

TECHNOLOGY HIGHLIGHTS

Seabed Logging – A Proven Tool for Offshore Exploration and Development

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INTRODUCTION

Wellbore resistivity logs have provided evidence of the presence of hydrocarbons for almost 80 years. The theory is simple. In many geological settings, rocks saturated with hydrocarbons exhibit significantly higher electrical resistivities than those saturated with brine. Thus a kick on the resistivity log is always exciting news. Of course, there is one big problem with a wellbore resistivity log: you need to drill a well before you get this vital piece of information. Wouldn't it be very useful to get resistivity information before drilling a well? In the late 1990's, Terje Eidesmo and Svein Ellingsrud, two Statoil researchers, were pondering this problem and their research led to the development of seabed logging. In this article, we will review the state of the art in seabed logging, and discuss where and how it can be used.

HISTORY

In 2000, Statoil acquired data over a producing field and proved the concept of seabed logging. Two years later, this revolutionary technology was made available to the industry through the formation of EMGS. The company was lead by Eidesmo and Ellingsrud, who were joined by Ståle Johansen, a long-time sponsor of the project within Statoil.

HOW DOES SEABED LOGGING WORK?

A ship tows a horizontal electric dipole source close to the seabed to create a large electric field. As the electric field propagates through the subsurface, it is perturbed by any variations in the subsurface resistivity. The electric and magnetic fields are both measured and recorded by highly sensitive units distributed over the seabed. Once sufficient data has been recorded, an acoustic signal is sent to the receivers to trigger a release mechanism, and the recorders return to the surface for data analysis.

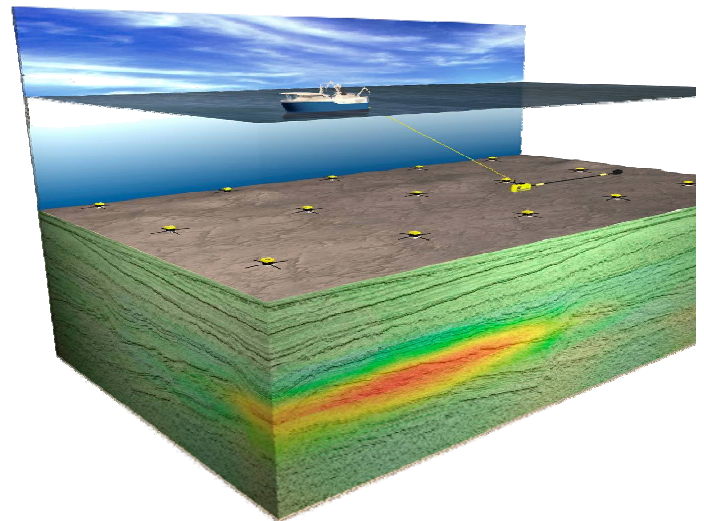


Figure 2. The acquisition of seabed-logging data.



Figure 1. Svein Ellingsrud and Terje Eidesmo, seabed logging inventors and founders of EMGS, sporting their Virgil Kauffman Gold Medals, awarded by the SEG in recognition of their pioneering work in applying controlled-source electromagnetics (CSEM) to the detection of hydrocarbons, which spawned an entirely new service industry.

Today, EMGS is the leading provider of seabed logging and deep electromagnetic (EM) imaging services. The company has five vessels, with more due to enter service in 2008. Over 40 of the world's leading energy companies, including super-majors, nationals and independents, have used EMGS to conduct more than 300 projects in water depths ranging from 50 to 3500 m.

The recorded data is processed to remove noise, and compensate for environmental variations such as water depth and background resistivity. In many cases, this data can then be interpreted directly. Increasingly, however, the data is imaged using depth migration or inversion to facilitate easy integration with seismic and other subsurface data.

WHY IS SEABED LOGGING SO EXCITING?

In its simplest form, an image of subsurface resistivity can indicate the presence or absence of hydrocarbons in a reservoir. Many experienced users of seabed logging are finding > 90% agreement between seabed-logging pore-fluid predictions and actual drilling experience. With normal wildcat frontier success rates below 20% and drilling costs at an all time high, seabed logging is rapidly becoming a key part of the offshore E&P workflow.

In simple clastic sequences, seabed logging can deliver a near-perfect direct hydrocarbon indicator. In areas of more complex geology, seabed logging can provide useful independent data to confirm earth models derived from seismic data. However non-hydrocarbon-related resistive bodies (salt, volcanics, carbonates, gas hydrates, etc) may influence the data and need to be considered during modelling and interpretation.

The first step towards a successful seabed-logging project is to model the expected response of the reservoir with and without hydrocarbons in place to ensure that the difference in response will be detectable using the proposed

EUROPEAN REGION NEWSLETTER

acquisition and processing technology. Careful use of modelling can ensure that seabed logging is used in only places where it can be effective.

HOW IS SEABED LOGGING APPLIED?

Most seabed-logging projects have been used to confirm the presence of hydrocarbons in structures identified from seismic data before drilling. This application significantly reduces the drilling risk – especially for operators of expensive deepwater wells.

Over the last few years, an additional application has emerged called EM scanning. Scanning is characterised by the rapid deployment of wide-azimuth sensors in regular, sparse grid-like patterns over large areas. In this application, scanning is used to investigate large regions and detect resistive subsurface formations early in the exploration cycle. This new approach has been shown to accelerate prospect delivery and focus exploration efforts in the areas most likely to contain hydrocarbons. Scanning can even detect unconventional reservoirs that are not always easy to see on seismic data (such as stratigraphic traps). Because scanning is often applied over wide areas before lease sales, it is increasingly thought of as both a proprietary and a multiclient application.

SUMMARY

Seabed logging is the first truly independent predrilling measurement of reservoir properties since the development of seismic technology early in the last century. It is a proven direct hydrocarbon indicator, which is now playing key role in addressing the ever-growing challenges of meeting the world's energy needs, and it has provided the catalyst for a completely new EM service industry.

RECOMMENDED READING

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Harvey, L.H., Skogly, O. P., Burke, T., and Amado, L.: "Integrated prospect evaluation using electromagnetic, seismic, petrophysical basin and reservoir engineering data," presented at AAPG Annual Meeting, Houston, USA (April 9–12, 2006).

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Ridyard D., Wicklund, T. A., and Lindhom, B. P.: "Electromagnetic prospect scanning moves seabed logging from risk reduction to opportunity creation," *First Break* (November 2006) 24, No. 11.

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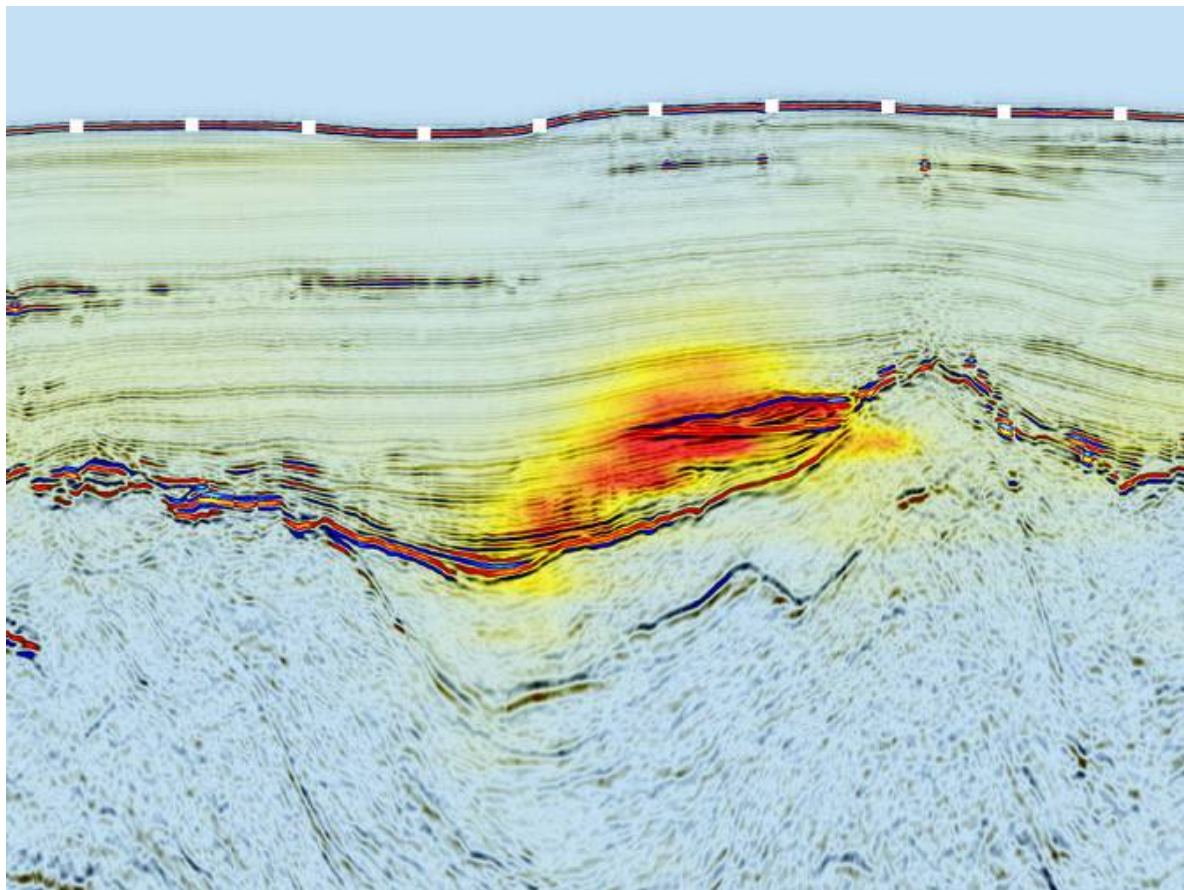
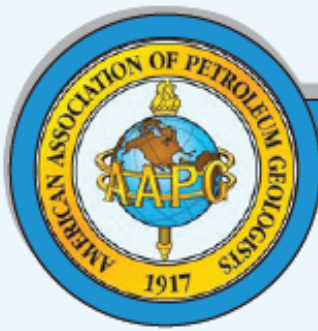


Figure 3. EM imaging data derived from seabed logging is integrated with seismic data and reveals which of the structures identified on this seismic image are likely to contain hydrocarbons and which can be downgraded in further geophysical or drilling investigations. (Data courtesy of Murphy Oil Corporation.)



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TABLE OF CONTENTS

President's Message	1
Technology Highlights	2
Seabed Logging	2
R&D Projects	4
CO ₂ TRAP	4
EDINSED ₃ D	6
Conferences and Seminars	7
AAPG – European Region News	11
A geological trip to Zakynthos	11
Elections	15
Awards	16
AAPG-ER Structure	17

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PRESIDENT'S MESSAGE



We have reached the very end of a really great conference. A couple of minutes ago you had the opportunity to listen to a short evaluation of the event. But what is more interesting is what happened behind the statistics, which usually cannot be seen.

Here's what cannot be seen:

- The more than two years of hard work of the committees, the work of the Tulsa and London Office personnel – both the elected officials and the employees.
- The hard work of our loyal exhibitors.
- The support of the companies delegating participants (their employees) to attend the conference.
- The contribution of our sponsors to negotiate, discuss and finally to sign the contracts

However spectacular, conferences like this one are the holidays of a professional organization. The holidays are sparser than the workdays. In my native language it is expressed by the metaphorical phrase that "A SAUSAGE IS NEVER LONG ENOUGH TO EAT EVERY DAY."

Now we have eaten a piece of the sausage, but let's look at when and what comes the next ...

Conferences are the key elements in our strategy to improve the visibility and the reputation of petroleum geology for both the public and the industry.

These conferences and other events are successful if we can convince our customers (the companies, government agencies, the society and the individual professionals) that we are not for ourselves – the high standard presentations, publications, documents can be considered as significant contribution to the new values created by the petroleum industry.

The high standard of the presentations, posters and publications should convince everybody that the Association is not less, is not more, than the extended arm of the industry's R&D, G&E and HR divisions.

To do so, we have to be able to enhance the frequency of our conferences, workshops, courses, field trips and research meetings. This multitude of different events – with different size, scale, and duration – should cover the scope of interests of any significant customers of the Association.

To do this efficiently and timely, we must have flexible and disciplined management – a pool of voluntary workers from each generation – who are committed to sacrifice a part of their leisure time to work for us.

This is not easy – particularly not recently, when a plethora of temptations are given that target your leisure time.

In this context let me list the main AAPG events of the coming years:

- The regular APPEX meeting, London, March 2008
- The AAPG ICE Cape Town, October 2008, note, that only seven weeks left to submit your abstracts to this large international.
- The "40 Years After" North Sea Conference, Oslo, September 2008.
- The "Polar Petroleum Potential" (3P) Conference, Moscow, April 2009.
- Black Sea Conference, venue TBA, 2010.
- Conferences are planned that examine the potential of the Mediterranean region, as well as the Baltic Sea.

Ladies and gentlemen, these are the events we have to keep in our mind when looking at the future. These are the events in which we again will need your co-operation and collaboration again.

In a hope of them I declare the Athens Conference and Exhibition closed and invite you to attend the last official activity of our meeting – the Sundowner Party, before the sun is really down.

But for your president the day has not come to an end yet. I have sit together with my Greek friends to implement the next point in our agenda. Why not to join us?

Good Luck and safe trip home.

Istvan Berczi
 President AAPG European Region