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The Gravity Anomaly Map
of County Donegal

by

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THE GRAVITY ANOMALY MAP OF CO. DONEGAL

INTRODUCTION

Co. Donegal has been the subject of detailed geological investigation for many years involving personnel from several universities and a bibliography has been recently published (Pitcher and Spencer, 1968). Previous gravity work in the Co. Donegal area of north-west Ireland is contained in three isolated traverses crossing major granite intrusions and formed an integral part of the initial regional gravity survey over the northern part of the country (Cook and Murphy, 1952).

The present surveys were conducted by the author and Dr. R. P. Riddihough during the summer months of 1967 and 1968 using a Worden gravimeter. The object was to obtain a complete gravity coverage of the county in an effort to ascertain the underground form of the several granite masses and the geophysical effect, if any, of the major dislocations, particularly the Leannan fault (Pitcher, Elwell, Tozer and Cambay, 1964). The Bouguer anomaly map together with a short description of the major features form the content of this bulletin and it is intended that the interpretation details be published separately.

THE MEASUREMENTS

The measurements are related to the gravity base stations located in towns throughout the area that form part of a countryside network. Observations were made at a preferred spacing of approximately 1.5 km although in certain areas of difficult accessibility or rugged terrain this was not always possible. 837 new stations form the basis of the Bouguer gravity map and details of all positions are available at the School of Cosmic Physics, Dublin.

Continuation of the isogals with those in the neighbouring counties of Derry, Tyrone and Fermanagh has been ensured by comparison with data published in 1967 by the Geological Survey and Museum, London.

ROCK DENSITIES

The geology of Co. Donegal is dominated by Dalradian metasediments in which the great variety of rock type makes selection of representative bulk densities extremely difficult. However, sample densities of the main geological units occurring in north-west Ireland have been considered in an earlier publication (Cook and Murphy, 1952) which listed average values for Dalradian strata as follows:

	g/cm ³
Schists and Phyllites	2.74 ± 0.03
Gneisses	2.83 ± 0.07
Marble and Limestone	2.75 ± 0.05
Quartzite (probably)	2.65

In addition, nine samples of the Ardara granite were collected during the present surveys. The average value for the saturated density obtained from these specimens was 2.64 ± 0.03 g/cm³. Inspection of other granite densities presented in the 1952 memoir, together with the value obtained for the Ardara granite suggests that the density contrast

between the granite masses and the Dalradian country rock is unlikely to be less than -0.1 g/cm^3 or in excess of -0.2 g/cm^3 . It is to be expected therefore that the presence in Co. Donegal of several granite massifs, of varying form and magnitude, will have a pronounced negative effect on the level of the Bouguer anomaly in those areas where they occur.

REDUCTION OF THE MEASUREMENTS

The Bouguer anomaly is related to the International Gravity Formula of 1930 for the normal value of gravity at sea level. A uniform density of 2.67 g/cm^3 was used throughout in the calculation of the Bouguer correction. The measurements are related to base stations forming part of a network covering the entire country. The primary base values located at Dunsink Observatory which in turn is related to Pendulum House, Cambridge, where the value is assumed to be 981.2650 mgal. Topographic corrections have been selectively applied to stations which were considered during fieldwork to require this adjustment.

SCALE OF THE MAP

The coastal outline of the sheet is taken from the half inch series covering Co. Donegal, Numbers 1 and 3, published by the Ordnance Survey, Phoenix Park, Dublin. The map is overprinted with the 10 km Irish grid network.

The presentation at this scale departs from earlier policy which has seen the publication, in Bulletins 18 and 22, of gravity maps on two of the five sheets of the map of Ireland at the scale of 1:250,000 covering the south-west and south-east parts of the country. The reason for using the half inch scale in this case was, in view of the recent systematic work mentioned earlier, to facilitate comparison with the geological maps. Further, a considerable area of Sheet 1 of the 1:250,000 series includes Northern Ireland for which area a Bouguer gravity map has recently been published. The southern part of the same sheet is overlapped by Sheet 3 so that the isolated north-west corner of the country is conveniently completed with the publication of this map covering Co. Donegal.

THE BOUGUER ANOMALY MAP

The Bouguer anomaly pattern over Co. Donegal is dominated by the gravity effects associated with the various post-tectonic granite masses. Of these the most important units comprise the Main Donegal granite, the Ardara pluton, the Rosses ring complex and the Barnesmore granite. These structures are emplaced within predominantly Dalradian metasediments which outcrop over a very large area in Co. Donegal. Inspection of the Bouguer anomaly values over the extensive Dalradian tract south-east of the Main Donegal granite indicates that the average Bouguer anomaly over these rocks, away from the influence of the granite mass is close to 20 mgal. This figure is in agreement with an earlier estimate based on a limited number of observations covering the north-west of Ireland (Cook and Murphy, 1952). The gravity values depart by only 2-3 mgal from this value over the Dalradian rocks in this area and the contours lack a well-developed trend. Estimation of the regional background anomaly during interpretation of the local anomalies is therefore likely to be best provided by reference to the values obtained over the Dalradian outcrop.

The Main Donegal granite anomaly

The negative Bouguer anomaly associated with the Main Donegal granite is the dominant feature of the gravity field in north-west Donegal. The anomaly is more than 30 km in length and about 5 km wide at the north-eastern extremity near Mulroy Bay. The long axis is aligned in a north-east to south-west direction. The width increases gradually to the south-west until the discrete anomaly begins to merge with a difference feature centred on Dungloe. The maximum width here is estimated to be 10 km.

The minimum measured value after correction for topographic irregularities was 6.1 mgal. Adopting a regional Bouguer anomaly of 20–22 mgal yields an estimate of 14–16 mgal for the amplitude of the local anomaly produced by the Main Donegal granite. The gravity feature ends in the north-east where the isogals close near the western shore of Mulroy Bay.

The Ardara gravity "low"

The gravity "low" associated with the Ardara granite pluton is circular in plan following closely the shape of the surface outcrop. The diameter is approximately 8 km and the minimum Bouguer anomaly recorded was 6.1 mgal. Estimation of the background regional anomaly is complicated by the proximity of other granite bodies but is considered to be about 9 mgal.

The Rosses ring complex

A pronounced negative anomaly of elliptical shape is developed with a centre positioned 2–3 km north of Dungloe. The minimum measured Bouguer anomaly was –8.4 mgal. The feature is elongate in a north-south direction with a length of approximately 15 km. The eastern boundary is obscure where the anomaly merges with that produced by the Main Donegal granite, but along the western margin the isogals are aligned with a north-south trend and a maximum measured gradient of about 3 mgal/km. If it is assumed that a regional Bouguer anomaly of approximately 20 mgal persists towards the west coast then the maximum amplitude of the anomaly north of Dungloe is nearly 30 mgal.

The Barnesmore granite anomaly

Inspection of the relatively undisturbed gravity field to the east and south-west of the Barnesmore granite suggests a background regional Bouguer anomaly of approximately 15 mgal and a resultant amplitude of 16 mgal for the local anomaly. The number of stations established to the west of the granite is sufficient to indicate that the sinistral shift along the Belshade fault is reflected in the gravity field by a prominent "nosing" of the isogals in a south-westerly direction north of the fault.

Two distinct trends which may be of major structural significance are present on the eastern and northern flanks of the Barnesmore anomaly. A north-south belt of isogals is developed in a position centred approximately along grid line E. 210, and extends southwards from the Barnesmore area for a total distance of about 25 km. This trend is truncated in the north by a pronounced east-west belt of isogals approximately 5 km wide centred on grid line N. 400. The feature extends for approximately 25 km from the line of the Leannan fault dislocation in the west, across the northern margin of the Barnesmore anomaly, to near Ballybofey in the east.

The Lough Derg "low"

Directly to the south of the Barnesmore anomaly is a further centre of relatively low gravity situated in an area of ancient rocks believed to be of predominantly Moinian age (Anderson, 1947). The minimum measured Bouguer anomaly was 5.9 mgal. The feature is similar in areal dimension to the Barnesmore anomaly although somewhat more elliptical in shape. The western boundary of the anomaly is bounded by a pronounced north-south alignment of the isogals coupled with a regional rise of the Bouguer anomaly in a westerly direction towards the coast. Values of 20 mgal are attained on the east shore of Donegal Bay where the gravity contours continue to maintain a predominantly north-south trend across the north side of the Bay until a value of nearly 30 mgal is reached at St. John's Point.

The northeast-southwest linear "high"

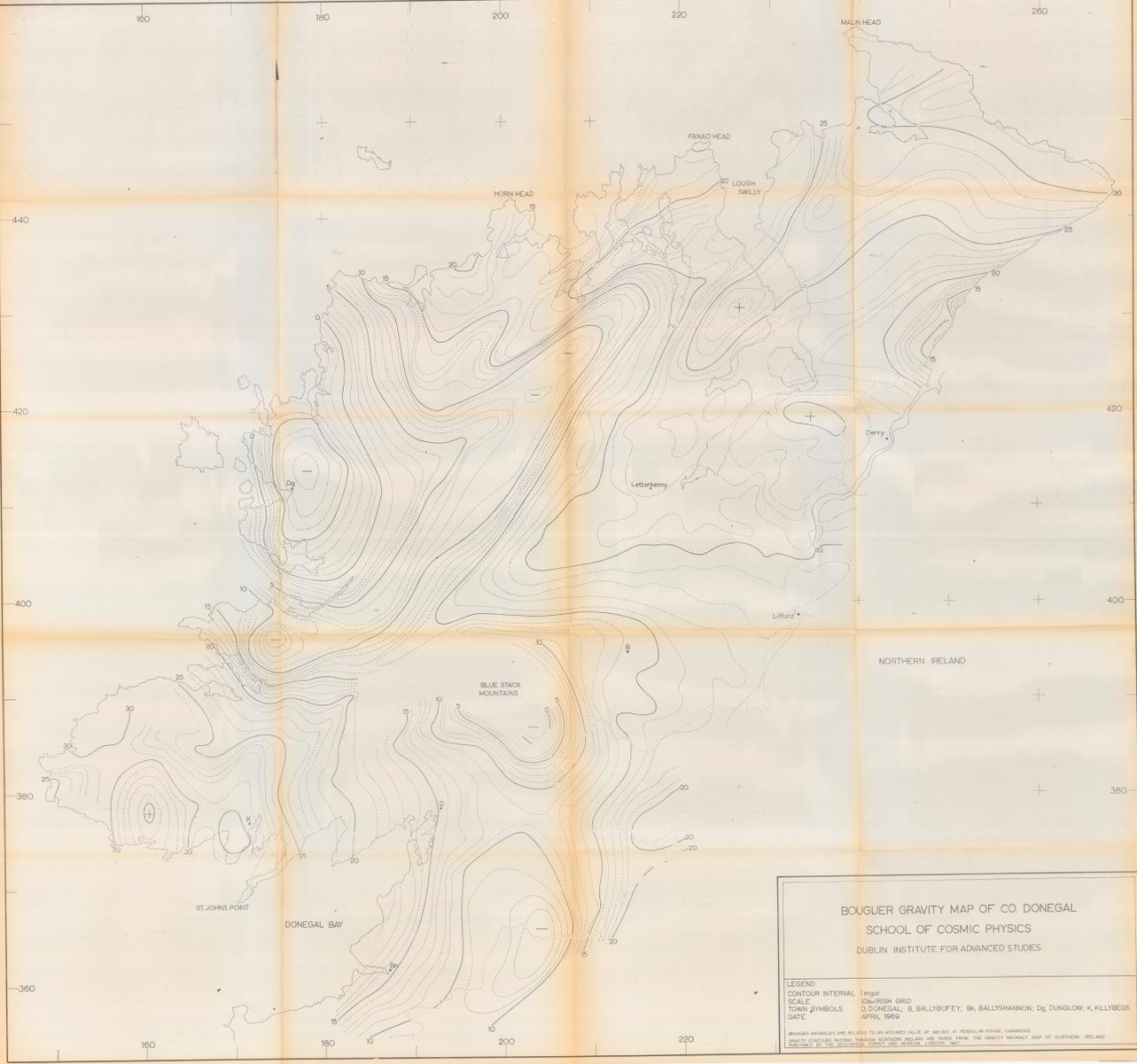
A linear positive anomaly extends from a position approximately 6 km due south of Mulroy Bay, in a north-easterly direction across Lough Swilly; maintaining a similar trend over Inishowen to a position near Trawbreaga Bay. A break in trend at this point causes the feature to assume a more easterly alignment before it disappears out to sea. The total length of the positive belt is approximately 40 km. A similar positive anomaly occurs near Killybegs and runs in a north-easterly direction for nearly 15 km. The axes of these gravity features may be continuous and the result of a persistent structure at depth.

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 SCHOOL OF COSMIC PHYSICS
 DUBLIN INSTITUTE FOR ADVANCED STUDIES

LEGEND
 CONTOUR INTERVAL 1 mgal
 SCALE 1:62,500
 TOWN SYMBOLS D, DUNEGAL; B, BALLYBOFEY; Bn, BALLYSHANNON; Dg, DUNGLOW; K, KILLYBEGS.
 DATE APRIL 1957

BOUGUER ANOMALIES ARE RELATED TO AN ASSUMED VALUE OF 981.895 AT PENDULUM HOUSE, CAMBRIDGE.
 GRAVITY CONTOUR PLOTS FOR NORTHERN IRELAND ARE TAKEN FROM THE GRAVITY ANOMALY MAP OF NORTHERN IRELAND
 COMPILED BY SIR J. HULL, 1952, AND REVISED, 1957.