Journal of Conference Abstracts
Volume 7(2), 154

Using electromagnetics to image sub-basalt sediments

MARION JEGEN (jegen@univ-brest.fr), SOPHIE HAUTOT (hautot@univ-brest.fr), G. CAIRNS (cairns@univ-brest.fr) and P. TARITS (tarits@univ-brest.fr)

IUEM, Universite de Bretagne Occ., Place Nicholas Copernic, 29280 Plouzane, France

Introduction

This document reports our research in the frame work of the SIMBA project, a joint Seismic/EM research project funded by the European Community. The target of this study is the identification of sedimentary basins beneath basalt extrusive units in the North Sea.

Seismic exploration of these targets has encountered difficulties as the basalt units reflect and scatter seismic signals, masking the characteristics of the underlying structure. Electromagnetic soundings, in contrast, are insensitive to the highly electrically resistive basalt units. However, it is strongly influenced by the characteristics of the underlying sedimentary basin, which is electrically conductive. Electromagnetic soundings are therefore a valuable compliment to seismic surveys in such areas, providing information which may be interpreted independently or which may be used to constrain parameters in the interpretation of seismic data.

Electromagnetic soundings were first adapted to the marine environment to investigate the oceanic crust and upper mantle. Throughout the 1980s and 1990s, instrumentation and data processing techniques have evolved steadily in the scientific community. Soundings for 1D and 2D structures have become commonplace, and imaging of 3D structures is an active area of research. The application of EM methods to marine economic targets is recent, arising from a convergence of technical developments in the scientific community and the growing interest of petroleum companies in deep offshore targets.

The Magnetotelluric Method

The suitable method to be used for the target is the Magnetotelluric (MT) method The MT method uses natural magnetic field variations as the energy source. These naturally occurring waves induce electric currents in the subsurface, the strength of which is proportional to the electrical conductivity. The secondary fields generated by these currents can be measured using autonomous electric and magnetic field sensors placed on the earth's surface or seafloor. The response measured is the impedance, i.e. the ratio of the electric and magnetic field as a function of frequency, which is a proxy of depth and is typically displayed as apparent resistivity curves versus frequency.

Instrument

In order to resolve features in the upper few kilometres of the oceanic crust, MT measurements require sensitivities at high frequencies (0.0001 to 1 Hz) 10 to 100 times greater than that of marine MT instruments currently used in scientific soundings of the deep crust and upper mantle. Such sensitivities have been demonstrated to be attainable, but require instruments specifically conceived for this purpose. In the framework of the project, we are building 6 of these MT stations.

MT Response to Sub Basalt Basin

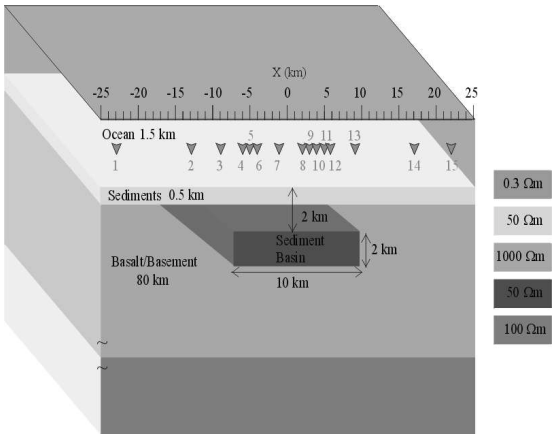

Figure 1: Resistivity Model of a Sub-Basalt Basin

Journal of Conference Abstracts
Volume 7(2), 155

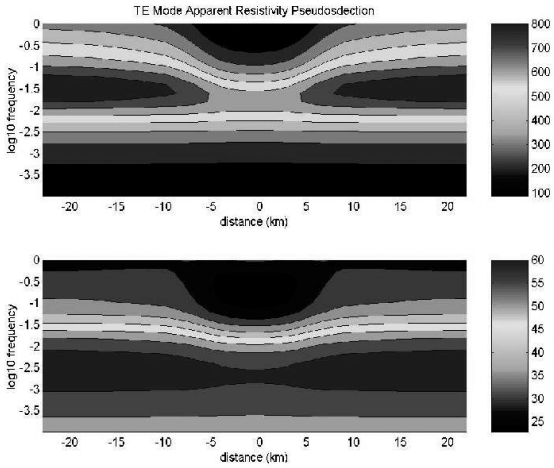

Figure 2: TE mode apparent resistivity section to model shown in Figure 1.

Figure 1 shows an electrical resistivity representation of a sedimentary basin in a basalt surrounding and the position of MT station where we generates synthetic data. The MT data of the model are displayed in figure 2. The figure shows the apparent resistivity compiled into a section of distance and frequency, the EM proxy of depth.

The depression of the electrical resistivity in the centre of the model at a frequency of 100 Hz shows, that the electrically conductive sediment basin is clearly visible in the data. Thus, a sedimentary basin might, in principal, be detected using marine magneto telluric.

While the presence of the sediment basin shows up in the data, the sensitivity of the data to the basin depends on a variety of other parameters. These might be geological parameters (e.g. the sediment coverage, extent of basin, depth of the basin) or experimental parameters (proximity to continental shelf, water depth etc).

In a 2D and 3D model study we will discuss how these parameter effect the feasibility of an EM experiment to identify sub-basalt basins. Joint interpretation of EM and Seismic data will be discussed in an accompanying paper by Hautot et al..

Summary and conclusions

In this presentation we try to introduce the concept of EM for sub basalt imaging. Marine Magnetotellurics is able to identify sediment basin underneath basalt covers under certain conditions. We study the parameters that influence the feasibility of an EM experiment for these targets and discuss the way an EM experiment should be laid out to obtain the maximum yield of information.