Targeting deeper

While seismic is still seismic, Controlled Source ElectroMagnetic (CSEM) diversifies into several types of competing technologies.

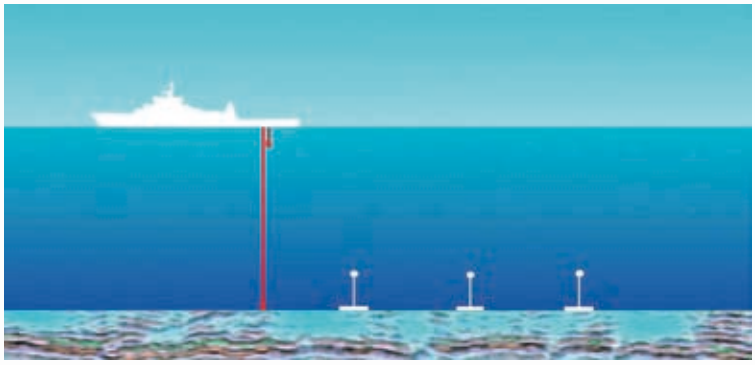
Halfdan Carstens

In October it became known that Schlumberger had acquired a minority interest in a Norwegian-based company that specializes in the development of marine electromagnetic technologies. "We believe that the integration of seismic and electromagnetic has enormous potential to provide a step change in reservoir definition," said Dalton Boutte, president of WesternGeco, offering their reasoning for the acquisition.

Succesful test

The first real field test with prototype transmitters and receivers have been successfully completed. In November PetroMarker acquired a line across the giant gas field Troll in the North Sea. The operations went smooth, and the results were in line with expectations.

"The data clearly demonstrates that our technology has the ability to detect hydrocarbons in the subsurface," Kjerstad says.



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The PetroMarker technology is using a vertical transmitter.

The new technology developed by Stavanger-based PetroMarker involves both acquisition and processing of electromagnetic data. It differs, however, from other technologies by using vertical transmitters and receivers. Furthermore, the vertical component of the electromagnetic field is measured in the time domain.

"This is different from other available techniques that all measure the horizontal component of the electromagnetic field in the frequency domain," says Jostein Kjerstad, who has been instrumental in the development of this new and innovative technology.

"We expect that the new method will give higher resolution and deeper subsurface penetration than the established technology providers," Kjerstad adds.

Their very first field experiment was done last year, also that one on the Troll field. Since then the company has made many improvements, and over the summer several tests were made using a barge outside Stavanger.

"The latest test is thus done with second generation equipment," explains Kjerstad.

The Norwegian oil company Discover Petroleum has an exclusive arrangement with PetroMarker on the Norwegian Continental Shelf, and the two first commercial surveys have now been completed. The next step is to move outside Norway, and early next year the company will sit down and negotiate a deal with several international majors.

"To prepare ourselves we are now building two spreads, one is to be used by Discover, the other we will offer outside Norway."

Technology development

While developments in technology often come from a sudden idea from brains in the research department, the story behind PetroMarker is a little bit different.

In 2000 the Offshore Resource Group was started offering subsea consulting to the oil companies. "We made money, and some of this went into research. Based on the low exploration success ratio in the oil and gas industry, we looked at how the seismic could be supplemented with other technologies. The EM method was one possibility, and we soon started to talk with several individuals that had the necessary expertise," Kjerstad explains.

In 2002 a research program was instigated to evaluate existing CSEM methods and patents, and a feasibility programme was carried out in 2003/2004. Detailed simulations and analysis of all known patented and operational CSEM systems was then carried out. Altogether 27 patents and 100 white papers have been reviewed and analysed in detail.

Seismic versus CSEM

The seismic method relies on the transmission of acoustic waves through the various geological layers at the speed of sound that depends on rock density. The CSEM method makes use of the defusion of electromagnetic fields through rock layers. Seismic works with rock density, CSEM with rock resistivity. While seismic defines the structures of the geological formations, CSEM indicates their content in terms of oil, gas or water.

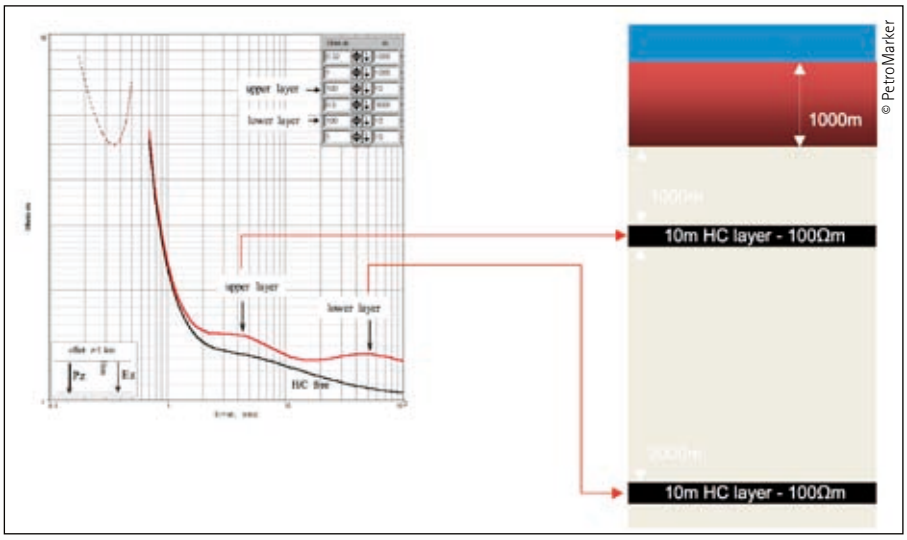
"We spent a lot of time trying to understand the technology and looking into several patents. As a consequence we put together a group of EM experts that should study existing methods and try to find alternative and better ways to get better resolution. One of the results was that we decided to use a vertical source."

"Three elements were important to us: We should not use existing patents, we wanted to develop a method with certain advantages compared to existing methods, and it should be possible to put the theory into practice."

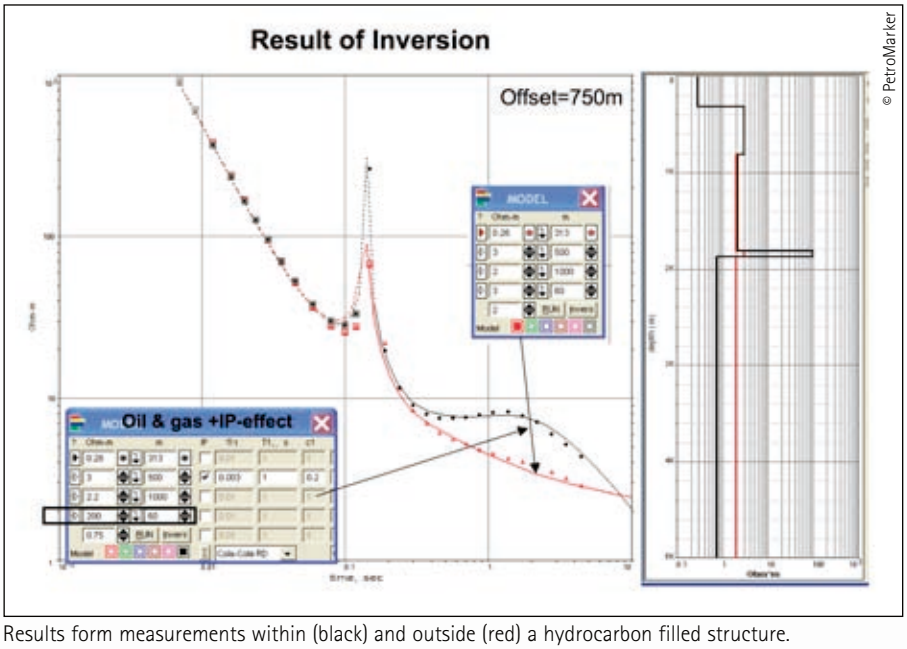
"The patent investigations and simulations have enabled us to form a knowledge base of existing technologies and methods and cleared the route to the best solutions and to get full freedom to operate," Kjerstad says.

PetroMarker was formed in 2004 with the purpose to develop and operate the new marine electromagnetic survey method that now had been patented.

A team of Norwegian and international scientists and researchers then refined the method, and it is now known as TEMP-VEL® (Transient ElectroMagnetic Prospecting with Vertical Electrical Lines). In parallel, a team of engineers with background and experience in geophysical surveying and offshore operations designed the offshore equipment as well as the acquisition and processing software. The original method was further developed for use in shallower waters. This new method was named TEMP-AEL® (Transient ElectroMagnetic Prospecting with Adjusted Electrical Lines).



TEMP-VEL resolution with respect to two thin (10 m) hydrocarbon layers located at 1000 and 4000 m depth. Resistance of these layers is100 Ohm-m. The resistivity of the sediments between these layers is very low (0.5 Ohm-m).



Results form measurements within (black) and outside (red) a hydrocarbon filled structure.

The TEMP-VEL® and TEMP-AEL® methods both consist of vertical transmitters and receivers, operating in time domain and in near zone. A basic system consists of one vertical dipole deployed from the survey vessel and one or more vertical receiver stations placed on the sea-bed using the same vessel. The typical distance between receiver stations is 1 000 m.

Kjerstad claims a number of advantages with these methods. "First of all, we offer improved investigation depth, all the way down to 5000 m below sea-bed. Our ambition is also to make the technology less dependent on water depths. Furthermore, we offer improved horizontal resolution, with target reservoir area between 5 and 25 km^2, as well as improved vertical resolution, with minimum target reservoir thickness between 30 and 100 m." Kjerstad also says that this technology has the capability to detect and discriminate vertically placed resistive targets. On top of that, his goal is to improve survey efficiency and thereby reducing cost.