

A blue sky with white clouds and an offshore oil rig in the distance.

30th May 2006

Rocksource & EM Technology

Introduction

The core of Rocksource's technological abilities is related to the use of electromagnetic (EM) data to reduce risk in exploration and proper reservoir management to enhance recovery in production.

We consider the EM technology proven and with a game changing potential! Proper use of EM technology can significantly improve exploration efficiency by

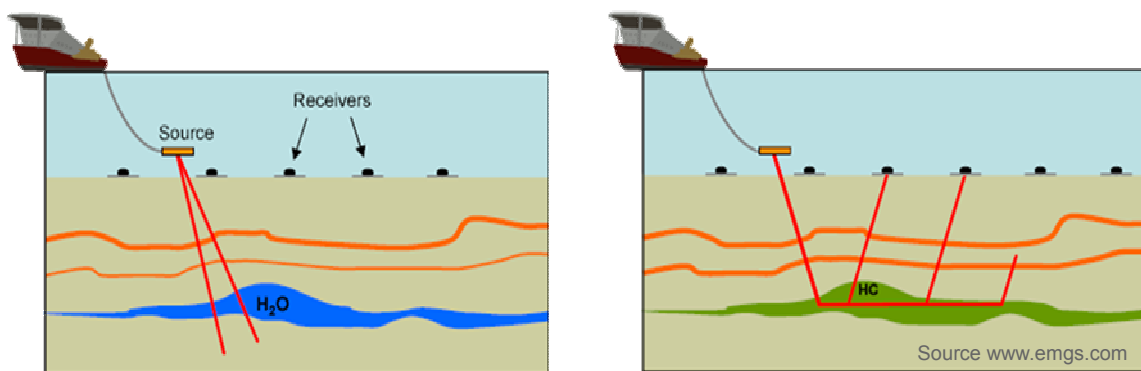
- reducing the number of dry wells
- optimizing rig capacity by drilling the right wells
- reducing finding cost per barrel

This leads to improved value creation from exploration. Rocksource has developed a proprietary state-of-the-art analysis approach to successfully deal with EM data in both simple and complex settings.

What is EM?

EM (electromagnetic) technology is a wide term and refers to a number of different things. When Rocksource uses the term, we refer to a specific methodology called CSEM (controlled source electromagnetic sounding) which is a remote surveying technique that enables measurements of resistivity contrasts in the subsurface. In very simple terms, hydrocarbons are resistive while surrounding rocks are typically filled with conductive saltwater. This creates a resistivity contrast that can be mapped using CSEM techniques.

Remote resistivity surveying is well established and various technologies have been used for decades both in the mining industry and for detecting hydrocarbons onshore. However, it is not until recently that the technology has proven successful for offshore settings. This is mainly due to technology improvements and access to high performance computer capacity which allow for high quality data being subjected to advanced processing and subsequently detailed resistivity imaging.



In marine settings, EM receivers containing electric antennas and magnetic coils are placed on the seabed. A source is towed above the receivers, emitting electromagnetic energy with low frequency. Energy from the source propagates (diffuses) into the subsurface. If there are no resistivity contrasts present, the energy will gradually be attenuated and disappear. If resistivity contrasts are present (such as that caused by an oil-filled sandstone), EM energy will propagate

back to the sea floor where it is recorded by receivers. The recorded information can be processed to create detailed charts of subsurface resistivity distribution.

There are some complicating aspects that must be considered. The recordings of the electric and magnetic fields contain significant amounts of natural background noise which, in addition to source and receiver noise complicate analyses. Furthermore, not only oil-filled reservoirs represent resistive objects. Salt, carbonates and volcanic rocks are other examples that will cause resistivity contrasts. As such, expertise in understanding energy propagation patterns in the subsurface is crucial, as well as having access to solid processing and interpretation algorithms.

Processing of EM data can be done in many ways. Basic processing is valuable, especially in areas without EM complexity caused by presence of salt, carbonate and volcanic rocks, cemented reservoirs and more. In complex settings, a more advanced approach is needed. Advanced processing allows use of all offsets (between receivers and source) and harmonics to the dominating source frequency and thus provides for better lateral and vertical resolution as well as proper placement of resistivity in depth.

EM data are complimentary to seismic data and proper geological understanding. An integrated approach implies the use of all available information. A too simple approach can lead to false-positive and false-negative results, especially in more complex settings. This understanding forms the basis for Rocksource's advanced analysis approach.

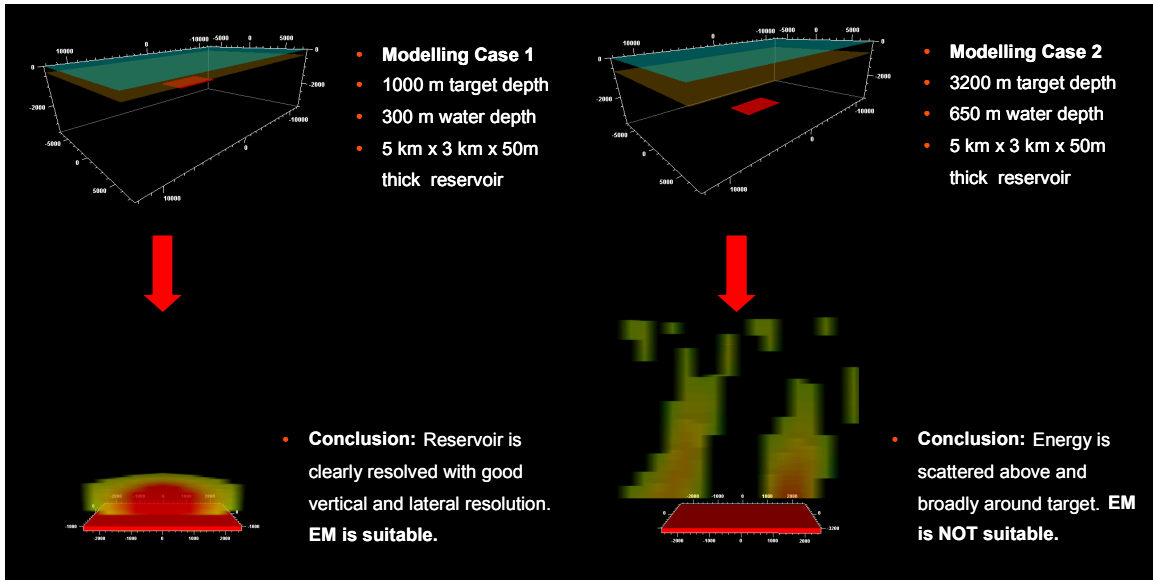
EM in Exploration

Offshore hydrocarbon exploration is a challenging and expensive business. Much of an exploration budget is set aside to fund collection and analysis of 2D and 3D seismic data, while the lion's share of exploration funding is earmarked for drilling wells. However, the chances of an exploration well discovering hydrocarbons are very slim – less than 20%, on the whole. This is partly due to the seismic response to hydrocarbon-filled reservoirs. As low a gas-saturation level as 5–10% (i.e. non-commercial reserves) can lead to the display of seismic features as bright spots and flat spots, thus demonstrating the problems related to the use of seismic data for direct hydrocarbon detection. New methods to boost hydrocarbon detection rates will greatly benefit oil and gas exploration operators.

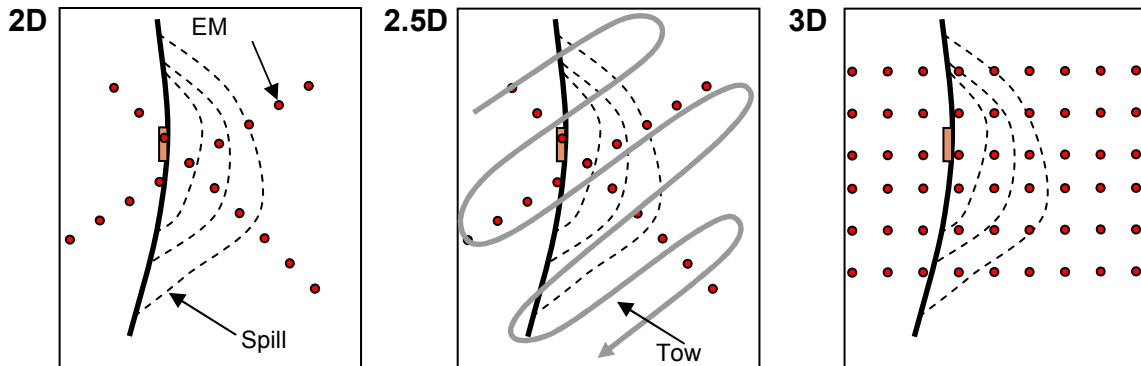
Groundbreaking developments in electromagnetic (EM) technology over recent years and subsequent use in offshore hydrocarbon exploration have already shown encouraging results in detecting hydrocarbon reserves in potential reservoirs prior to drilling wells. The concept is proven by the drilling of numerous discoveries. The implications are that EM data have the potential to raise detection rates by as much as 50%, or even more. As such, EM heralds a new epoch for the oil and gas industry, with great potential as this new technology is being exploited. Rocksource is the first resource company to base operations on exploiting EM as a key competitive edge.

Although EM technology is already deemed a success, the petroleum industry and research institutions still face the task of designing data interoperability with other data types in order to fully exploit reserves detected by remote resistivity surveys. This includes integrating EM data with seismic and well data as well as adopting a sound geological approach. Geoscientists will be invited to participate in the establishment of a new and highly advanced integrated work flow where EM data are incorporated into the analyses. Rocksource has access to state-of-the-art technical solutions to boost an advanced integrated policy.

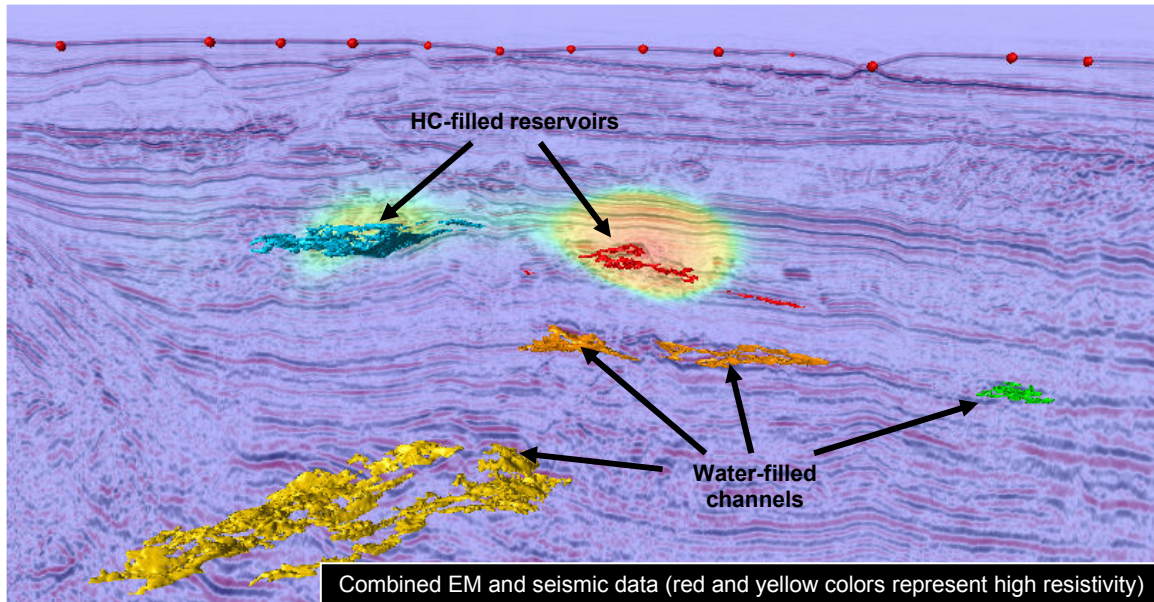
The EM workflow involves a number of different aspects. First, a detailed feasibility study using advanced modeling algorithms must always be performed before any EM data can be collated.



Provided a feasibility study concludes that the setting is suitable for using EM data, it is necessary to develop a proper survey design that is optimized for the specific setting. This includes decisions on using 2D, 2.5 D or 3D acquisition, receiver spacing, source emitting frequency etc.



After acquisition, the EM data must be processed using advanced inversion and migration algorithms. The approach used depends on the complexity of the setting. Next, the EM data are co-rendered with seismic and geological data for advanced integrated interpretation. This is the most important step, and one that requires meticulous modeling and processing pre-work.



Our EM expertise

Rocksource's technology department is located in Bergen, Norway, where the company's electromagnetic (EM or, more accurately, CSEM) technology is being developed. The basis for the company's technology is related to integrated research in the fields of electromagnetic, seismic and geological data for the past several years. The EM group in Bergen is led by Dr. Jonny Hesthammer (one of the founders of the company) who also has a position as professor at the University of Bergen. He has worked with an integrated approach to analyze geophysical data for the past several years and worked with Statoil for 11 years prior to joining the university and, subsequently, Rocksource.

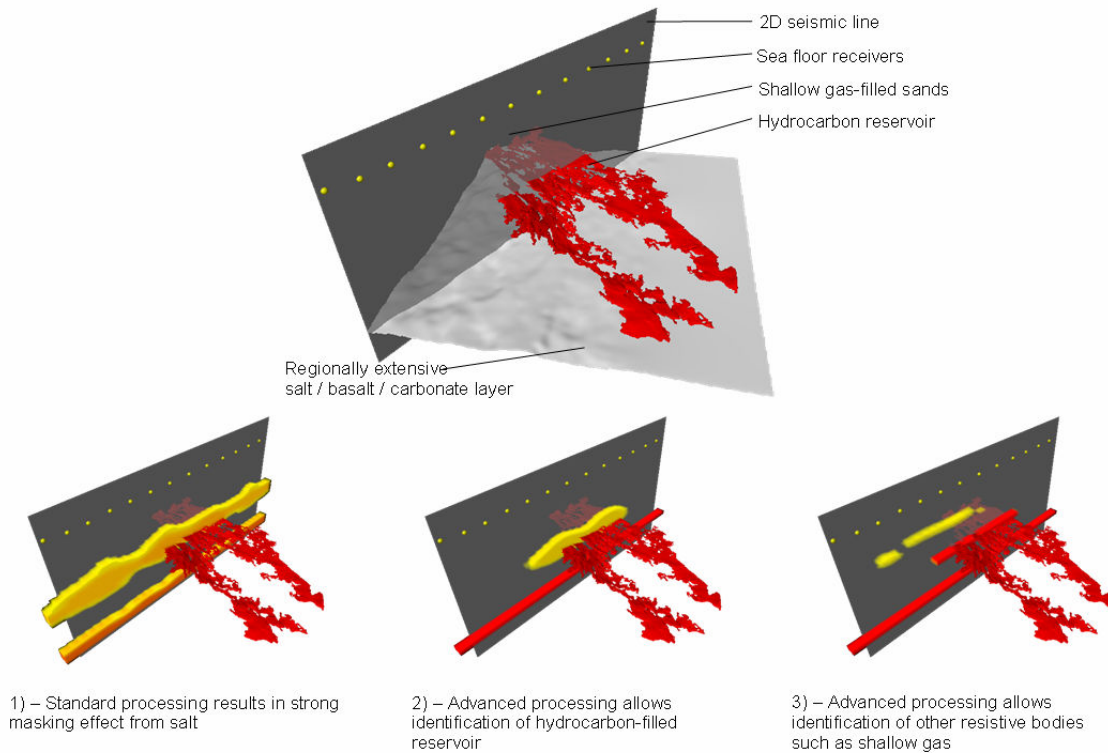
In 2005, Rocksource developed and tested its proprietary technology on several real EM data sets and verified the results against numerous wells and 3D seismic data. The tests were successful and led to the establishment of a system for modeling, processing and integrated analyses of EM data. Rocksource's approach is suitable for using EM data in both offshore and onshore settings.

A key conclusion from research results is that optimal use of EM data requires an integrated approach where EM data are used in conjunction with seismic data, well data and geological knowledge. Failure to do so may lead to false-positive and false-negative results. Proper use of EM data can enable not only detection of hydrocarbons, but also delineation of hydrocarbon filled reservoirs. Rocksource has the capability to use a highly advanced approach to deal with electromagnetic data for detecting and delineating hydrocarbon reservoirs and to use results from integrated analyses in risking and ranking of prospects.

Rocksource will use existing service providers for acquisition of EM data. The company's EM expertise is not related to acquisition of such data, but to processing and analyses of CSEM data in conjunction with other data types. The company has developed advanced algorithms for this purpose.

When dealing with EM data, it is necessary to distinguish between EM "simple" and EM "complex" settings. In EM "simple" settings, an objective approach to processing of the EM data

can be carried out. Such settings include lack of carbonates, volcanics, salt, cemented reservoirs and other resistive bodies that can lead to a false-positive conclusion. In more EM "complex" settings, it may be necessary to include information from seismic or geological data into the inversion or migration process. Rocksource has the capability to deal with such settings and has successfully tested the advanced work flow on real data, including verification against 3D seismic data of good quality and numerous wells.



Based on the results from testing and verification of Rocksource Discover v-1, Rocksource has demonstrated that the advanced work flow is in place and ready to be used in areas that Rocksource considers suitable.

The verification process includes 4 different EM surveys being subjected to advanced integrated analyses. All the surveys represent different basin settings and 2 surveys are considered to represent EM complex settings. The results have been verified with numerous wells (post-analysis verification) and 3D seismic data. The verification process shows successful correlation between EM data, well data and seismic data for all cases.

In short, Rocksource has successfully developed and tested a proprietary system to deal with advanced EM analyses. The company is ready to apply the technology in suitable areas.

EM FAQ

Q: Is Rocksource a competitor to EM acquisition companies such as emgs, Ohm and AGO (Schlumberger)?

A: No, Rocksource does not carry out the acquisition of EM data. That is done by service companies. The better services they provide, the better results Rocksource can achieve. As an oil and gas company, Rocksource wants to work with several providers of EM data, using different technological approaches, and in different settings both onshore and offshore.

Q: What distinguishes Rocksource's technology from that of the service companies?

A: To answer this, it is important to understand the EM value chain. A suitable comparison can be made to seismic data. An oil company will need to use a service company to acquire the seismic data. Depending on the capability of the oil company, they may decide to outsource the processing or do it themselves. The final interpretation and analyses that forms the basis for decision making is carried out within the oil company. Rocksource believes that a similar approach relates to the use of EM data. We depend on service companies to deliver top quality EM data. At the same time we believe that optimal use of EM data requires detailed understanding of the subsurface in the relevant area, and integration with traditional seismic interpretation of prospects. This understanding is built up over time and an oil company can use anything from months to years to mature a prospect into a decision phase on whether or not to drill.

Q: Why is it so important to use an advanced integrated approach?

A: The key issue using EM technology in exploration is to reduce risk. The ability to identify potential for getting false-positive (EM response related to something else than hydrocarbons) and false-negative (EM data fails to identify a HC-filled reservoir) results is important to provide for reliable decisions. Furthermore, in many settings a simple approach to dealing with EM data will not yield interpretable results. This is the case when other resistive bodies occur near the hydrocarbon reservoir (causes a masking effect). Other complicating factors are shallow water settings, deep targets, changing bathymetry, varying overburden resistivity and more.

Q: How important is the EM technology?

A: EM technology addresses a main weakness associated with seismic data. Whereas seismic data can successfully define a structure, it is not reliable as a fluid indicator. Seismic energy reacts to variations in rock density and velocity. EM energy reacts to variations in resistivity. This is why resistivity logs provide a main input to identifying hydrocarbon zones when drilling wells. EM data thus provides what is close to a direct hydrocarbon indicator. The combination of seismic data and EM data thus allows both identification of a suitable structure and to tell something about the fluids that the structure contains. Rocksource believes that the EM technology will change the way exploration is being done and lead to significantly higher chances of making discoveries.

Q: How sure can Rocksource be that the technology works?

A: Rocksource has tested the technology on several different data sets from different basins in the world. The results have been verified with numerous wells and seismic data. The results have been accurate in all cases. We know it works!