Geophysical measurements in Jeløya

By

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Summary

As a part of geological/geophysical student field courses a series of magnetic and gravimetric observations has been carried out at Jeløya. Geological samples have been collected and the physical properties of the samples have been determined in the laboratory.

The results of the surveys and the laboratory investigations are presented in form of figures.

Introduction

Geological Institute, Aarhus University, arrange every summer a compulsory field course in geological/geophysical mapping. The course is attended by students of geology and geography by preference in the summer following their second year of study. After consultation with Professor, Dr. St. Skjeseth, Geological Institute, NLH, Vollebekk, this course takes place in Østfold fylke, Norway. The courses commenced in 1965 at the road-cuttings in the Moss area along the new highway from Svinesund to Oslo. Reports on the geological results will be published on a later occasion. Geophysical measurements, i.a. gravimetric and magnetic observations, were undertaken in the same area in 1965 and extended in 1966 to include Jeløya. This report, which is considered preliminary, is concerned with the Jeløya survey. It is intended to make additional geophysical measurements later on and also to investigate the geological conditions in detail.

Geology

Jeløya belongs geologically to the Oslo field with young rocks, paleozoic and permian, downfaulted in the precambrian. The geological setting is shown on fig. 1, which is adopted from Brøgger and Shetelig (1926). The oldest

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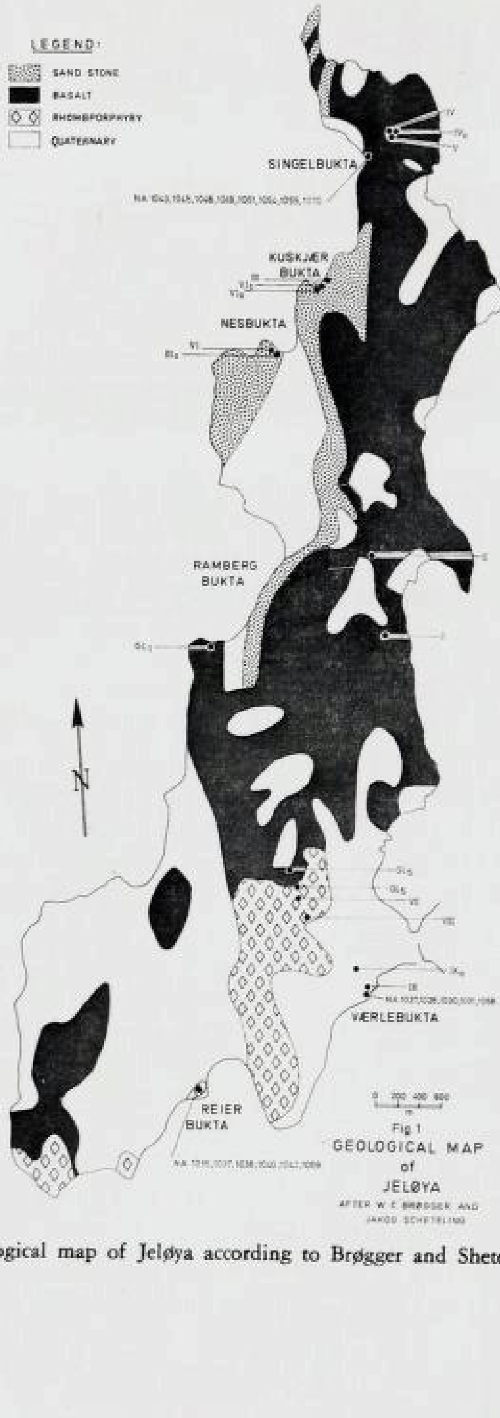

Fig 1. Geological map of Jeløya according to Brøgger and Shetelig (1926).

rocks on Jeløya are downtonian sandstone and conglomerate which occupies the western part of the island, and having a gentle dip towards the east. On top of these lies permian basalt (B_1), which covers the main part of the island. The youngest rocks are the permian rhomb-porphyries (Rp_1) with outcrops in the southern part of the island. The above mentioned faultline runs east of the island in a north-south direction. Where no outcrops are shown on the map, the rocks are covered with quaternary clay, sand, and moraine.

Table 1 shows the rocksamples which were taken and analysed for their physical properties. The localities are shown on both fig. 2 and fig. 3 together with density values on the gravimetric map and susceptibility on the magnetic map. It should be noticed that the samples with numbers beginning with NA are taken for paleomagnetic measurements and that is why many samples are taken at the same locality. Samples GL 6 and II, which both are basalts, seem to differ a little from the rest in that group. Sample GL 6 is a porous type and strongly zeolitised, sample II is a basalt with phenocrysts of plagioclase and it seems to differ from the rest only by having a more reddish groundmass. A more detailed study of the petrographic properties of the rocks compared to their physical properties will be made in the near future.

Gravity

The gravimetric readings have been carried out by means of Worden gravimeters 142 and M 779. The observations are referred to Oslo Fundamental Gravity Stations with G = 981.92815 gals. A density value of 2.67 gr/cm^3 has been employed. The coordinates are taken from the topographical maps in the scale of 1 : 5 000, the reference point being Jeløya radio $\varphi = 59°26'00''$ and $\lambda = 10°35'42''$ E Grw. The elevation values are taken partly from polygon-points, the heights being known in millimetres or centimetres, and partly from dot-points in the topographical maps, the heights being in metres or half-metres. Topographic correction is not applied.

Two stations determined by the Geographical Survey of Norway, station G 36 top 3 Jeløya radio $\varphi = 59°26'00''$, $\lambda = 10°35'70''$ E Grw, h = 0.1 m, G = 981.90938 gals, and Bouguer anomaly + 30.15 mgals, and G 36 top 4 Nestangen $\varphi = 59°28'93''$, $\lambda = 10°38'57''$ E Grw, h = 0.3 m, G = 981.90820 gals, and Bouguer anomaly + 25.14 mgals are included in the map. We have measurements very close to these stations, No. 173 with an anomaly of + 30.03 mgals, and No. 4 with an anomaly of + 26.07 mgals. The agreement between the two sets of observations must be considered satisfactory.

In fig. 2 the Bouguer anomalies are plotted and isogal contours are drawn, the equidistance being 1 mgal. The general trend is decreasing anomalies from

Table 1

Sample No.	Rock-Type	Locality	Density g/cm³	Remanent Magnetiz. cgs	Suscepti-bility cgs	Q
VII	Rhomb-Porphyry	Vardeveg	2.56	0.00016	0.00016	1.95
NA 1035	—	Reierbukta	2.56	0.00006	0.00012	1.00
NA 1068	—	Værlebukta	2.61	0.00156	0.00032	9.64
NA 1069	—	Reierbukta	2.56			
NA 1037	—	—	2.56			
NA 1038	—	—	2.56			
NA 1040	—	—	2.56			
NA 1042	—	—	2.56			
VIII	—	Vannbasseng	2.60	0.00012	0.00004	5.07
IX	—	Værlebukta	2.60	0.00129	0.00006	39.92
GL 5	—	Vardeveg	2,61			
NA 1027	—	Værlebukta	2.61	0.00084	0.00054	3.10
NA 1028	—	Værlebukta	2.61	0.00036	0.00007	10.08
NA 1030	—	—	2.61	0.00113	0.00010	22.87
NA 1031	—	—	2.61	0.00082	0.00016	10.08
IX a	—	200 m NW of Værlebukta	2.64	0.00114	0.00179	1.27
GL 6	Basalt	Orkerød	2.62			
GL 1	—	Rambergbukta	2.73			
NA 1043	—	Singelbukta	2.74	0.00089	0.00236	0.76
NA 1045	—	—	2.74	0.00047	0.00233	0.41
NA 1048	—	—	2.74	0.00040	0.00299	0.27
NA 1049	—	—	2.74	0.00036	0.00278	0.27
NA 1051	—	—	2.74	0.00078	0.00140	1.11
NA 1054	—	—	2.74	0.00041	0.00341	0.24
NA 1055	—	—	2.74	0.00062	0.00330	0.38
NA 1070	—	—	2.74	0.00032	0.00419	0.16
IV	—	300 m NNE of Singelbukta	2.76	0.00233	0.00565	0.83
V	—	—	2.77	0.00202	0.00655	0.63
IV a	—	—	2.78	0.01484	0.00503	6.03
I	—	Nesvegen	2.79	0.00117	0.00008	26.19
II	—	Kjellandsvik	2.87	0.00209	0.00439	0.96
VI	Sandstone	Nesbukta	2.63			
III	—	Kuskjærbukta	2.64			
III a	—	Nesbukta	2.65			
VI b	—	Kuskjær	2.67			
VI a	—	—	2.69			

west to east. The peak value + 31.09 mgals is obtained in the south-western part of the island, while the lowest value of + 21.81 mgals is to be found at the northern end. The general trend is also seen at the gravimetric map Oslo-Feltet (NGO, 1960).

The location of the samples listed in table 1 are plotted on fig. 2 and the corresponding density values are listed. Rhomb-Porphyry samples have values from 2.56 to 2.64 gr/cm^3, the mean being about 2.60 gr/cm^3. Basalt runs from 2.62 to 2.87 gr/cm^3; sample GL 6 with 2.62 gr./cm^3 and sample II with 2.87 gr/cm^3 are not considered representative for basalt; the mean value of the remaining samples is about 2.76 gr/cm^3. Sandstone varies from 2.63 to 2.69 gr/cm^3, the mean value being 2.66 gr/cm^3.

Magnetic Measurements

An Askania (GfZ) torsion magnetometer with a scale constant of 230 γ per scale division, where the vertical component Z can be measured with an accuracy of ± 10 gamma, was used for the magnetic investigation. The field work was carried out in July 1966 during seven days and it covered most of the area. The points measured lie mostly along roads and around the coast. The distance between the points measured varies from 200 - 500 m. A main base station at Ås (NLH) was established, and five sub-base stations in the Jeløya have been selected, being remeasured two to three times a day.

Fig. 3 shows the magnetic map of $\triangle$ Z. The anomaly contours are marked in gamma units. The location of the samples and the magnetic properties of the analysed samples which have been measured by means of an oerstedmeter are listed in table 1 and plotted on fig. 3.

Rhomb-Porphyry samples have remanent magnetization and susceptibility values from 0.00006 to 0.00156 cgs, the mean being 0.00074 cgs and 0.00032 to 0.01484 cgs, the mean being 0.00105 cgs, respectively.

Basalt samples have RM values from 0.00004 to 0.00179 cgs, the mean is 0.00033 cgs and susceptibility value from 0.00008 to 0.00655, the mean being 0.00339 cgs. From these values it is seen that the basalts are stronger magnetised than Rhomb-Porphyry and that basalts also have higher susceptibility.

Because of the complexity in magnetic anomalies only representative curves are drawn. More variation and non-uniformity in the magnetic intensity can be seen from the values. This is accounted for inhomogenity in the rocks.

It is worth noting that basalt sample II with rather strong magnetic properties is situated close to the local magnetic maximum of 1550 γ while basalt sample I with very weak magnetic properties is placed close to the even stronger magnetic maximum of 3150 γ.

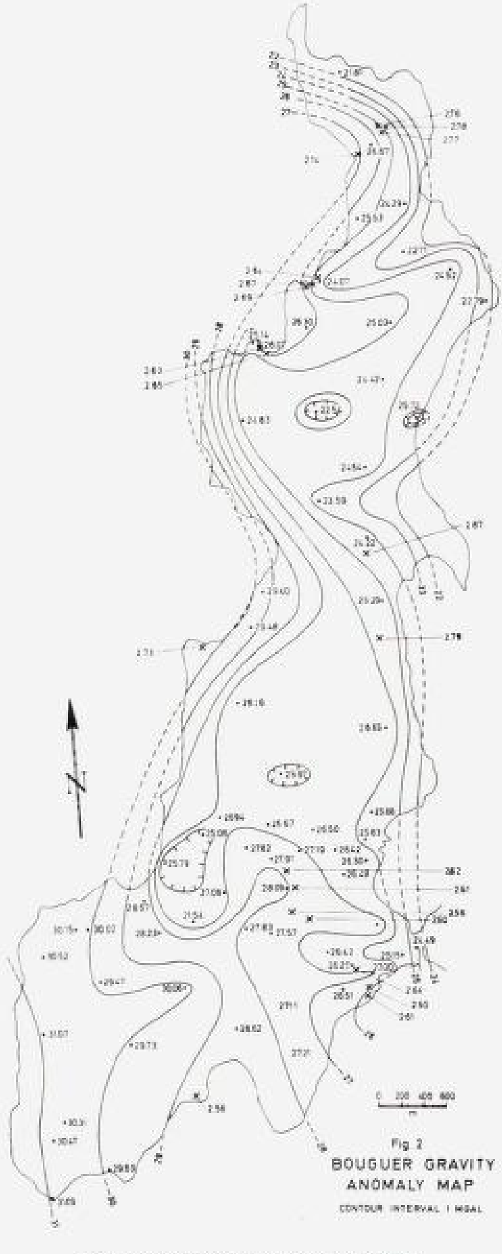

Fig. 2. Gravimetric map of Jeløya.

Discussion

By a comparison of the geological picture (fig. 1) and the isogal contour picture (fig. 2) a certain correlation can be seen; i.g. the minimum of 26 mgals between the two basaltic blocks and the minimum of 26 mgals in the midst of the basaltic block; see also the gravimetric features in the sandstone area. Large parts of the Jeløya island is covered by overburden, and it is the intention by geophysical means to determine this thickness during the coming field season. More discussion concerning this problem is therefore to be taken up on a later occasion.

The magnetic anomaly picture is characterized by rapid changes of several hundred gammas. Some of the anomalies can be correlated to the geological formations. The very strong, local maxima must be due to special conditions in the basalts.

The correlation between the gravimetric and the magnetic anomalies is but small. Certain trends can be seen, however, before either more details of geophysical data or a reworked geological map are present, and at the same time the geological/geophysical conditions in Jeløya can be considered together with similar conditions in the main-land area there is no purpose in studying the present figures.

References

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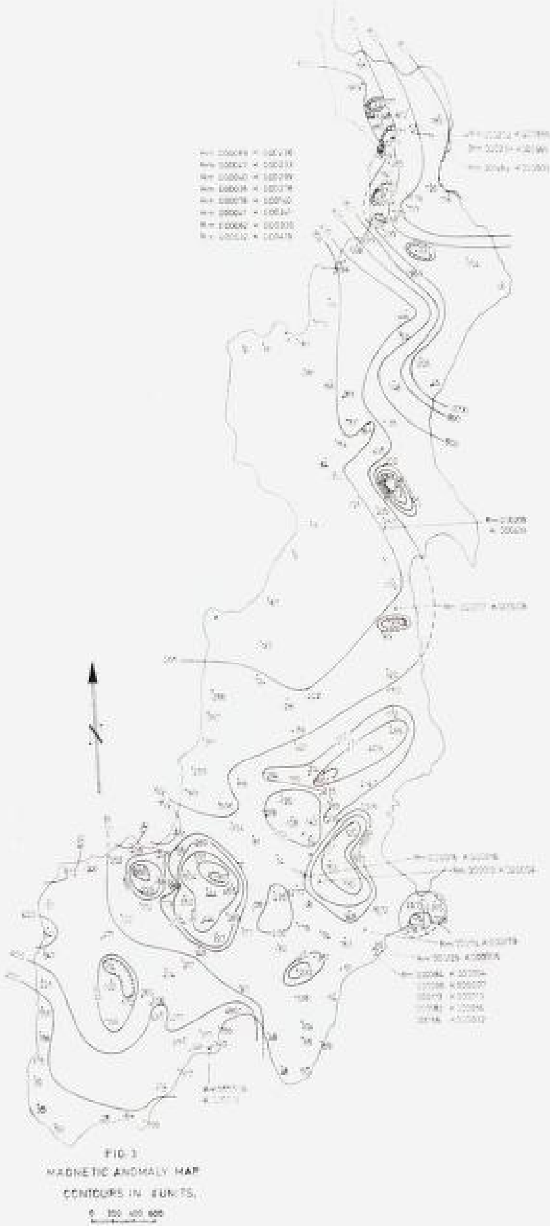

Fig. 3. Magnetic vertical intensity map of Jeløya.

Appendix

Bouguer anomalies computed in the usual manner, being referred to Oslo Gravity Fundamental Station G = 981.92815 gals, the International Formula of 1930 being applied as far as the normal gravity in gals in the surface of the sea is concerned, and a density value of 2.67 gr/cm^3 being employed. Elevations are either levelling points or dot-points from the 1 : 5 000 topographical maps.

No topographic correction is applied.

Station No.	φ	λ	H	G	Bouguer Anomalies
2	59°25′.76	10°39′.20	2.4 m	981.90295 gals	+ 24.49 mgals
3	24.84	36.19	1.0	90714	+ 29.63
4	27.91	38.16	0.5	90774	+ 26.07
5	27.51	39.77	0.5	90542	+ 25.72
31	26.74	37.99	100.22	88647	+ 25.97
32	26.38	38.28	53.129	89579	+ 26.50
33	26.29	38.46	42.486	89768	+ 26.42
34	26.15	38.51	29.120	90021	+ 26.49
35	26.19	38.81	16.603	90253	+ 26.30
36	26.41	38.80	31.053	89951	+ 25.83
37	26.56	38.93	34.204	89914	+ 25.88
38	26.83	39.11	37.669	89957	+ 26.65
39	26.24	38.19	59.83	89485	+ 27.19
40	26.24	37.81	76.293	89233	+ 27.91
41	26.33	37.84	79.197	89178	+ 27.82
42	26.51	37.93	85.971	88966	+ 26.67
43	26.02	37.97	80.339	89153	+ 28.09
44	25.86	37.92	59.491	89487	+ 27.57
45	25.92	37.48	42.352	89863	+ 27.83
46	25.96	37.08	36.381	89958	+ 27.54
47	25.94	36.77	28.773	90173	+ 28.23
48	25.76	38.33	32.804	89889	+ 26.42
49	25.52	38.34	15.321	90211	+ 26.51
50	25.45	37.94	46.033	89657	+ 27.11
51	25.58	38.67	8.626	90396	+ 27.00
52	25.71	38.73	12.932	90252	+ 26.20
53	25.73	39.11	7.512	90256	+ 25.15
54	25.85	38.85	11.250	90312	+ 27.14
93	30.25	39.28	10	90470	+ 21.81
94	29.88	39.42	45	90218	+ 26.67
95	29.58	39.74	25	90336	+ 24.29
96	29.31	39.78	44	89767	+ 22.71
97	29.18	40.23	50	89813	+ 24.52

Station No.	φ	λ	H	G	Bouguer Anomalies
98	29.08	40.58	5	90513	+ 22.79
99	29.01	39.47	90	89053	+ 25.03
100	28.73	39.35	59	89565	+ 24.42
101	29.54	39.24	25	90433	+ 25.33
157	27.42	39.18	25	90149	+ 25.29
158	27.83	39.03	35	89900	+ 24.22
159	28.08	38.54	20	90157	+ 23.59
160	28.54	37.92	10	90546	+ 24.83
161	28.58	38.63	15	90225	+ 22.54
162	29.20	38.78	5	90656	+ 24.07
163	28.98	38.60	25	90456	+ 26.30
164	28.24	39.10	65	89405	+ 24.64
165	27.75	38.12	2.5	90604	+ 29.40
166	27.50	37.85	30	90480	+ 29.48
167	27.07	37.60	84	89068	+ 26.54
168	26.09	37.32	44	89779	+ 27.08
169	26.36	36.83	2	90512	+ 25.79
170	26.43	37.18	20	90096	+ 25.08
171	26.64	37.37	100	88734	+ 26.94
172	26.11	36.58	20	90403	+ 28.57
173	25.92	35.81	19	90542	+ 30.02
174	25.74	36.08	20	90444	+ 29.47
175	25.39	36.31	20	90423	+ 29.73
176	25.65	36.92	20	90491	+ 30.06
177	25.39	37.35	12	90470	+ 28.62
178	25.22	38.08	20	90149	+ 27.21
367	25.82	35.54	7.5	90806	+ 30.52
368	25.56	35.45	10	90776	+ 31.07
369	25.10	35.77	35	90145	+ 30.31
370	25.07	35.60	75	89366	+ 30.47
371	24.78	35.64	0.5	90779	+ 31.09