

**DETAILED COMPILATION MAGNETIC  
MAP OF IRELAND  
AND A SUMMARY OF ITS DEEP GEOLOGY**

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## INTRODUCTION

This report presents a detailed compilation of magnetic data centred upon the aeromagnetic survey commissioned by the Geological Survey of Ireland during 1979-1981.<sup>1</sup>

In addition, published and unpublished data is incorporated so as to utilise the most detailed information available: this is necessary because the aeromagnetic survey is incomplete. The aim of this report is to present the magnetic data and a regional magnetic interpretation. When the magnetic data is compared with the surface expression of rocks of Caledonian and older age, positions of the deep geological structural lines and geophysical provinces can be proposed. High frequency magnetic anomalies, usually caused by Carboniferous and Tertiary volcanic and intrusive rocks, are not referred to in this summary of major regional deep features.

Figure 1 is a regional magnetic and location map with a 50 nT contour interval modified in part from Max *et al.* (1982). It allows comparison of the Irish and British linears and major geological lines and provides a key to the "highs" and "lows" on the detailed map, where data density prevents insertion of contour values. The seven data sources areas (Fig. 2) overlap. In all areas of overlap the more detailed information has been used. Magnetic maps were used exclusively. Data tapes were not reprocessed. Minor projection corrections from the photographically reduced data were made by hand smoothing. Compilation was originally made by MDM at 1:750,000 (Max and McIntyre, in press) to overlay the widely circulated Geological Map of Ireland. Mismatch between data from adjoining areas has not been smoothed, nor is there a common zero. Clear, continuous patterns which pass from one area to the other, however, show that the numerical mismatching is of no qualitative significance and that the map is valid for regional geological interpretation. Comparison of the magnetic map (Fig. 3) with a Lower Palaeozoic and major fault map (Fig. 4) modified from the 1:1,000,000 geological map recently prepared by the Geological Survey of Ireland (1979) shows a direct relationship between geology and geophysics. Major magnetic patterns (Fig. 5) can be related to geology (Fig. 6).

Although the magnetic data compiled here have been collected over a 17 year period by different contractors and individual research geophysicists, the magnetic patterns flow consistently from one data source area to another, with no breaks or apparent artefacts introduced at the boundaries. Magnetic linears remain traceable, which is important as these almost certainly reflect the position of major deep seated structural, lithological and/or tectono-thermal breaks. The magnetic map is contoured at 10 nT intervals to enhance the anomalies and steep gradient zones of linears; but as there is no common zero the magnetic values are of relative importance only (see Fig. 1). Comparison of the 50 nT (Fig. 1) and 10 nT (Fig. 3) maps illustrates the value of plotting the smaller contour intervals in that the course of major linears is much more easily followed, and direct relationships between many recognised geological faults and subjacent magnetic linears and basement province boundaries can be seen clearly for the first time.

## SUMMARY OF THE MAGNETIC MAP AND INTERPRETATION

Four main magnetic provinces are separated by the Fair Head – Clew Bay, Southern Uplands and Wexford Linears; other linears occur within the provinces (Max *et al.* 1983). The linears are briefly described along with the magnetic provinces but no detailed assessment of their geological significance is presented here. A more complete deep geological description is presented by Max *et al.* (1983).

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<sup>1</sup> Inspection and acquisition of information about the aeromagnetic survey on 1:250,000 and 1:63,360 scales can be arranged through the Geophysics Section of the Geological Survey of Ireland.

**Figure 2.** Data source map for detailed Figure 3 and generally for Figure 1. Longitude and latitude for scale. Heavy lines show the outlines of data sources 1-7. Original compilation on 1:750,000 Geological Map of Ireland (Max and McIntyre, in press). High frequency areas are open contoured for clarity where linework would otherwise close owing to reduction. No common zero. No smoothing between areas.

**Area 1.** 1:250,000 total field aeromagnetic maps: flown August-November, 1979, April-August, 1980 and September 1981. Compiled by Hunting Geology and Geophysics Ltd for the Geological Survey of Ireland (Williams, 1981) 5 sheets. 10 nT contour interval here, simplified in high density areas; mean flight line spacing 1 km but locally 2 km. Mean tie line spacing 10 km. Mismatch of south-western part.

**Area 2.** Land magnetics in Ireland. Compilation map at 1:500,000 by R.P. Riddihough for the Geological Survey of Ireland: now open file. 1 sheet 1:500,000 scale. Compiled from predominantly vertical field data; contoured at 50 nT intervals. Largely published by Max and Riddihough (1975) and Phillips *et al.* (1976).

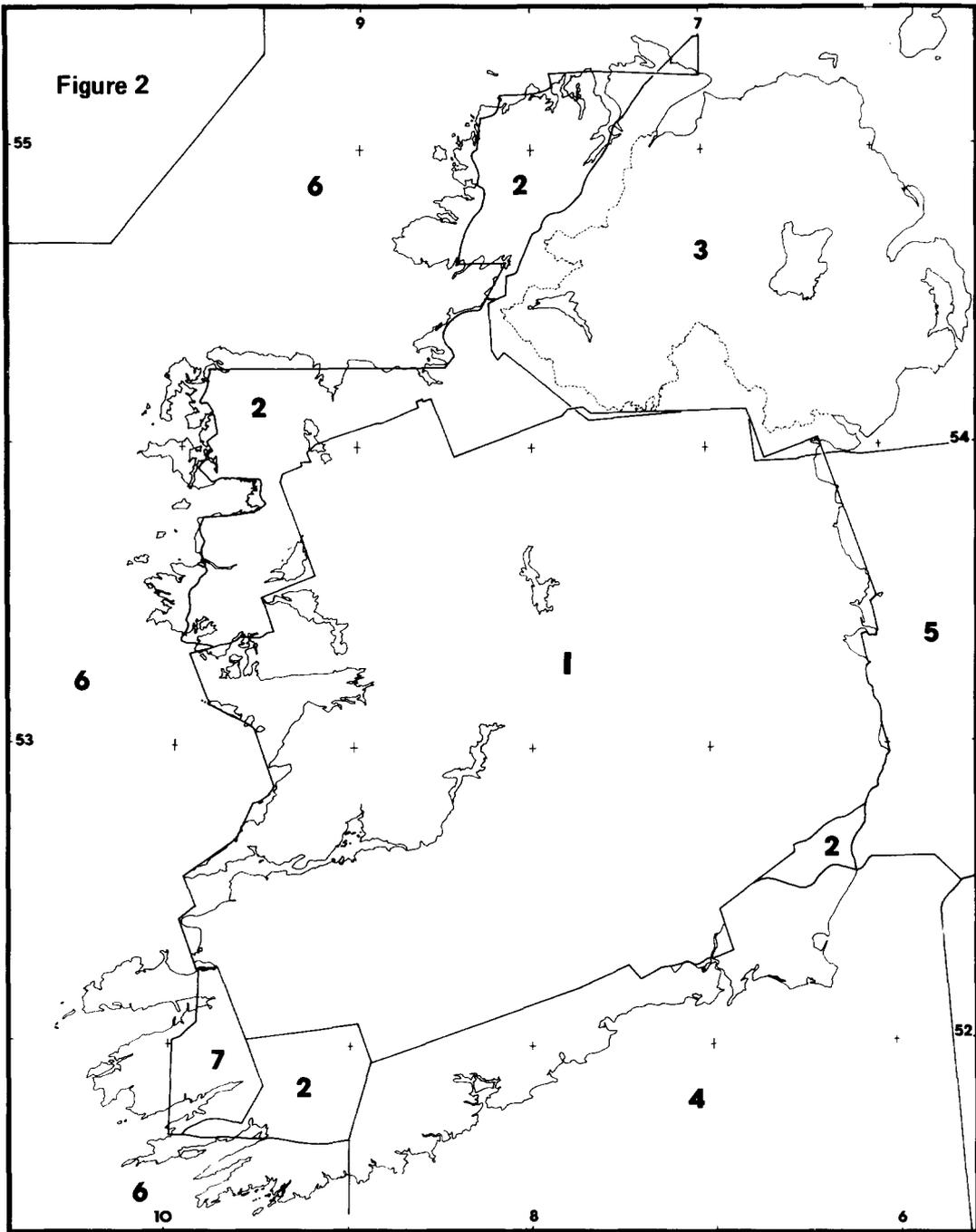
**Area 3.** Aeromagnetic maps published by the Institute of Geological Sciences, Great Britain, (Bullerwell, 1971). Original data by Huntings and Canadian Aero Services Ltd Surveys on contract. 1:652,000 scale except Northern Ireland at 1:253,440 scale. Total field corrected for epoch 1955.5. Mean altitude over sea and terrain 1000 feet except in southwest England where it was 500 feet; flight line spacing 2 km or closer; tie lines 10 km or closer. 10 nT contours used here.

**Area 4.** 1:500,000 total field aeromagnetic map supplied by Elf-Aquitaine to the Geological Survey of Ireland. Flown at a mean altitude of 2000m AMSL. North-south flight lines at about 10km spacing; East-west tie lines about 20 km. 20 nT contours.

**Area 5.** Detailed data unavailable. Data is either confidential or isolated areas of seaborne surveys. Detailed aeromagnetics now flown but confidential.

**Area 6.** Fairey Surveys data, now held by the Geological Survey of Ireland: in the public domain, 5 sheets 1:250,000 scale. Aeromagnetic total field. Flown and compiled 1971, original contouring at 2½, 5, 10, 50, 100 etc. nT; mean flight level 450 m AMSL; mean east-west flight line spacing 4 nautical miles; mean north-south tie line spacing 20 nautical miles; Loran C locations at about 3 km. Part of Donegal Bay published (Max and Barber, 1978).

**Area 7.** Geological Survey of Ireland (D.D. Inamdar, 1974), 20 nT.



## Magnetic Linears

**Great Glen Linear (GGL).** The course of the Great Glen Fault can be followed from the Firth of Lorne north of Islay (Evans *et al.*, 1979) and along a series of linears which pass off the Donegal and North Mayo coasts (Fig. 1) and towards the head of the Porcupine Seabight (Riddihough and Max, 1976). Splays to the north of this linear extend towards the Rockall Trough. A major splay to the south is the Leannan Fault of Donegal, which can also be traced from the Firth of Lorne and towards the head of the Porcupine Seabight (Max, 1978).

**Fair Head – Clew Bay Linear (FCL).** The most well defined linear on Figure 3 is the Fair Head – Clew Bay line of Max and Riddihough (1975) who regarded it as marking an important deep geological line, separating different tectono-thermal subzones within an area affected by the Grampian (c. 500 Ma) orogeny. This interpretation has received support and a new emphasis owing to the recognition of a deep geological history associated with the surface continuation of the FCL along the Highland Boundary Fault of Scotland (Henderson and Robertson, 1982). The FCL in western Ireland bifurcates along a number of splays which are coincident with major faults displaying a lengthy history of sinistral movement.

**Southern Uplands Linear (SUL).** The western continuation of the Southern Uplands Fault can be traced geologically to the vicinity of north Galway Bay (Max and Ryan, 1975). Geophysically a good linear can be traced to the vicinity of Strokestown (Fig. 1), where the line bifurcates. It can then be followed along several courses, some of which are offset, to the vicinity of Connemara and Galway Bay. The main bodies of Lower Palaeozoic rocks in Ireland and Scotland which have proven oceanic crust affinity occur along this line (i.e. at Ballantrae, Strokestown and in the South Connemara Group (Ryan *et al.*, 1983).

**Virginia Linear (VL).** This linear links the disrupted SUL in the east Galway Bay area with the Solway line in Britain; its geological status is uncertain but at least beneath the Longford-Down Massif magnetically very different deep basements are separated. In the eastern part of the Longford-Down massif elongated Caledonian and younger igneous rocks are coincident with the linear.

**Navan – Tipperary Linear (NTL).** The Navan – Tipperary Linear passes from east of Navan to the vicinity of Tipperary where it either terminates or is offset along the major NW-SE cross-linear. It lies about where Archer (1981) suggested the course of part of the Iapetus suture zone should pass but to the east of that suggested for the suture by Phillips *et al.* (1976). This line marks an important boundary between quite different magnetic basements. The NTL is less well defined than the GGL, the FCL, or the SUL, but as it may be at greater depth and therefore be of greater or equal importance to the VL and GWL within this zone, we prefer to regard its geological status as uncertain. It appears to coalesce with the Virginia Linear and the Solway line of Britain in the northern Irish Sea.

**Graiguenamanagh – Wicklow Linear (GWL).** Shearing along this line took place during the intrusion of the 400 Ma Leinster Granite (O'Connor and Brück, 1978), but it was active earlier as to the northeast it marks a root zone to the 'Bray Nappe' of allochthonous Cambrian rocks which were thrust to the north over lower Ordovician rocks, prior to injection of the granite (Brück and Reeves, 1976). The line is poorly defined in Ireland owing to a large number of high frequency anomalies related to volcanic rocks in SE Ireland, but it appears to pass as a segmented magnetic ridge across the Isle of Man where it also appears to coalesce with the Solway line in Britain (Fig. 1).

**Wexford Linear (WL).** This reflects the course of a deep geological line, which probably marks the northern limit of rocks deformed during the Cadomian orogeny in Ireland. The linear is

very well defined in southeast Ireland but appears to be truncated at the major NW-SE transverse line at its western end. The line is continued to the west, on weak magnetic evidence, along the northern margin of a basement block (Inamdar and Horne, 1971) probably similar to the basement block seen in SE Ireland, southeast of the WL. In the west the line is termed the Dingle Bay Linear (DBL). The linear can be traced to the northeast where it passes north of Anglesey, which contains rocks similar to those seen in Southeast Ireland (Barber *et al.*, 1981).

### Magnetic Provinces

**Northern Cratonic Zone.** The area to the northwest of the Fair Head – Clew Bay line is largely underlain by negatively magnetised rocks (Max and Riddihough, 1975) with few important magnetic linears or bodies. This zone is characterised by Lewisian and Grenvillian continental basement underlying Moine and Dalradian sediments, which were deformed and metamorphosed largely during Grampian (530-480 Ma) times.

**Segmented Zone.** This zone lies between Fair Head – Clew Bay Linear and the Southern Uplands Linear and contains low to moderate frequency, dominantly magnetically positive basement bodies, which are well defined and relatively small. The separate positive and negative areas almost certainly reflect a magnetic basement which rapidly changes magnetic character laterally. Different segments of 'docked' basement are probably present. This segmented zone is probably in part a relic of the sheared margin of the northern craton to the Ordovician Iapetus ocean which lay to the south of the SUL.

**Vestiges of Iapetus.** Like Newfoundland, Ireland has a broad central area between the northern craton and its segmented margin and the Avalon Platform and its segmented margin to the south (Williams and Max, 1981). In Ireland this broad zone lies between the SUL and the WL and represents the sutured Iapetus ocean in the sense that the crust everywhere within this zone has evidently been thickened during the Caledonian orogeny. The area is characterised by large, deep seated, dominantly positive magnetic anomalies and the depth to magnetic basement is deeper than elsewhere in Ireland. Locally, ancient crustal fragments may be preserved at depth but none are exposed. Linears within this zone (VL, NTL, GWL) denote important deep structural lines whose significance is not fully understood, but all of which may also be important in the development of the Paratectonic Caledonides.

**Irish Sea Zone.** Dominantly positive, moderate frequency, shallow magnetic anomalies characterise this zone in those areas where no deep Mesozoic and younger sedimentary basins are developed. The rocks exposed in Ireland are part of the segmented margin to the Avalon Platform, which is exposed to the southeast of the Menai Straits Line in Wales (Williams and Max, 1981).

### ACKNOWLEDGEMENT

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## FOLDED MAPS

**Figure 1.** Location and generalised magnetic key map. Longitude and latitude for scale. Simplified coastlines and projection computer drawn at Geological Survey of Canada by R.T. Haworth. British magnetics after Bullerwell (1965, 1972). Modified after Max *et al.* (1982). Dashed lines separate data source areas (Fig. 2) with offshore magnetics drawn to limits on land, whereas Figure 3 is drawn with the more detailed overland magnetics drawn to the offshore limits. 50 nT contour interval. Area 4 has been recontoured from 20 nT; other areas used 50 nT intervals. A, Anglesey; BL, Belfast Lough; CB, Clew Bay; CM, Connemara; DB, Donegal Bay; DBA, Dingle Bay; FH, Fair Head; GB, Galway Bay; K, Kintyre; L, Letterkenny; LDM, Longford-Down Massif; NM, North Mayo; OM, Ox Mountains; S, Sligo; ST, Strokestown.

**Figure 3.** Detailed magnetic trend map of Ireland and part of the immediate offshore area. Longitude and latitude for scale. No contour values because of data density. Fig. 1 provides a generalised guide to contour values. Slight differences in the margins of the data source areas between Figures 1 and 3 are due to Figure 1 being modified from Max *et al.* (1982) which was largely completed before the Geological Survey's aeromagnetic data became available.

**Figure 4.** Magnetic and geological map. Geology only shows the disposition of pre-Caledonian and Caledonian rocks with major faults. Caledonian rocks include those up to mid-Devonian age. Geology modified from 1:1 M compilation for the Geological map of the Royal Irish Academy *Atlas of Ireland* and updated to June 1983. Some high frequency anomaly areas (Fig. 3) in younger rocks not depicted here reflect Carboniferous and Tertiary igneous rocks. Dashed lines show offshore or hidden extensions of Galway, Leinster and Donegal Granites. 1-7, pre-Caledonian rocks. 1, Lewisian gneisses of the Inishtrahull platform; 2, Garnet-muscovite-biotite schists of the Inishtrahull platform; 3, Lough Derg and the northeast end of the Ox Mountains also east end of the Rosses Point inlier; the Sliswood Division; 4, Annagh Division of the Erris Complex; 5, Inishkea Division of the Erris Complex; 6, Rosslare Complex; 7, Cullenstown Formation. Other areas in which possible pre-Caledonian basement occurs are in the Connemara Massif, the south side of

Clew Bay, part of the Ox Mountains and the Tyrone inlier. ABF, Achill Beg Fault; BN, Bray Nappe; CBF, Clew Bay Fault; DLF, Doon Rock – Lough Nafooe Faults; KF, Killavail Fault; L, Leck Fault; NBF, Nephin Beg Fault; NOM, North Ox Mountains Fault; SRF, Skird Rocks Fault.

**Figure 5.** Geophysics and interpretative map: Magnetic linears and bodies with magnetic data and selected geology. Numbers on magnetic bodies refer to the approximate depth in km to the body determined by slope methods; largely after Huntings report to the Geological Survey which accompanied the original data. S. indicates exposed at the surface. S1, Rosslare Complex; S2 Cullenstown Formation; S3, Strokestown Inlier, Ordovician + Silurian; S4, Galway Granite; S5, Charlestown Inlier (in part) Ordovician – Silurian. Linears: DBL, Dingle Bay Linear; FCL, Fair Head – Clew Bay Linear; GGL, Great Glen Linear; GWL, Graiguenamannagh – Wicklow Linear; HBF, Highland Boundary Fault Line. NTL, Navan – Tipperary Linear; SUL, Southern Uplands Linear; TF, Tyndrum Fault; VL, Virginia Linear, WL, Wexford Linear.

**Figure 6.** Interpretation and geological map. See descriptions of Figs. 4 and 5.

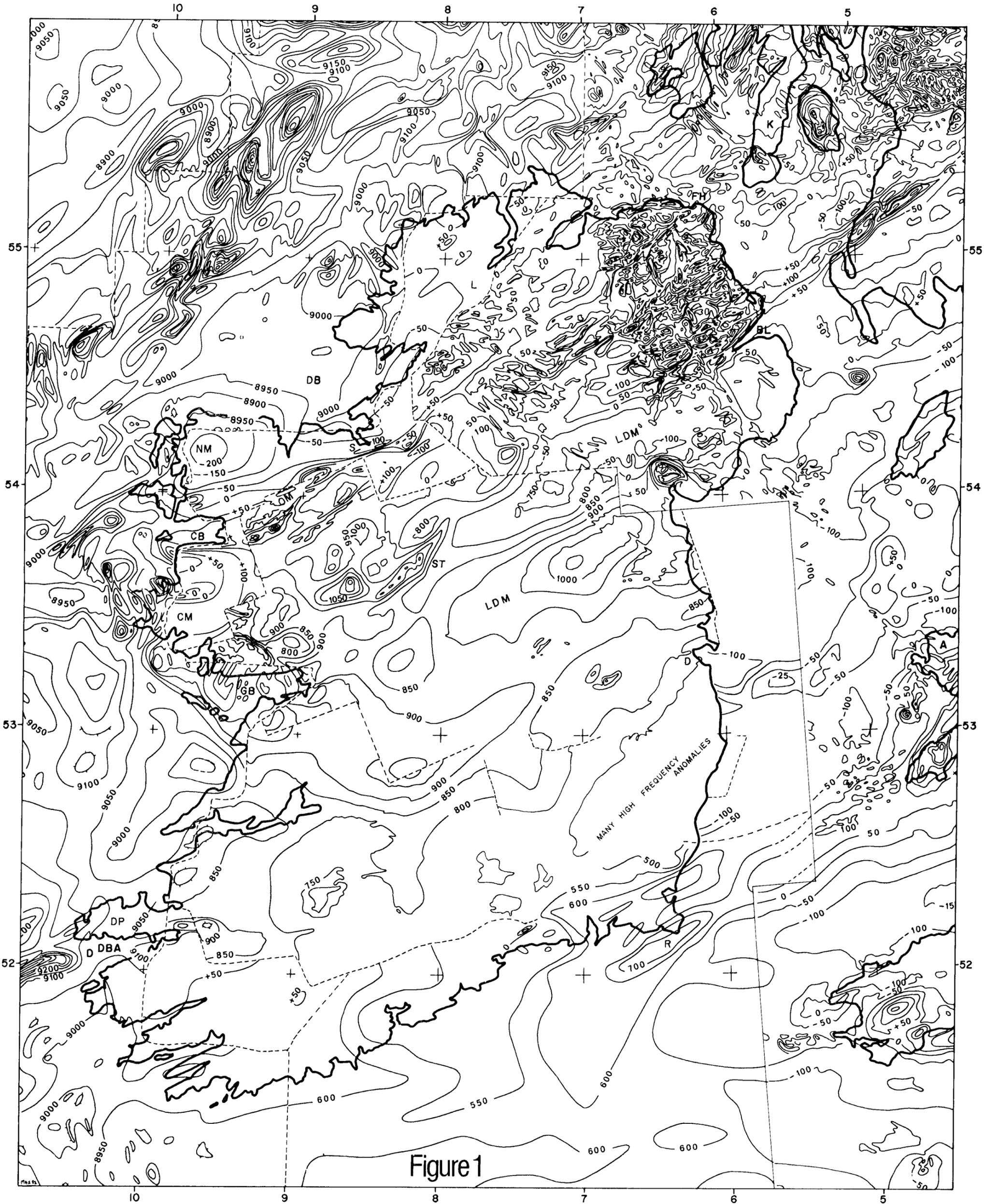
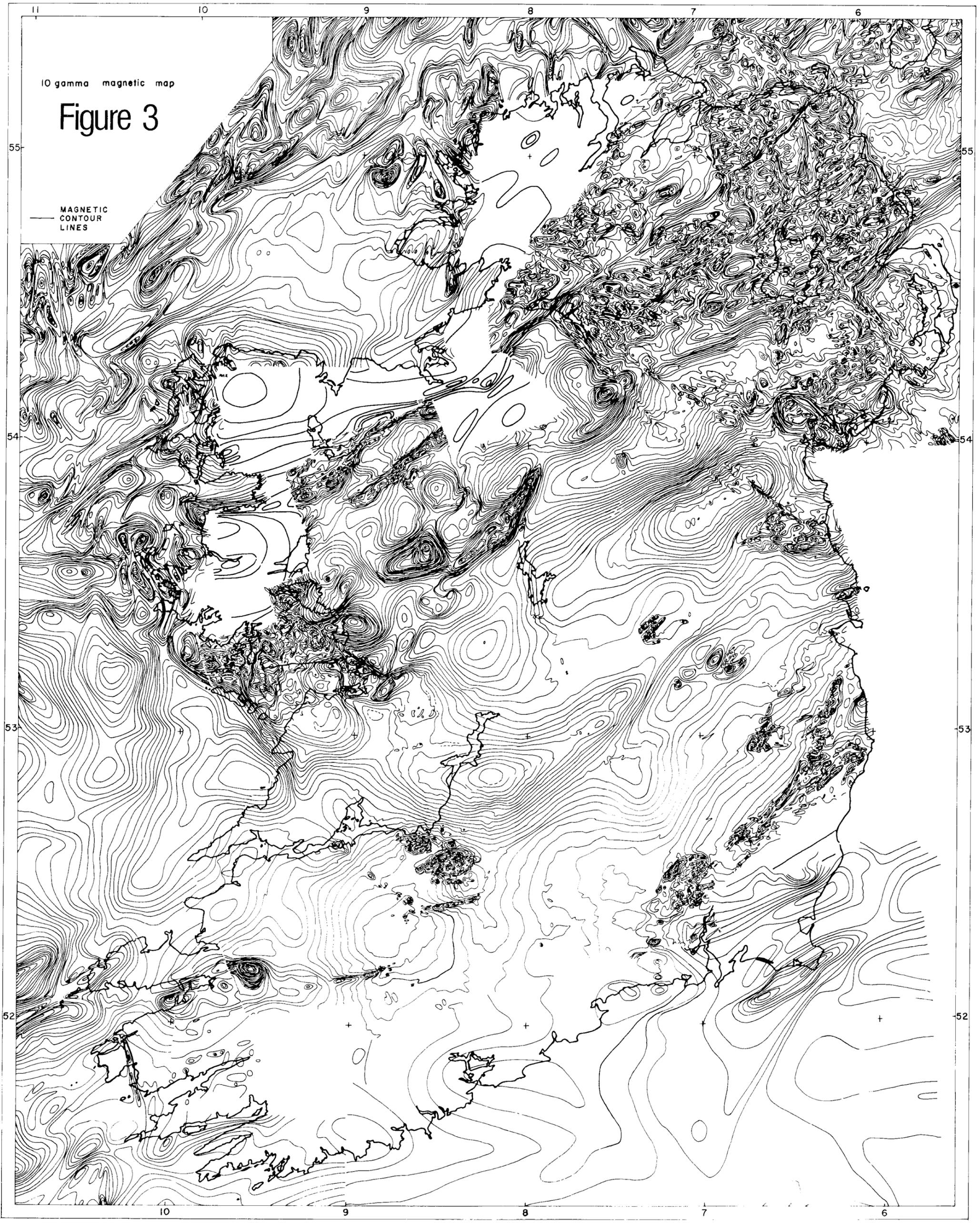


Figure 1

10 gamma magnetic map

# Figure 3

MAGNETIC  
CONTOUR  
LINES



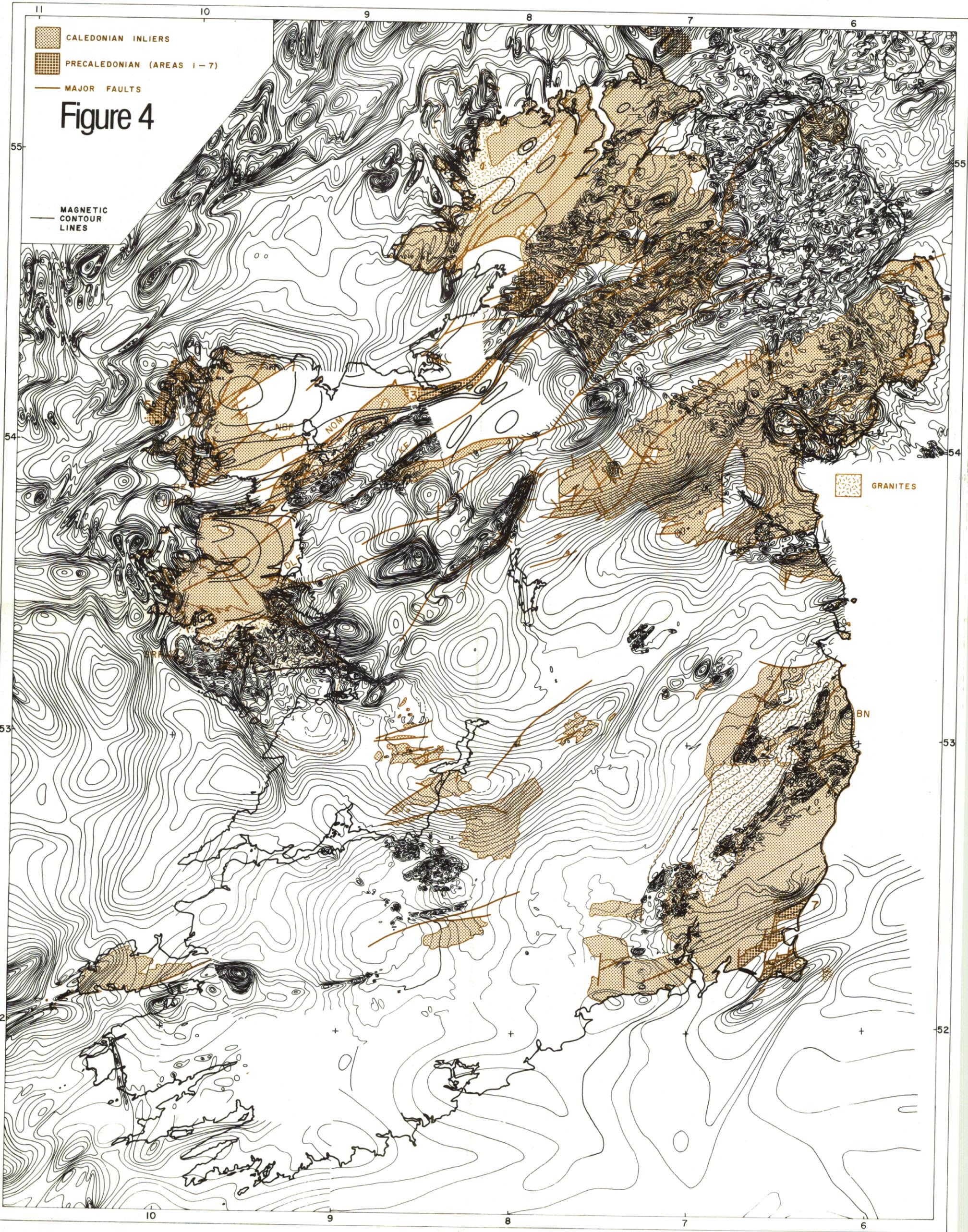


Figure 4

CALEDONIAN INLIERS  
PRECALEDONIAN (AREAS 1-7)

MAJOR FAULTS

MAGNETIC  
CONTOUR  
LINES

GRANITES



Figure 5

MAGNETIC LINEAR & BODY MAP  
GEOLOGICAL OVERLAY



Figure 6