316.209	0.001	121.74	0.01
51	65.707	17.674	314.450	−0.013	121.24	0.01
52	65.705	17.655	316.400	−0.003	112.37	0.01
68	65.697	17.638	316.499	−0.021	112.90	0.02
62	65.696	17.625	316.416	0.000	117.15	0.02
61	65.696	17.621	316.894	−0.020	116.08	0.07
78	65.697	17.596	321.003	−0.009	106.00	0.03
73	65.693	17.564	320.369		114.81	
88	65.687	17.545	321.812	−0.018	111.90	0.03
89	65.685	17.545	321.230	−0.011	114.35	0.03
81	65.681	17.514	304.916	−0.022	205.13	0.06
82	65.678	17.497	295.522	−0.006	253.45	0.09
90	65.677	17.463	291.522	0.003	280.14	0.09
83	65.742	17.419	341.934	0.011	49.36	0.01
92	65.660	17.382	291.683	−0.009	269.24	0.07
93	65.720	17.365	338.550	0.000	55.22	0.01
100	65.655	17.355	282.667	−0.020	312.76	0.10
109	65.655	17.354	282.251	−0.004	314.43	0.10
			982…			
101	65.654	17.331	291.819	−0.004	260.03	0.10
102	65.648	17.308	302.948	−0.009	206.89	0.07
119	65.650	17.279	286.303	−0.010	291.92	0.11
110	65.649	17.270	293.799	−0.010	253.09	0.10
111	65.643	17.259	287.491	−0.012	281.02	0.11
113	65.621	17.235	283.322	−0.014	292.70	0.12
129	65.635	17.193	274.681	0.000	337.23	0.18
120	65.634	17.190	275.201	−0.015	334.02	0.19
123	65.593	17.178	280.045	−0.021	284.20	0.14
121	65.630	17.172	297.659	0.000	216.08	0.18
124	65.596	17.132	279.347	−0.026	280.86	0.18
132	65.604	17.104	279.067	−0.027	281.57	0.19
133	65.619	17.086	279.992	−0.032	282.53	0.21
148	65.617	17.057	280.125	−0.046	281.34	0.22
140	65.617	17.052	280.688	−0.047	280.31	0.22
143	65.569	17.045	270.554	−0.040	287.68	0.18
141	65.621	17.031	280.656	−0.060	279.51	0.28
142	65.632	16.992	281.563	−0.064	279.16	0.36
150	65.631	16.966	280.836	−0.097	281.31	0.43
151	65.657	16.951	283.278		286.59	
170	65.631	16.927	277.343	−0.123	296.28	0.62
5276	65.645	16.923	282.004	−0.122	284.81	0.64
169	65.642	16.920	283.007		279.70	
5604	65.641	16.904	279.427		295.40	
171	65.641	16.886	274.103	−0.163	321.87	0.73
5603	65.639	16.869	274.331		319.42	
307	65.639	16.863	272.742		325.68	
180	65.642	16.846	265.170	0.225	363.15	−1.10
306	65.644	16.841	259.730		389.72	
188	65.639	16.840	267.498	−0.048	349.88	0.24
182	65.646	16.819	258.969		394.38	
115	65.644	16.812	266.981		359.65	
181	65.645	16.812	266.975	−0.117	359.74	0.56
183	65.645	16.803	266.555		362.30	
303	65.646	16.781	266.931		358.97	
190	65.649	16.778	266.546	−0.159	359.73	0.61
193	65.650	16.752	267.160	−0.145	359.29	0.61
302	65.649	16.748	267.015		359.61	
200	65.652	16.673	256.546	−0.112	404.00	0.47
209	65.650	16.670	257.469	−0.114	397.84	0.44
202	65.653	16.634	257.490	−0.081	391.89	0.37
201	65.649	16.634	258.966		383.41	
			982…			
203	65.656	16.602	259.852	−0.081	374.84	0.32
210	65.662	16.563	259.054	−0.064	377.40	0.25
211	65.660	16.519	258.395	−0.031	387.82	0.20
229	65.657	16.482	257.950	−0.033	386.87	0.17
220	65.659	16.480	258.537	−0.035	384.08	0.17
221	65.655	16.452	261.150	−0.050	371.16	0.17
222	65.655	16.425	262.247	−0.031	369.17	0.12
239	65.650	16.391	262.915	−0.031	360.34	0.08
230	65.650	16.391	264.159	−0.038	354.64	0.08
233	65.640	16.372	260.295	−0.031	366.64	0.06
234	65.640	16.371	261.798	−0.053	360.31	0.04
231	65.647	16.357	261.679	−0.044	363.56	0.07
232	65.644	16.322	262.466	−0.022	365.26	0.05
248	65.637	16.299	259.286	−0.020	377.70	0.05
249	65.638	16.299	259.958	−0.005	375.11	0.05
241	65.638	16.271	262.132	−0.016	362.56	0.03
242	65.637	16.244	259.799	−0.019	368.21	0.03
250	65.639	16.224	260.222	−0.013	366.43	0.01
258	65.641	16.224	260.079	−0.023	366.59	0.01
251	65.626	16.192	259.012	−0.021	371.09	0.03
252	65.641	16.149	262.281	−0.016	376.77	0.03
263	65.644	16.122	261.107	−0.013	384.31	0.03
300	65.648	16.103	259.872	−0.005	392.77	0.03
310	65.653	16.079	256.361	−0.029	412.61	0.02
320	65.657	16.057	253.379	−0.028	429.65	0.02
330	65.663	16.042	253.185	−0.037	428.98	0.02
340	65.668	16.027	251.084	−0.026	440.94	0.03
350	65.673	16.009	245.764	−0.032	470.42	0.04
360	65.680	15.993	240.829	−0.055	496.46	0.05
370	65.687	15.974	239.148	−0.044	507.84	0.05
380	65.693	15.957	232.650	−0.047	536.80	0.05
390	65.699	15.941	235.333	−0.077	525.15	0.05
400	65.700	15.923	233.341	−0.061	534.36	0.05
410	65.703	15.900	226.548	−0.039	567.47	0.05
420	65.705	15.879	212.009	−0.040	630.61	0.08
430	65.706	15.863	205.755	−0.031	658.49	0.04
440	65.710	15.844	202.543	−0.011	680.78	0.03
450	65.710	15.834	204.283	−0.035	669.36	0.05
459	65.710	15.834	203.613	−0.036	672.89	0.04
458	65.710	15.834	203.783	−0.043	671.85	0.04
460	65.709	15.817	186.312	−0.044	756.87	0.08
			982…			
470	65.711	15.804	186.237	−0.028	758.83	0.05
480	65.711	15.783	178.419	−0.030	799.30	0.04
490	65.712	15.760	197.834	−0.033	720.06	0.05
500	65.714	15.740	206.254	−0.025	682.55	0.05
510	65.716	15.717	205.666	−0.024	686.50	0.04
520	65.715	15.697	205.887	−0.024	680.94	0.10
530	65.712	15.678	227.565	−0.027	579.87	0.05
540	65.708	15.659	235.036	−0.023	542.14	0.05
550	65.705	15.642	233.248	−0.018	551.54	0.08
560	65.701	15.623	236.917	−0.020	534.89	0.10
570	65.697	15.602	229.669	−0.012	567.40	0.06
580	65.695	15.582	236.202	−0.012	532.57	0.07
590	65.693	15.559	238.160	0.001	528.54	0.06
608	65.692	15.538	238.959	−0.016	531.20	0.06
600	65.692	15.538	239.041	−0.017	530.88	0.05
609	65.691	15.538	238.876	−0.008	531.68	0.06
610	65.689	15.517	237.597	−0.006	538.47	0.06
620	65.687	15.495	239.684	−0.010	529.52	0.05
630	65.686	15.473	243.687	−0.014	509.77	0.05
640	65.684	15.451	242.871	−0.027	511.64	0.05
650	65.682	15.431	245.753	−0.028	495.90	0.03
660	65.679	15.410	252.709	−0.019	455.51	0.02
670	65.677	15.390	260.930	−0.008	415.09	0.02
680	65.676	15.373	262.232	−0.003	408.26	0.02
690	65.676	15.347	264.142	−0.003	402.14	0.02
700	65.673	15.328	265.086	−0.002	395.23	0.03
710	65.669	15.308	269.310	−0.017	371.53	0.03
720	65.665	15.289	264.840	−0.019	394.63	0.03
730	65.661	15.274	262.552	−0.023	406.97	0.03
740	65.659	15.256	263.671	−0.019	401.65	0.03
750	65.656	15.236	270.540	−0.022	361.66	0.02
760	65.657	15.212	286.463	−0.020	280.57	0.01
770	65.659	15.185	301.674	−0.023	207.23	0.00
780	65.659	15.175	304.883	−0.028	193.59	−0.01
790	65.658	15.165	306.746	−0.011	184.32	0.01
798	65.656	15.162	304.186	−0.027	198.86	0.02
799	65.653	15.159	295.969	−0.006	233.78	−0.01
99010	65.656	15.010	339.476	−0.020	54.24	0.02
99011	65.655	15.010	339.015	−0.019	53.86	0.02
5227	65.758	14.849	368.862	−0.019	14.91	

[a] The gravity values refer to the gravity datum introduced by Kanngieser (1982a). The gravity system is compatible with the IGSN 71. The gravity and height values before 1980 are given in Torge and Drewes (1977)

Appendix 2. Gravity and height values[b,c] 1978, 1979 and 1981 along the Námafjall profile (part of the west-east main profile)

Station no.	ϕ (°)	λ west (°)	g(78) (10^{-5} ms^{-2})	g(79) (10^{-5} ms^{-2})	g(81) (10^{-5} ms^{-2})	H(78) (m)	H(79) (m)	H(81) (m)
			982...	982...	982...			
60932	65.676	18.098	333.382	333.382	333.382			
93	65.720	17.365	338.543	338.547	338.544			
143	65.569	17.045	270.572	270.559	270.545		287.66	287.67
170	65.631	16.927	277.354	277.352	277.332	296.16	296.16	296.29
5276	65.645	16.923	282.021	282.014	281.992	284.67	284.69	284.83
169	65.642	16.920	283.028	283.026	282.997	279.55	279.56	279.71
5604	65.641	16.904	279.458	279.455	279.424	295.28	295.29	295.42
171	65.641	16.886	274.116	274.115	274.087	321.82	321.83	321.87
5603	65.639	16.869	274.304	274.327	274.330	319.42	319.40	319.40
307	65.639	16.863	272.658	272.702	272.749	325.74	325.70	325.65
180	65.642	16.846	265.163	265.165	265.167	363.16	363.17	363,16
306	65.644	16.841	259.736	259.725	259.715	389.72	389.75	389.74
188	65.639	16.840	267.509	267.490	267.503	349.87	349.88	349.89
182	65.646	16.819	259.003	258.985	258.954	394.30	394.35	394.39
181	65.645	16.812	267.015	266.998	266.963	359.63	359.67	359.76
115	65.644	16.812	267.024	267.008	266.971	359.56	359.60	359.69
183	65.645	16.803	266.598	266.576	266.538	362.16	362.21	362.33
303	65.646	16.781	267.006	266.976	266.918	358.80	358.85	359.02
190	65.649	16.778	266.630	266.599	266.538	359.55	359.60	359.79
199	65.648	16.776	266.370	266.338		359.80	359.86	
193	65.650	16.752	267.228	267.207	267.150	359.08	359.14	359.35
302	65.649	16.748	267.092	267.070	267.005	359.40	359.47	359.67
234	65.640	16.371	261.836	261.807	261.802			
263	65.644	16.122	261.115	261.127	261.119			

[b] All values refer to the datum introduced by Kanngieser (1982a). The gravity system is compatible with the IGSN 71
[c] The values before 1978 are given in Kanngieser (1982a)

Appendix 3. Gravity and height values[b,c] 1978, 1979, 1980 and 1981 along the central Gjástikki profile

Station no.	ϕ (°)	λ west (°)	g(78) (10^{-5} ms^{-2})	g(79) (10^{-5} ms^{-2})	g(80) (10^{-5} ms^{-2})	g(81) (10^{-5} ms^{-2})	H(78) (m)	H(79) (m)	H(80) (m)	H(81) (m)
			982...	982...	982...	982...				
704	65.847	16.822			258.981	258.977			477.77	477.79
703	65.845	16.813			263.472	263.480			462.80	462.82
702	65.843	16.804			265.417	265.424			454.72	454.73
701	65.842	16.798			266.804	266.820			447.37	447.36
538	65.840	16.793	268.486	268.407	268.325	268.333	438.60	439.15	439.40	439.39
539	65.840	16.792	269.221	269.148	269.066	269.068	434.94	435.50	435.75	435.74
544	65.840	16.791	268.583	268.495	268.433	268.428	434.97	435.53	435.78	435.77
545	65.840	16.790	275.116	275.053	274.991	274.971	407.06	407.53	407.78	407.83
548	65.838	16.781	278.347	278.340	278.304		394.54	394.58	394.82	
549	65.837	16.776	278.715	278.652	278.590		391.61	391.89	392.27	
550	65.836	16.771	278.250	278.194			392.79	392.95		
552	65.835	16.763	278.164	278.174			389.58	389.30		
553	65.834	16.759	278.150	278.175			389.20	388.86		
554	65.834	16.758	275.806	275.849			399.06	398.70		
556	65.833	16.753	275.055	275.101	275.108	275.008	401.93	401.57	401.53	401.66
558	65.831	16.745	271.219	271.087	270.908	270.883	417.37	417.89	418.34	418.50
592	65.830	16.741	270.193	270.092	269.963	269.958	422.45	422.94	423.38	423.54
61	65.829	16.736	266.733	266.648	266.523	266.509	430.92	431.47	431.85	432.02

Appendix 4. Gravity values[b] along the Hverfjall profile (800...840), the northern (850...880 and 284) and southern (399...601) Gjástikki profile and Lyngás profile (801–832)

Station no.	ϕ (°)	λ west (°)	g(78) (10^{-5} ms^{-2})	g(79) (10^{-5} ms^{-2})	g(80) (10^{-5} ms^{-2})	g(81) (10^{-5} ms^{-2})
			982...	982...	982...	982...
800	65.611	16.921			277.103	277.098
820	65.606	16.897			277.096	277.103
830	65.611	16.855			263.612	263.627
840	65.603	16.805			261.724	261.733
850	65.857	16.790			266.634	266.650
860	65.859	16.768			274.184	274.126
870	65.860	16.756			271.590	271.610
880	65.862	16.744			273.774	273.792
284	65.866	16.705			276.182	276.198
399	65.820	16.742			264.776	264.759
401	65.821	16.746			268.895	268.860
499	65.825	16.759			272.431	
501	65.827	16.770			274.664	
502	65.829	16.782			275.564	
599	65.831	16.796			269.313	269.225
601	65.832	16.801			269.452	269.447
801	66.049	16.637	376.298	376.253	376.263	376.283
802	66.043	16.608	377.604	377.559	377.571	377.570
808	66.040	16.594	376.148	376.126	376.136	376.147
805	66.041	16.593	377.035	377.000		376.576
832	66.041	16.590	376.687	376.661	376.655	376.669
804	66.037	16.570	376.593	376.551	376.555	376.562

Appendix 5. Gravity values[b,c] 1978, 1979, 1980 and 1981 along the Gjástikki-Kelduhverfi profile

Station no.	ϕ (°)	λ west (°)	g(78) (10^{-5} ms^{-2})	g(79) (10^{-5} ms^{-2})	g(80) (10^{-5} ms^{-2})	g(81) (10^{-5} ms^{-2})
			982...	982...	982...	982...
284	65.866	16.705	276.322	276.234	276.182	276.198
285	65.885	16.674	283.304	283.190	283.139	283.155
286	65.904	16.678	292.251	292.152	292.125	292.123
289	65.948	16.662	320.667	320.701	320.676	320.687
290	65.971	16.660	331.023	331.010	331.007	331.015
291	65.992	16.655	345.415	345.389	345.395	345.405
293	66.022	16.637	367.436	367.424	367.437	367.430
294	66.040	16.627	374.391	374.385	374.383	374.388
295	66.056	16.643	374.554			
296	66.074	16.689	382.581	382.582	382.575	382.590
297	66.076	16.716	382.181	382.169	382.165	382.168
298	66.099	16.689	383.707	383.679	383.680	383.685
299	66.123	16.730	389.373			
301	66.123	16.730	389.282	389.271	389.274	389.273