NGU Report 96.061

Interpretation of a gravity profile across the Engebøfjellet rutile-bearing eclogite deposit

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REPORT

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Title:
Interpretation of a gravity profile across the Engebøfjellet rutile-bearing eclogite deposit

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County: Sogn & Fjordane	Commune: Fjaler
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Fieldwork carried out:	Date of report:	Project no.:	Person responsible:
September -95	2/5-1996	67.1900.05	[signature]

Summary:

As a part of a collaborative project with DuPont, NGU has made gravity measurements across the eastern part of the Engebøfjellet rutile-bearing eclogite deposit in Fjaler commune, Sogn & Fjordane county. The main objective of the investigations was to delineate the morphology and subsurface extension of the eclogite body through gravity modelling. Gravity measurements were made at 39 stations along one 775 m long profile.

Two alternative models are proposed in the interpretation of the gravity data. The first model (model 1) has one eclogite body with a density of 3400 kg/m^3 and a dip of 70-75° towards north-north-west. The length along the dip is on the order of 350-400 m. The average width (horizontal cross section) of the body is c. 90 m, and it seems to become thicker towards the surface. The length of the modelled eclogite in the strike direction is set to 1200 m (although the eclogite is longer and wider towards west, but this has little or no effect on the calculated model response). With the dimensions given above, the total volume of the modelled body is c. $40 \cdot 10^6$ m^3 equivalent to a mass of c. 136 Mt.

Model 2 was constructed to get a better match between the calculated model response and the observed Bouguer anomaly values for some stations. An additional body had to be added to the south and in the close vicinity of the main eclogite body to get a better match. However, it was found that the stations in question suffered from erroneous or insufficient terrain corrections due to severe topography, and that these stations should be taken into little or no account in the modelling. The introduction of the additional body in model 2 thus seemed unlikely.

Keywords: Geofysikk	Gravimetri	Eklogitt
Rutil	Modellforsøk	
		Fagrapport

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MAPS

1 INTRODUCTION

As a part of a collaborative program between NGU and DuPont on the investigation of rutile-bearing eclogites in Western Norway, gravity measurements have been made along one profile across the eastern part of the Engebøfjellet deposit in Fjaler commune, Sogn & Fjordane county. The main objective of the investigations was to delineate the morphology and subsurface extension of the eclogite body. Data acquisition was conducted by Jomar Gellein in September 1995. Data processing was conducted both by Jomar Gellein and Eirik Mauring, while interpretation was carried out by Eirik Mauring.

2 DATA ACQUISITION

Data acquisition was carried out using a LaCoste & Romberg gravity meter (model G No. 569). Measurements were made at 39 stations along one profile having a length of 775 m. The location of the profile and stations is shown in maps -01 and -02. The stations are labelled 1 to 39 from south to north on the map. The distance between stations is 25 m, except around the outcrop of the eclogite body where the distance was reduced to 12.5 m (stations 14-28). To correct for diurnal variations in the gravity field and instrument drift, base station readings were made before and after measurements along the gravity profile at a station located close to the profile (UTM 32W 3108 68228 ED50). This base station was tied to a gravity base station at Mo School of Agriculture in Førde (UTM 32W 3391 68149 ED50) where the value of absolute gravity was known. Hence, absolute gravity values for all 39 stations could be obtained. Station levelling was performed by Jomar Gellein and Jomar Staw (NGU).

3 PROCESSING

Bouguer anomaly values were calculated using software from the Norwegian Mapping Authority (Statens Kartverk, Mathisen 1976). Bouguer and terrain corrections were carried out using a standard density of 2670 kg/m^3. Within 1 km of each station, circle radii of 50, 100, 200, 400 and 800 m were used for terrain corrections. The relatively high number of circle radii was used due to severe topography in the area. For terrain corrections, 1:5000 scale maps were used as basis for manually reading elevations on the circle radii. In addition, elevations from the Norwegian Mapping Authority's database were used for terrain corrections. A table of terrain correction function values is shown in appendix 1. A table of co-ordinates, absolute gravity, corrections and Bouguer anomalies is shown in appendix 2. Prior to modelling the data, the regional gravity gradient was subtracted from the terrain corrected Bouguer anomaly values (see appendix 3). Modelling of the data was performed using the GMM

(Gravity and Magnetic Modelling) program from the Swedish Geological Co (1991). For the presentation of the models and the model response curves, the GRAPHER program from Golden Software Inc. was employed.

4 INTERPRETATION

Most of the background material for the interpretation is based on a report in preparation which covers results from a core-drilling program at Engebøfjellet (Korneliussen et al. 1996). Density values measured on samples from drillhole 1 (Dh1 in appendix 5 & 6) were applied in the modelling. According to Korneliussen et al. (1996), the massive eclogite body has an average density of 3400 kg/m^3, whereas the surrounding rocks (mostly banded amphibolitic eclogite with gneissic zones, and gneiss with eclogite layers) have an average density of 2850 kg/m^3. Along drillhole 1, fairly massive eclogite is found in a continuous length of ca. 90 m. Observations of geological structures at the surface indicate that the rocks are steeply dipping towards north-north-west (Korneliussen, pers. comm.). The main objective of the modelling was to delineate the morphology and subsurface extension of the massive eclogite body, given the constraints mentioned above.

Two alternative models are proposed in the interpretation of the gravity data. These are shown in appendices 5 and 6 (scale 1:5000). Number tags on the observed values refer to stations on map -02.

Model 1

Model, Bouguer anomaly values and the calculated response curve are shown in appendix 5. The calculated response from the model shows severe mismatch to the observed values between station 10 and 14 and for station 30. The observed value for station 30 is considered as noise. The mismatch for stations 10-14 is discussed and dealt with for model 2.

The modelled eclogite body has a dip of 70-75° towards north-north-west. In order to get a match to the observed values, the modelled eclogite body had to be made thicker towards the surface, given the constraints from drillhole 1 which intersects fairly massive eclogite in a length of c. 90 m. Furthermore, for the calculated response curve to reach the level of maximum observed value, the eclogite is modelled towards depth to a level of c. -200 m. Thus, the total length of the eclogite along its dip is in the order of 350-400 m. The lower part of the model is given a sawtooth pattern to indicate that the fairly massive eclogite probably has no abrupt termination towards depth. The length of the model in the strike direction is set to 1200 m, with 200 m to the east-south-east of the profile and 1000 m to the west-north-west. The model could be made longer, as this would have little or no effect on the calculated response. In fact, geological observations suggest a length of at least 2000 m. Also, geological mapping and core-drilling to the west of the profile show that the massive eclogite is thicker in this area

(Korneliussen et al. 1996). Given the dimensions of the eclogite body in the model, the total volume is c. $40 \cdot 10^6$ m^3 equivalent to a mass of c. 136 Mt.

Model 2

The model and its response curve are shown together with the observed Bouguer anomaly values in appendix 6. This alternative model was constructed in order to get a better match between the calculated response and the observed values for stations 10-14. An additional, shallow body had to be added to the model to accomplish this. The body was given a density of 3400 kg/m^3 to suggest the presence of an additional massive eclogite body. Some adjustments also had to be made on the near-surface part of the main eclogite body to achieve a good curve fit. The new model response now show better match for stations 10-14 than for model 1, at the cost of a poorer match for stations 15-17. In fact, the observed values change too abruptly in this area to get a perfect match. Given the rough terrain in this area, one might suspect that the local anomaly between station 10 and 14 could be due to erroneous or insufficient terrain corrections. To help resolve this problem, one has to compare the Bouguer anomaly values to the terrain correction values. In appendix 4, the two sets of values are plotted. The plot shows that the shape of the two curves yield good correlation between station 10 and 14. This indicates that the Bouguer anomaly values between station 10 and 14 could be affected by erroneous or insufficient terrain corrections as suspected. Thus, these values should be taken into little or no account when modelling. The relationship between erroneous terrain correction and its effect on the Bouguer anomaly values is even more profound for station 30, where a spike on the terrain correction curve corresponds to a spike on the Bouguer anomaly curve. Clearly, the Bouguer anomaly value for this point must be considered as noise.

From the above discussion, model 1 is probably more correct than model 2, as model 1 does not take stations 10-14 into account in the modelling. Furthermore, model 2 introduces an outcropping, additional massive eclogite body which would probably have been discovered by surface geological mapping, which is not the case.

5 CONCLUSIONS

Gravity measurements have been made at 39 stations along one profile across the eastern part of Engebøfjellet rutile-bearing eclogite deposit. Two alternative models are proposed in the interpretation of the gravity data.

The first model (model 1) has one eclogite body with a density of 3400 kg/m^3 and a dip of 70-75° towards north-north-west. The length along the dip direction is on the order of 350-400 m. The average width (horizontal cross section) of the body is c. 90 m, although it seems to be thicker towards the surface. The length of the model in the strike direction was set to 1200 m (although it is longer and wider towards west, but this has little or no effect on the calculated response). With the dimensions given above, the total volume of the modelled body is c. $40 \cdot 10^6$ m^3 equivalent to a mass of c. 136 Mt.

The alternative model 2 was constructed to get a better match between the calculated model response and the observed values for some stations. An additional body (with a density of 3400 kg/m^3, suggesting massive eclogite) had to be added to the south and in the close vicinity of the main eclogite body to get a better match. However, it was found that the stations in question suffered from erroneous or insufficient terrain corrections due to severe topography, and that these stations should be taken into little or no account in the modelling. The introduction of the additional body in model 2 thus seemed unlikely.

6 REFERENCES

Korneliussen, A., Furuhaug, L., Staw, J. & Fossflaten, G. 1996: Core-drilling at Engebøfjellet 1995/96; Dh1 to Dh5. *NGU Report 96.062 in prep.*

Mathisen 1976: Method for Bouguer reduction with rapid calculation of terrain corrections. *NGO. Geodetic publications no. 18.*

Swedish Geological Co. 1991: GMM. Interactive Gravity and magnetic modelling program. *User's manual.*

TABLE OF TERRAIN FUNCTION VALUES

TERRAIN CORRECTION INCREMENTS PR. KM RADIUS. CHECK AGAINST UNNORMAL VALUES

DISTANCE KM 0 0.002 0.068 0.23 0.59 0.90 1.28 1.75 2.29 2.87 3.52 5.24 8.44 12.4 18.8 28.8 58.8 99.0 166.7

																				CIRCLE
1	1	0.00	1.20	1.09	1.02	0.66	0.43	1.28	0.85	0.55	0.45	0.262	0.182	0.063	0.023	0.010	0.000	0.000	0.000	1.39
1	2	0.00	0.51	0.89	1.21	1.37	0.43	1.31	0.86	0.60	0.48	0.241	0.179	0.064	0.023	0.010	0.000	0.000	0.000	1.58
1	3	0.00	0.31	1.46	1.26	1.40	0.43	1.34	0.88	0.60	0.48	0.241	0.178	0.063	0.023	0.010	0.000	0.000	0.000	1.72
1	4	0.00	1.37	2.15	1.25	1.57	0.76	1.23	0.89	0.60	0.48	0.241	0.175	0.065	0.023	0.010	0.000	0.000	0.000	2.67
1	5	0.00	4.73	2.42	1.47	1.52	0.74	1.83	0.78	0.59	0.47	0.241	0.170	0.063	0.023	0.009	0.000	0.000	0.000	3.82
1	6	0.00	6.10	1.91	1.31	1.47	0.68	1.80	0.74	0.55	0.44	0.225	0.158	0.061	0.021	0.009	0.000	0.000	0.000	3.36
1	7	0.00	7.98	1.70	1.20	1.50	0.58	1.67	0.67	0.48	0.39	0.197	0.143	0.054	0.019	0.008	0.001	0.001	0.000	4.15
1	8	0.00	4.71	1.68	1.16	1.59	0.57	1.67	0.66	0.47	0.38	0.193	0.138	0.053	0.019	0.009	0.001	0.001	0.000	4.13
1	9	0.00	2.24	1.75	1.04	1.86	0.56	1.69	0.65	0.46	0.37	0.187	0.133	0.051	0.018	0.008	0.001	0.001	0.001	3.70
1	10	0.00	2.17	1.75	1.00	1.93	0.56	1.73	0.66	0.46	0.37	0.188	0.133	0.051	0.018	0.008	0.001	0.001	0.001	3.21
1	11	0.00	3.92	1.93	1.00	1.94	0.55	1.96	0.39	0.44	0.36	0.177	0.128	0.050	0.018	0.008	0.001	0.001	0.001	2.84
1	12	0.00	5.16	2.09	1.02	1.93	0.53	1.92	0.38	0.43	0.34	0.171	0.124	0.048	0.017	0.008	0.001	0.001	0.001	2.44
1	13	0.00	5.88	2.28	1.15	1.90	0.52	1.81	0.15	0.40	0.30	0.164	0.115	0.046	0.016	0.008	0.001	0.001	0.001	2.94
1	14	0.00	4.07	2.20	1.27	1.88	0.51	1.80	0.16	0.46	0.26	0.164	0.111	0.044	0.016	0.007	0.001	0.001	0.001	3.10
1	15	0.00	3.66	2.32	1.35	1.88	0.51	1.76	0.16	0.45	0.26	0.161	0.109	0.043	0.016	0.007	0.001	0.001	0.001	4.07
1	16	0.00	3.58	2.56	1.38	1.86	0.44	1.55	0.17	0.44	0.25	0.158	0.108	0.042	0.015	0.007	0.002	0.001	0.001	3.31
1	17	0.00	3.82	2.73	1.43	1.83	0.39	1.57	0.21	0.43	0.25	0.156	0.106	0.041	0.015	0.007	0.002	0.001	0.001	3.37
1	18	0.00	3.51	2.87	1.42	1.78	0.36	1.55	0.21	0.42	0.24	0.171	0.098	0.041	0.015	0.007	0.002	0.001	0.001	3.09
1	19	0.00	2.77	2.40	1.37	1.77	0.37	1.58	0.21	0.43	0.24	0.175	0.097	0.041	0.015	0.007	0.002	0.001	0.001	2.44
1	20	0.00	1.13	2.04	1.31	1.75	0.37	1.60	0.23	0.44	0.24	0.176	0.097	0.041	0.015	0.007	0.002	0.001	0.001	2.32
1	21	0.00	0.79	2.20	1.26	1.74	0.38	1.60	0.23	0.44	0.25	0.176	0.098	0.041	0.015	0.007	0.002	0.001	0.001	2.27
1	22	0.00	0.90	1.51	1.26	1.76	1.26	1.27	0.23	0.44	0.23	0.181	0.098	0.040	0.015	0.007	0.002	0.001	0.001	2.18
1	23	0.00	0.84	1.51	1.17	1.80	1.27	1.27	0.23	0.45	0.23	0.182	0.099	0.040	0.015	0.007	0.002	0.001	0.001	1.88
1	24	0.00	1.38	1.02	1.14	1.41	1.34	1.29	0.22	0.46	0.23	0.185	0.100	0.041	0.015	0.007	0.002	0.001	0.001	1.88
1	25	0.00	1.33	0.69	1.17	0.00	1.39	1.31	0.21	0.47	0.24	0.192	0.101	0.041	0.016	0.007	0.001	0.001	0.001	1.96
1	26	0.00	1.34	0.59	1.20	0.00	1.42	1.32	0.21	0.49	0.24	0.196	0.103	0.042	0.016	0.007	0.001	0.001	0.001	2.03
1	27	0.00	1.20	0.54	1.29	0.00	1.45	1.35	0.21	0.50	0.25	0.199	0.103	0.042	0.016	0.007	0.001	0.001	0.001	2.12
1	28	0.00	0.67	0.58	1.37	0.00	1.47	1.36	0.21	0.58	0.23	0.206	0.103	0.041	0.016	0.007	0.001	0.001	0.001	2.17
1	29	0.00	0.25	0.67	1.48	0.00	1.50	1.38	0.29	0.51	0.24	0.203	0.103	0.043	0.016	0.007	0.001	0.001	0.001	2.27
1	30	0.00	0.31	0.58	0.13	3.16	1.51	1.39	0.29	0.52	0.25	0.197	0.103	0.043	0.016	0.007	0.001	0.001	0.001	3.35
1	31	0.00	0.40	0.54	2.15	0.00	1.52	1.40	0.29	0.51	0.25	0.196	0.102	0.043	0.016	0.007	0.001	0.001	0.001	2.95
1	32	0.00	0.48	0.60	2.34	0.00	1.55	1.43	0.36	0.53	0.19	0.193	0.101	0.042	0.016	0.007	0.001	0.001	0.001	2.99
1	33	0.00	0.40	0.74	0.22	3.00	1.57	1.44	0.36	0.59	0.19	0.193	0.101	0.042	0.016	0.007	0.001	0.001	0.001	3.13
1	34	0.00	0.38	0.92	0.24	3.08	1.59	1.45	0.41	0.50	0.19	0.193	0.100	0.042	0.016	0.008	0.001	0.001	0.001	3.62
1	35	0.00	0.13	1.24	0.22	3.19	1.63	1.47	0.41	0.50	0.19	0.194	0.100	0.042	0.016	0.008	0.001	0.001	0.001	3.92
1	36	0.00	0.29	1.69	0.21	3.33	1.69	1.51	0.41	0.54	0.19	0.196	0.101	0.042	0.016	0.008	0.001	0.001	0.001	4.21
1	37	0.00	0.64	2.58	0.21	3.44	1.72	1.52	0.41	0.55	0.30	0.162	0.100	0.042	0.016	0.008	0.001	0.001	0.001	4.82
1	38	0.00	1.57	3.40	0.24	3.48	1.73	1.53	0.43	0.49	0.30	0.164	0.098	0.041	0.016	0.008	0.001	0.001	0.001	5.21
1	39	0.00	3.12	2.68	4.65	3.44	1.71	1.52	0.42	0.49	0.29	0.161	0.095	0.040	0.015	0.008	0.002	0.001	0.001	5.53

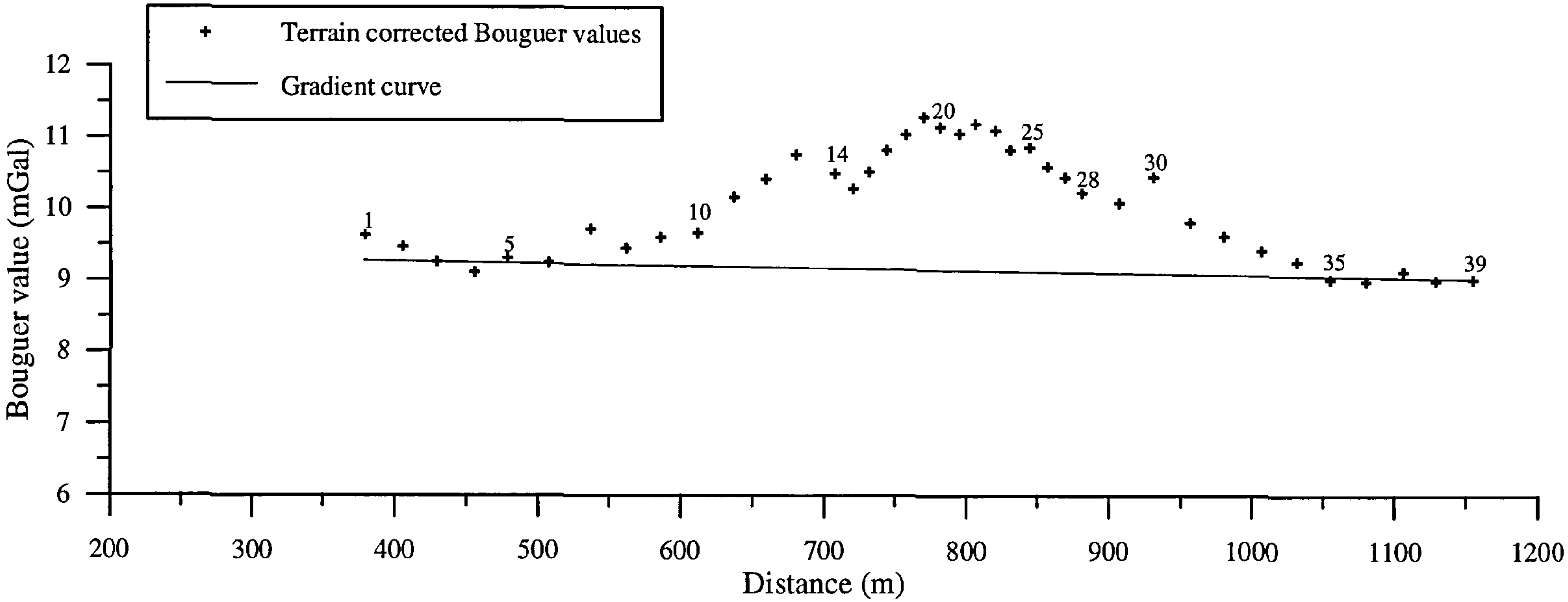
Terrain correction function values for various distance intervals at each gravity station. The total terrain correction is the sum of each function value multiplied by the corresponding distance interval (e.g. for station 16, the terrain correction is; 0*(0.002-0)+3.58*(0.068-0.002)+ 2.56*(0.23-0.068)+1.38*(0.59-0.23)+ ....). The total terrain correction values are listed in appendix 2.

TABLE OF CO-ORDINATES, ABSOLUTE GRAVITY, CORRECTIONS AND BOUGUER ANOMALIES

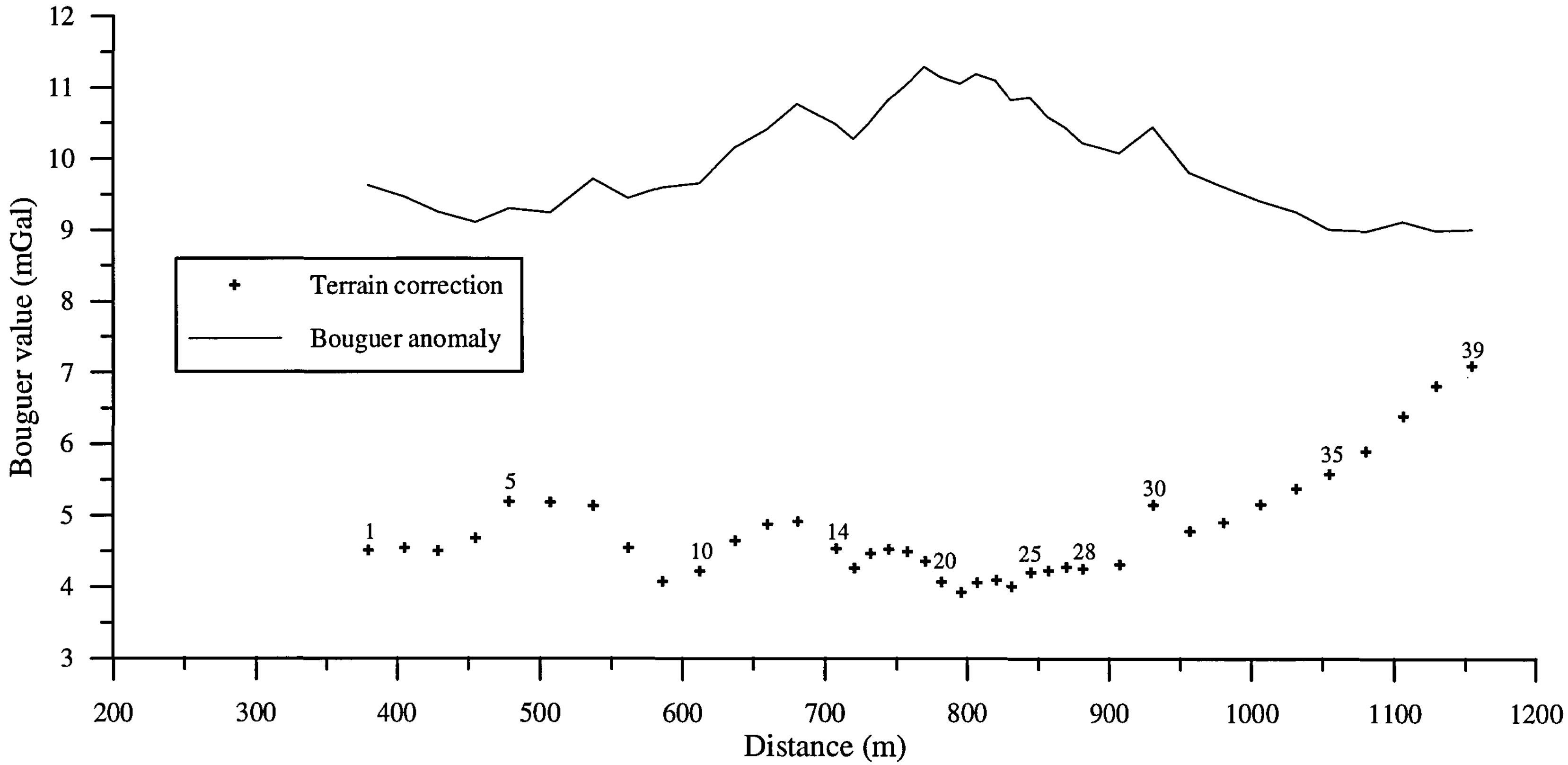
Location : Engebøfjellet   Project no. : 671900   Fieldwork carried out in 1995   Processing performed in February 1996

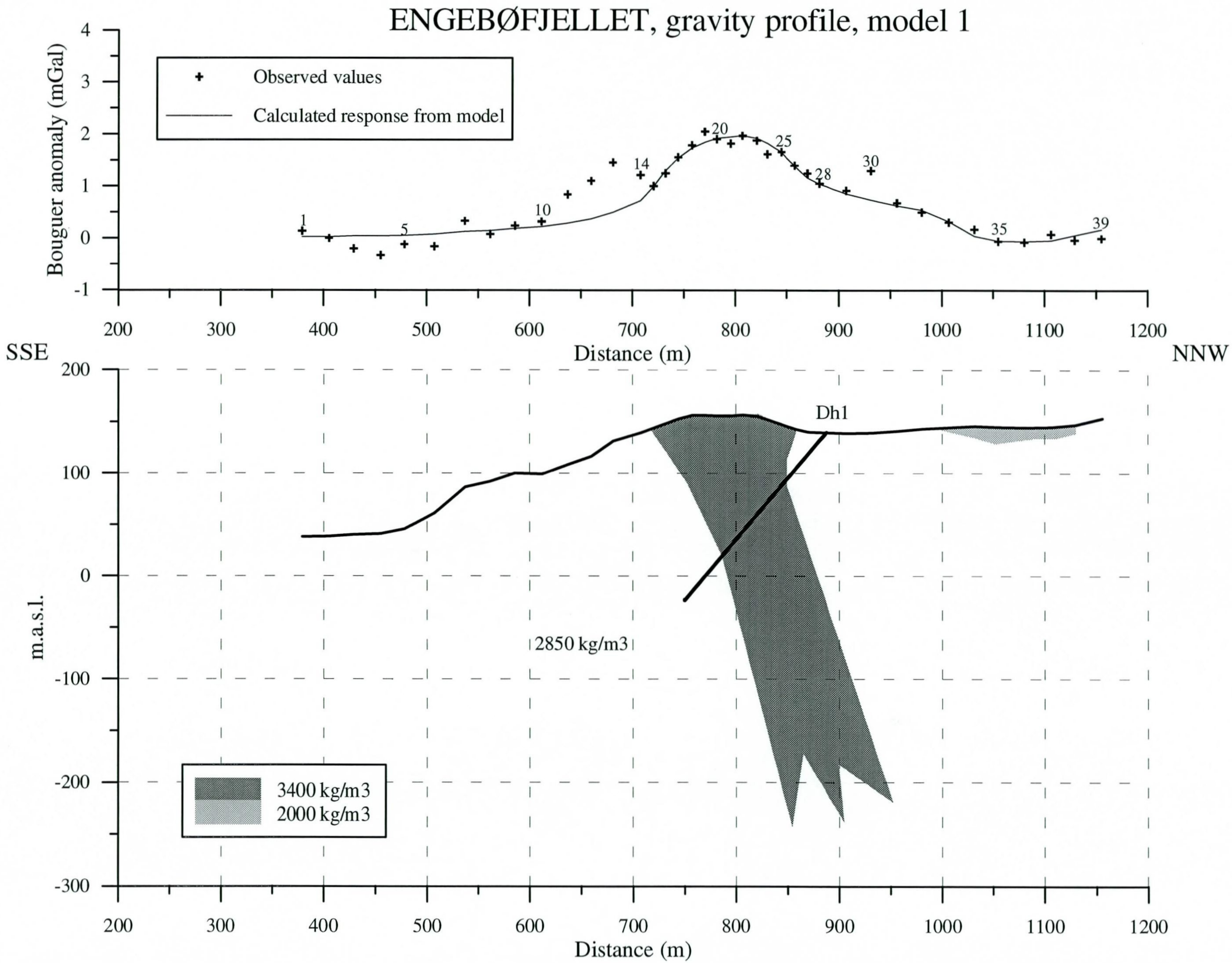
Station Profile	Point	Latitude	Longitude	UTM zone	UTM east	UTM north	Elevation: (in m)	Absolute gravity	Bouguer: corr.	Terrain corr.	Free air corr.	Bouguer anomaly
1	1	61 29.52	5 27.65	32	311605	6822871	38.00	982030.992	4.31	4.50	11.72	9.63
1	2	61 29.53	5 27.64	32	311598	6822896	38.44	982030.706	4.36	4.54	11.86	9.47
1	3	61 29.55	5 27.63	32	311592	6822919	40.31	982030.236	4.57	4.49	12.43	9.25
1	4	61 29.56	5 27.62	32	311584	6822944	41.20	982029.734	4.67	4.68	12.71	9.11
1	5	61 29.57	5 27.61	32	311576	6822966	45.80	982028.526	5.19	5.19	14.13	9.31
1	6	61 29.59	5 27.60	32	311569	6822994	60.92	982025.519	6.90	5.18	18.79	9.24
1	7	61 29.60	5 27.59	32	311558	6823022	86.30	982021.153	9.78	5.14	26.62	9.72
1	8	61 29.61	5 27.58	32	311552	6823046	91.87	982020.394	10.41	4.54	28.33	9.45
1	9	61 29.63	5 27.57	32	311544	6823069	99.98	982019.424	11.33	4.07	30.84	9.60
1	10	61 29.64	5 27.56	32	311537	6823094	99.24	982019.488	11.24	4.22	30.61	9.67
1	11	61 29.65	5 27.55	32	311529	6823118	108.34	982017.846	12.27	4.65	33.41	10.16
1	12	61 29.66	5 27.54	32	311523	6823140	116.65	982016.254	13.21	4.87	35.98	10.42
1	13	61 29.67	5 27.53	32	311516	6823160	131.21	982013.721	14.86	4.91	40.47	10.77
1	14	61 29.69	5 27.52	32	311509	6823186	139.26	982012.255	15.77	4.53	42.95	10.49
1	15	61 29.69	5 27.52	32	311505	6823198	143.85	982011.413	16.29	4.26	44.37	10.28
1	16	61 29.70	5 27.51	32	311502	6823209	148.23	982010.664	16.79	4.46	45.72	10.52
1	17	61 29.71	5 27.51	32	311498	6823221	152.76	982010.021	17.30	4.53	47.11	10.83
1	18	61 29.71	5 27.50	32	311495	6823234	156.42	982009.558	17.72	4.49	48.24	11.04
1	19	61 29.72	5 27.50	32	311491	6823246	156.07	982010.018	17.68	4.35	48.13	11.30
1	20	61 29.73	5 27.49	32	311487	6823257	156.04	982010.166	17.67	4.07	48.12	11.15
1	21	61 29.73	5 27.49	32	311483	6823270	155.65	982010.292	17.63	3.92	48.00	11.06
1	22	61 29.74	5 27.48	32	311480	6823281	156.54	982010.123	17.73	4.06	48.28	11.20
1	23	61 29.74	5 27.48	32	311475	6823294	155.29	982010.321	17.59	4.01	47.89	11.10
1	24	61 29.75	5 27.47	32	311472	6823304	151.95	982010.766	17.21	4.00	46.86	10.83
1	25	61 29.76	5 27.47	32	311468	6823317	147.22	982011.526	16.68	4.20	45.40	10.87
1	26	61 29.76	5 27.46	32	311465	6823329	142.94	982012.067	16.19	4.23	44.08	10.60
1	27	61 29.77	5 27.46	32	311461	6823341	140.22	982012.396	15.88	4.28	43.25	10.44
1	28	61 29.78	5 27.45	32	311457	6823352	139.70	982012.313	15.82	4.25	43.09	10.23
1	29	61 29.79	5 27.44	32	311450	6823377	138.92	982012.264	15.74	4.31	42.84	10.09
1	30	61 29.80	5 27.44	32	311443	6823400	139.26	982011.785	15.77	5.15	42.95	10.45
1	31	61 29.81	5 27.43	32	311435	6823424	140.85	982011.214	15.95	4.77	43.44	9.82
1	32	61 29.83	5 27.42	32	311428	6823447	143.25	982010.414	16.23	4.91	44.18	9.62
1	33	61 29.84	5 27.41	32	311420	6823472	144.32	982009.753	16.35	5.16	44.51	9.42
1	34	61 29.85	5 27.40	32	311413	6823496	145.76	982009.159	16.51	5.38	44.95	9.26
1	35	61 29.86	5 27.39	32	311405	6823518	144.65	982008.925	16.38	5.59	44.61	9.02
1	36	61 29.88	5 27.38	32	311397	6823542	144.22	982008.661	16.34	5.90	44.48	8.99
1	37	61 29.89	5 27.37	32	311390	6823567	144.74	982008.209	16.39	6.39	44.64	9.13
1	38	61 29.90	5 27.36	32	311383	6823589	146.81	982007.317	16.63	6.82	45.28	9.00
1	39	61 29.91	5 27.35	32	311377	6823614	153.33	982005.773	17.37	7.10	47.29	9.02

ENGEBØFJELLET, terrain corrected Bouguer anomaly values and regional gradient



ENGEBØFJELLET, terrain correction and Bouguer anomaly values





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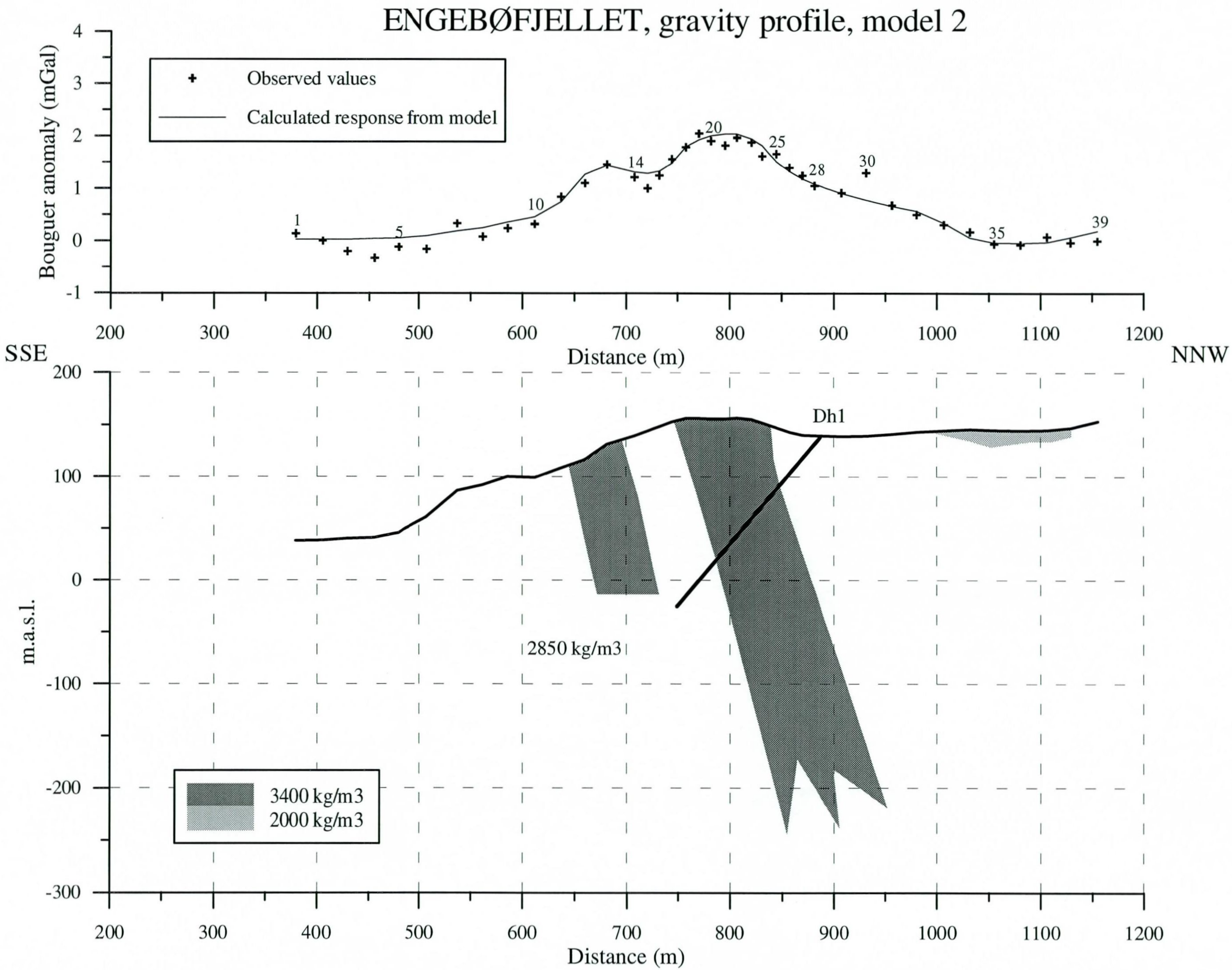
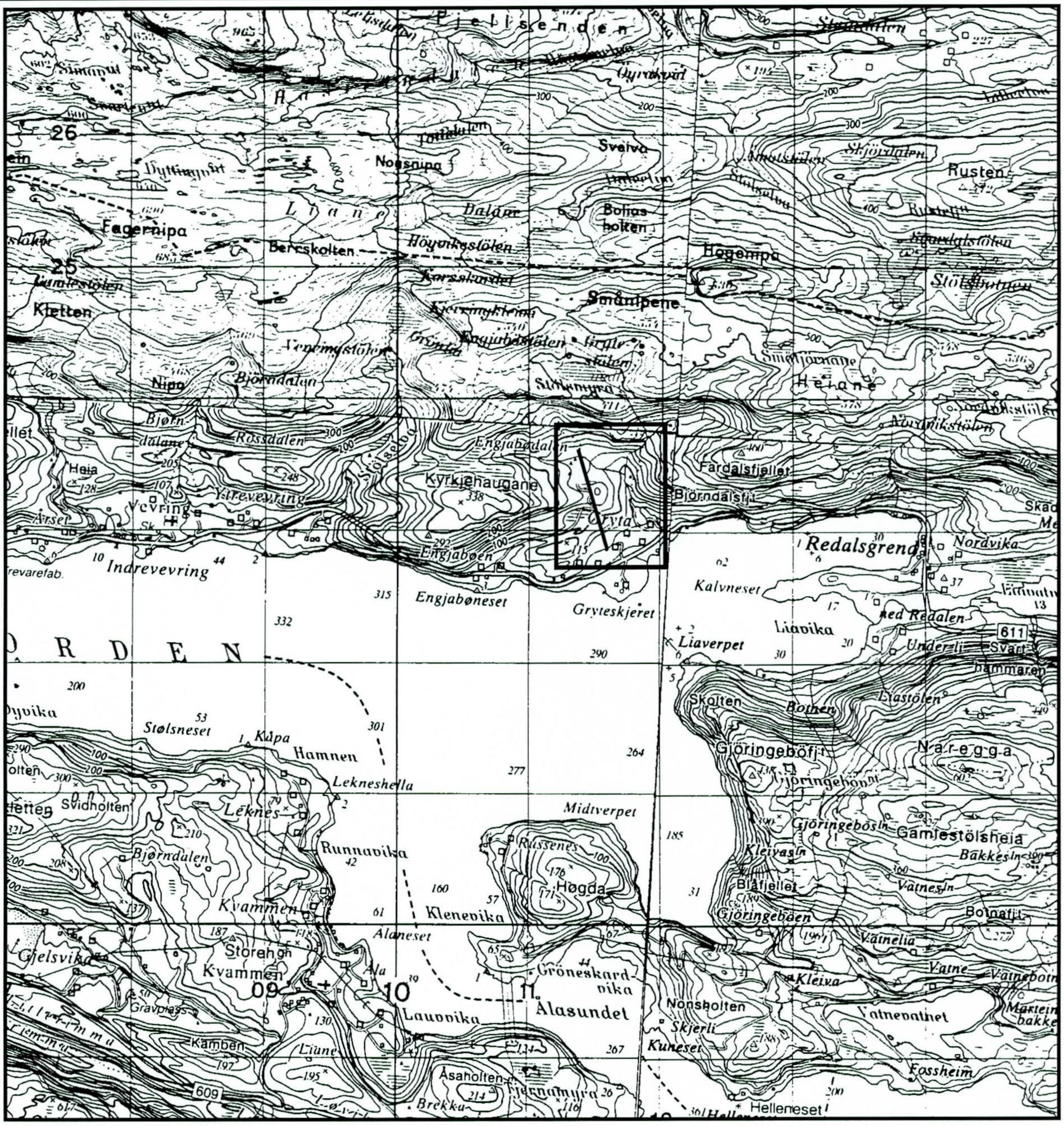
Appendix 5



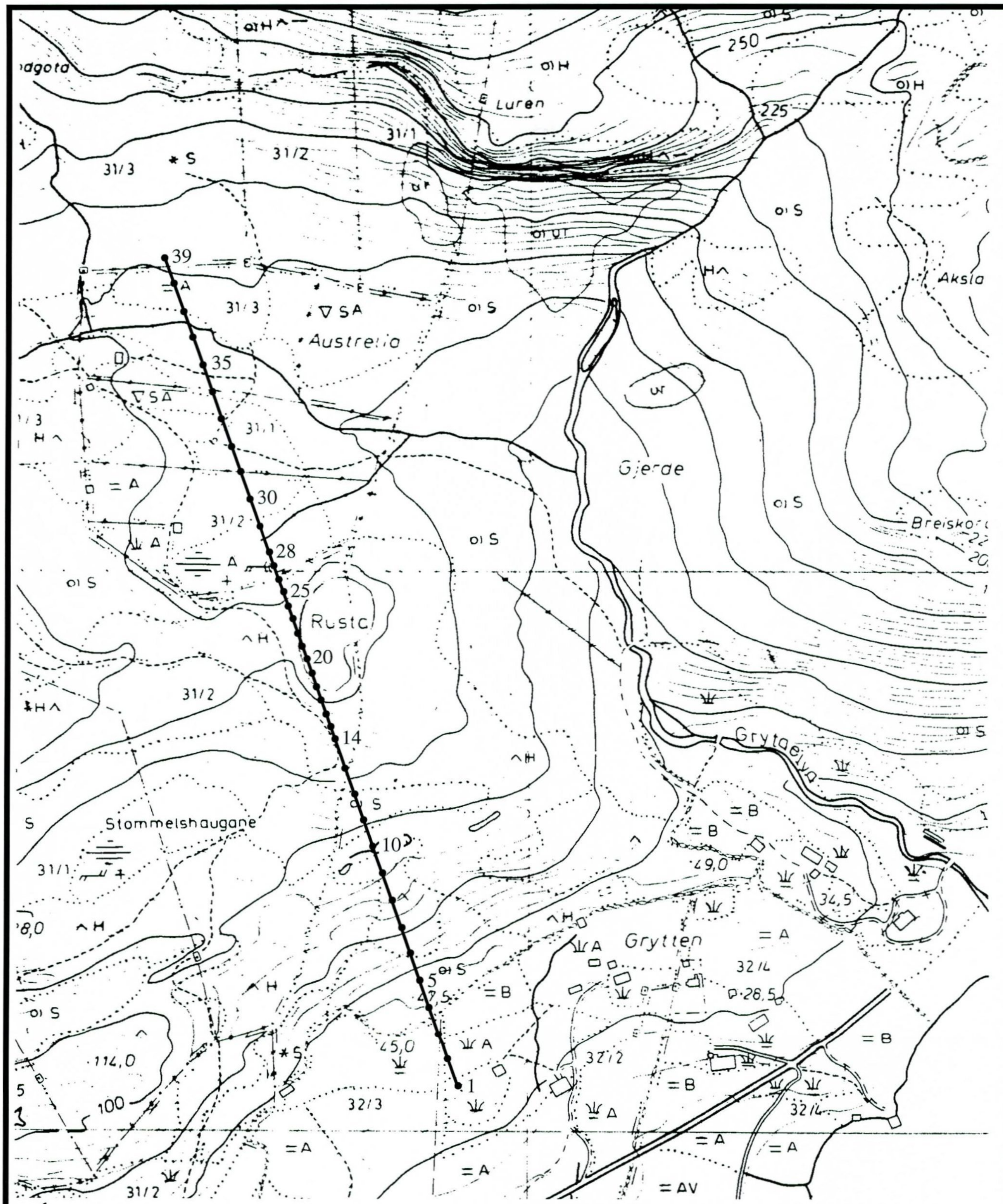
ENGEBØFJELLET, gravity profile, model 2
Observed values
Calculated response from model
Bouguer anomaly (mGal)
4
3
2
1
0
-1
1
5
10
14
20
25
28
30
35
39
200
300
400
500
600
700
800
900
1000
1100
1200
Distance (m)
SSE
NNW
Dh1
200
100
0
-100
-200
-300
m.a.s.l.
2850 kg/m3
3400 kg/m3
2000 kg/m3
Distance (m)



Gravity profile

Area enlarged in map -02

NGU/DuPont LOCATION MAP **ENGEBØFJELLET** SOGN & FJORDANE, NORWAY	SCALE 1:50 000	OPER JG DRAW EM TRAC	Sept. -95 April -96
GEOLOGICAL SURVEY OF NORWAY TRONDHEIM	MAP NO. 96.061-01	MAP 1:50 000 1117 I, 1118 II 1218 III, 1217 IV	



Gravity profile

• 5 Gravity station no.

NGU/DuPont GRAVITY PROFILE AND STATIONS **ENGEBØFJELLET** SOGN & FJORDANE, NORWAY	SCALE 1:5000	OPER JG	Sept. -95
		DRAW EM	April -96
		TRAC	
GEOLOGICAL SURVEY OF NORWAY TRONDHEIM	MAP NO. 96.061-02	MAP 1:50 000 1117 I	