MTEM LIMITED

SUMMARY

In 2001 Anton Ziolkowski, Bruce Hobbs and David Wright of the University of Edinburgh invented a new electromagnetic method to detect sub-sea and underground hydrocarbons. In 2003 they founded MTEM Ltd. to develop the technology and provide land and marine surveys to oil companies. They invited Leon Walker to become CEO, which he did, leaving Schlumberger in 2003 and starting in January 2004 to help raise funds to launch MTEM. In November 2004 MTEM Ltd. was launched from the University of Edinburgh with £7.4M of funding from three equal investors: HitecVision, Energy Ventures, and Scottish Equity Partners. MTEM Ltd. developed and built systems to perform land and marine transient electromagnetic surveys that can identify hydrocarbons *before* drilling, thus reducing the risk of drilling "dry" wells and saving millions of dollars per well. In June 2007 Petroleum Geo-Services (PGS) bought MTEM Ltd. for $275M. The University of Edinburgh's share of the sale was £8.6M, of which £2.6M funded 164 PhD studentships. Since 2004 MTEM Ltd. has provided over 200 man-years of employment in Edinburgh. PGS continues to develop the technology.

INTRODUCTION

MTEM was the biggest-ever spin-off company from a Scottish University and the second-biggest spin-off from a UK university. The sale of MTEM Ltd. for $275M staggered many observers. The purpose of this brief article is to present the main elements of the MTEM story from my perspective.

The idea for the company came as a result of a breakthrough in 2001 by PhD student David Wright in the analysis of data that had been acquired in a European Commission-funded THERMIE project.

The THERMIE project, led by Anton Ziolkowski, Professor of Petroleum Geoscience at the University of Edinburgh, began on 1 October 1992 as a three-year project with a total budget of ECU3,315,947, of which the European Commission would contribute a maximum of 40%, or ECU1,326,379. Elf Enterprise Caledonia Ltd. also supported the project with a contribution of FFr1 m. The balance was paid by the partners. The primary goal of the project was to develop a method to detect hydrocarbons directly using multichannel transient electromagnetic (MTEM) soundings in combination with other complementary data such as seismic reflection surveys and well logs. An alternative goal was to develop a method to monitor the movement of hydrocarbons in a known reservoir.

No suitable site could be found in Europe to demonstrate the primary objective: the presence of pipe networks at otherwise ideal sites proved to be insuperable obstacles to a convincing demonstration. Gaz de France proposed an underground gas storage site they operated at St. Illiers la Ville about 30 km west of Paris; it was found to be ideal to demonstrate the second major objective. Two surveys were planned: one when the gas volume in the reservoir was at its maximum, and one when it was at a minimum. Two data sets were acquired, in October 1994 and in August 1996. The timing of these surveys was not optimum and was constrained partly by farmers and partly by Gaz de France. Analysis of well information showed subsequently that there was a decrease in gas volume between the two surveys of no more than 1.8%, corresponding to a lateral movement of the gas/water contact of less than 10 m, and well below what could be resolved.

Unfortunately, the project team failed to produce any meaningful results from the data.

This article focuses on the key technical steps leading to the idea for a company, the steps to start the company and create the business, the purchase by PGS, the economic impact, and the continuing research and development.

ST. ILLIERS LA VILLE DATA

The infrastructure at St Illiers la Ville was fixed, but the amount of gas being stored varied during the year. The gas input rate was roughly constant, but the rate of consumption of stored gas was greater in the winter than in the summer, so maximum gas volume was in the autumn and minimum was in the spring. The two data sets were acquired with the intention of observing differences in the data corresponding to the differences in quantity of stored gas. There was no expectation that the gas reservoir itself would be observable in the electromagnetic data in the presence of the infrastructure of steel wells and horizontal steel pipes.

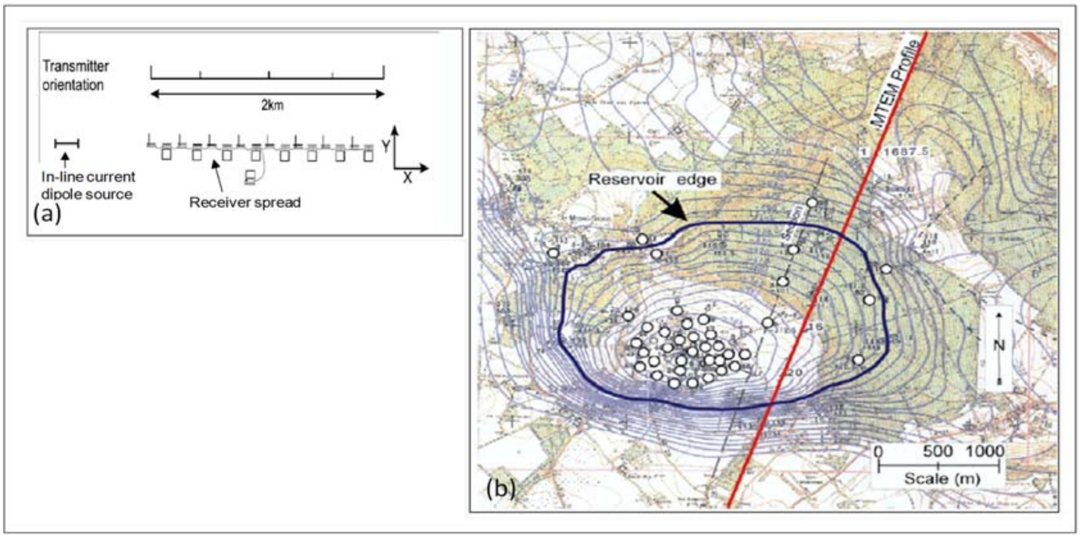


Figure 1 (a) Field layout for in-line configuration showing in-line current dipole source and 2 km receiver spread containing 16 in-line and 8 cross-line 125 m electric dipole receivers and 8 horizontal 50 m magnetic loops; (b) position of the MTEM line relative to the gas reservoir. The reservoir is an anticlinal structure about 500 m below the surface; the white circles are control wells (After Wright et al., 2002).

Figure 1(a) shows one configuration of source and receivers along the survey line and Figure 1(b) shows the position of the MTEM survey line over the gas reservoir. Details of the data acquisition are provided in Hördt et al. (2000) and Wright et al. (2002).

DAVID WRIGHT'S BREAKTHROUGH

In October 1999, David Wright started a PhD project at the University of Edinburgh, funded by the Natural Environment Research Council (NERC), and supervised by Anton Ziolkowski and Bruce Hobbs. Dr. Hobbs, with extensive expertise in electromagnetic methods, had been Ziolkowski's colleague in the THERMIE project. Ziolkowski and Hobbs thought Wright might be able to make sense of the THERMIE data which had cost so much to obtain.

In August 2001, Wright produced the result shown in Figure 2(b), which shows a clear red horizontal event at a level of 4 ms, corresponding to resistive hydrocarbon gas in the reservoir. Such a picture had never been produced before with electromagnetic data. To produce this result Wright had recovered earth impulse responses from the data and corrected timing errors, of as much as 3 ms, caused by the recording system. Figure 2(b) should be compared with Figure 2(a), which is a display of the same data, published earlier by colleagues in the THERMIE project (Hördt el al., 2000), but without any correction for the timing errors. There is no coherency in the data of Figure 2(a) and the reservoir cannot be seen.

Ziolkowski, Hobbs and Wright realised immediately that the method had potential for detecting resistive hydrocarbons from the surface before drilling, thus reducing the risk of drilling "dry" wells. They wrote a patent application identifying the key step of recovering the earth impulse response from the data, which was filed by the University of Edinburgh on 7 September 2001.

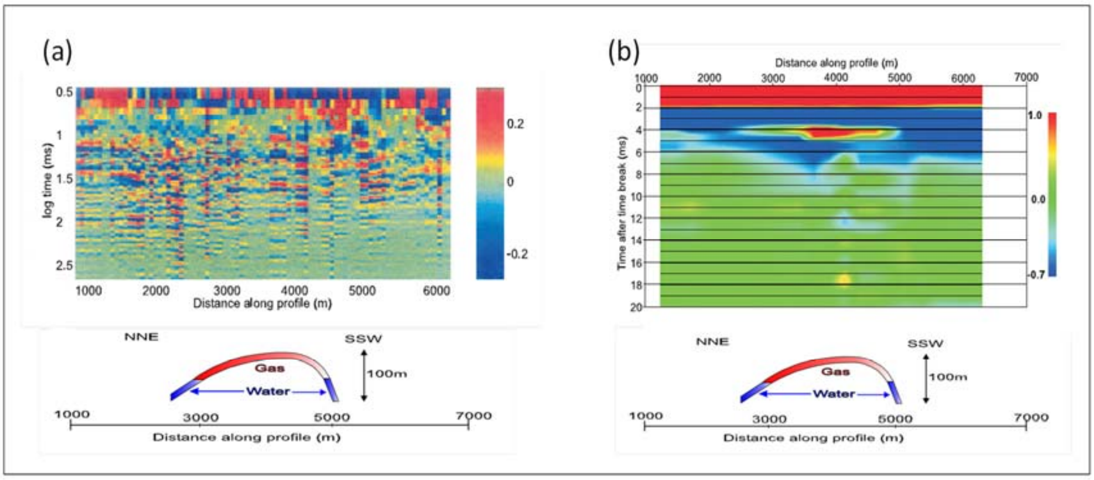


Figure 2. Data from the St. Illiers la Ville gas storage site. (a) input to 3D inversion by Hördt et al. (2000); (b) same dataset as (a) after different processing by Wright et al. (2002) to give the first derivative of the impulse response displayed as 1000-m common-offset section. A cross section through the reservoir is shown below each plot on the same horizontal scale (After Ziolkowski and Wright, 2012).

STARTING MTEM

With the assistance of Edinburgh Research and Innovation (ERI), the University's commercial arm, Ziolkowski and Hobbs applied in September 2001 to Scottish Enterprise for a Proof of Concept (PoC) award. The application was turned down. In August 2002 Bill Bryan and Professor Jim Murray, representing Scottish Enterprise, visited the University, where Ziolkowski and Hobbs presented the invention of the multi-transient electromagnetic (MTEM) method. Bryan and Murray said it was exactly the kind of thing that was supported by a Scottish Enterprise PoC award and Bryan offered to help with the application. A second application was written and submitted in September 2002. This resulted in a PoC award of £198k for a one-year project to design and build field equipment for the invention, and test it over a known gas-storage reservoir in France. It also paid over £19k for patent applications to provide the widest possible protection for the invention, within the budget.

In December 2002 the University of Edinburgh granted Ziolkowski and Hobbs permission to start a company to commercialise the technology and, with assistance of a representative from ERI, they began to write a business plan; the representative wrote the spread sheets. David Wright elected not to be part of the management team.

In January 2003, Bill Bryan and Campbell Murray of Scottish Enterprise invited Ziolkowski and Hobbs to a meeting to discuss the way forward with the commercialisation. They made four key points: (1) sort out the relationship with the University; (2) appoint independent lawyers; (3) appoint corporate financial advisors; (4) above all: Don't screw it up! This advice was new and unexpected. Bryan and Murray provided names of contacts in two legal firms, one of which was DLA, and the names of four corporate financial advisors. Ziolkowski and Hobbs appointed DLA as MTEM's legal advisers in April 2003. The initial fee was £5,000; the remaining legal costs would be paid from the money to be raised from investors. In February 2003 Ziolkowski, Hobbs and Wright incorporated an off-the-shelf company Quilco 143 Limited and changed the name to MTEM Limited in September 2003. A draft agreement with the University was reached in March 2003 and a detailed agreement was signed in September 2003, with advice from DLA.

The main thrust of the business plan was to raise enough capital to enable the company to reach positive cash flow. In early 2003 it was estimated that about £2M would be needed. Ziolkowski and Hobbs recognized that it would be impossible to raise so much money without an experienced business manager at the head of the team. In April 2003 Ziolkowski approached Leon Walker, a Vice-President of Schlumberger. Walker was impressed by the science and believed it would work as a business. He left Schlumberger and in January 2004 began to work for MTEM Ltd. for no salary.

In parallel with this, after making presentations to venture capitalists at meetings arranged by ERI, it became clear to Ziolkowski and Hobbs in June 2003 that the business plan and supporting spreadsheets from ERI were inadequate: better advice was needed. After serious study, Ziolkowski and Hobbs concluded that much more money was needed: £7M - £10M. Bryan provided a better structure for the business plan and Hobbs began to write the spreadsheets. Ziolkowski and Hobbs talked to six potential financial advisers but were unable to find suitable advisers. Bill Bryan organized a meeting of Ziolkowski, Hobbs and himself with Simmons and Co. in Aberdeen. Based in Houston, Texas, Simmons and Co. specialised in transactions in the oil and gas business, but did not do start-ups. Nevertheless they listened to the presentation, decided it was "sensational" and sought permission from Houston to act for MTEM. Permission was granted and Ziolkowski and Hobbs appointed them on the same basis as DLA: £5,000 initially, the remainder to be paid from the money raised from investors. MTEM now had professional advice from outside the University.

From that point on things went well: the data and equipment from the PoC project, which was proceeding in parallel with the business planning, provided the evidence that there was real substance behind the claims. The business plan, especially the plan for the first six months, was becoming more concrete, with the influence of Leon Walker and Simmons and Co., who were now constructing the spreadsheets. By May 2004 two consortia of venture capitalists were interested in funding the start-up of MTEM Ltd. The management team of Walker, Ziolkowski and Hobbs pursued the more attractive of the two offers, and intense due diligence investigations took place throughout June 2004.

On 3 July 2004 the lead investor of the consortium decided the consortium would pull out, the other consortium then decided they were no longer interested, and Leon Walker immediately resigned. At this point Ziolkowski and Hobbs owed DLA and Simmons and Co. a considerable sum of money. The situation looked very bleak for them.

Bill Bryan came to the rescue again, explaining that it was necessary to put the management team back together, possibly with an adjustment of the equity share, and to let Simmons and Co. put together a deal. That's what happened. Two of the investors in the original consortium were keen to do a deal: Energy Ventures and HitecVision. On 11 November 2004 MTEM Limited was spun out from the University of Edinburgh with £7.4M venture capital funding from three equal investors: HiTecVision, Energy Ventures, and Scottish Equity Partners. At the time, this was the largest-ever spinout from a Scottish university and the second largest UK spinout. MTEM's transaction costs – the costs of lawyers and corporate financial advisers – were substantial: about 5 per cent of the total sum raised.

At School level Ziolkowski and Hobbs were required to perform all their full-time teaching, research and administrative duties. When they informed the School that the venture capital funding would most probably be raised in October or November 2004, they were told to compress their teaching for the whole semester into four weeks to ensure the teaching was completed before the spinout.

Between the end of the PoC project, June 2004, and the start of MTEM Ltd., November 2004, there was a funding gap for David Wright and Graham Dawes, two University employees who were essential to take the technology forward. At the suggestion of Bill Bryan, Scottish Enterprise's High Growth Start-Up Unit offered £5,000 to help bridge the funding gap on condition that the University provided a matching sum. This £5,000 risk money came from the School of GeoSciences and was paid back when MTEM was funded in November 2004.

STRUCTURE OF MTEM

The Board of MTEM Ltd. consisted of three executive directors, three non-executive directors and a non-executive chairman. Executive directors were Leon Walker (CEO), Anton Ziolkowski (Technical Director) and Bruce Hobbs (Research Director). Bruce Dingwall, former CEO of Venture Production and former President of UKOAA, was appointed Non-Executive Chairman by the Executive Directors. He considerably enhanced the visibility of MTEM Ltd. in the oil industry. Ola Saetre, Non-Executive Director, represented HitecVision, and Einaar Gamman, Non-Executive Director, represented Energy Ventures. Scottish Equity Partners (SEP) wanted an observer at board meetings, but no directorship. Mike Fleming, independent, was the third Non-Executive Director. He had previously worked closely with Bruce Dingwall. The non-executive directors were strong characters with considerable business experience, especially in the oil and gas business.

Hobbs and Ziolkowski were seconded from the University to MTEM Ltd.; that is, the University paid their salaries, but were recompensed by MTEM Ltd., who paid the University their salaries plus all overheads.

The investment agreement provided funds in four tranches: initial funding of about £1.5M on Day 1 and further funding when agreed milestones were met. It was imperative to meet the milestones. The reason for this approach was understandable nervousness on the part of the investors. They were risking a considerable amount of money for technology in which they had some confidence, but little knowledge. No patent had been granted, so the value of the company's intellectual property – under exclusive licence from the University of Edinburgh – was uncertain. It was indeed a risky business.

The first milestone, in Month 4, was successful demonstration of the land capability, earning the second tranche of £1M; the second milestone, Month 6, was a letter of intent from a customer, earning the third tranche of £0.5M; the third milestone, end of Year 1, was a successful trial of the marine system, which earned the remainder of the money. In July 2005 the patent for the 2001 application was granted by the United States (Wright et al., 2005). This provided an increased level of comfort for both the founders and the investors.

MTEM Ltd. had to develop very fast to meet the milestones and then get to the market. The strategy was to hire key managers and let them hire their own people. Ten per cent of the ordinary shares were reserved for employees. The key managers were Chief Financial Officer (CFO), Product Development Manager, Marketing and Sales Manager, Land Operations Manager, and Marine Operations Manager. The first four positions were filled very quickly with excellent well-qualified and experienced managers: Tony Robison, Richard Carson, Paul O' Brien, and Jonathan Hutchinson, respectively. The last position was filled equally appropriately by John Karran after the successful marine trial at the end of Year 1.

Board meetings were held monthly, in Edinburgh, or in Aberdeen, or in the city of the annual meeting of the European Association of Geoscientists and Engineers (EAGE). At each board meeting, safety was the first item of the agenda. Minutes, drafted by CFO Tony Robison, were signed by all board members and by the SEP observer. Monthly Board meetings were too infrequent to keep track of rapid developments, so each manager had to produce weekly reports for the Board, which forced every manager to track progress weekly on all tasks for which he was responsible.

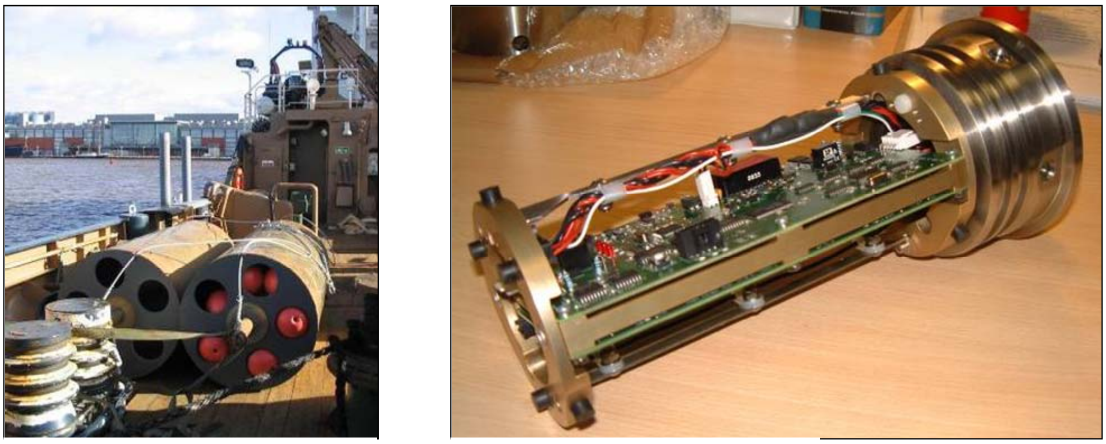
BUILDING MTEM

The geophysical ideas of Ziolkowski, Hobbs and Wright were developed into hardware and software systems that were built and taken into the field for geophysical surveys. The difference between university prototype and rugged commercial hardware built for use in a range of environments is typified by the land receiver system shown in Figure 3. The prototype was designed and built in the University within the very tight budget and timing constraints of the Scottish Enterprise Proof of Concept project 2003-2004. The commercial system was designed from scratch, built and tested by MTEM Ltd., and first used commercially in Wyoming in September 2006. Before it was ready, an intermediate system was made, based on the prototype, but more rugged and easier to use. The final commercial system shown in Figure 3(b) had a much extended low-frequency capability.

(a) (b)

Figure 3 MTEM land receiver box (a) Proof of Concept prototype; (b) MTEM Ltd. commercial system.

The land system was easier to design than the marine system because each receiver box could have its own battery. Power for the marine system had to be delivered by cable from the vessel.



(a) Source electrodes (b) Receiver module

Figure 4 Source electrodes and receiver module for marine system.

It was essential to get to market as fast as possible and for minimum cost. MTEM Ltd. designed and built only what could not be bought commercially. Usable commercially-available equipment and software were often not ideal and had to be adapted for MTEM use. Where equipment absolutely had to be developed in-house, designs were made on computers and manufactured outside. Assembly was in-house. The source and receiver modules are examples of this. This policy was the brain-child of the Product Development Manager, Richard Carson.

MTEM Ltd. sought patent protection for every valuable innovative new design or geophysical method.

It was the vision of both Richard Carson and Chairman Bruce Dingwall that all essential company information be filed systematically and readily retrievable, with the objective of having “the whole company on a CD.”

Interaction with MTEM’s customers, the oil companies, was initiated by the Marketing team. The Land Operations team and the Marine Operations team had day-to-day contact with customers in the performance of field work, processing of the data, and interpretation of the results.

UNFORESEEN RISKS

In the business plan there were two inter-connected problems that had not been fully appreciated. They amounted to unforeseen risks. The first was the unanticipated problem that it would be difficult to persuade the customers that they needed the service to be provided. The second was the difficulty of extracting subsurface resistivities from the electromagnetic (EM) data.

This second problem is well-known in geophysics and applies to all geophysical methods except seismology. Seismic data obey the wave equation and subsurface seismic velocities can be obtained directly from the data by aligning reflected, diffracted, or refracted arrivals. For all other geophysical data, subsurface geophysical parameters are estimated by computing the response of appropriate earth models and comparing the responses with the measured data. Finding an earth model whose responses are a good match with the measurements is known as "inversion."

The MTEM approach to data acquisition is similar to the seismic method, but the responses do not have clear reflected and refracted arrivals like seismic data. Interpretation of the data is difficult. In fact there is no proven procedure to determine the subsurface resistivities from the data. Appreciation of these problems was slight at the start of MTEM. Eight years later geophysicists are well aware of them.

Oil company customers had two reasonable questions that were difficult to answer at short notice: How deep can you see with this method? and How much does it cost per kilometre of survey? For seismic surveys the answers to these questions are known from many years of experience for a variety of environments. For immature electromagnetic methods there is little experience and answers are not readily available. They can be provided only as a result of feasibility studies; that is, performing modelling calculations, based on resistivity well logs from the proposed survey area and local measurements of the electromagnetic noise levels.

With the benefit of hindsight, it can be recognized that the period 2004-2007 was one of optimism, when companies were prepared to take risks and test new ideas. It must also be recognized that MTEM's Chairman, Bruce Dingwall, helped MTEM gain important land and marine contracts that significantly increased the credibility of the enterprise.

PGS PURCHASE OF MTEM

In early 2007 MTEM began to plan to expand the company, based on £22 m of new investment. Carnegie, of Oslo, was appointed to advise on raising the money. The goal was first to expand the business and then to offer shares on the open market in an initial public offering (IPO) in the last quarter of 2008. The investors needed a return on their investment by then. The new capital was required by end of July 2007. Extensive preparations were made to assemble relevant information for investment bankers.

In March 2007, Ziolkowski received a phone call from his friend Svein Vaage of Petroleum Geo-Services (PGS), Oslo, requesting that he and his senior PGS colleague Sverre Strandenes meet Ziolkowski in Edinburgh to have a discussion "with no particular agenda." The meeting was scheduled for 13 April 2007. The MTEM

Executive Directors agreed that the meeting should take place off-site in a hotel in Edinburgh and that Ziolkowski and Hobbs should present the achievements of MTEM. The meeting was scheduled immediately after completion of MTEM's first commercial marine survey in the North Sea, overseen by Ziolkowski, and he was able to present examples of the exciting new marine MTEM data. At the meeting it was clear that Vaage and Strandenes had come to find out about MTEM's capabilities, as anticipated by the Executive Directors.

Several expressions of interest in MTEM had come from potential buyers during the spring of 2007. In May 2007 PGS sent a firm cash offer for the purchase of MTEM. MTEM's Board appreciated that this offer might fall through and that it was necessary to proceed in parallel with the original plan to expand the company, which required a commitment by the end of June 2007 in order to raise the money in time. For several weeks there was no firm decision to accept PGS's offer, but there was considerable posturing to drive up the price. The final price was marginally higher than the original offer. Ziolkowski and Hobbs proposed that the Board accept the offer at the final price of $275M and the Board agreed. At this time MTEM had more than 70 employees.

There were three important factors in the determination of the price of MTEM. First, MTEM had only two serious competitors: Electromagnetic Geo-Services (emgs) and Ocean Hydrographic Mapping (OHM), while there were several large geophysical service companies that were potential buyers. That is, it was essentially a seller's market, which had been anticipated by Simmons and Co. in 2004. Second, emgs had already been floated on the Oslo Stock Exchange on 29 March 2007 with an offering of 19,623,200 shares, representing approximately 26.7% of the company. This valued emgs at about £1000 M. There had been very strong interest from both retail and institutional investors, with the offering approximately thirteen times subscribed at the IPO price. This had a significant influence on the price of MTEM. Third, MTEM's approach to the acquisition and processing of electromagnetic data was different from that used by OHM and emgs, and fitted much better with the concept of a towed electromagnetic system which PGS had already begun to develop.

Once the agreement to proceed had been reached, MTEM put a deadline of 30 June 2007 to conclude the transaction, because that was the deadline to commit to the alternative plan. MTEM had been preparing for the due diligence process for months. This proceeded very rapidly and the transaction was completed on 30 June 2007.

The University's share in the transaction was £8.6M.

ECONOMIC IMPACT

There are three main economic impacts: identification of hydrocarbons before drilling; jobs in Edinburgh and elsewhere; £8.6M to the University of Edinburgh.

The main purpose of the technology developed by MTEM Limited is to increase the probability of finding hydrocarbons and reduce the risk of drilling dry wells. Promising reservoirs identified by seismic exploration can be surveyed with the MTEM technology to determine whether they are electrically resistive and thus containing hydrocarbons, or electrically conductive and thus saturated with salt water. Several surveys showed that apparently promising reservoirs were not resistive and thus not worth drilling. This saved the oil company millions of dollars, but is not hard evidence that the method works. A survey for ENI of Italy, conducted in the Mediterranean Sea off the coast of Tunisia, showed a resistive target that was drilled immediately. Drilling confirmed the presence of hydrocarbons. The results were presented by ENI at the Electromagnetics, Gravity and Magnetics 2010 International Workshop, Capri, Italy, April 11-14, 2010 (D'Arienzo et al., 2010). Figure 4 from their paper, reproduced as Figure 5 below, shows a resistive zone at a depth of about 2000 m in the centre of the figure. This was subsequently drilled by Well 3 and found to contain hydrocarbons. The authors state: "This represents a first important result that seems to confirm the value of MTEM methodology for relatively deep hydrocarbon exploration purposes."

Since the launch in 2004, MTEM Ltd. has created about 200 man-years of employment in Edinburgh. MTEM Ltd., now owned by the multi-national company Petroleum Geo-Services (PGS), is company No. SC243297, registered at Companies House. The Edinburgh office employs about 30 people at Birch House, 10 Bankhead Crossway South, Edinburgh, EH11 4EP.

£2.6M of the University's £8.6M share in the sale of MTEM was set aside to fund the "Principal's Studentships" for PhD students studying in disciplines across all three of the University's Colleges and represents a significant reinvestment in training scholars at the University. 164 PhD studentships of various sorts were funded. The other £6M has been used for a variety of purposes in the University, including help in funding new laboratories, a substantial contribution to the School of GeoSciences, and £0.5M being used in support of the commercialisation of a new generation of technology innovations, with 42 projects supported in a wide variety of topics from statistical hydrocarbon reservoir modelling to influenza therapeutics.

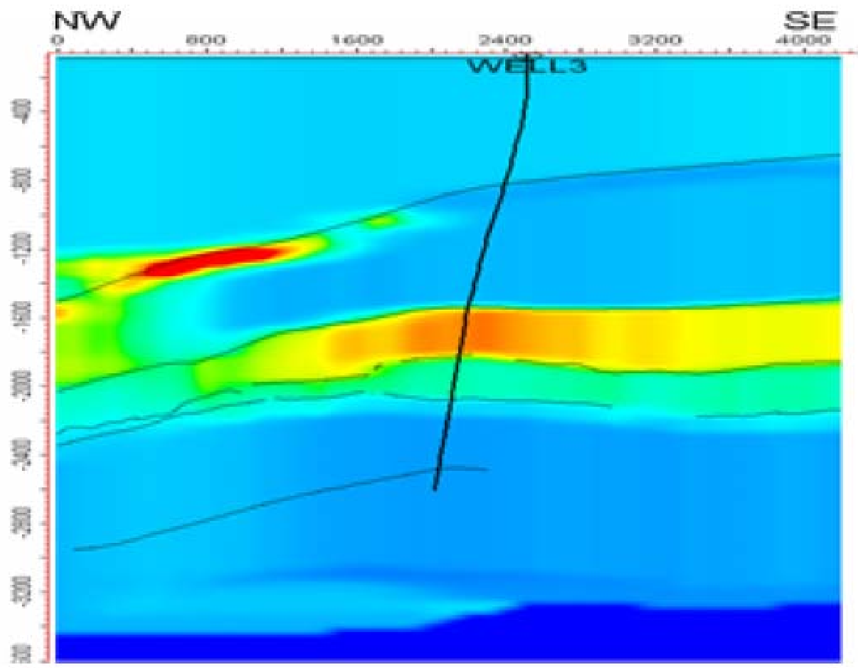


Figure 5 Line 3 interpolated section of 1D inversion (from D'Arienza et al., 2010)

RESEARCH AND DEVELOPMENT

Research and development of the MTEM method is continuing, both in PGS and, with substantial PGS support, at the University of Edinburgh. PGS plans to launch a fully-towed marine controlled source electromagnetic system and has already established that electromagnetic data and seismic data may be acquired simultaneously by the same vessel.

A robust solution to the inversion problem, extraction of subsurface resistivities from electromagnetic data, is of paramount importance. Without this capability the product is incomplete. The University of Edinburgh has developed a procedure to relate background resistivities to seismic velocities using constraints imposed by rock physics relations and information from well logs. This severely limits the range of resistivities that can exist in any layer not related to a potential hydrocarbon reservoir, and consequently limits the range of subsurface models that can be found to fit the data. Finding a resistivity model that is a good fit to the data becomes much easier.

The present depth limitation of the method is intimately linked to signal-to-noise ratio. Part of the research focuses on increasing signal strength and devising methods to reduce the noise. A towed system is inherently noisier than a stationary one, and understanding the induced electromagnetic tow noise and suppressing it is clearly a key ingredient of the research.

Twenty years ago scientists from Berkeley (Lee et al., 1989; Lee and Xie, 1993) proposed that transient electromagnetic data can be mapped to a domain where they obey the wave equation. This intriguing possibility has dramatic consequences for the way electromagnetic data are handled. If this mapping can be done correctly, much of seismic data processing methodology can be applied to find equivalent velocities that are directly related to subsurface resistivities. This would be a step change in the capability and usefulness of the method. Part of the University of Edinburgh research is focused on this problem.

CONCLUSIONS

The story began with a good patentable idea and the recognition that the idea could not be realized without the formation of a company. Company formation depended on a sound business plan, excellent lawyers, expert advice from corporate financial advisers, and, most importantly, professional mentoring by business start-up experts in Scottish Enterprise.

The start-up, for most of 2004, was particularly stressful for Ziolkowski and Hobbs, who had no relief from their full-time University jobs, and who bore the financial risk of hiring the lawyers and the corporate financial advisers. The stress was shared by their wives and families, who gave unconditional support.

Creating the company and developing the business required tremendous commitment from all employees, who needed to be thrilled that they were doing something special and different. It also required constant pressure from the Board.

The business plan severely underestimated the customer resistance to new technology and the difficulty of inverting the data to find subsurface resistivities. Nevertheless, by research and ingenuity, ways were found to work around these difficulties and the MTEM method was shown to work and identify previously unknown hydrocarbon reserves, one example being in the Mediterranean Sea, offshore Tunisia.

At many points the story could have turned out differently. It turned out to be a very risky adventure and it needed a lot of luck. The story is not over yet.

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