

Finding oil and gas beneath the seabed

A revolutionary remote survey technique...

Norwegian company Electromagnetic Geoservices AS, known as emgs, is the inventor of seabed logging, a revolutionary electromagnetic survey technique for the remote location of oil and gas beneath the seabed. Seabed logging has propelled this small, highly innovative firm to a position centre stage in the international oil industry simply because, when companies drill for oil, they now stand a much better chance of finding it. The first person to strike oil by drilling a hole in the ground was an American gentleman called Colonel Drake – and he was very lucky. Modern geophysicists reckon that, even though he was drilling in an area of Pennsylvania, USA, where oil was seeping naturally to the surface, Drake would probably have missed the underlying reservoir had he set up his rig only 100ft away from the chosen spot – and then his place in history might have gone to someone else.

It is nearly 150 years since Colonel Drake – actually a former railway conductor with no military connections – drilled the world's first oil well and launched the oil industry as we know it today. It is still a very risky business. In fact, the success rate of oil exploration companies has remained at around 15–20% for some time. That is, the odds against a company finding oil when it drills an exploration well have been at least four to one.

Not to put too fine a point on it, but the oil industry has got to do better. For the past 20 years, we have been consuming more oil than is being found. Oil consumption, which currently stands at roughly 85 million barrels per day, is expected to rise to 120 million barrels per day by 2030, largely as a result of massive increases in demand for transport fuels in Asia and South America. The pity is that, as demand is rising, some of the world's established oil provinces are in

decline. Close to home, the North Sea is a particularly good example.

Because much of the easy oil has already been found, oil companies are being forced to explore in more challenging areas, in particular, in the deep waters off the coasts of West Africa and South America and in the Gulf of Mexico and the South China Sea – with huge cost implications. Oil may be trading at around \$70

per barrel, but with deepwater drilling rig rates in excess of \$500,000 per day, companies are badly hurt when they drill a dry hole. In fact, such results are estimated to be costing the oil industry in excess of \$3bn every year.

Finally, there is the issue of resources. The industry is not awash with the experts, nor the sophisticated equipment, needed to find oil in these difficult environments, and companies desperately need to make the best possible use of the resources available to them.

So, what is the normal way of finding oil – or at least, in the first place, establishing the most favourable places in which to drill? Since the 1920s, the oil companies have relied heavily on an acoustic method commonly referred to as seismic surveying. Sound energy (created by shots from an airgun when surveys are performed under the sea) is directed into the seabed. The complex sound reflections picked up by receivers are then analysed to establish the nature of the geological formations deep beneath the surface.

Seismic surveying is a well developed art and has proved highly effective at locating the kind of structures that might be expected to contain hydrocarbons. The drawback of the

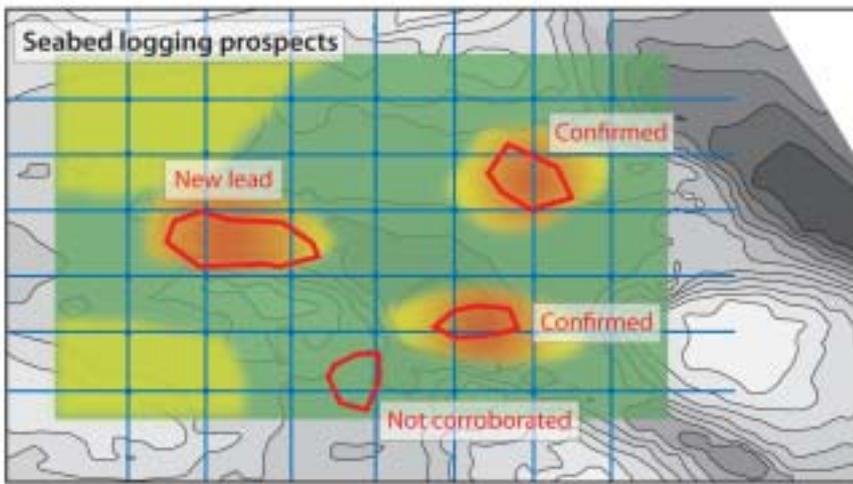
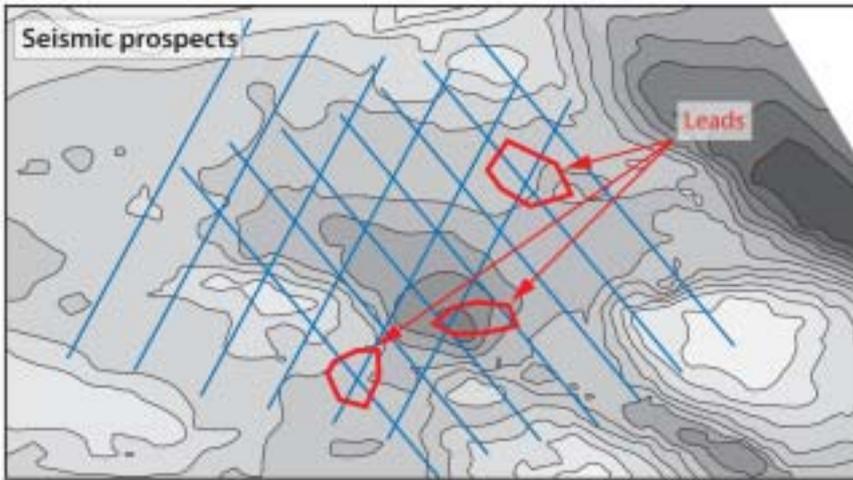


Government recognition: Ståle Johansen of emgs explains seabed logging to The Norwegian Petroleum and Energy Minister, Odd Roger Enoksen (right), during a recent visit to the company's headquarters in Trondheim, Norway

technique is that it is fundamentally incapable of determining the presence of oil in a formation, a fact that goes a long way to explaining the relatively poor odds of finding oil using seismic data alone.

The industry does have a method of locating and describing subsurface hydrocarbon accumulations; it relies on the difference in the electrical resistivity between oil- and water-bearing rock sediments, which may be up to three orders of magnitude if oil is present in commercial quantities. Resistivity techniques have been around as long as seismic surveys but, until emgs came along, nobody had been able to find a way of making measurements from the surface and, thus, without drilling. In contrast, great progress has been made with techniques to make measurements down a drilled hole, commonly referred to as borehole logging.

In the late 1990s, emgs' founders, Svein Ellingsrud and Terje Eidesmo, then with Norwegian oil company Statoil, started to look again at how resistivity measurements could be made remotely, in the case of exploring for oil offshore, from the seabed. Finding a source of electromagnetic (EM) radiation



Improving the odds: A seismic survey (upper chart) indicates three areas where hydrocarbons may be found. Seabed logging (lower chart) confirms the presence of hydrocarbons in the case of two of the three leads, the red hot spots, and highlights a fourth area worth investigating, which the seismic survey had missed. Falklands Oil & Gas recently announced its intention to assess over 100 seismic prospects in the South Atlantic in this manner

sufficiently powerful to penetrate the necessary 2km or more into the earth, the depth at which oil reservoirs are typically found, heralded the start of the two scientists' work in the late 1990s. Their research with this source showed that EM energy is guided, with low attenuation over long distances, by resistive bodies such as hydrocarbon reservoirs. Furthermore, they showed that low frequency EM radiation emitted by a source close to the seabed can propagate to potential reservoir depths and that, by placing the receivers at distances from the source in excess of three times the burial depth of the reservoir, the signals from the reservoir would dominate those arriving by other routes. In short, they would be able to detect the hydrocarbons lying beneath the surface. It is unfortunate that, when described so briefly, Ellingsrud and Eidesmo's achievement may not seem particularly

special. But it certainly is. Those wishing to learn more about the theory behind seabed logging can refer to a recent article in Oil & Gas Journal: 'Long-offset techniques head advances in marine electromagnetic surveying,' Oil & Gas Journal 103 No 41 p 34 (7th November 2005). Since the first demonstration of seabed logging, offshore Angola in 2000, and then the first commercial application of the technique in Statoil's North Sea Ormen Lange field in 2002, emgs has carried out over 150 commercial surveys, a total distance logged in excess of 13,000km. In a short time, more than 30 oil companies have adopted the technique. One of them, Shell, has successfully applied seabed logging in Brazil, the Mediterranean, Norway and West Africa. The company's Executive Director, Exploration and Production,

Malcolm Brinded, described the integration of the technique with more established exploration methods as an 'essential enabler' in the effort to improve discovery rates.

As an example of how Shell has benefited from the technique, and, ironically, one that involves not finding oil, the company recently used seabed logging over a prospect that had been sitting in its portfolio for several years. No hydrocarbons were detected and the prospect was dropped in order to raise confidence in the company's stated portfolio value.

In every case where well data have subsequently become available, the seabed logging predictions have been confirmed. These cases include major offshore oil discoveries in Europe and South East Asia that were indicated by seabed logging before drilling commenced. On the basis of the track record that seabed logging is rapidly establishing, oil companies are being obliged to carry out such surveys by some of the national licensing authorities. Seabed logging was included, for instance, as part of the commitment programme by the Norwegian government in the 2005 award in predefined areas licensing round.

Oil exploration is synonymous with risk, and those companies involved are constantly looking for ways of improving the chances of finding oil. Given the exploration challenges facing companies today and, indeed, the energy challenges facing society, every well has to be made to count. With seabed logging, emgs is helping to make that happen.



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