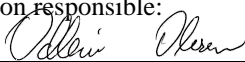


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| Report no.: 2007.068 | | ISSN 0800-3416 | Grading: Confidential to 17.02.2011 | |
| Title: Compilation of Gravity and Magnetic data in the area of Statoil's licence block 02/06, offshore West Ireland | | | | |
| Authors: Stephanie Werner, Marco Brønner | | | Clients: Statoil Exploration Ireland Limited | |
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| <p>Summary:</p> <p>For the recently awarded Statoil block 02/06, offshore West Ireland, gravity and magnetic data of the area from Statoil's DRAGON database were assorted to give a comprehensive overview of what data are already on hand. For the area of interest eight folders with gravity and 12 folders with magnetic data were extracted and displayed.</p> <p>For both gravity and magnetic, the different surveys were evaluated in terms of data quality and resolution. For gravity data, a compilation of the requested surveys already exists, whereas for the magnetic the corresponding datasets were merged in one map considering the evaluation results.</p> <p>The datasets on hand already cover almost the entire Statoil block 02/06 and its surroundings to the west. Towards the east and for the eastern most part of the blocks themselves, new data need to be purchased or acquired. Therefore, an overview of additional available data is presented and evaluated based on the available information. An outlining of the eastern basin edges is not permitted on the base of the high-resolution data sets.</p> <p>All maps and compilations are produced with Geosoft Oasis Montaj and presented in an Esri ArcGIS project. Grids are provided in Gosoft Oasis Montaj format.</p> | | | | |
| Keywords: Geofysikk | | Kontinentalsokkel | Tolkning | |
| Berggrunnsgeologi | | Magnetometri | Forkastning | |
| | | Gravimetri | Fagrapport | |

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1 INTRODUCTION

With the aim to give a comprehensive overview of the potential field data already on hand and additional available datasets for the area of Statoil's Irish licence 02/06 and surroundings, NGU performed this study. From Statoil's DRAGON database the different gravity and magnetic surveys in the area of interest were extracted and evaluated in terms of resolution, reliability and accuracy.

Furthermore for both gravity and magnetics a compilation of these different surveys was performed. For a more regional view gravity and magnetic data from satellite observations were added as well as bathymetry data.

A selection of additional maps with first interpretation steps like RTP, Bouguer anomalies and isostatic residuals are enclosed.

Based on the results of this work a recommendation concerning the need and availability of additional data and a possible improvement by a state of the art reprocessing is given.

All data are provided as Geosoft Oasis Montaj grids within an ESRI ArcGIS project.

2 DATASETS

From the DRAGON database, the corresponding surveys were extracted and data were imported into an Oasis Montaj project. The original survey lines were converted to a common datum and projection (ED50, UTM 29N) and plotted to check the data coverage and overlapping. For the different surveys as listed in the contract some of them turned out to be already compilations or a subarea of another survey also listed in the database. Additional surveys not listed in the contract were found in the database and added to the compilation. All utilized surveys and compilations are displayed in Fig. 1, and represent the currently available DRAGON datasets for the area of interest.

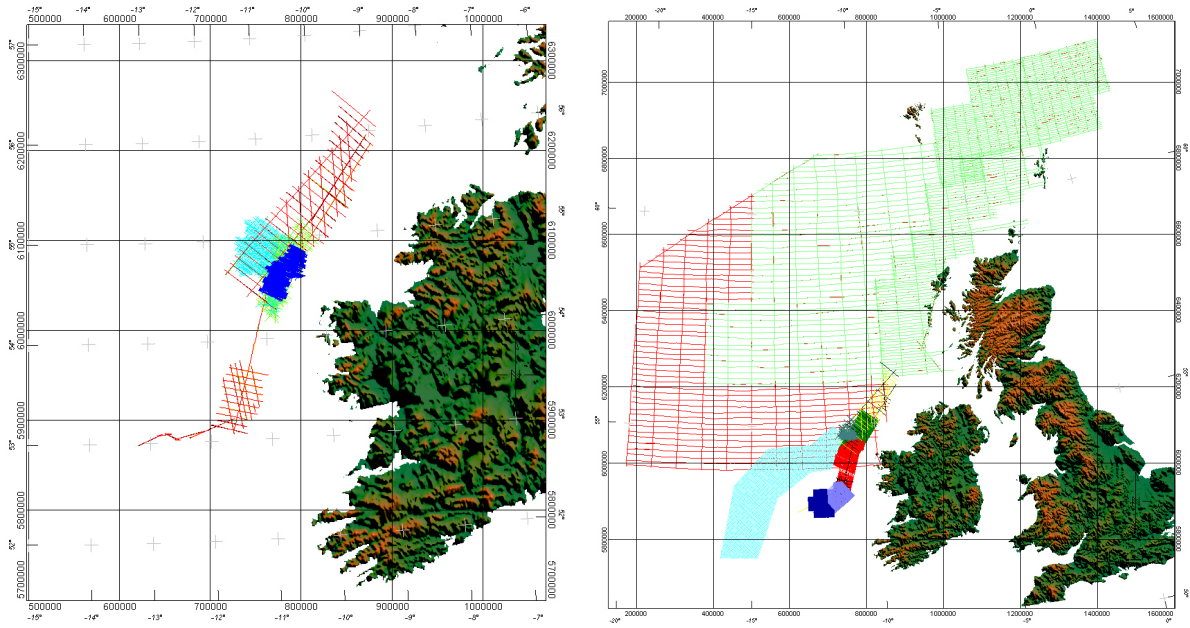
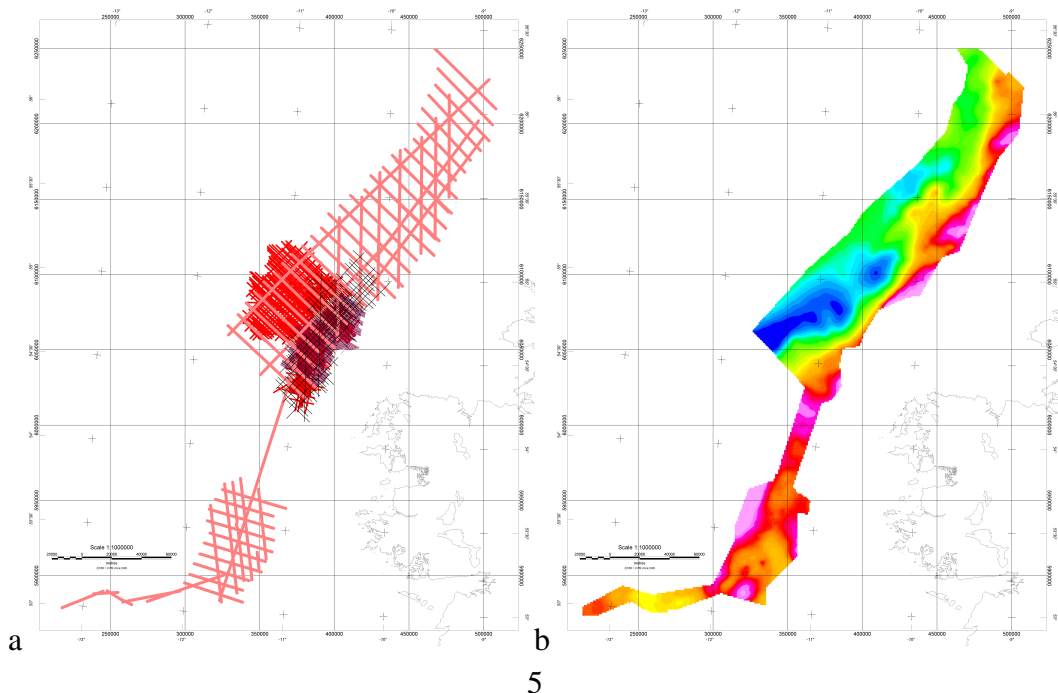


Figure 1a,b Overview map of available (a) gravity and (b) magnetic line data.

2.1 Gravity

Eight folders of the DRAGON database contain surveys and products covering parts of the area of interest. Fig. 1a shows an overview of the profile position and survey locations. Folder 170 contains a compilation of folder content 169 and 171 and is summarized as North West Ireland 1991 & 1993 (NWI -91/93) compilation. Folder 178 contains a survey of the area West Erris (1995 Phase 2) that includes data from an earlier survey period (folder 179, not listed in the contract). Folder 301 holds a compilation of two different surveys across the Erris Trough. One of the used dataset is identical with the compilation of folder 170 but the compilation itself in 301 was cut and limited to the Erris Basin for some reasons.



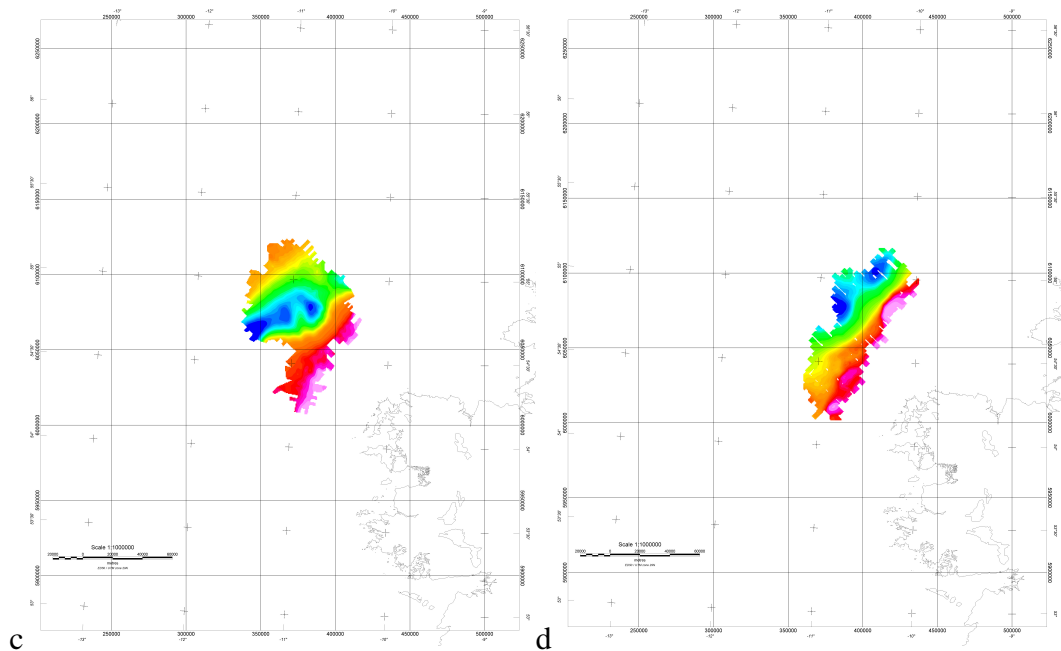


Figure 2a-d (a) Map of the profile lines as discussed in the text, (b) grids of the free air gravity anomalies of survey 170, (c) survey 178, and (d) survey 301b.

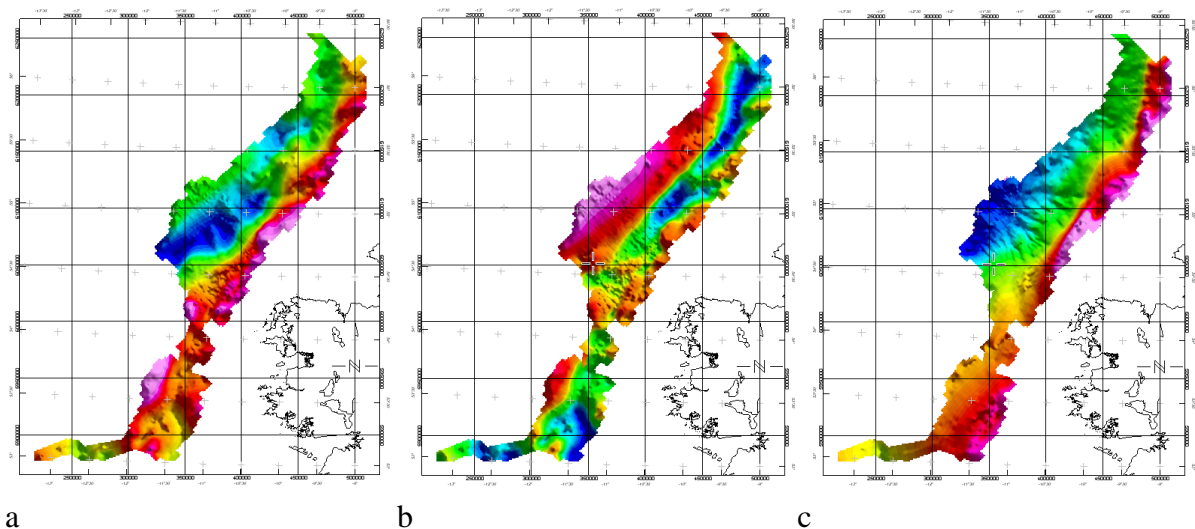


Figure 3 Grids compiled by ARK of all aforementioned surveys: (a) free air gravity anomaly, (b) bathymetry, and (c) Bouguer gravity anomaly.

For folder 181 it turned out to be a compilation of all surveys (folder 170, 178 and 301b, see Table 1). This compilation (Figs. 3a-c) has been performed by ARK (Project: STA9902), with deliverables: Free air gravity grid data, Bathymetry grid data, Bouguer gravity grid data, 30km cut-off residual Bouguer gravity grid data, and Horizontal gradient of Bouguer gravity grid data. No report is available through the NGU database. Another high-resolution survey is not listed in the contract and includes a detailed report of the Licence Area 5/94. (folder 156, performed by FUGRO-LCT). All survey details are given in Table 1 and key grids are shown in Figs 2b-d.

2.1.1 Evaluation of the gravity data

In the case of evaluation of the available gravity datasets, the existence of a compilation is an advantage, even though no detailed report is available. This implies that no information about the Bouguer reduction density is available. Brief tests suggest that the density figure used ranges between 2100 and 2200 kg/m³. If needed the Bouguer gravity anomaly for this compilation can be recalculated on demand.

The grids provided have a cell size of 200 metres and are projected in UTM 29N with an ED50 datum. The spheroid International 1924 is used as reference.

The gravity and bathymetry survey performed by Fugro-LCT with a grid resolution of 100 metres covers the Licence 5/94 area well, but does not completely cover the Licence 2/06 area (blocks 19/9, 19/13, 19/17). Here, Fugro-LCT provided bathymetry, free air gravity and Bouguer gravity (reduction density 2000 kg/m³) and a set of low-pass-filtered Bouguer gravity anomaly residuals.

Additionally, for the more regional aspect of this study, GEBCO bathymetry, Free Air satellite gravity data (Sandwell & Smith 1997), and the GRACE satellite Gravity Model (GGM02) are implemented in the ArcGIS project, also derived Bouguer gravity anomalies (reduction density 2670 and 2200 kg/m³) as well as the second derivative of the Free Air data (upward continued to 15 km) and the second derivative of the isostatic residuals calculated for an elastic thickness of 20 km (and upward continued to 20 km) are provided.

| Survey Name | Dragon folder | Year of Acquisition | Original projection | Data type | Total distance [km] | AverageLine spacing | | Recom. grid interval [m] | Remarks |
|-----------------------------------|---------------|---------------------|---------------------|-----------|---------------------|---------------------|---------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | | | | | inline [m] | tieline [m] | | |
| Irish Sector, Licence 5/94 - 2001 | 156 | 2001 | UTM ED50 29N | Ship | 7656 | Various (0-450) | Various | 100 | Marine gravity and bathymetry; Vessel: M/V Geo Pacific |
| NWI - 91/93 Slyne & Erris Trough | 170 | 1991- 1993 | UTM ED50 29N | Ship | 3904 | 8000;10000 | Various | 1000 | Marine gravity and magnetic line data; Compilation of Dragon folder 169,170 and 171, equal to folder 301b |
| West Erris Phase 2 Gravity | 178 | 1998 | UTM ED50 29N | Ship | 5649 | ~1000 - 2000 | ~2000 - ~4000 | 500 | Marine gravity and bathymetry line data; Compilation includes STAR97 West Erris NW Ireland (1997) DRAGON folder 179 |
| Slyne/Erris Trough | 301a | 1995 | UTM ED50 29N | Ship | 2440 | 1000; 5000 | 2800-12500 | 1000 | Marine gravity and bathymetry profile data |
| West of Ireland (COMP) | 181 | Various | UTM ED50 29N | Ship | 13043 | Various | Various | 200 | Processed bathymetry and gravity profile data from: NWI - 91/93 Slyne & Erris, E94IE09 Slyne Trough, ST9505 Erris Trough, STAR97 West Erris, ST9808 West Erris Phase 2 |

Table 1 Overview of gravity survey parameters.

2.2 Magnetics

From the DRAGON database 12 folders were extracted, containing magnetic data in the area of interest, whereas folder 202 turned out to be a subarea of folder 65, 170 is a compilation containing 169 and 171 and 176 contains two different datasets and a compilation of both. At the end magnetic data from seven different surveys/compilations were on hand and evaluated in terms of their resolution and accuracy (Fig. 1b, Tab. 2).

In a second step a compilation of all datasets was performed.

2.2.1 Evaluation of magnetic data

For each survey, survey parameters like e.g. line distance, acquisition height but also year of the survey acquisition were listed (Tab.2) and regarded to evaluate the accuracy and resolution of the different surveys.

Of the extracted seven data sets, all data derived from airborne surveys except two: folder 170 and 179. Folder 170 is a compilation of three shipborne surveys, acquired along with gravity data and 2D seismic surveys in the years 1991-93, most likely together with 2D seismic surveys.

This compilation extends over a quite large area, covering both Slyne and Erris basins (Fig. 4b). But the line spacing is rather wide (approx. 8000 – 9000m). Consequently, the resolution in between the lines must be considered as relatively low.

Survey of folder 179 was acquired in 1997 and is situated NW of the southern Erris Basin, mapping the escarpment and partly the NW flank of the basin. Here, line spacing is 1000 to 3000m (decreasing to the N), which already provides a fairly good resolution. As a matter of fact, the area of both surveys is also almost completely covered by significantly denser measured airborne magnetic surveys. Thus the shipborne surveys mainly provide additional information for the area NW of the southern Erris Basin and for the central and northern Erris Basin, where only more regional and rather old aeromagnetic data exist (Folder 065 from the 70s, see below).

From the five airborne magnetic surveys/compilations four are recently measured high-resolution aeromagnetic data (folder number 158, 176, 262 and 296), covering large parts of the basins (northern Rockall Trough, Slyne and southern Erris basins), whereas folder 065 contains a large and coarse survey of significant lower resolution.

| Survey Name | Dragon folder | Year of Acquisition | Original projection | Data type | Acquisition height | | average height [m] | Total distance [km] | AverageLine spacing | | Recom. grid interval [m] | Remarks |
|--------------------------------------------|---------------|---------------------|---------------------|-----------|--------------------|---------|--------------------|---------------------|---------------------|------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | | | | min [m] | max [m] | | | inline [m] | tieline [m] | | |
| Rockall Shetland Faroe Islands | 65 | 1971- 1973 | UTM ED50 28N | Aero | ?? | ?? | -431 | 85888 | ~17000 ~7400 | ~60000 ~23000 | 5000 1000 | Compilation of Fairey surveys 1971-1973, reprocessed by ARK 1996. Dragon folder 202 is part of this dataset, Eastern part with significant higher resolution |
| Slyne/Erris 2001 PGW | 158 | 1994 | UTM WGS84 29N | Aero | 84 | 134 | 99 | 17246 | ~500 | ~1500 | 200 | |
| SLYNE AND ERRIS TROUGHS NORTH WEST IRELAND | 170 | 1991- 1993 | UTM Int24 29N | Ship | 0 | 0 | 0 | 6119 | ~8000 ~9000 | ~12000 ~33000 | 2000 | Compilation of Dragon folder 169,170 and 171 |
| Slyne Trough and Trade with Chevron | 176 | 1995 | UTM ED50 29N | Aero | 91 | 153 | 120 | 9374 9551 | 500 | 2000 | 200 | one flight line at ~400 m already groundlevelled |
| West Erris NW Ireland | 179 | 1997 | UTM ED50 29N | Ship | 0 | 0 | 0 | 1767 | ~1000 - 3000 | 2000 | 500 | |
| Slyne Trough | 262 | 2006 | UTM ED50 29N | Aero | 98 | 145 | 122 | 9415 | ~1000 | ~3000 | 300 | some missing inlines |
| Ireland Rockall Trough | 296 | 1996 | UTM ED50 28N | Aero | 83 | 225 | 155 | 28226 | ~2000 | ~8000 | 500 | |

Table 2 Overview of magnetic survey parameters.

The high-resolution aeromagnetic data were acquired between the mid 1990s and 2006. The flight height was approx. 100-150m and the line spacing was 500 to 2000m. Due to their survey parameters in the covered area they provide high-resolution magnetic data, which are most suitable for a magnetic interpretation of the basin geometry and intra-basin structures (see Fig. 4a,c,e,f).

A much coarser grid (Fig. 4g, line spacing 7400 to 17000m) of lower resolution was added from the DRAGON folder 065. The data are mainly situated beyond the area of interest, covering a huge area over the Rockall Basin and Rockall High to the west and up to the Faeroe and Shetland islands to the north. However, although this dataset should be considered as less accurate and of a rather low resolution, it provides additional information for the central and northern Erris Basin with a link to the Donegal Basin. Furthermore, the dataset provides a comprehensive overview of the magnetic settings westwards of the area of interest in a more regional scale, which might be beneficial for a later interpretation of the area.

In addition, the processed data for each survey were gridded and visualized (with a shaded relief technique applying illumination from NW) to quality control the data processing and line levelling in terms of a necessary reprocessing (Fig. 4a-g). A detailed documentation of the processing applied on the data is not available and thus could not be reproduced, but in principle the magnetic data of the surveys/compilations seem to be processed quite well. IGRF reduction and line levelling were carried out for all datasets. Significant artefacts due to an improper line levelling are not obvious for most of the data. At least for the surveys in folders 179 and 296 an additional line levelling, especially for the 296, data a microlevelling might achieve further improvements.

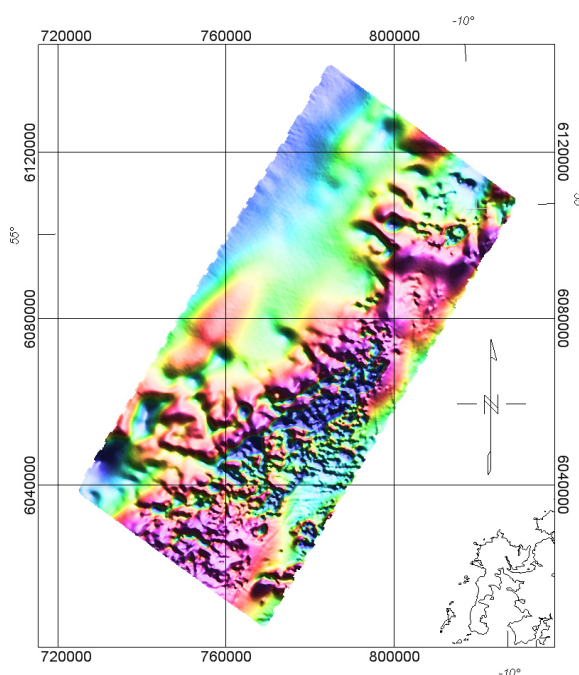


Figure 4a

TMI Magnetic data from DRAGON folder 158, Slyne/Erris Basins.

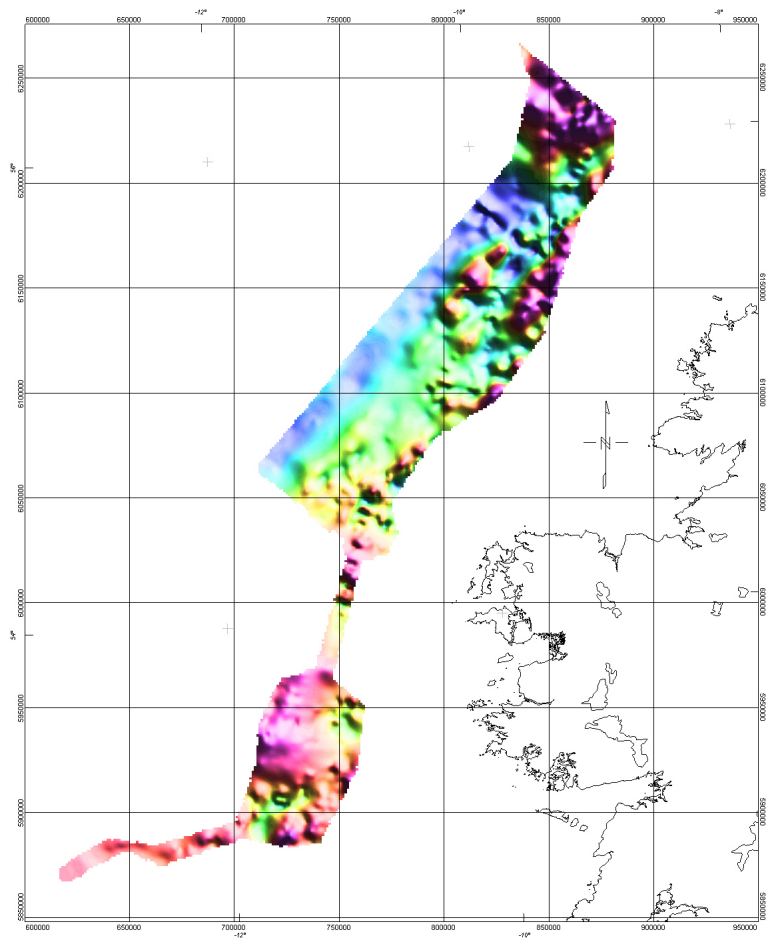


Figure 4b TMI data from DRAGON folder 170, Slyne/Erris Basin.

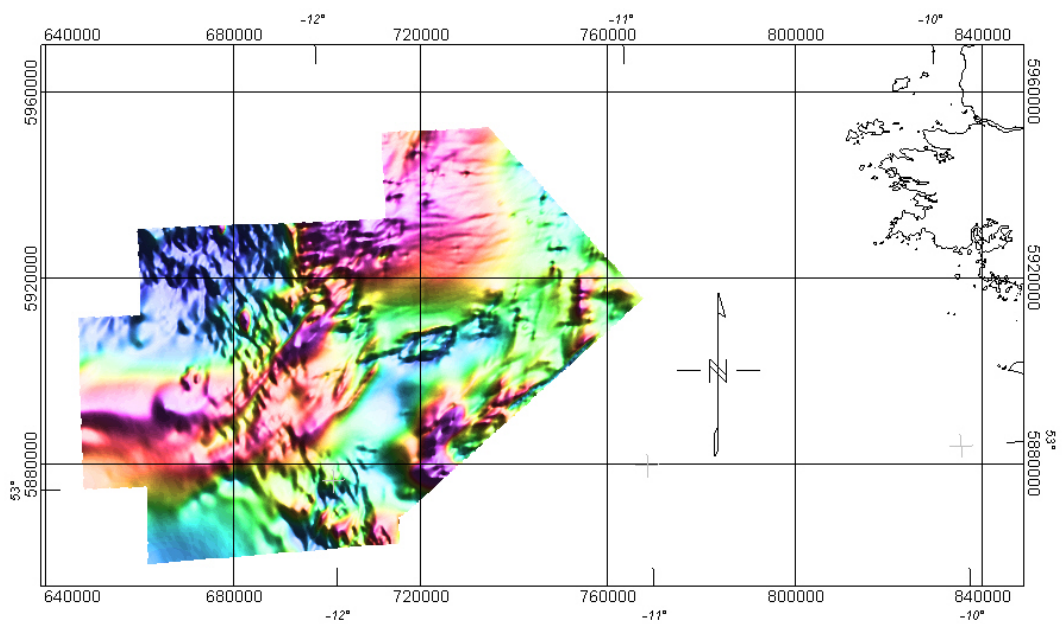


Figure 4c TMI data from DRAGON folder 176, Slyne Trough.

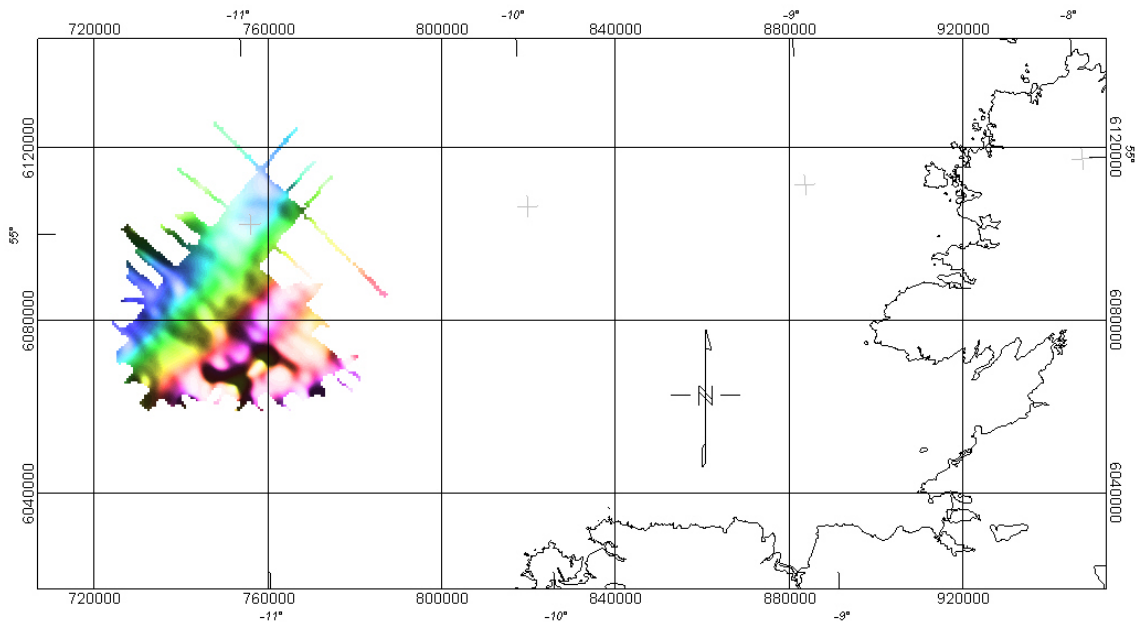


Figure 4d TMI data from DRAGON folder 179, West Erris, NW Ireland.

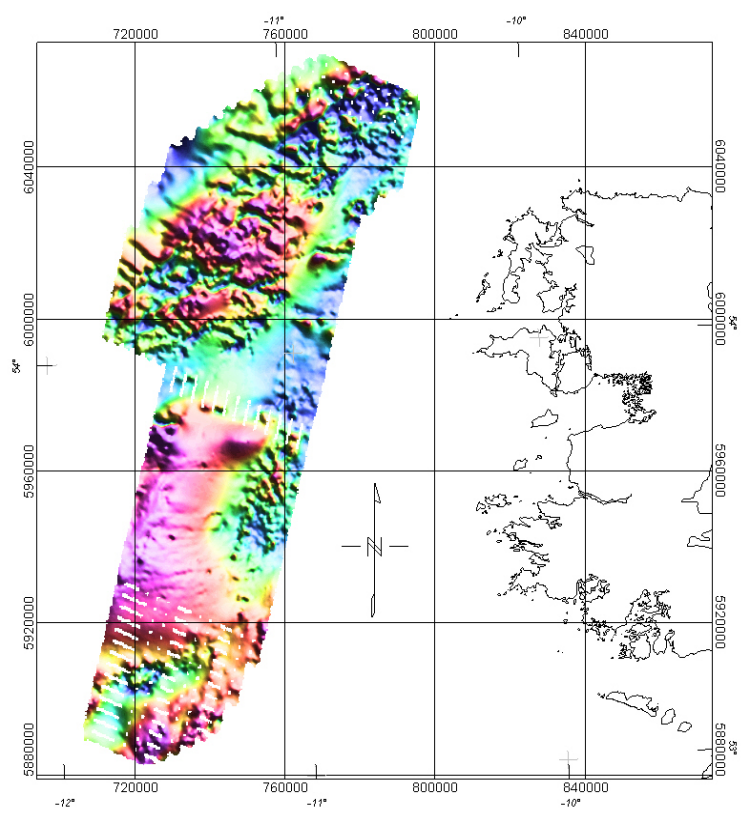


Figure 4e TMI data from DRAGON folder 262, Slyne Trough.

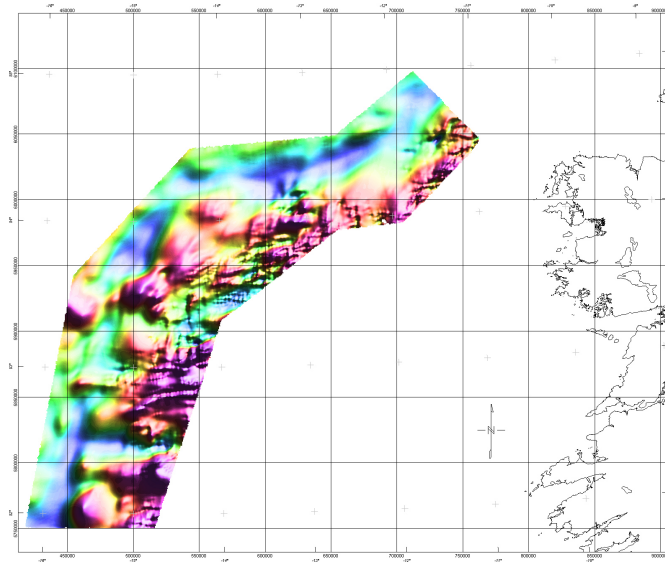


Figure 4f TMI data from DRAGON folder 296, Ireland Rockall Trough.

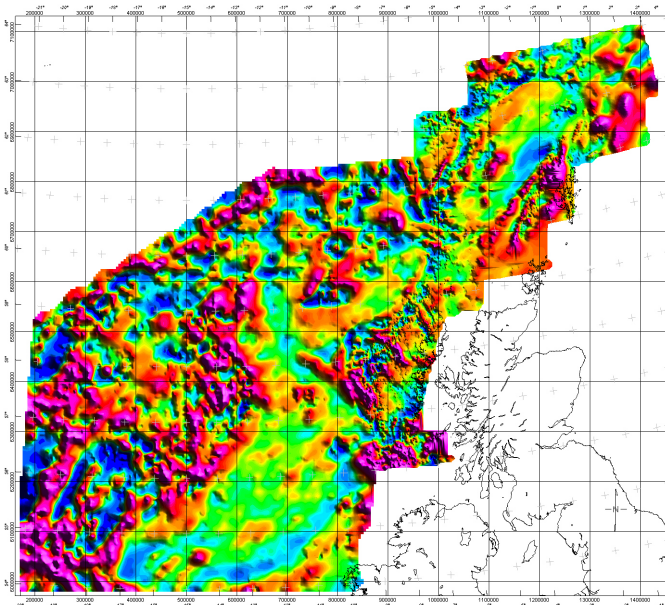


Figure 4g TMI data from DRAGON folder 065, Rockall, Shetland, and Faroe islands.

2.2.2 Compilation of magnetic data

Based on the evaluation a ranking for the different surveys was performed. As pointed out in Ch. 2.2.1 the most recent aeromagnetic surveys provide the most reliable data set with high resolution. Accordingly, in a first step these four datasets (176-262-296-158) were compiled, utilizing Geosoft Oasis Montaj's GridKnit module. Subsequently, the shipborne datasets DRAGON folders 170 and 179 were compiled and added to the aeromagnetic data. This compilation already covers the Statoil block 02/06 and surroundings and provides a high-resolution magnetic map for this block (Fig. 5a).

In a last step and for the discussed reasons, this dataset was merged with the more regional dataset of DRAGON folder 065 (Fig. 5b).

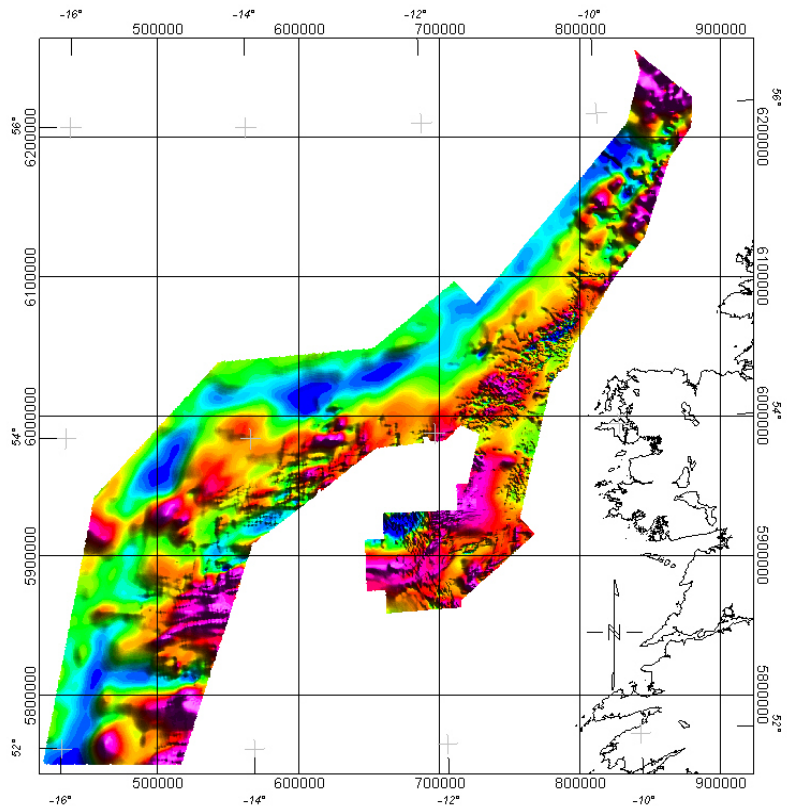


Figure 5a *Compilation of high resolution TMI data in the area of interest.*

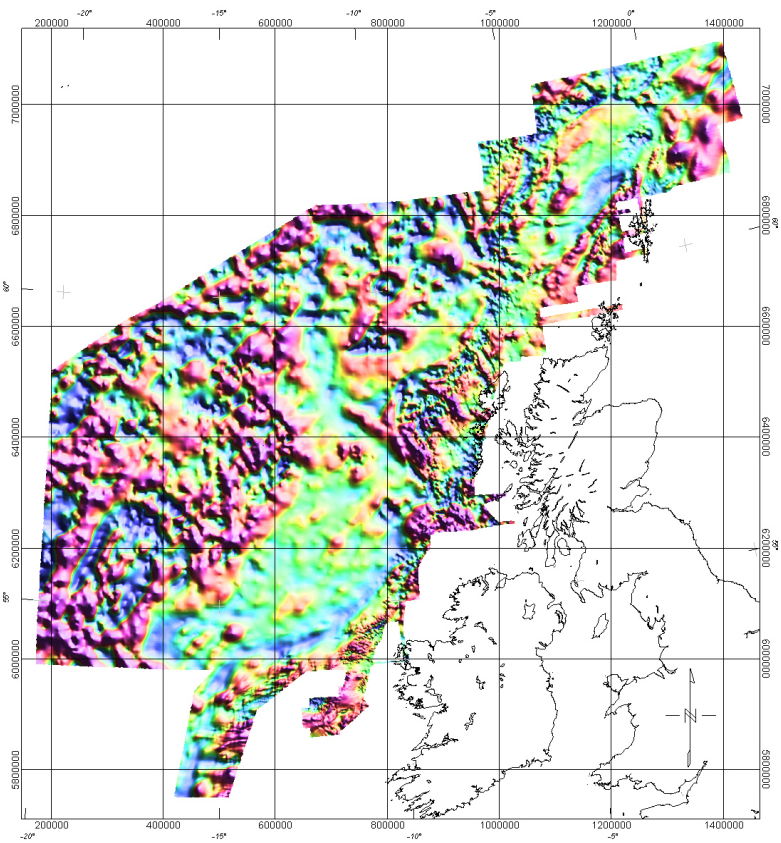


Figure 5b *Regional compilation of TMI data from the Statoil DRAGON database.*

3 ADDITIONAL DATA

In addition to the presented DRAGON database datasets, the client provided other gravity and magnetic datasets during this study to get a better data coverage to the east of the licence area 02/06. Fig. 6a shows an overview of the distribution of the additional surveys/compilations and the available datasets.

For this study and at the present project status only the survey in the area of the Donegal Bay (red ellipse) was of use to provide additional information for the licence area 02/06. The dataset comprises densely measured shipborne magnetic data, acquired as part of the Irish National Seabed Survey project (INSS). The dataset was evaluated and quality controlled based on the available information. Some preprocessing was applied to the data, including leveling and microleveling. The resulting grid is of good quality but still remains some obvious failures and artifacts. An additional processing including IGRF reduction is recommended.

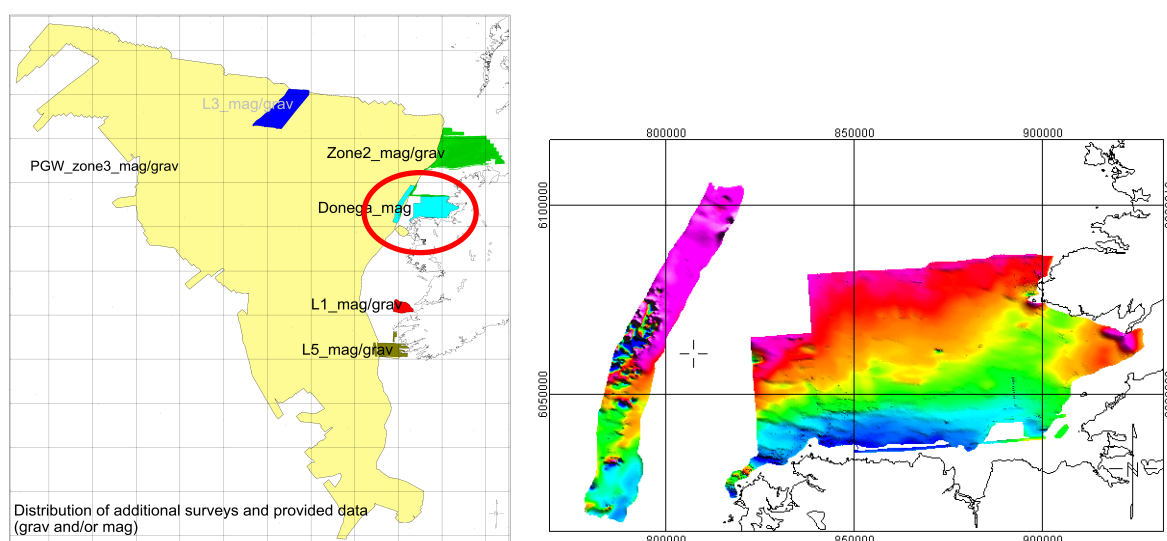


Figure 6a,b (a) overview of additional provided data, (b) INSS Donegal Bay TMI map, no IGRF subtracted.

4 RESULTS AND RECOMMENDATIONS

The datasets discussed here, already cover almost the entire Statoil block 02/06 and its surroundings to the west, but for the eastern parts of the blocks data are lacking and the development of the basins towards Ireland and probably their SE flanks are not covered by gravity or magnetic data on hand. Also the additional survey in the Donegal Bay can only provide some additional magnetic data, but does not completely cover the eastern edge of the licence block.

For gravity the data coverage is very much limited to the area of the Slyne Basin, other surveys extend only to the Porcupine Basin. The western edge of the basin could be detected with the existing data, supported by the magnetic data (see below), but needs confirmation through seismic interpretation.

Here, for a better understanding of the basin geometry etc, and for the complete coverage of the new licence area, new gravity data eastwards of the available surveys need to be purchased or acquired.

Bouguer gravity anomalies calculated from satellite data allow insight to the extent of sedimentary deposition areas due to density variations, which can characterise the basin extent and provide clues for additional gravity survey outlines and acquisition of seismic lines.

From the magnetic map the southern Erris Basin is already covered quite well, but for its central and northern part, as well as for the Slyne Basin additional data towards SE would be beneficial and are highly recommended in terms of a reliable interpretation of the SE edge of the basins. Here, at the PAD webpage two additional datasets (Figs. 6 & 7) are listed: WGNW73 for the northern Erris Basin and WGSLYN for the central and northern Erris and the Slyne Basin. Both datasets are shipborne, acquired in 1973 with rather wide line spacing. However, depending on the data quality one could expect some additional hints to define the SE flank of the Erris Basin.

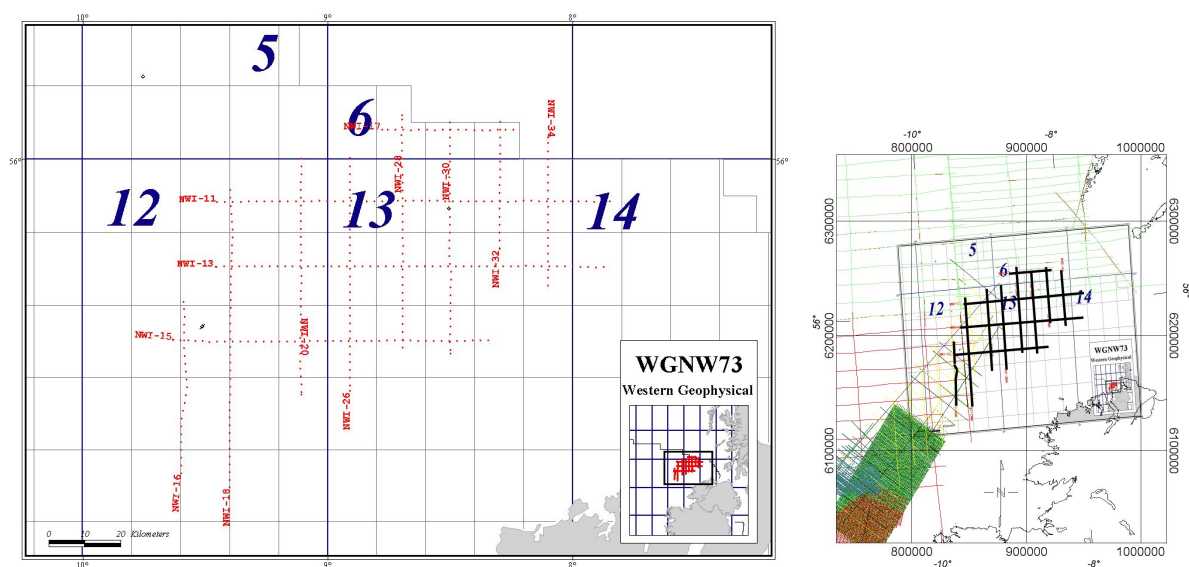


Figure 7a,b (a) Additional magnetic dataset [WGNW73¹](#) from PAD database, (b) WGNW73 dataset plotted with others.

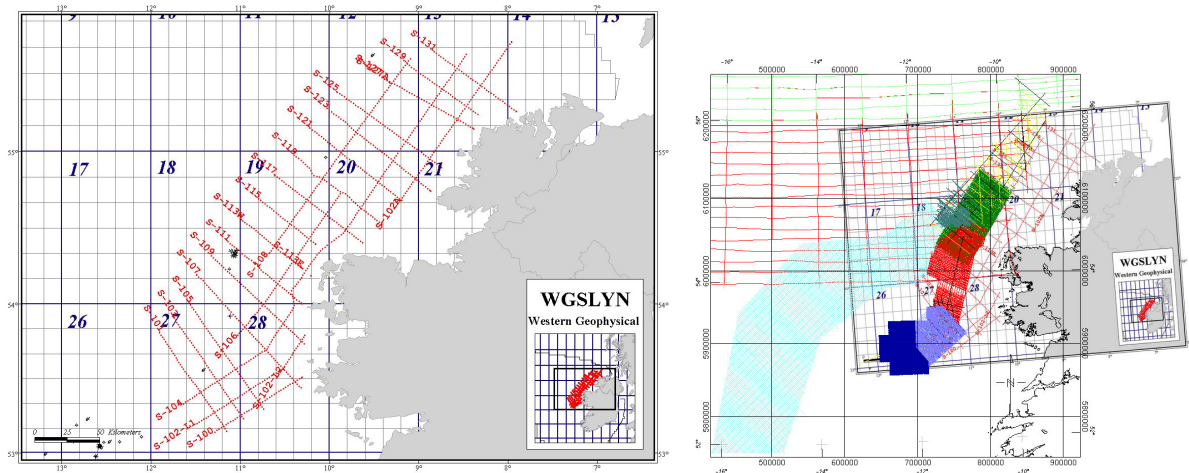


Figure 8a,b (a) Additional magnetic dataset [WGSLYN²](#) from PAD database, (b) WGSLYN dataset plotted with others.

Furthermore a recently acquired shipborne survey ERM07, provided by TGS can contribute some additional data (Fig. 9). Wide line spacing here also limits the data resolution, but a combined reprocessing of all three surveys is proposed and will be a good compliment to the current compilations.

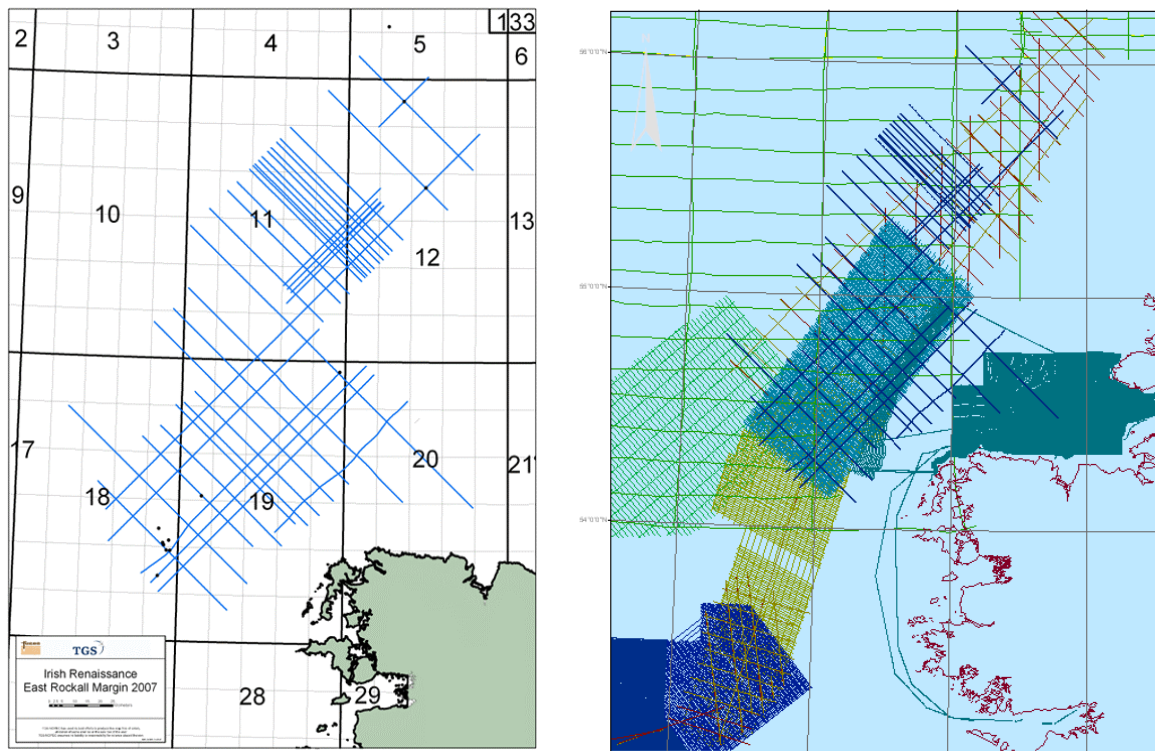


Figure 9a,b (a) Additional dataset [ERM07³](#), provided by TGS, (b) ERM07 dataset plotted with others.

This study with all shown grids and datasets are presented in an ESRI ArcGis project, which is included on the attached CD. Additional cultural data like well locations, current authorizations and designation outlines offshore Ireland were added for orientation purposes.

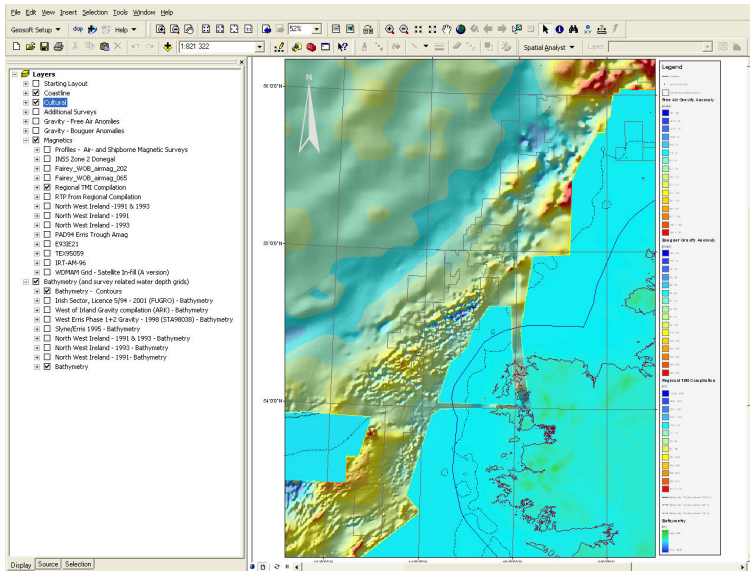


Figure 10 Snapshot of this study ESRI ArcGis project.

5 REFERENCES

Sandwell, D. T. and Smith, W. H. F. (1997). Marine gravity anomaly from Geosat and ERS-1 satellite altimetry. *J. Geophys. Res.*, 102:10039-10050.

¹ http://www.informatic.ie/paddi/paddiFormView.asp?Table_Name=%5BPotential+Field+Surveys%5D&ID=26

² http://www.informatic.ie/paddi/paddiFormView.asp?Table_Name=%5BPotential+Field+Surveys%5D&ID=27

³ http://www.tgsnopec.com/data_library/pip_detail.asp?id=4&pid=25



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