Listed Diabas Dike, Density, and Gravity

by

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It is well known that several diabas dikes exist on Bornholm, the width of the dikes varying from 60 meters to a few centimeters. In a previous paper (SAXOV 1958) gravimetric determinations of the best known diabas dike, Keldseå dike, have been reported, the width of the dike being 60 meters.

Another well known diabas dike is the Listed dike. The diabas is seen in its full width of 30 meters on the coast at Gulehald, Listed and can be seen again at Tamperdal in Paradisbakkerne, the width now being 20 meters. The distance between the two outcropping places is 5–6 km. Diabas has also been found in a well about 500 meters south af Gulehald (CALLISEN 1934).

The most southerly part of the dike is surrounded by Paradisgranite. KALB (1914) has determined the density of the Paradisgranite to a value of 2.765 gms/cc. The most northerly part of the dike is encirled by Svaneke granite (CALLISEN 1956). The density of Svaneke granite is given as 2.706 gms/cc (CALLISEN 1934). The sample, however, is taken at Ibskirke, which is about 3 km from Gulehald. In order to determine the density of the granite and the diabas at Gulehald, samples were collected and density determinations carried out. Likewise samples of Paradisgranite were collected at Slamrebjerg. The results together with previous values are given in Table 1.

Table 1

Locality	Density	Reference
Diabas at Gulehald, Listed[1]	2.83 gms/cc	
Diabas at Gulehald, Listed[1]	2.77	
Granite at Gulehald, Listed[1]	2.64	
Granite at Ibskirke	2.706	CALLISEN 1934; SOLE MUNCK & NOE-NYGAARD 1942.
Granite at Paradisbakkerne[2]	2.765	KALB 1914; SOLE MUNCK & NOE-NYGAARD 1942.
Granite at Slamrebjerg, Para-disbakkerne[1]	2.73	

[1] Samples collected by V. MÜNTHER; density determination by J. HJELME & SVEND SAXOV.

[2] KALB does not indicate the localities where the samples are collected, but we consider it most likely that the samples are collected in Paradisbakkerne and not at Slamrebjerg.

Table 2.

Name of Profile	Stati-on No.	North-ern Lati-tude	Longi-tude east from Greenwich	Height in meters	Densi-ty gms/cc	Normal Gravity in Gals	Gravity in Gals[1]	B. C. in mGals	Bouguer anomaly in mGals
		φ	λ	H	θ	γ_0	g	B. C.	Δg
Listed	5	55°08.′61	15°06.′91	11.72	2.64	981.52675	981.56053	2.32	+36.10
Vasebro	15	08.25	07.07	35.97	2.64	52625	55526	7.13	+36.14
Ibskirke	1	07.25	06.22	60.81	2.71	52483	54951	11.87	+36.55
Hagelbjerg....	11	06.67	06.17	70.32	2.76	52402	54779	13.58	+37.35
Paradisgaarde .	17	06.20	06.09	74.74	2.76	52335	54742	14.43	+38.50

[1]) based upon Rønne K^e g = 981.53177 Gals

A series of gravimetric profile measurements were carried out by means
of Worden gravimeter No. 142. The gravity values of the traverses referred
to Rønne K^e g = 981.53177 Gals (SAXOV 1945 & 1955). In Table 2 the
principal facts of one station in each profile are listed, columns being ar-
ranged in the usual manner. The height of the stations has been determined
by levelling between bench-marks; the coordinates are taken from the
topographical maps on the scale of 1:20000 and normal gravity values
from the tables by EINAR ANDERSEN (1956). Density values are listed in
column 6. A value of 2.64 gms/cc is used for the profiles Listed and
Vasebro, 2.71 gms/cc for profile Ibskirke, and 2.76 gms/cc for the profiles
Hagelbjerg and Paradisgaarde. By plotting the Bouguer anomalies
on the gravity map of Bornholm (SAXOV 1945) one will see that the
anomalies fit into the isogal contour map with only minor differences in a
few of the curves.

The stations in the profiles are measured twice except the last station.
In this way the drift of the gravimeter is kept under control. The distribu-
tion of the deviations is given in Table 3, which also contains the mean
error.

Table 3

Difference Backwards–Forwards		
B—F	Number	
+0.04 mGals	1	
+0.03	3	
+0.02	9	
+0.01	12	$[vv] = 0.0176$
0.00	21	$n = 71$
−0.01	14	$\dfrac{[vv]}{n-1} = 0.000251$
−0.02	7	
−0.03	3	$m = \pm 0.016$ mGals
−0.04	1	

Assuming the same exactness of the Bouguer correction and theoretical gravity as stated for Keldseå diabas dike we obtain a mean error for the Bouguer anomalies of

$$m_{\Delta g} = \pm 0.02_1 \text{ mGals.}$$

For Keldså diabas dike we found $m_{\Delta g} = \pm 0.02_3$ mGals.

Five gravity profiles were established. The stations are numbered, station No. 1 being the most westerly. In the following tables the Bouguer anomalies are given together with the distances. Following upon the tables the corresponding figures are shown.

Profile Listed is situated at the main road (coast road) Svaneke–Gudhjem. Station No. 5 is 110 meters east of No. 1 which is at the fork to Lillehøj. Density 2.64 gms/cc.

Table 4

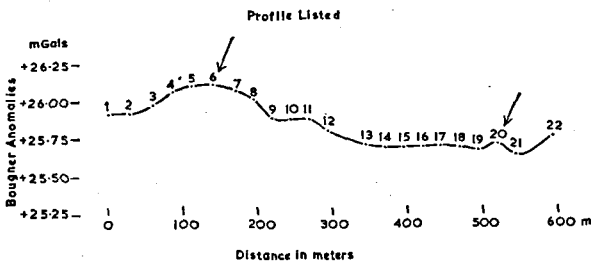| Station No.	Distance	Bouguer anomaly
1	0 m	+35.92 mGals
2	30	35.92
3	60	35.98
4	85	36.07
5	110	36.10
6	140	36.12
7	170	36.07
8	195	36.01
9	220	35.89
10	245	35.88
11	270	35.88
12	295	35.80
13	345	35.72
14	370	35.70
15	395	35.70
16	420	35.70
17	445	35.71
18	470	35.70
19	495	35.67
20	520	35.72
21	545	35.64
22	595	35.76

Profile Listed

Fig. 1.

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Profile Vasebro is situated at the main road Svaneke–Almindin-gen–Rønne. Station No. 15 is at the approach to the farm immediately east of the brook, Vaseå. Density 2.64 gms/cc.

Table 5

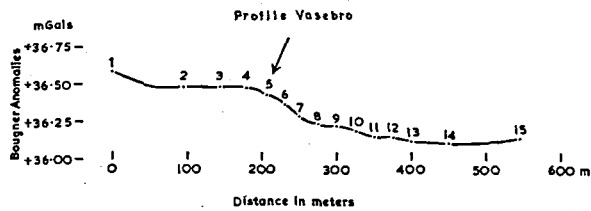| Station No.	Distance	Bouguer anomaly
1	0 m	+36.59 mGals
2	95	36.48
3	145	36.49
4	180	36.48
5	205	36.44
6	230	36.37
7	250	36.28
8	275	36.24
9	300	36.23
10	325	36.20
11	350	36.15
12	375	36.15
13	400	36.12
14	450	36.12
15	545	36.14

Fig. 2.

Profile Ibskirke is situated at the main road Neksø–Ibsker–Østermarie. Station No. 11 is the most easterly station and close to the bend of the road. Density 2.71 gms/cc.

Table 6

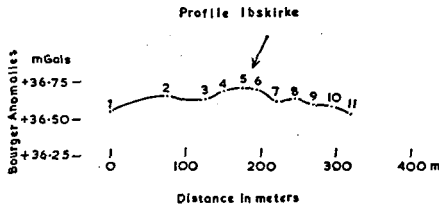| Station No.	Distance	Bouguer anomaly
1	0 m	+36.55 mGals
2	75	36.66
3	125	36.64
4	150	36.69
5	175	36.71
6	195	36.70
7	220	36.62
8	245	36.64
9	270	36.60
10	295	36.58
11	320	36.53

Fig. 3.

Profile Hagelbjerg is situated at the parish road from Hagelbjerg to Timannegaard. Station No. 11 is the most easterly station and off the parish road from Østerli to Bertelsgaard. Density 2.76 gms/cc.

Table 7

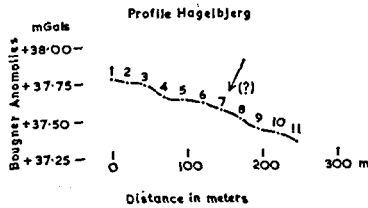| Station No.	Distance	Bouguer anomaly
1	0 m	$+37.78$ mGals
2	20	37.76
3	45	37.74
4	70	37.66
5	95	37.64
6	120	37.62
7	145	37.56
8	170	37.51
9	195	37.44
10	220	37.41
11	245	37.35

Fig. 4.

Profile Paradisgaarde is situated at the parish road from Paradisgaarde to Bertelsgaard. Station No. 17 is the most easterly station and off the parish road from Hagelbjerg to Paradisgaarde. Density 2.76 gms/cc.

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Table 8

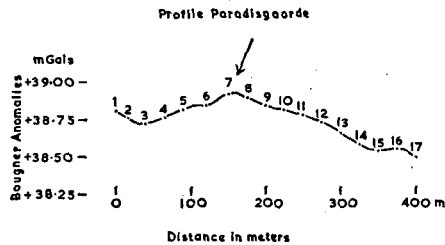| Station No.	Distance	Bouguer anomaly
1	0 m	+38.81 mGals
2	15	38.76
3	40	38.72
4	65	38.76
5	90	38.82
6	120	38.84
7	150	38.92
8	175	38.89
9	200	38.84
10	225	38.81
11	250	38.77
12	275	38.73
13	300	38.66
14	325	38.58
15	350	38.54
16	375	38.56
17	400	38.50

Fig. 5.

An inspection of the profiles, Fig. Nos. 1 to 5, reveals the crossings of the diabas dike. The points are marked by arrows. In Fig. 6 we have plotted the profile stations and a line is drawn indicating the dike. Furthermore the outcropping places are indicated by arrows. It is seen that the line is straight from Gulehald to Ibskirke, followed by a slight bend fitting into profile Hagelbjerg; from Hagelbjerg the line bends slightly fitting into a straight line through profile Paradisgaarde and the outcrops at Tamperdale. The lastmentioned bend may be regarded as a displacement of the dike. The Paradisbakke granite region is probably a horst which might conceivably have caused the displacement.

Considering that the density contrast diabas-granite is of the order 0.15 gms/cc at Gulehald and 0.05 gms/cc at Paradisbakkerne and at the same time taking the modification of the width of the dike into consideration, it is not surprising that the gravimetric effect changes from 0.25 mGals in the northern end of the dike to about 0.10 mGals in the southern end. The gravimetric results confirm the theoretical investigation carried out for the Keldseå diabas dike, viz. that a modification of the density contrast between diabas and granite causes a marked gravimetric
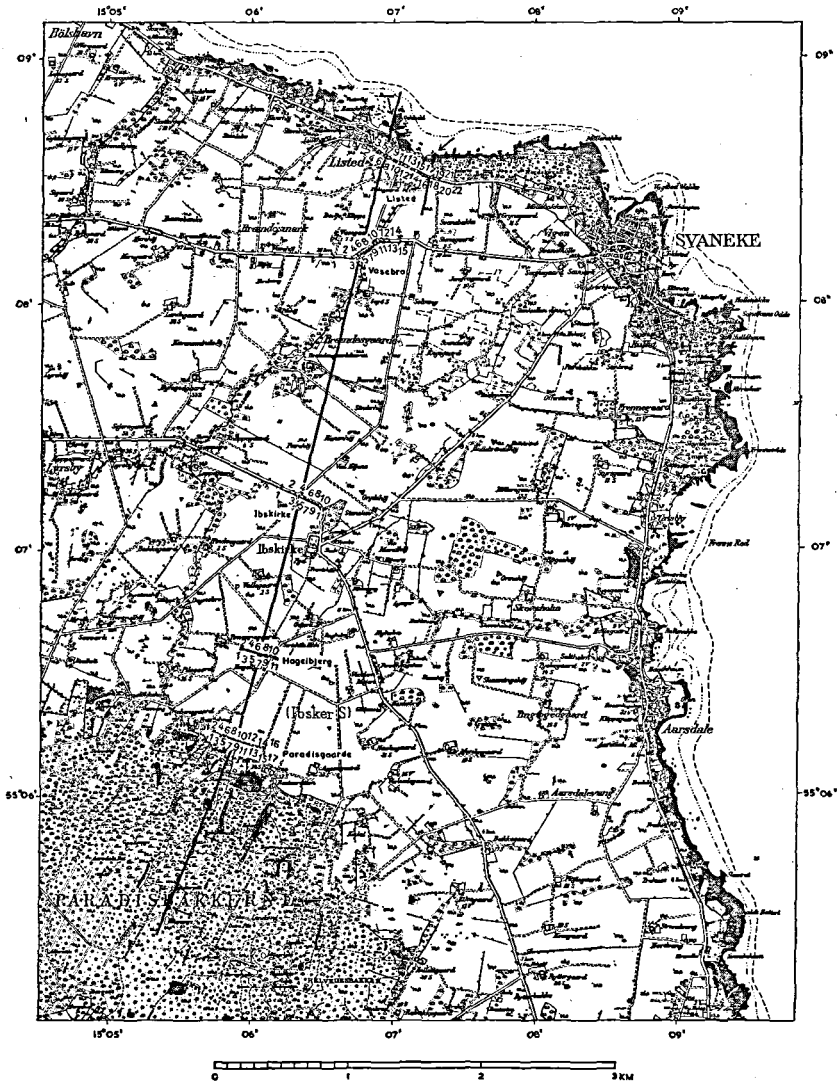
Fig. 6. The line indicates the Listed diabas dike. The arrows indicate the places where diabas is outcropping. The names and the stations of the profiles are stated. Map sheet no. 5236, Svaneke. Authorized by the Geodetic Institute of Denmark.

difference. The gravimetric results of 0.50 mGals obtained for the Keldseå diabas dike, having a width of 60 meters and a density contrast of 0.30 gms/cc, are in agreement with the recent results for the Listed dike.

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The drawings are carried out in the topographical division of the Danish Geodetic Institute.

DANSK RESUMÉ

Diabasgangen ved Listed er fremme i dagens lys ved Gulehald i en bredde af 30 m, og den træffes atter ved Tamperdal i Paradisbakkerne i en bredde af 20 m. Desuden er den fundet i en brønd ca. 500 m syd for Gulehald.

Diabasgangen løber i Svanekegranit i den nordlige ende og i Paradisbakkegranit i den sydlige ende. Da der kun forelå to vægtfyldebestemmelser i det omhandlede område, blev der foretaget yderligere bestemmelser. Disse sammen med de tidligere værdier er nævnt i tabel 1. Ved beregningen er derefter benyttet værdien 2.64 g/cm³ for de to nordligste profiler, 2.71 g/cm³ for den midterste og 2.76 g/cm³ for de to sydligste.

Tabel 2 giver data for de 5 gravimetriske profiler, og i tabel 3 er sammenstillet resultatet af gentagelsesmålinger. Det ses, at middelfejlen på en Bouguer anomali ikke overstiger ±0.021 mgal.

Resultaterne for de enkelte profiler er vist i tabellerne 4—8 og figurerne 1—5, og på figur 6 er resultaterne sammentegnede. Diabasgangen forløber retlinet fra Gulehald til Ibskirke fulgt af en svag bøjning til Hagelbjerg og af en ny bøjning gennem Paradisgaarde og Tamperdal. Denne sidste bøjning er muligvis en forkastning af diabasgangen, idet Paradisbakkeområdet må opfattes som en horst og muligvis har forårsaget forkastningen. Det gravimetriske udslag er på ca. 0.25 mgal ved Gulehald, hvor vægtfyldeforskellen er ca. 0.15 g/cm³ og diabasgangens bredde 30 m, medens det kun er ca. 0.10 mgal ved Paradisgaarde, hvor vægtfyldeforskellen er ca. 0.05 g/cm³ og bredden ca. 20 m. De opnåede resultater stemmer pænt sammen med tidligere resultater for Keldseå diabasgang.

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