COMMUNICATIONS OF THE
DUBLIN INSTITUTE FOR ADVANCED STUDIES
Series D, Geophysical Bulletin No. 36

GRAVITY ANOMAY MAP
1: 126 720 Scale
Sheet 16
Wicklow-Kildare

by

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Introduction

In 1971, after publication of the two sheets on the scale of 1: 250 000 in Bulletins 18 and 22, the International Gravity Standardisation Net was introduced which resulted in a change of value of the Dunsink base. This was followed in 1980 by the International Gravity Formula. It was decided then to suspend the issue of further sheets of the 1: 250 000 series and concentrate on larger scale maps increasing the station density to better than one station for each three square kilometres. The present sheet is a start on the scale of 1: 126 720 known popularly as the 'half-inch' series because of the scale, one half inch to one mile.

Measurements

The measurements, carried out with WORDEN gravimeters, are based on a value of 981 374.92 mGAL for the DUNSINK base station (cf Bulletin No. 14) as listed in the International Gravity Standardisation Net 1971.

The stations are almost always taken on roads or tracks which have been levelled by the Ordnance Survey and the height above Mean Sea Level is in general $\pm$0.5 m unless near bench marks when the accuracy is $\pm$0.05 m. The percentage of stations close to bench marks varies widely from district to district being as high as 80% falling to a low of 5%, the latter due mainly to destruction when roads and farm holdings are improved.

The station density varies from county to county depending on the road network, the area of lakes and inaccessible mountain regions. On this sheet the density for the various counties is as follows. Dublin : 1 to 2.5 km^2, Kildare : 1 to 2.9 km^2, Laois : 1 to 3.3 km^2, Offaly : 1 to 2.8 km^2 and Wicklow approx.

1 to 4 km^2. The total number of stations is 1500, giving an average overall density of 1 station for each 3.36 km^2.

The position of each station can be obtained to about three metres on the large scale maps used (1 : 10560) but because of various uncertainties known to exist in the adjustment of these nineteen century maps the latitude can only be obtained with reasonable accuracy to one second of arc on the International Spheroid.

The BOUGUER anomaly is obtained from the International Gravity Formula 1980, the height being reduced to Mean Sea Level using a density of 2 670 kg/m^3.

Terrain corrections were applied where necessary and no correction exceeded 1.5 mGal.

Over large parts of this sheet the 'overburden' consists of peat bog and glacial till. The latter can reach 50 m in thickness so that there is what could be called a hidden terrain correction of up to 1.4 mGal since the density of this overburden can be as low as 2000 kg/m^3. When the station is located on peat bog, which ranges from two to seven metres in depth, this hidden correction is up to half a milligal. When contouring in such areas allowance has been made for abnormally low values if these lie in known peat covered areas. Thus there is a certain amount of subjective reasoning in the drawing based on the knowledge of the local geology around the station positions.

Brief Description of the Anomaly Field

Over approximately half the area of the sheet the Bouguer Anomaly is positive with an extreme value of 35.2 at a station located at 330 880, 194 520 (National Grid Coordinates) close to the coast in the town of Wicklow. The lowest value is -22.8 at 282 250, 183 640.

The overall trend of the contour lines is from northeast to southwest which can be attributed to the Caledonide structure which is predominant in Ireland. On the west of the sheet the mean value of the anomaly is close to zero in contrast to that on the east where it is high and rising as the coast is approached. This has been referred to in the earlier publication (Bulletin 22, 1959) and the explanation was given that it is caused by a thinning of the crust from west to east. Later, Bott and Young (1971) observed that 'a regional high appears to be a characteristic feature of the whole Irish Sea area'. This high of approximately 40 mGal they attributed to 'either a thinner or denser crust beneath the Irish Sea relative to the adjacent land areas'. Readings taken further south in Co. Wexford are in fact above 40 mGal so that the 'high' is not simply related to the sea area.

Considering a thinning of 2 km (R. Meissner et al., 1986), and taking a density contrast between the crust and the mantle of 500 kg/m^3 a difference of 42 mGal would result and could explain the relative values. However, even if the thinning took place abruptly the maximum gradient would be less than 0.5 mGal/km. From profiles taken WNW - ESE east of 310 000, the gradients are of the order of 3 mGal/km and thus, coupled with the range of approximately 20 mGal, indicate that the cause must be well above the MOHOROVICIC discontinuity (Bott and Smith 1958). When modelling the gravity effects of the Leinster granite, Cassidy and Locke (1982) allowed for a regional gravity gradient stating 'This regional field, which dips SW over the granite outcrop with a maximum gradient of 6.25 g.u. km^{-1}, was substracted from the Bouguer anomaly data'. This they further state was obtained from 'a third-order trend surface', but such a surface (eg Morris 1975) does not show any gradients as large as this. Furthermore, 6 g.u. km^{-1} is a very steep gradient for a regional field. They made no comment as to the cause of this

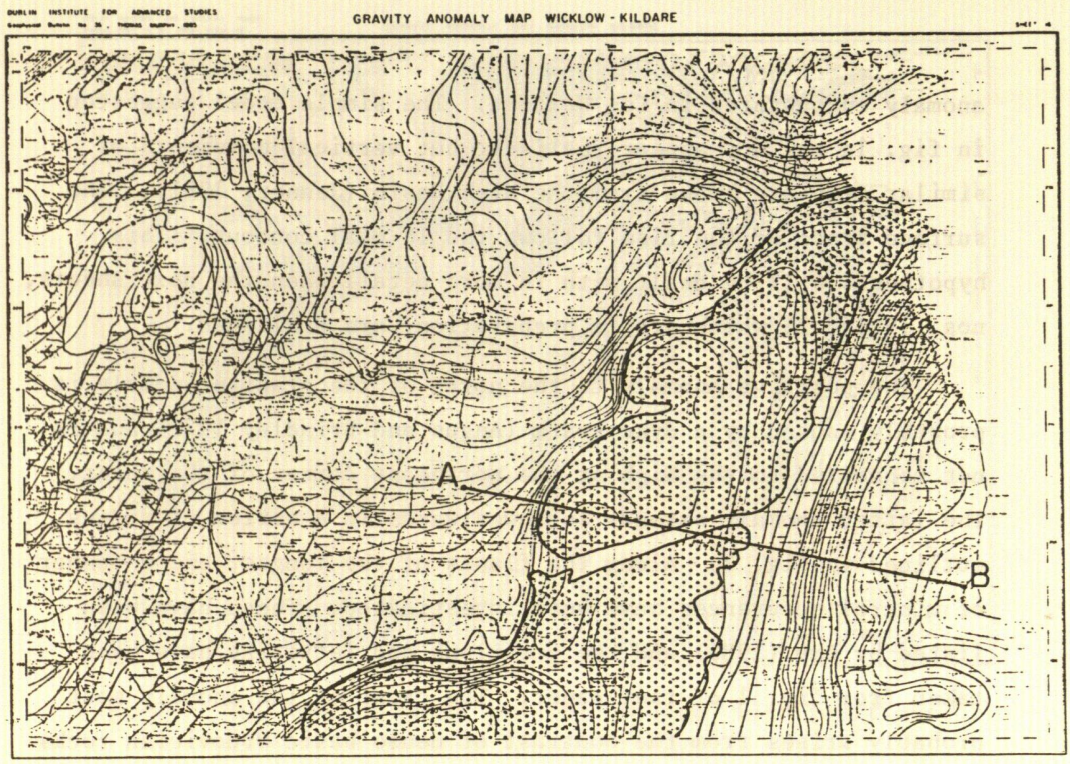
field. Before discussing this further the largest feature on the sheet will be considered.

This, see fig. 1a, is the low stretching from Dublin Bay in a SSW direction which can be attributed to the presence of the granite bodies in the Leinster chain summarised by Brück and O'Connor in 1977. The steep gradient on either side agree with the mapped limits of the granite allowing for the additional gradient on the east as mentioned above. The outline of the granite bodies has been taken from the Mineral Deposits Map of Ireland by Browne and Reid (1984).

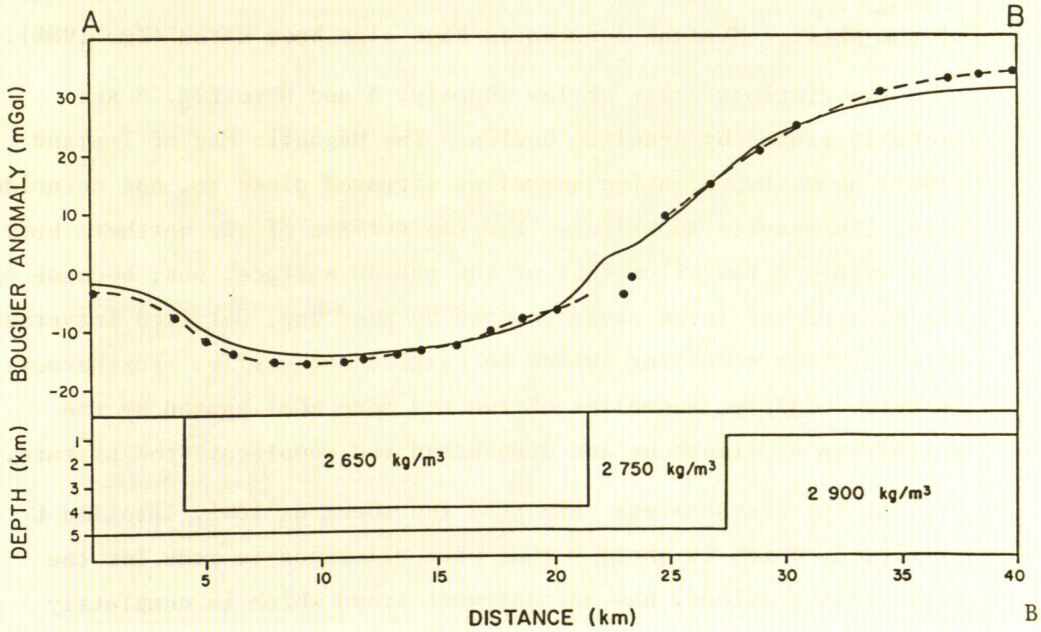
Cassidy and Locke in 1982, using data from the earlier survey along with additional data, produced a model of 'an essentially vertical sided body extending to a depth of 8 km in the south and to 6 km under the Upper Liffey Vally Unit ..... '. The high values near the coast were attributed to a deep sited dense basic body reaching from 4 km to 8 km. They did not consider a thinning of the crust. With the data then available to them they could not carry out a more detailed investigation.

A cross section AB in fig. 1a is given in fig. 1b so positioned to avail of the maximum number of readings. The model is built on a low density two dimensional body contrasting with the enveloping Ordovician strata whose density is taken as 2750 kg/m^3. The limits were set by the geological boundary and the density, 2650 kg/m^3, from actual measurements of fresh samples obtained from a tunnel cut into the granite for a hydroelectrical power station. The density contrast is thus less than that of Cassidy and Locke. The thickness is taken as 4 km.

An explanation for the high values east of the granite is suggested as consisting of two parts. Firstly, a thinning of the crust of one kilometre, and secondly, a rise of 4 km of dense underlying formations such as those which produce the high values of the



A



B

Figure 1. a) Outline of the Leinster Granite from Browne and Reid.
b) Gravity profile across the granite bodies.

anomaly encountered in Co. Wexford. The simple model suggested in fig. 1a may not appear realistic but vertical movements of similar size are known from the Kish Basin (Jenner, 1981). The surface trace of the rise follows the 16 mGal contour. This hypothesis will be dealt with in more detail when the next sheets, nos. 19 and 25 which are in preparation, are published.

The positive anomaly to the north of the granite anomaly is probably caused by a dyke swarm (Angus and Brindley 1970) and is not connected to the high at the northeast corner of the sheet. The latter anomaly extends southwestwards in a series of ridges outlined in fig. 2. Along the flanks of the longest one a number of mineral occurences have been investigated. These have been listed by Emo (1986) and the positions and lettering have been taken from fig. 1 of that paper. The cause of the anomaly most probably arises from the contrast of dense basic Ordovician rocks such as those which outcrop north of Kildare. The ridge continues in a southwesterly direction from Monasterevin.

Part of a ridge and furrow occur at the northwestern extreme of the sheet. Mineral occurences have also been noted (Emo 1986).

Two distinct areas of low anomaly, A and B in fig. 3 are probably caused by granitic bodies. The Magnetic Map of Ireland (1981) shows two negative anomalies situated close to, not coincident with, the gravity anomalies. The top surface of the northern body lies within a few kilometres of the ground surface, but, because of the presence of large areas covered by peat bog, detailed traverses necessary for modelling cannot be carried out easily. Furthermore, in this locality, anomalies of two and more mGal caused by the weathering of limestone are widespread and complicate the picture.

At the southeastern corner of the sheet a 'low', labelled C in fig. 3, which is about 7 mGal when allowance is made for the east coast gradient, has an east-west trend which is completely different from the surrounding gravity contours which are northerly.

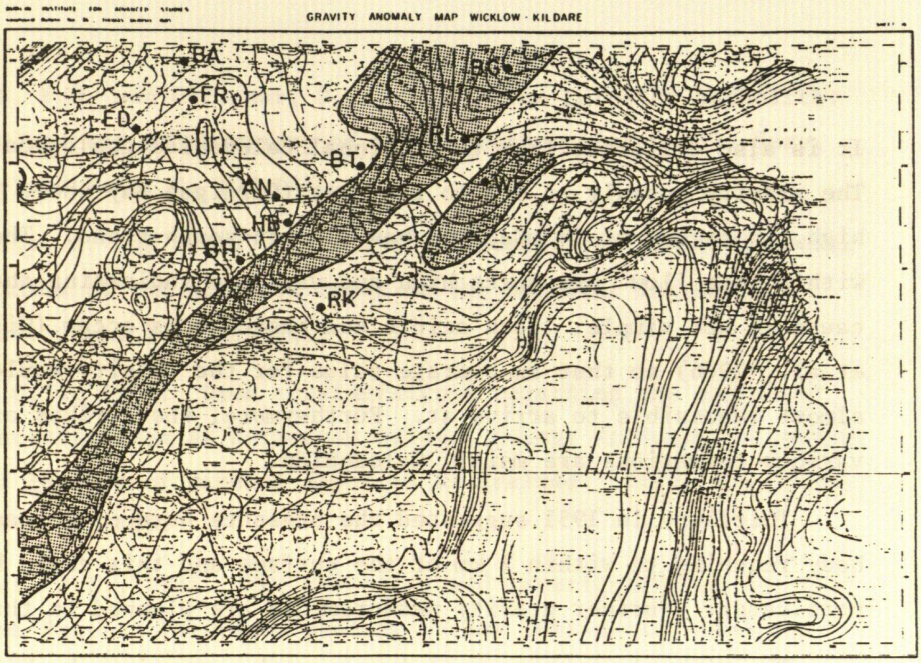


Figure 2 The shading marks gravity 'ridges' with positions of mineral occurences listed by Emo.

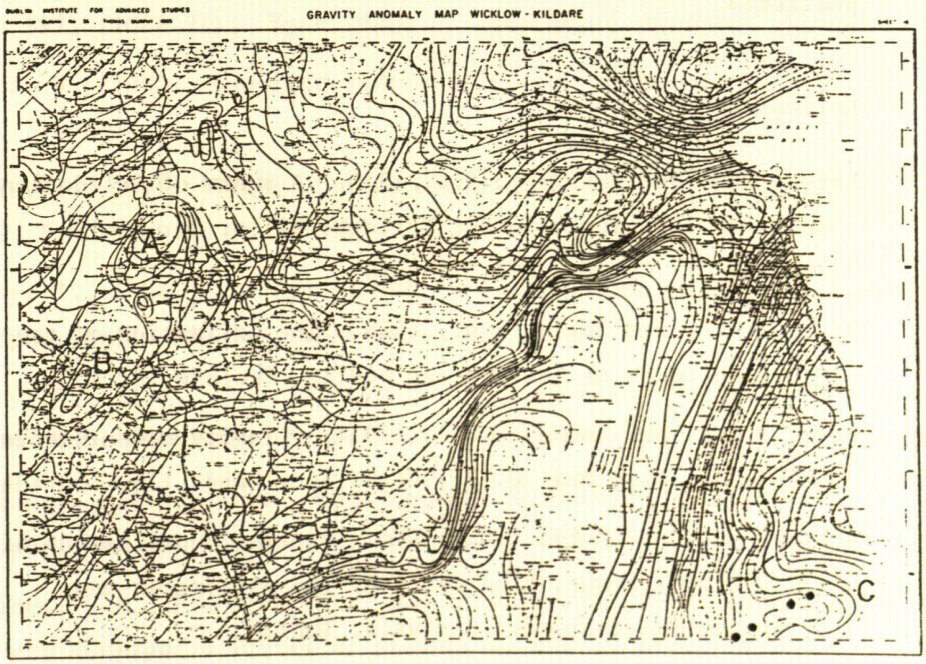


Figure 3 A and B mark the positions of discrete anomalies attributed to granite bodies. C is a low anomaly with contrasting 'strike'. The position of mineral occurences are taken from Willaims, Sheppard and McArdle.

It is also different from the regional Caledonide geological trend. The gravity anomaly at sea to the east (Cardigan Bay sheet 1980) is high, in excess of 35 mGal and has a north-south trend. The gradients within this 'low' are quite high and variable indicating that the cause is not simple. Both acidic and basic rocks occur (Williams et al., 1986) so that an average value for the density would be almost impossible to arrive at. Furthermore, the strikes of the various formations are mainly Caledonide.

Thirlaway in 1951 suggested the presence here of a granitic body reaching to within 2 km of the surface and this could be a part cause. Further gravity measurements are planned in this area.

The mineral occurences at Avoca nearby are given by Williams (1986) and are marked in fig. 3.

At the northwestern extreme of the sheet anomalies with strong gradients occur and will be discussed when the adjacent sheets are published.

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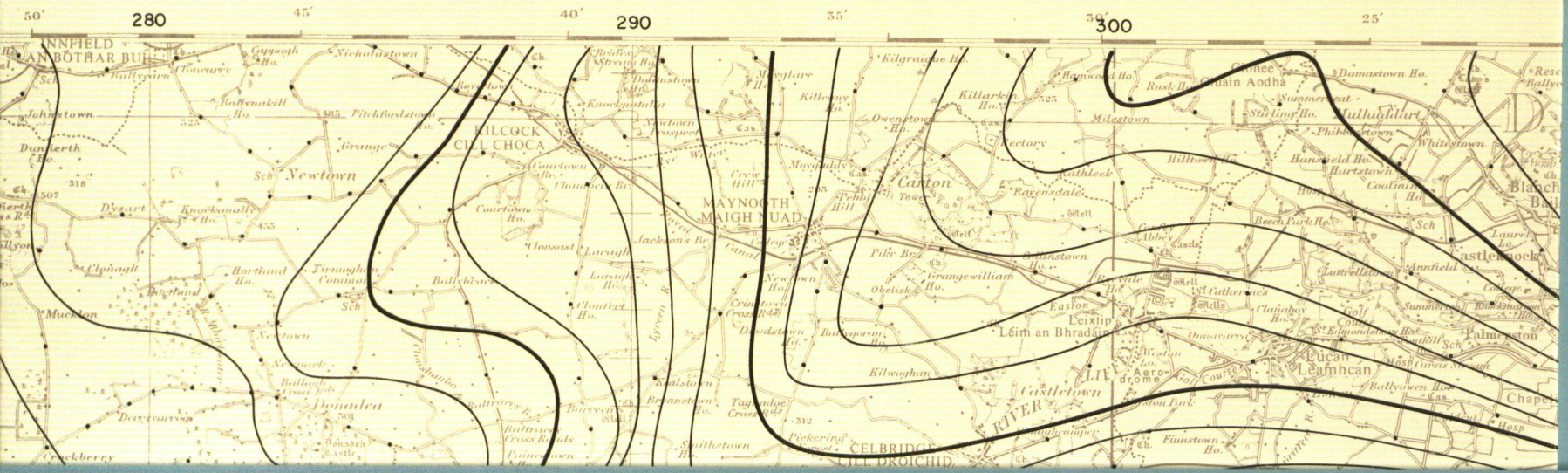
School of Cosmic Physics,
5, Merrion Square,
Dublin 2.

GRAVITY ANOMALY MAP WICKLOW - KILDARE



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SHEET 16

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 / m^3.

Contour Interval 1 mGal

Scale of 1/2 inch to 1 Mile:- 1:126,720

5 0 0 2 4 6 8 10 Kilometres

2 1 0 2 4 6 8 Miles

Gravity contours drawn by Eilish Ryan

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