EM Tech As a Cost-Saving Complement to Seismic

By LOUISE S. DURHAM, EXPLORER Correspondent

Resistivity measurements are inarguably a basic necessity in the E&P realm where the distinction between water-filled pores and those containing resistive hydrocarbons in the reservoir is essential.

In the past, downhole wellbore logging was the only way to get a handle on formation resistivity.

While this approach remains the accepted standard in some instances, more sophisticated technologies are basking in the limelight. The downside is that widespread applications of certain newer developments in general await better times in the industry – read "higher commodity prices" – to reach their full potential.

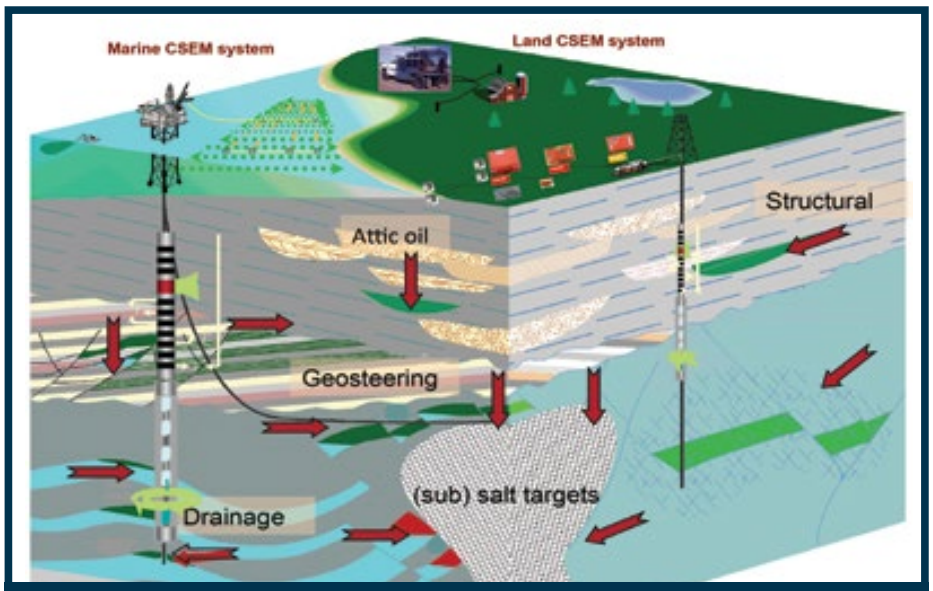
Over the last decade or so, marine controlled source electromagnetic (CSEM) technology has proven to be an effective tool to de-risk deepwater, really high cost drilling decisions. Yet it, along with magnetotellurics technology (MT), has both good days and bad days in the continuing uncertain financial environment.

Still, there's often going to be a way to make the most of valid oil industry technology despite negative external influence.

Basically, the focus here is on pore fluids and their response to electromagnetic energy (EM) in the target reservoir rock.

When applying CSEM, a self-supplied source – such as a horizontal electric dipole – transmits a low frequency electromagnetic signal into the subsurface by physically injecting current into the ground.

EM energy is noted for being attenuated rapidly in conductive sediments yet exhibiting slower attenuation and more rapid propagation in resistive environments such as hydrocarbons.



This figure shows how the electromagnetic system fits into the 3-D cube that is usually populated by seismic data. It shows a sketch of the marine and onshore acquisition scenarios with a salt dome. The high value targets are marked in red. Image courtesy of KMS Technologies.

"You can distinguish the fluid character (in the pores) by measuring the electrical resistivity of the rock," said geophysicist Kurt Strack, president of Houston-based KMS Technologies-KJT Enterprises, Inc., which he noted is the only firm manufacturing CSEM and MT equipment.

"This direct measurement is why electrical measurements are much more suited for fluid determination than other techniques," he said.

Strack is unquestionably up to speed in this milieu. Besides presiding over the company, he has been teaching EM and borehole geophysics at the University of Houston since 2000 and serves as an adjunct professor at universities overseas, including China and his home base, Thailand.

Pros and Cons of Magnetotellurics

Like CSEM, MT entails the use of sources, but these are naturally occurring electric and magnetic fields generated in the ionosphere.

MT is capable of penetrating thicker resistive layers but lacks the level of sensitivity toward thin horizontal resistors provided with the CSEM technique.

As a result, MT has great difficulty measuring anisotropy in transgresssive/regressive environments, such as sedimentary basins, where the sediment layers tend to have like physical characteristics in the horizontal direction unlike those in the vertical path.

The super-thin layers and lamina that occur in the vertical direction are unsuited to MT application.

Even so, when it comes to electromagnetics, MT has been the accepted workhorse of the industry since the 1980s.

Complementing Seismic

Although CSEM has been around for a time, it's more difficult to do, explained Strack, who noted that that's why people didn't pick up on it sooner.

Typical of this industry, perseverance was key to garnering respect for this complex application as a bona fide drilling-risk reduction technique in global basins.

There's more to come, when you consider the potential for this technology to complement seismic data for cost efficient deepwater reservoir appraisal and monitoring applications

"Recent (studies) have shown that time lapse CSEM data could play an important role in improving our knowledge of reservoir structure, fluid flow and fluid

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saturation changes, requiring less degree of repeatability when proper acquisition and advanced 3-D integrated quantitative interpretation technologies are applied," Strack said.

The need to evaluate 4-D CSEM potential becomes a given.

Strack has a simplistic take on the combination of seismic – which is used principally for structure – and EM used for fluid typing.

"Seismic is like having the outside of a container where you see the bottle," he said. "EM tells you what's inside, tells you if it has oil or water."

Benefits of CSEM

Although new technology may suffer depending on industry circumstances, CSEM offers some positives that can help to elevate its use even now.

"One reason this has a hard time is because it's run independently, meaning the cost is very high," Strack emphasized. "If it's run combined with seismic, there would be the same logistics cost with only 10 percent more for the seismic to try the EM data.

"It looks like there will be a new generation after we overcome the current oil price scenario," he predicted. "It will have dramatically more channels and dramatically reduced cost in combination with seismic data, so the technology will become more readily available."

Even today, there's some rather impressive activity.

"The biggest jewel is subsalt," Strack exclaimed. "CSEM for EM salt is absolutely transparent, perfect for imaging; the salt is very resistive and the sediments very conductive. We did some fantastic


STRACK

Kurt Strack of KMS Technologies is one of the organizers of "Marine EM: Quo Vadis," a workshop to be held at the Society of Exploration Geophysicists International Exposition and 87th Annual Meeting in Houston, Sept. 24-29. The workshop will examine the use of controlled source electromagnetic (CSEM) technology as a drilling risk reduction tool.

imaging on land in Europe."

Sub-basalt offers another fertile arena for application.

Strack noted there are two kilometers of basalt north of the U.K. offshore and around India, emphasizing that CSEM and MT are being used in every exploration program in India.

He said there is essentially the same potential with Brazil and, in fact, all over Latin America, where there are volcanics.

Another promising energy niche he pointed to is geothermal exploration, where MT already is the standard geophysical technique.

When it comes to monitoring potential, the largest market Strack anticipates will be enhanced oil recovery (EOR). He commented that EOR was a $20 billion market in 2015 and is predicted to soar to $200 billion in 2010, considerably above his estimate of $80 billion.

Unconventionals loom as likely another big opportunity – think hydraulic fractures mapping.

Strack's goal for EM overall is straightforward.

"My interest is to be sure this technology survives," he noted.

Art Form
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careful about checking and re-checking the data to make sure you have it all and have it right."

Only then comes the selling, the cajoling and the marketing, which is also an art form.

"You have to have the ability to deliver your project to all audiences. Some audiences are very technically oriented, some are pretty naive."

He saw early on the difference between working for a company – the prejudices, layers of bureaucracy one needs to overcome in a large corporate setting where everyone has an opinion before the exploration begins – and the freedom of being on your own, pursuing the plays for which you have a passion and not having to worry about, for example, project size.

"The cool thing about being an independent is being able to have the freedom to explore, without the encumbrances (of a corporate set up). If you can convince a small investor, and you can go find four or five wells – 100,000 to 500,000 barrels – you're absolutely thrilled. The corporations, they could not care less about a project that size, but that much oil, or gas, represents a huge – huge – financial plus."

Love of the Chase

He said there wasn't a master plan when he graduated with a doctorate from the University of Colorado, other than that he knew he liked the oil business. He worked for six years with Shell Oil Company where he prepared stratigraphic studies in the Rockies, prospect generation in Illinois, Wyoming, Montana and Colorado, as well as being one of the first to apply stratigraphic geophysical analysis to plays. Along the way, he was responsible for supervision and prospect generation leading to the discovery of significant hydrocarbons in the Green River Basin and western Montana, and was part of a select team who founded High Plains Exploration, where he originated and sold a major, high-potential frontier play. Then, along with Eells, he founded Lariat Exploration, where they made significant discoveries in Kansas and the D-J Basin. In addition, he has had a 20-year association with Thomasson Partner Associates, headed by past AAPG President M. Ray Thomasson.

Why did he leave Shell to go out on his own?

"I didn't get to do a lot of exploration there," he said.

As for the award: "I tip my hat to all contributors to the project including others unmentioned. Also to the AAPG Executive Committee and Advisory Council who saw fit to grant me this honored distinction, you have my heartfelt thanks."

When he looks back at his career, while admitting he's "loved the chase," it was the whole process, the journey that he cherishes.

"That's why when you drill a dry hole, it's devastating."