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GRAVITY ANOMALY MAP

1 : 126 720 Scale

Sheet 19

CARLOW-WEXFORD

by

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Price £10

Gravity Anomaly Map Carlow-Wexford Sheet 19, 1 : 126 720 Scale

Thomas Murphy

This commentary accompanies the Gravity Anomaly Map of Carlow-Wexford at a scale of 1 : 126 720 corresponding to the Ordnance Survey 'half inch' series Sheet No. 19. Three gravity profiles are described and interpreted using simple 2-D gravity modelling.

1. Introduction

This is the third sheet of the Gravity Anomaly Map of Ireland covering the area of sheet no. 19 of the Ordnance Survey 'half inch' map series at the scale of 1 : 126 720. The values of Bouguer anomaly are based on the International Gravity Formula 1980 with the reduction to Mean Sea Level using a density of 2670 kg m^{-3} . The latitude correction was made using the International Spheroid European Datum 1950.

Stations are located on roads and tracks which have been 'levelled' by the Ordnance Survey and if possible are adjacent to Bench Marks. However the existence of bench marks has suffered badly due to improvements to roads and farm holdings and as a result recourse to using 'spot heights' has had to be made in the collection of the gravity data for this map. The Geographical and National Grid coordinates were obtained from the 1 : 10 560 scale maps by the methods given in Bulletin No. 39 (Murphy, 1988). The average station coverage for counties Carlow and Wexford are one station to 2.6 km^2 and 2.0 km^2 , respectively. Terrain corrections were applied where necessary but because contours on the 1 : 10 560 scale sheets are not drawn above 1000 feet, accurate calculation was not always possible and resort was made to estimation based on experience.

2. Brief description of the anomaly field

There are two dominant features of the anomaly field in this part of the country both depicted in Figure 1 which covers this sheet. They are (i) the closed low anomaly measuring approximately $38 \times 29 \text{ km}$ in extent centred on the National Grid coordinates 275300 E, 172000 N and, (ii) the marked gradient, with increasing values from west to east, of approximately 1.3 mGal km^{-1} over 40 km. This includes a steeper gradient of up to 3.2 mGal km^{-1} on the

eastern side of the closed low anomaly. To the east, approaching the coast, the anomaly reaches over $+40 \text{ mGal}$, which from work in the Irish Sea (Maroof, 1974) appears to be approximately the maximum value of the anomaly. The total range of the anomaly within the map area is from the minimum of -28 mGal over the Leinster granite to $+40 \text{ mGal}$ at the coast, i.e., 68 mGal .

3. An interpretation

The large gravity low is interpreted as being caused by the presence of a mass of granitic or similar material with a density much less than that of the surrounding rocks. The steep gradient on the east is attributed to three affects; (i) the above mentioned, (ii) the rise of underlying denser formations and (iii) the thinning of the crust. This is similar to the explanation given in Bulletin No. 36 which describes the Bouguer anomaly map for the sheet (no. 16) to the immediate north of this one. Since there is at present no seismic evidence available for the area, the following interpretation can only be considered tentative.

A simple model has been constructed as follows. Thinning of the crust of the order of 1 km (e.g. as shown by Meissner, 1986) would produce an increase in the anomaly of approximately 20 mGal . The large low density mass referred to above is assigned a density of 2650 kg m^{-3} based on density measurements of Irish granites (Morris, 1973). However as the presence of the granite together with a 1 km thinning of the crust cannot alone account for the steep gradient to the east, a dense body with a density of about 2850 kg m^{-3} has been introduced into the model. These densities are then contrasted with 2750 kg m^{-3} for the crust.

The problem now arises regarding the depth down to which these density contrasts should be carried. Cassidy and Locke (1982) found that 8 km was sufficient, and for the discussion of the profile described in Bulletin No. 36

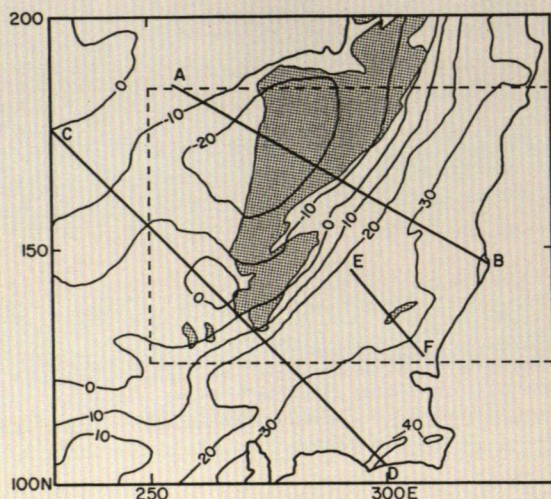


Figure 1. Sketch map showing the extent of granite outcrops and the positions of the profiles. National Grid coordinates are shown in km. Outline of Sheet 19 is shown by the dashed rectangle.

(sheet 16) 5 km was found to be adequate. Young (1974) in his analysis of the gravity data over the granites of Donegal (which are of the same age and type as those of Leinster), also found that thicknesses of only about 5 km were necessary to obtain a satisfactory model (he used a density of 2630 kg m^{-3} obtained from the measured densities of samples, which is slightly lower than the value used here). Murphy (1987) has given an explanation for a closed gravity low centred north of Dublin as due to the presence of a spherical mass the top of which was modelled at 0.45 km depth with a diameter of 6.88 km and density contrast of 80 kg m^{-3} . His model was supported by considerable seismic evidence in the area.

The large anomaly here investigated cannot be explained with the depths given above, even with a density contrast of 100 kg m^{-3} , so the depth has been taken down to 10 km. This corresponds approximately to the depth of the upper / mid-crust reflector of Lowe and Jacob (1989), (i.e. layer 4 of their figure 14). At this depth gravity interpretation is fairly insensitive.

Three profiles, the locations of which are shown in Figure 1, have been extracted from the map and adjacent maps, and have been interpreted as described below using simple 2-D modelling.

(a) Profile A - B

The section (A - B) runs from the just outside the northwest corner of the sheet to Cahore Point on the Irish Sea passing about 2 km southwest of Carlow (i.e. from 254650 E, 183800 N to 321620 E, 146180 N). Starting over Carboniferous sediments the profile then crosses the Tullow granite pluton (O' Connor, 1986) thence over the Ordovician volcanic belt to end over Cambrian strata. The gravity profile is shown in Figure 2a.

The thinning of the crust, alluded to above, was allowed for by the simple method applying a regional gradient of 0.2 mGal km^{-1} throughout the profile, the regional anomaly increasing towards the southeast. The interpretation shown in Figure 2a is a rather simple one but as there are so many unknowns, particularly the mean densities of the formations coupled with the lack of seismic data, it is probably all that can be justified. It should be looked on as one of many possible interpretations.

(b) Profile C - D

The second section (C - D) cuts across the southwest corner of the sheet passing close to Kilkenny stretching from 230000 E, 175000 N to 300000 E, 105000 N near to Carnsore Point. This profile, shown in Figure 2b, does not have a pronounced low similar to that of profile (A-B) but does show a similar steep rise in the anomaly to the southeast. The Blackstairs pluton depicted by O' Connor (1986) lies just off the profile to the northeast and was suggested by Brindley (1973) to continue for about ten kilometres further to the southwest.

Discussion

The two profiles shown in Figure 2 have common features, namely, a gradual decrease from the northwest with a steeper rise to the southeast. While profile (A-B) falls to a marked low, the low in profile (C-D) is more complicated but is still lower than the levels at either end of the profile. Here it is suggested that both profiles are underlain by a mass of low density material at least 6 km in thickness and approximately 45 km wide with the top 4 km below the surface. This would produce a general low in the Bouguer anomaly with a minimum value of -21 mGal . It is suggested that this body is of a granitic character, similar to the outcropping plutons. Further to the west Lowe and Jacob (1989) found a zone of low seismic velocity and linked it to an area of low gravity. A subsequent analysis gave a low density body similar in dimensions to the above.

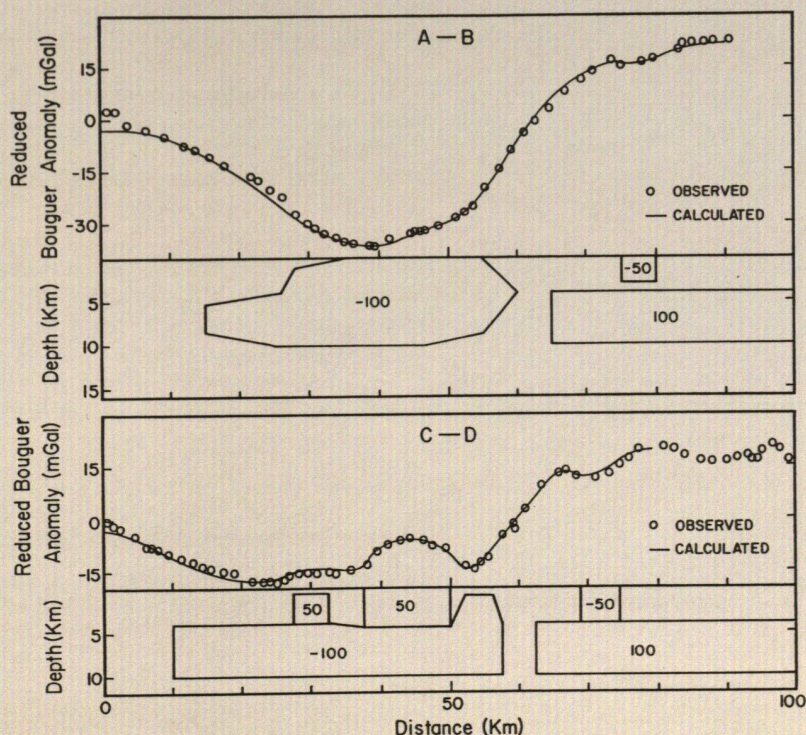


Figure 2. Profiles (A-B) and (C-D) together with 2-D gravity interpretations. The observed data are shown by circles and the calculated profile by the continuous line. A regional gradient of 0.2 mGal km^{-1} has been removed from the observed data (see text).

To explain the profile (A-B) it is suggested that the Tullow and Blackstairs plutons be represented by a large mass of granite 25 km wide and 4 km thick reaching down to the underlying 'granitic' layer mentioned above. The limit to the east would coincide with the mapped geological boundaries of these plutons, but this is not the case to the northwest.

A borehole put down southwest of Carlow at Quinagh (272700 E, 173800 N) by the Geological Survey of Ireland (McArdle et al., 1988) into Carboniferous limestone 1.5 km northwest of the nearest granite exposure of the Tullow pluton encountered granite at 196 m below the limestone cover, indicating that the pluton extends below the surface to the northwest beyond the surface exposure, and that the boundary of the pluton is thus unknown. The interpretation shown in Figure 2a would extend the pluton 7.5 km to the northwest with the surface dipping at approximately 10° to a point 5.5 km

west of Carlow. The slope is similar to that found at Quinagh.

Brindley's suggestion that the Blackstairs pluton continues to the southwest would fit in with the interpretation of profile (C-D) and a simple calculation shows it to be about only 5 km across with the top surface roughly 1 km below the surface. The complicated centre of the profile is most likely caused by the presence of what Brindley calls 'the considerable complex of older basic rocks', which are expected to be denser.

Thus it appears that the Leinster granite plutons though quite extensive in area are only the surface manifestations of a much larger mass of granitic material. This could explain the absence of mineral occurrences on the mapped western margin of the Tullow pluton as commented on by McArdle et al. (1988).

The steep increase to the southeast exhibited in both profiles does not occur at or near the margin of the granite

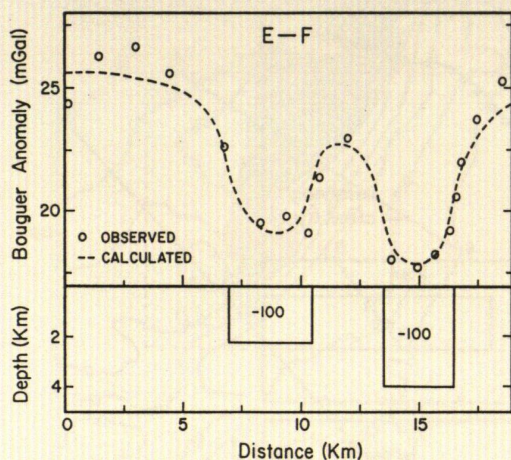


Figure 3. Profile (E - F) crossing the Ballynamuddagh granite.

plutons, but at about five kilometres away. The cause, attributed to the pre-Ordovician, lies somewhat below the surface and here is modelled as a dense layer with the top surface at a depth of 4 km extending down to 10 km, the arbitrary limit mentioned above. Cassidy and Locke (1982) gave a different interpretation for their sections and introduced an intrusive with a density of 2900 kg m^{-3} in a similar position separated from the granite unit.

Throughout the region east of the Leinster mountains in the Ordovician volcanic belt, there are many closed anomalies, both high and low, aligned in a northeast-southwest direction. Both acidic and basic rocks occur with densities ranging from 2500 to 2860 kg m^{-3} (Morris 1973). Lows near the south-eastern ends of both profiles have hence been interpreted as being caused by bodies with a density of 2700 kg m^{-3} i.e., a contrast of 50 kg m^{-3} .

(c) Profile E - F

The third section, profile (E - F) stretching from 292980 E, 145710 N to 308540 E, 127610 N is shown in Figure 3 and passes through Enniscorthy crossing two elliptical shaped areas of low Bouguer anomaly.

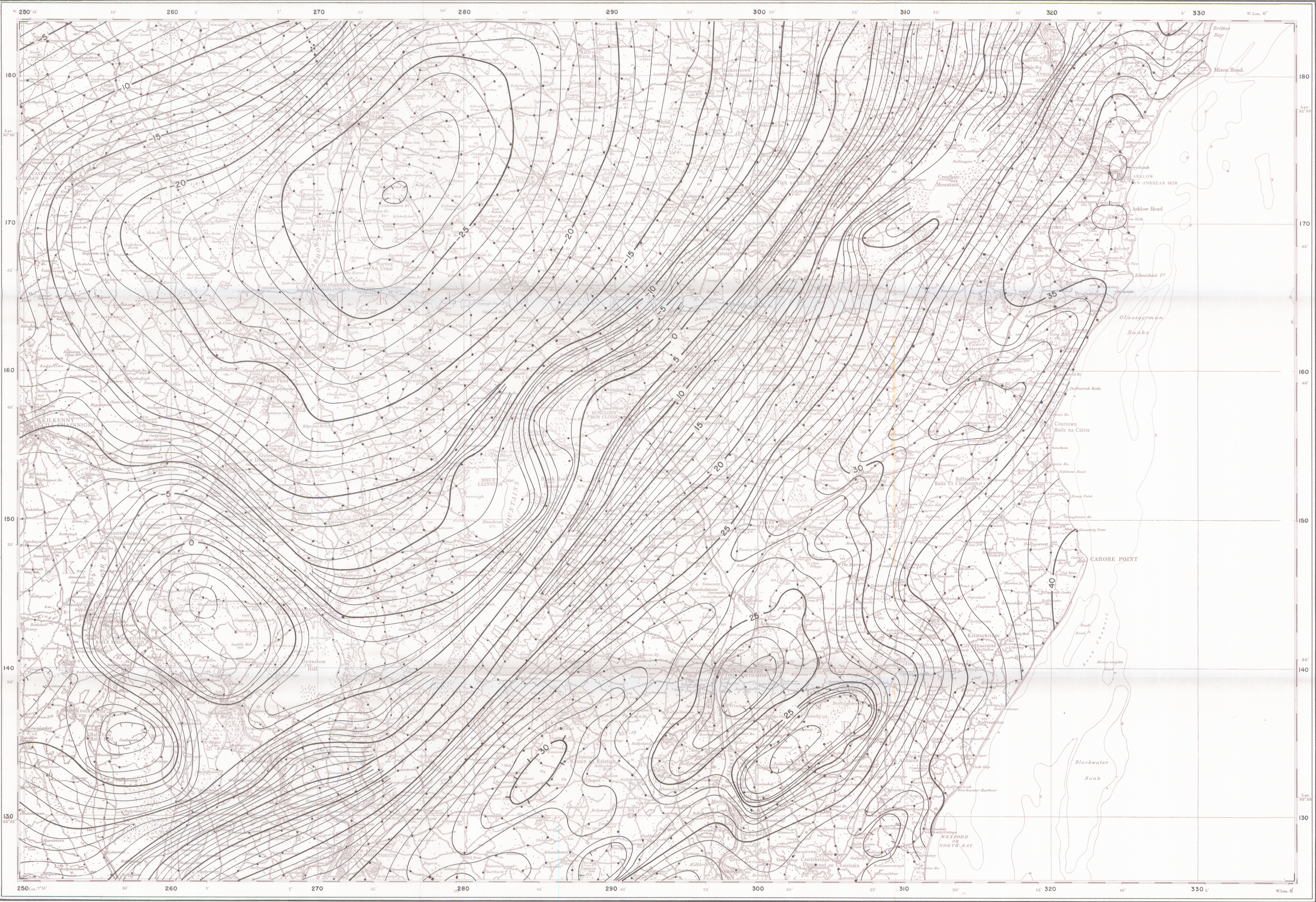
The south-eastern low covers a granite body known as the Ballynamuddagh or Glenbrien granite. It is poorly exposed with only the north-western margin visible as

outcrop. The 25 mGal Bouguer anomaly contour follows this limit closely. The other closed low anomaly is interpreted as being caused by a similar granitic body. Using the same density contrasts as above these bodies are depicted as two longitudinal masses approximately 3 km wide stretching from the surface to a depth of 2 km and 4 km, the south-eastern one extending to the deeper level. There is a large magnetic anomaly associated with the latter which however is not confined to the limits of the gravity anomaly but since no outcrop is available the source of this anomaly cannot be investigated. The north-western gravity anomaly does not on the other hand have any associated magnetic effects.

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Bouguer Anomaly derived from :
International Gravity Standardisation Net 1971 value for DUNSINK
981 374.92 mGal
International Gravity Formula 1980 at mean sea level
Surface Density 2670 kg/m³
Contour Interval 1 mGal • Gravity Reading

Scale of 1/2 Inch to 1 Mile:- 1:126,720
5 1 0 2 4 6 10 Kilometres
2 8 Miles
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