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CORRELATION ANALYSIS OF THE PRIMARY GEOLOGY AND GEOPHYSICS DATA FOR THE MARINE GEOPHYSICAL EXPLORATION

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ABSTRACT

A selection of the marine exploration geophysics data is done for the region Rockall Trough, west of Scotland. Marine data of the gravitational and magnetic fields are explored regarding the hydrocarbon possible deposits in the region. Spatial correlation distributions are obtained for the complex gravity and magnetic data and transformations. Special attention is paid to the local bottom digital elevation model anomaly, which clearly correlated with the local geophysical anomalies. All research is targeted to the hydrocarbon pattern recognition and future 3D seismic exploration network intended to the higher resolution mapping of the depth structures.

INTRODUCTION

The marine geophysical exploration data are collected to do the correlation analysis between some measured geophysical parameters – bathymetry, gravitational field (different transformations) and magnetic field. (UKOilandGasData, 2017) The object of the investigation is an area located in the region Rockall Trough, west of Scotland. Two major forms of igneous bodies are encountered in the basin; large (km) scale igneous domes (plutons) which can be encountered from sea level through to the basement; and smaller scale igneous sheets which are commonly found concordant to the strata packages. The major reservoir interval in the basin usually is located within the Paleocene turbiditic sands, which are commonly the strata packages intruded by the igneous sheets. (Powis, 2016)

THE MAIN PURPOSE OF THIS STUDY AND THE COLLECTION OF DATA AND MAPS

The target of this investigation is to perform the spatial correlation analyses between the collected data and material to reveal the correlation links between the different geophysical parameters measured by marine vessels. The research has been performed by several local marine expeditions during the last years. The location of the site is presented on fig.1.

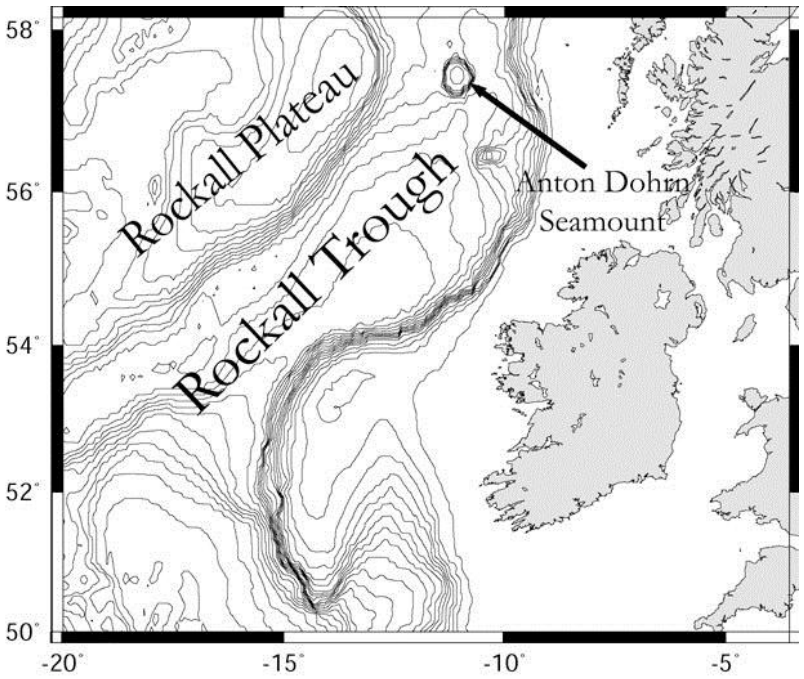

Fig.1. The bathymetry and the Anton Dohrn Seamount – the main object of the correlation analysis.

Due to the secure requirements of the firm which is performed geophysical exploration and is interested of this region, the publicity of many data is restricted.

The data about the different geophysical fields are extracted from the primary materials, but interpolated and correlated for the purposes of this study.

Maps for the cross-correlation analysis are as follows:

Bathymetry map - scale: 1:750,000; Bouguer Gravity map - density 2.0 g/cm^3 ; Free-Air Gravity map - scale: 1/750,000; Total field magnetic anomaly map - Scale: 1:750,000
C.I. = 10nT; sample rate: 1 second; Reduction to Pole of Magnetic Anomaly map
Scale: 1:750,000, C.I. = 2 mGal - sample rate: 1 second

WORKING HYPOTHESIS

The main hypothesis explored in this study is that the two dimensional correlation of all collected data and maps can reveal the links between the geophysical parameters anomalies and the presence and deep composition of the investigated geological structures. (Yilmaz, 2001)
The first step to this study is to build the cross-correlation two dimensional maps and to see if correlation exists and what are the values of these correlations (positive, negative, low or high correlation coefficients, their space distributions, etc.). (Telford and Sheriff, 1990) This hypothesis is divided in two major directions – interpolation of the rough data and creation of a network with the interpolated values of the geophysical parameters. (Добрев, 1984) Then the cross correlation and two dimensional calculations are performed. The expected results can discover the two dimensional correlation coefficients which are informative for further interpretation. Because of the large volume of data and results obtained, the interpretation of the observed links is intended to be done as a second step and in another paper.

METHODOLOGY AND RESULTS

Used methodology explores the correlation and cross-correlation of the two dimensional models between each of the studied parameters. The calculations were made using a computer correlation analysis program developed by Prof. Dimovski and provided for the purposes of the study.
This program in general works in the following way:
- Data and coordinates for values / variables to be correlated are taken. The data volume must be the same for both dimensions and the coordinates should match for each variable.
- A data window is set, the correlation coefficient is calculated for the data that falls into it and it is referenced to the centre of the window.
- Then the window moves on a coordinate system with a set step, and everything is repeated until the data is exhausted.
- The obtained values are processed and tabulated and then visualized as a correlation map.

The following diagrams have been calculated and analysed.

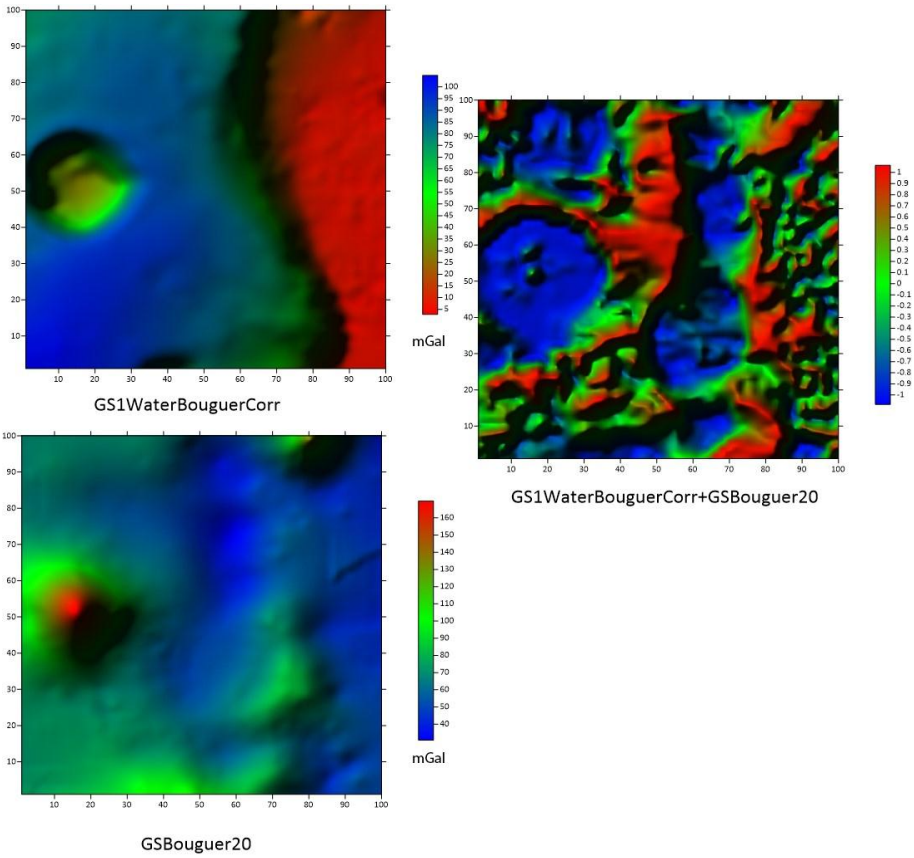

Fig.2. Two dimensional correlation between Bouguer 2.0 and water Bouguer correction. The visible negative correlation (Correlation coefficient – CC is -1 on the dome and the slope of the anomaly. CC is +1 in the central part of the anomaly). This picture is low informative, but respects the physical properties of the gravitational anomalies.

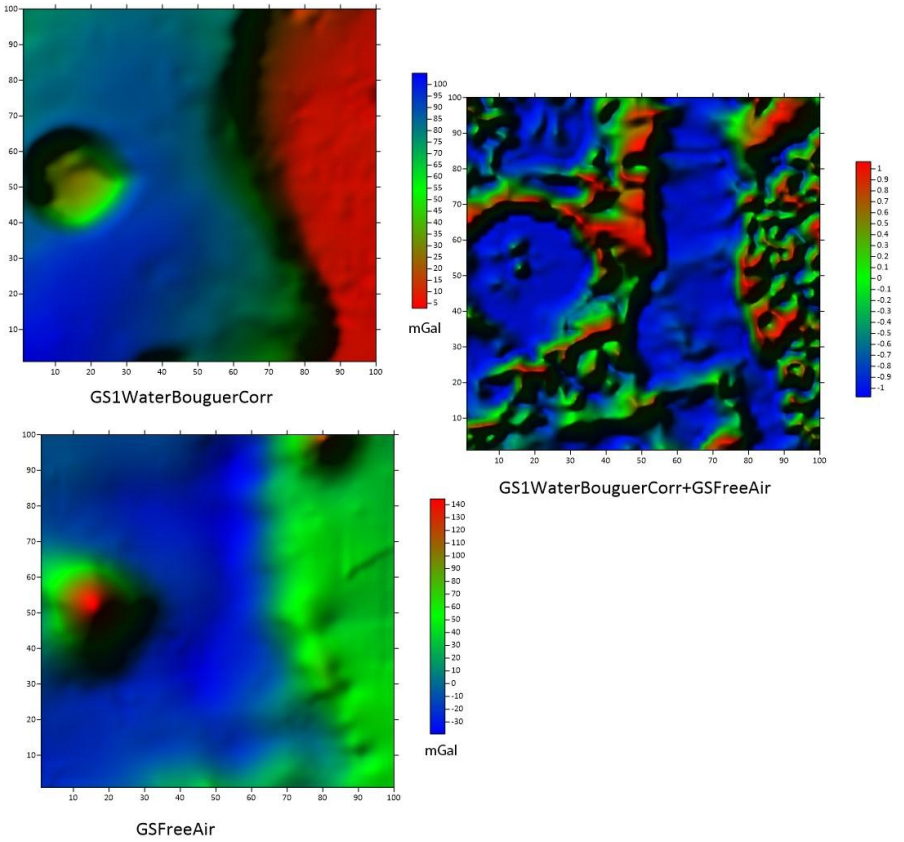

Fig.3. The correlation diagram between the Free air anomaly and the water corrected Bougouer anomaly. The explanations are similar to fig.2.

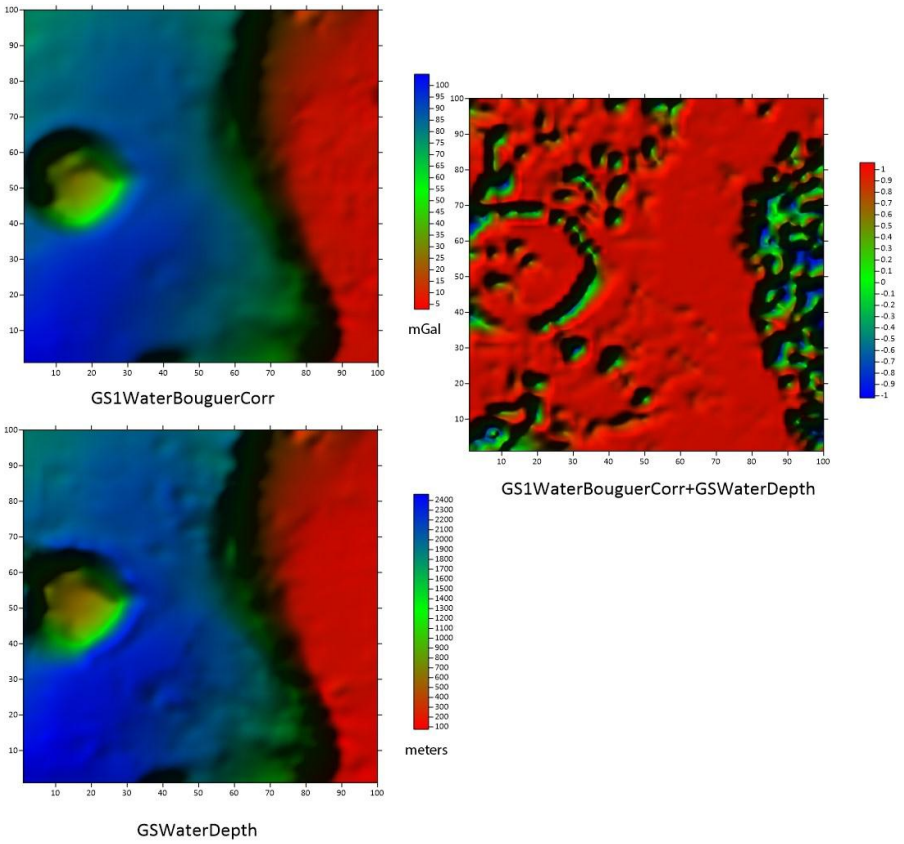

Fig.4. The correlations between bathymetry and water Bouguer anomaly correction. An intensive positive anomaly reflects this correlation.

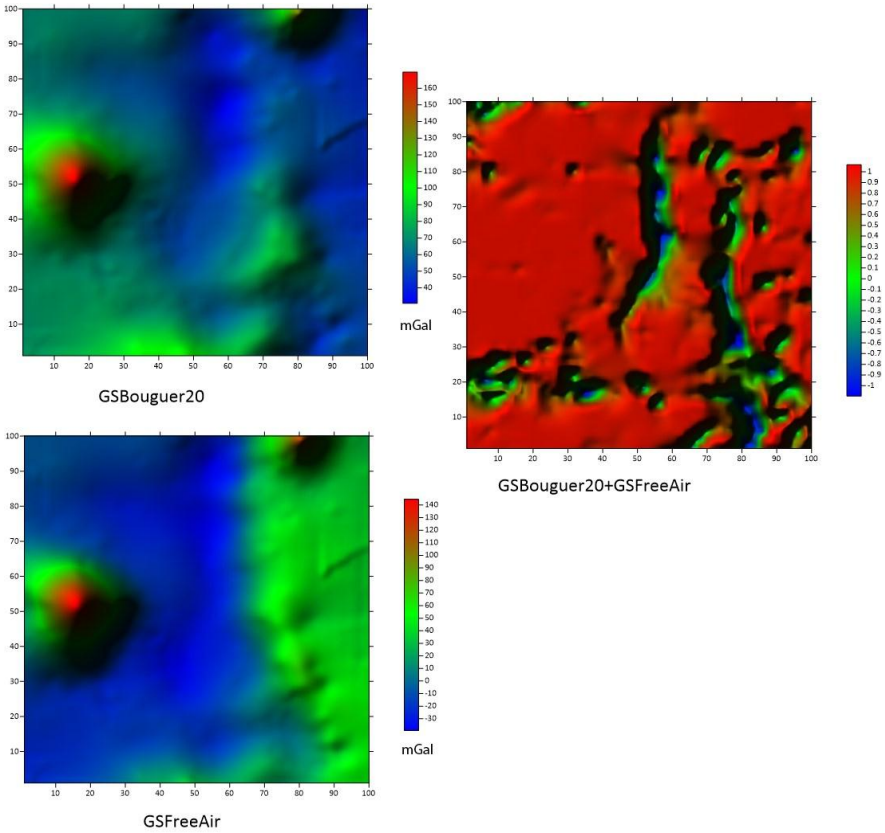

Fig.5. Bouguer 2.0 anomaly correlated with the Free air anomaly. Intensive positive correlation is observed to the left part of the map.

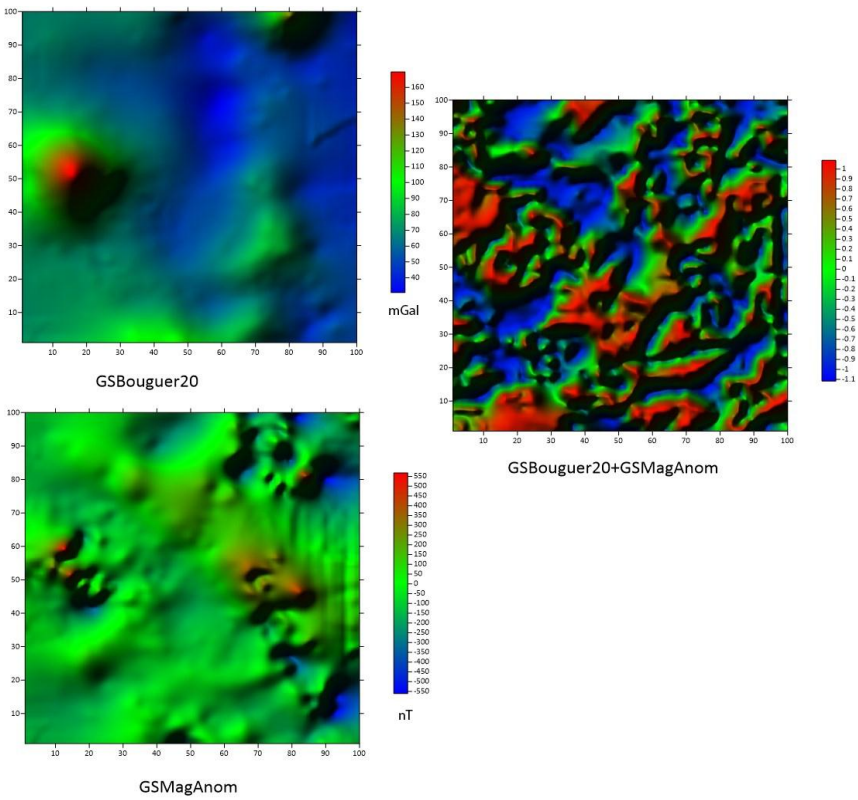

Fig 6. The Bouguer 2.0 anomaly correlated with the total vector magnetic anomaly. The results is a mosaic distribution, which means that this correlation is low informative.

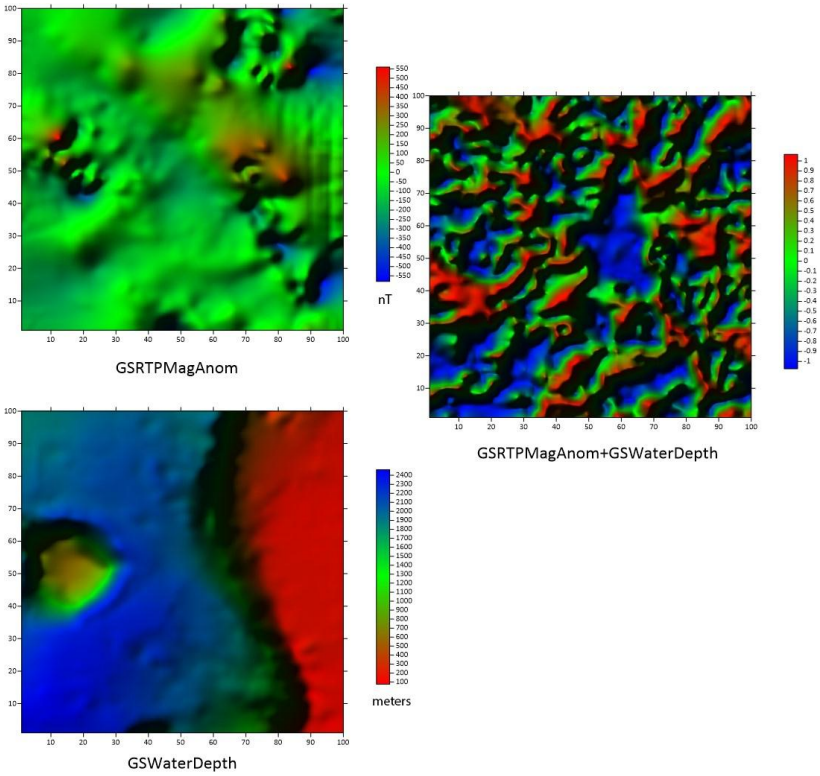

Fig. 7. The total vector magnetic anomaly correlated with the water depts. The mosaic picture of the spatial distribution of the correlation coefficients shows that this correlation is not informative. This could be expected due to the magnetic properties of the rocks and water.

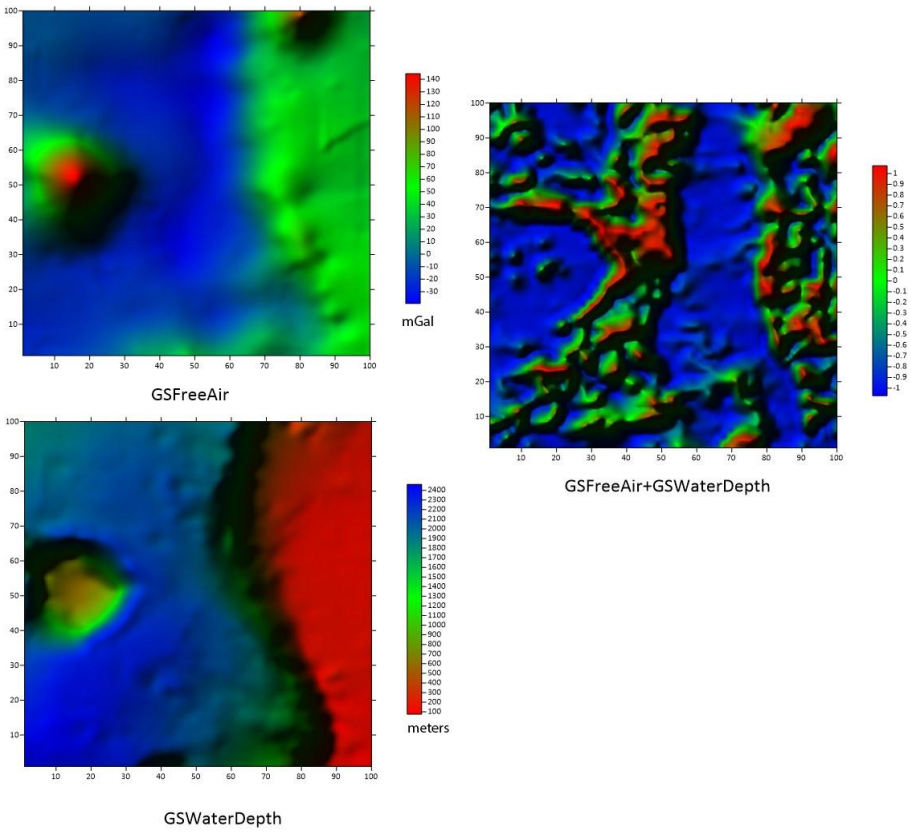

Fig.8. The correlation between the water depth and Free air anomaly. The strong negative correlation over the dome and on the slope shows that the free air corrections are effective.

CONCLUSIONS

The calculated two dimensional correlation diagrams represent the first step of the pioneer work to the performance of the spatial correlation analysis to the marine geophysical data.
As expected the CC varied between +1 and -1 and sometimes this picture is rather clear and informative, in other cases – shows the mosaic distribution, which is very difficult to interpret.

The process of the selection of informative data and results is continuing. The initial idea to use this material for the hydrocarbon search and exploration seems rather disputable. But, the information extracted by the performed correlation analysis could be rather useful to study plutonic domes as this one – Anton Dohrn famous seamount.

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