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A COMPOSITE MAGNETIC MAP OF IRELAND

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PETER MORRIS

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INTRODUCTION

Although most of the Irish mainland and surrounding waters has been covered by some form of magnetic survey there is such a variety of different types of map available that it is difficult to view the area as a whole. The Geological Survey of Ireland have produced a number of composite magnetic maps (e.g. Max, McIntyre and Inamdar 1983) but these suffer from the fact that they have not been reduced to a common datum and the observer can be misled by mismatches between the various surveys. The map presented here is an attempt to fit the pieces of the Irish magnetic jigsaw together in a systematic way and contains additional data not included in earlier maps.

In view of the desire to produce a coherent picture and because magnetic station spacing is sparse in some regions no attempt has been made to preserve all the fine detail present in some of the surveys. The final map is produced from a 142 x 121 point grid. The size of the grid cells is 3.333 x 3.333 km.

MAGNETIC SURVEYS IN IRELAND

Four main types of survey have been used to construct the map:

- 1) Regional aeromagnetic surveys carried out by the Irish and British Geological surveys.
- 2) Regional offshore aeromagnetic surveys carried out for oil exploration.
- 3) Marine magnetic surveys in the Irish Sea carried out by the Dublin Institute for Advanced Studies and the British Geological Survey.
- 4) Ground magnetic surveys mostly carried out by workers from the Dublin Institute for Advanced Studies and the Geological Survey of Ireland.

All the data included has either been published previously or are freely available for inspection. Further, as yet confidential, surveys exist but those which the author has been able to inspect confirm his opinion that owing to the regional nature of the map their inclusion would not change the picture significantly.

CONSTRUCTION METHOD

The choice of a 3.333 km grid interval was governed by the fact that this interval had been chosen when the British

Geological Survey (BGS) data was digitised to produce the Smoothed Magnetic Map of Great Britain and Northern Ireland (Hall and Dagley 1970). The Irish portion of this digitised data set was regridded from the British to the Irish National Grid. Data from the other aeromagnetic surveys were digitised by placing a transparent Irish National Grid overlay over the respective maps and reading off the map values at the 3.333 km intersections. These values were then entered into the computer. Most of the subsequent grid manipulations and contouring processes were carried out using the CPS1 program package.

The aeromagnetic surveys form the major elements of the map. These were fitted together first before the gaps between them were filled with smaller surveys. Ideally all the aeromagnetic surveys should have been upward or downward continued to a common altitude. In view of the comparatively small range of altitudes involved (from 300 m to 600 m above sea level) and because of the impossibility of making accurate corrections with the data on such a widely spaced grid it was decided not to attempt the exercise. In the event the various grids fitted together reasonably well and it does not appear that altitude variation between surveys has introduced serious distortion. The final map can be considered to represent a survey at 450 metres above sea level.

A greater problem was encountered with regional corrections. The surveys span a period of some 20 years and even after reduction to a standard reference field (IGRF) mismatches were still present. These were corrected empirically by applying additional gentle regional gradients to the various surveys so that a satisfactory fit was achieved. The map as presented has been converted from the IGRF to the regional field used for the British Aeromagnetic survey so that a direct comparison can be made with British maps.

After the main surveys had been joined together the gaps between them were filled with the best alternative set of data. The treatment given to the individual small surveys depended very much on what type of records were available and how much overlap existed with the main aeromagnetic surveys. The basic technique was however:

- 1) Grid - upward continue - smooth the infill survey as required to approximate to a survey altitude of 450 m.
- 2) Calculate the local regional across the hole to be filled using the aeromagnetic data round the edge.
- 3) Correct the infill survey to make its regional identical to the regional derived from the aeromagnetic surveys.

Even though all available useful data known to the author were included certain gaps remain, notably in Connemara and Cork. The southwestern gap is probably not

particularly serious as the magnetic field is fairly flat and little significant detail should be lost. The gap in Connemara is more irritating as it lies in an area with considerable magnetic activity. The general regional picture can however be guessed at by interpolation of the surrounding data.

SMOOTHED MAGNETIC MAP

Once a gridded set of data is available in the computer many manipulations may be carried out with ease. It was considered of interest to produce a smoothed magnetic map similar to the one available for the United Kingdom. The Irish data set was therefore filtered in a manner analogous to that described by Hall and Dagley (1970) and was plotted out at the same scale so that the continuity of the magnetic features between the two may be examined (Fig.1).

GENERAL COMMENTS

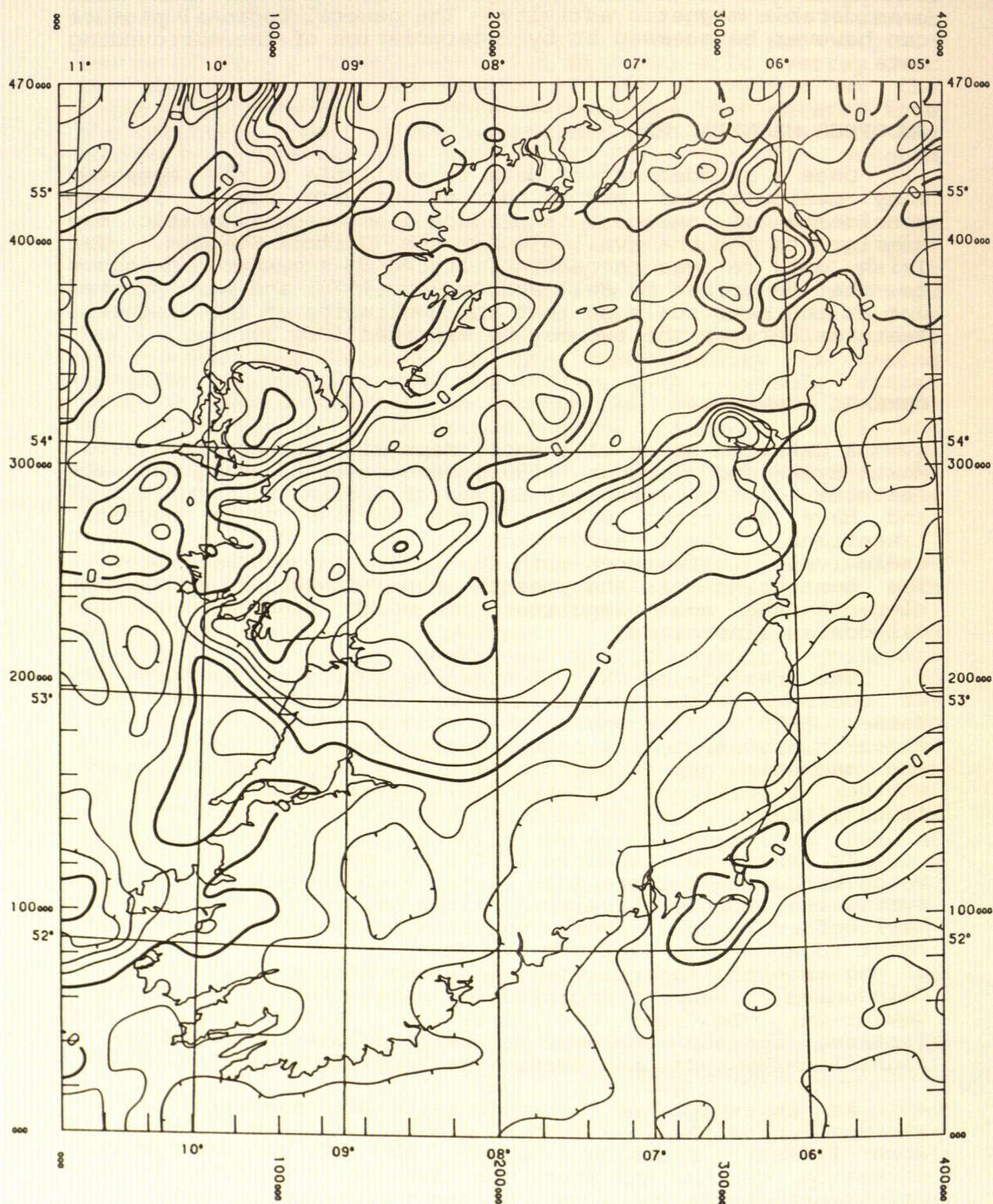
A detailed study of the two maps will not be given here. Max, Ryan and Inamdar (1983) have reviewed many of the features of the Geological Survey of Ireland's compilations and have described most of the obvious major magnetic lineations. Their exposition is however confined almost exclusively to features with NE - SW, Caledonoid, trends. The contouring of the present map emphasises additional elements the most important of which trend across the Caledonian lineations.

The presence of NW - SE trending geological features has of course not passed unnoticed by Irish Geologists (e.g. Horne, 1976). In general they must be assumed to be fault zones transverse to the regional structure. Those shown on the magnetic map appear to be of two types depending on whether significant lateral fault movement has or has not taken place.

An excellent example of the former type is the line which marks the Western edge of the high frequency anomalies over the Antrim basalts. This extends through the Carlingford igneous complex and along just offshore the Irish coast to about the latitude of Lambay Island. An examination of the smoothed magnetic map indicates that most of the major Caledonian linears trend straight across this line without deviation. In view of its obvious relationship to the Tertiary igneous complexes we must conclude that this was a significant extensional feature in Tertiary times.

As an example of the second type of transverse feature we shall note the line running from west of Achill via the Aran Islands, Limerick, Youghal and off to sea in the direction of England where the trend is continued in the Sticklepath fault which cuts across the Cornubian Peninsula. It is very obvious that none of the major Caledonian trends which are marked by magnetic features, such as the Highland

A SMOOTHED MAGNETIC MAP OF IRELAND TOTAL FIELD ANOMALY



ANOMALY VALUES ON A 33x33 KM GRID, HAVE
BEEN SMOOTHED USING A FILTER WITH A CUT OFF
WAVELENGTH OF APPROXIMATELY 13KM (Mc Grath and Hall 1969)

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Peter Morris, 1989.



Figure 1

boundary fault and its extensions which can be traced for long distances from the North Sea and across Scotland, actually cross the line. It would seem possible that this is the line of a major fault which was active in the Caledonian orogeny and along which later adjustments have taken place (as suggested by the Limerick volcanic centre which lies on the fault line). A seismic traverse of Ireland (Jacob et al. 1985) provides some evidence that important changes in crustal structure take place across this line. Fig. 2 shows a possible simple model for the later stages of Caledonian collision in the British Isles in which the fault forms the southern boundary of a discrete wedge of the collision front, the Northern boundary being perhaps the Tournquist zone (Pegrum, 1984). One can envisage that the block to the west of the fault was pushed further to the North than that to the East. The line of the Iapetus suture may not now therefore run out to sea along the line of the Shannon estuary (as it is often currently shown) but be displaced bodily to the Northwest. If the feature identified as the Iapetus suture on BIRPS WIRE line 1 is indeed the suture zone (Klemperer 1989) then a displacement of up to 100km is possible on the fault. The Wenlock age rocks of the Dingle peninsula were possibly once closer to their equivalents in the Welsh borderlands than at present.

The zone south of the Hercynian front is characterised by a general E - W magnetic grain which contrasts with the Caledonian grain to the North. The fault line can be seen to cut across the Hercynian frontal zone again emphasizing its importance as a major basement feature visible beneath the thin skinned Hercynian overthrust.

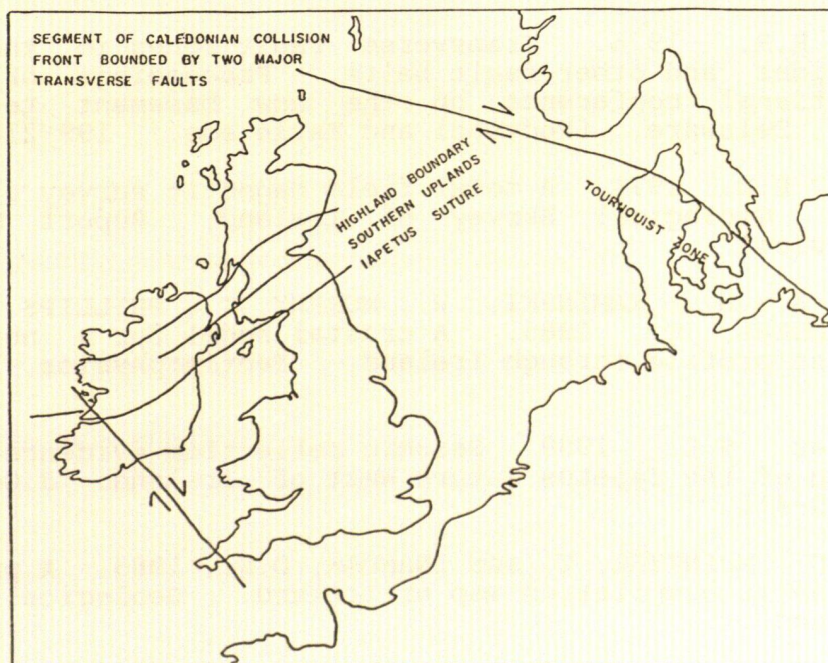


FIG 2 POSSIBLE MODEL FOR A MAJOR NW-SE BASEMENT FAULT IN SW IRELAND

ACKNOWLEDGMENTS

First I would like to thank C.P. English who originally first aroused my interest in magnetic surveys in Ireland. This publication would not have been possible without free access to the work carried out over many years by Prof. T. Murphy and his co-workers at the Dublin Institute for Advanced Studies. I would also like to acknowledge the assistance of members of the staff of the Geological Survey of Ireland, in particular M.D. Max. Data from survey publications has been included by permission of the Director. I am grateful to the Director of the British Geological Survey for permission to include British magnetic data including that from unpublished marine surveys and to P. Dagley of the University of Liverpool for supplying me with gridded UK aeromagnetic data and to ARCO Ireland Inc. for permission to use offshore West coast data. Northern Ireland data has been incorporated with the permission of the Director of the Geological Survey of Northern Ireland (Department of Economic Development).

Finally I wish to thank the British Petroleum Company for permission to publish this work. The opinions expressed herein are however not necessarily those of the Company.

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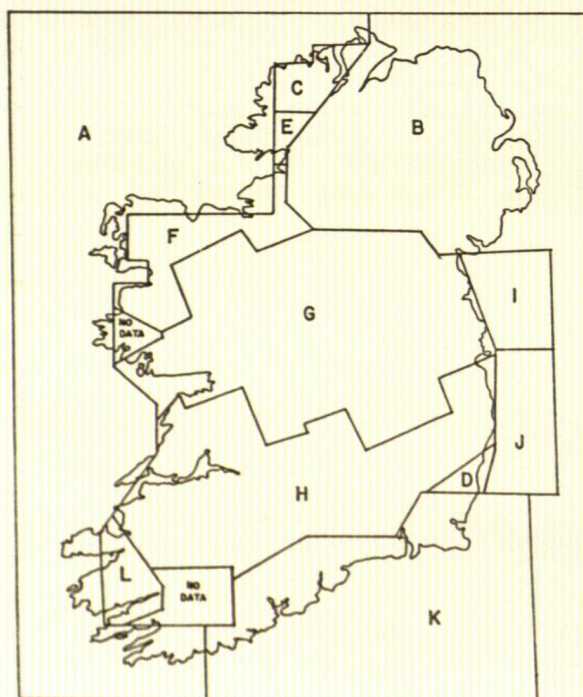
APPENDIX 1

MAGNETIC SURVEYS USED IN COMPILING THE MAP

REF	SURVEY	YEAR	ALTITUDE	OPERATOR	PUBLICATION
A	AERO	1971/73	450m	Fairey	Max 1982
B	AERO	1955/59	300m	BGS	Hall & Dagley 1970
C,D	GROUND	1986	0	P.Morris	
E	GROUND	1967/68	0	DIAS	Riddihough 1969
F	GROUND	1967/75	0	C.P.English	
G,H	AERO	1979/81	450	GSI	Max & Inamdar 1983
I	MARINE	1970	0	BGS	
J	MARINE	1975/80	0	DIAS	
K	AERO	1964	600m	Huntings	Max & Inamdar 1983
L	GROUND	1970/72	0	GSI	Inamdar 1974

The regional fields of the various aeromagnetic surveys are as follows:

GSI IGRF (epochs 1979.9, 1980.5, 1981.7) + 1000 gamma
 BGS Regional increase 2.1507 gamma/km north and 0.43362 gamma/km west (Irish Grid) with datum value of 47490 gamma at the grid origin (epoch 1955.5)
 FAIREY IGRF75 (epoch 1971.3 altitude 0m)
 HUNTINGS Regional increase 2.7 gamma/km north and 0.2 gamma/km west with datum value of 47000 gamma at 50°N 8°W.



APPENDIX 2

FITTING TOGETHER THE MAIN MAGNETIC SURVEYS

The northern half of the GSI aeromagnetic survey was taken as the standard and the remaining surveys were fitted around this. An attempt was made to convert all surveys to the IGRF/DGRF before an empirical comparison of overlapping regions was made in order to determine what extra corrections had to be applied to each survey in order to make them fit together. To change to the BGS datum the inverse of the corrections applied to the BGS survey data were applied to the compiled grid.

From a comparison of the original grid values of the individual surveys and the final grid values of the compilation map we can determine the actual corrections which were applied to correct the BGS datum.

These are:

$$Z(\text{BGS}) = Z(\text{GSI north}) - 918 - 0.0953X + 0.3397Y$$

$$Z(\text{BGS}) = Z(\text{GSI south}) - 893 - 0.0953X + 0.3397Y$$

$$Z(\text{BGS}) = Z(\text{Huntings}) - 154 + 0.2359X + 0.5093Y$$

$$Z(\text{BGS}) = Z(\text{Fairey}) - 9054 + 0.1019X - 0.2440Y + 0.0002Y^2 - 0.0003XY$$

where X and Y are the Irish grid coordinates in km.

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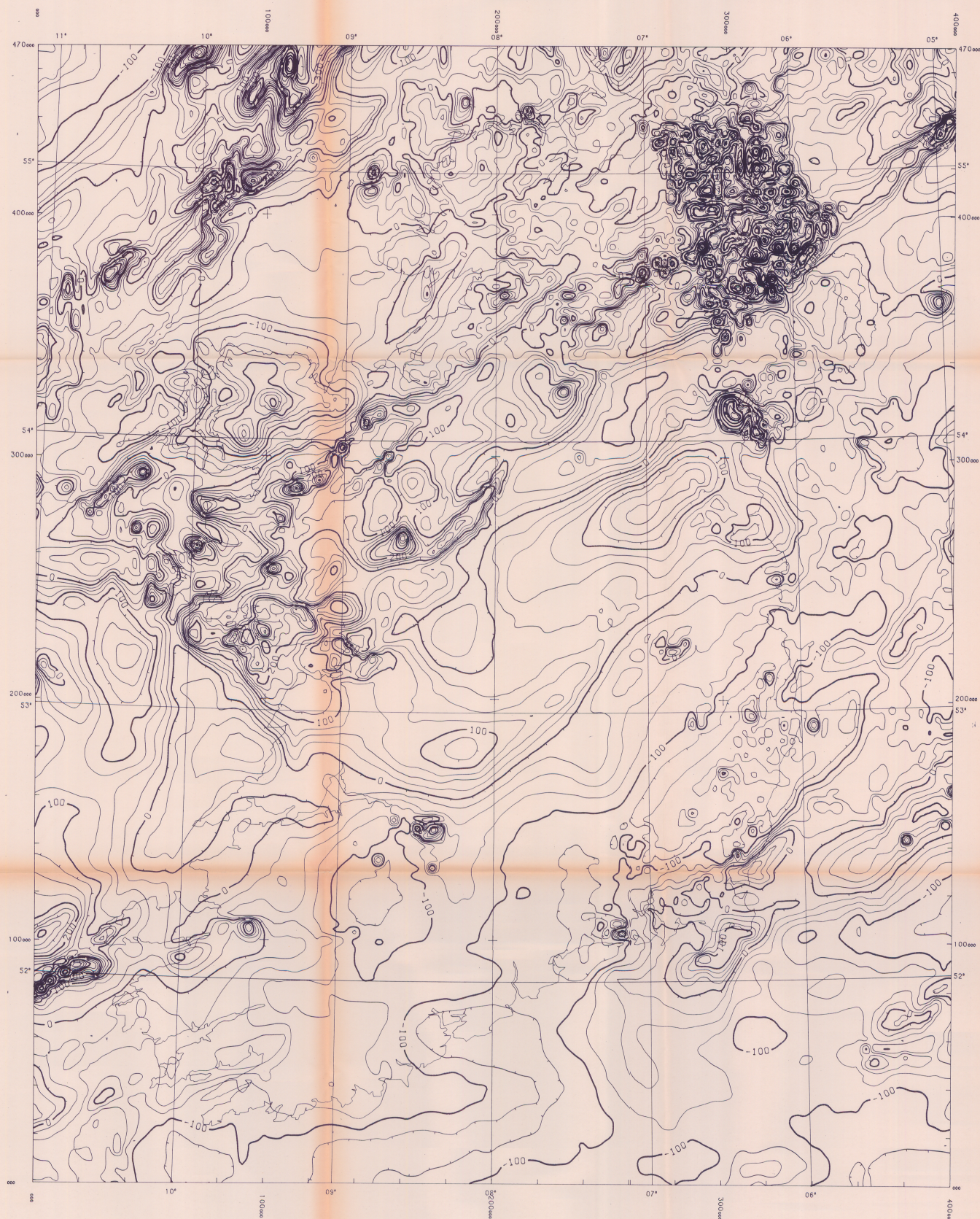
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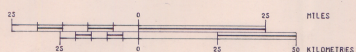
TOTAL FIELD ANOMALY

GEOPHYSICAL BULLETIN NO. 42, PETER MORRIS, 1989.



COMPILED ON 3.3X3.3 KM GRID REDUCED USING REGIONAL
FIELD OF THE MAGNETIC ANOMALY MAP OF NORTHERN
IRELAND: EPOCH 1955.5

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PROJECTION: TRANSVERSE MERCATOR
ZONE: IRISH NATIONAL GRID
CONTOUR INTERVAL 25 GAMMA