ROUND TABLE

Staying ahead of the curve

New technology is changing the face of petrophysics, sometimes faster than the petrophysicists can keep up.

By Exploration Technology Editor
RHONDA DUEY

In 1927 Conrad and Marcel Schlumberger decided to test a theory. Having discovered that the generation and measurement of an electric field in the Earth's subsurface helped delineate structures, the brothers determined even more information could be obtained if the measurements were taken downhole. And the first electric log was run.

As the oil industry celebrates the 75th year of this historic achievement, it seems timely to take stock of the status of petrophysics and turn toward the future. A recent meeting in Houston, Texas, on these issues resulted in 4 hours of lively discussion. But an overarching theme seemed to be the fact that new tools are gathering more data at a faster rate than commercial interpretation systems can keep up with.

Hart's E&P talked to Bob Truman, senior director of industry affairs, Baker Atlas; Gary Beck, senior petrophysicist for the NAX appraisal unit at BP and a past president of the Society for Professional Well Log Analysts (SPWLA); Bruce Bilodeau, team leader for formation evaluation development at ChevronTexaco Exploration and Production Technology Co.; Richard Ostermeier, senior staff research physicist, Shell International Exploration and Production Inc.; Philippe Theys, data quality manager for Schlumberger and immediate past president of SPWLA; Doug Seiler, formerly business development manager for formation evaluation at Halliburton; Sheng Ding, a principal engineer and integrator for El Paso; and Steve Mack, logging while drilling (LWD) business development manager for Computalog Drilling Services.

Philippe Theys

Among the topics of discussion were the most exciting recent logging developments of the past few years and the reliability of LWD and measurement-while-drilling (MWD) measurements.

Recent developments

Ostermeier: I would say the LWD nuclear magnetic resonance (NMR) tool has been a pretty phenomenal development, considering what one has to do to put a tool in the hole while you're drilling.

Bilodeau: In the last couple of years NMR technology development alone has offered a lot of benefits to oil companies for characterizing reservoirs, and the promise of the technology is tremendous, even beyond where it is today.

Beck: The other thing is formation testers. No question that it's an exciting development to us, definitely in the deepwater arena over the past several years, to be able to sit and pump out a formation to make sure we get a noncontaminated sample. That's just critical to our evaluation program.

Theys: This is all very true in open hole, but I think that what has also been very interesting is the development in casing – analysis behind casing, using resistivity and pressure measurements performed behind casing.

Beck: The cased-hole resistivity tool is really on the forefront and will turn out to be a big development.

Truman: Generically what we're looking at with both open hole and cased hole is the movement of sensors downhole that allow you to monitor and make measurements while wireline testing or producing. I think we're going to continue to see a trend in that direction. Examples of this are the increasing variety of sensors on wireline test tools and permanent sensors that allow you to not only monitor the production but characterize the reservoir.

Demographics

Ostermeier: One of our problems is that we've got a graying expertise level, and we're trying to bring in other people, but it's tough. It's the asset organization that we're all using – it has its real benefits, but it also has its downside in terms of bringing people up to speed.

Truman: That's a real risk on asset teams. If you take your professionals out of their domain-specific groups and put them into an asset team, the risk you run is lack of training quality assurance. If you're working within your petrophysical group and you put out some bad work, one of your peers will have a chance of catching it. If you take a relatively inexperienced person and put him on an asset team, he's surrounded by other people who are not educated in his expertise. The safety net's gone and some of the training's gone, so when he makes a recommendation and makes an error, nobody on the team catches it in the near term.

Richard Ostermeier

Ostermeier: We've got value assurance reviews that have been instituted in the last couple of years to provide some sort of technical oversight, not just for petrophysics but for all specialties. Typically you have an asset leader who has expertise in specialty A, but he really doesn't know too much about B, C, D and E. How do you balance that? In the old days it used to be organized according to specialties, and you had a team of petrophysicists who looked over everybody's shoulders. But then everybody was siloed, and you can't do that either. What's the happy medium? I think we're all trying, even after all these years, to come to grips with that.

Beck: The demographics and graying of our discipline is a big concern. Combine that with what we're now seeing in terms of data quality and data management and just the sheer volume of data that we are now faced with, and even though the tools are becoming smarter and doing a lot more checking, now you've got inexperienced people coming in who are forced to make decisions on vast amounts of extremely sophisticated data. How can people 2 years out of college sit and look at an NMR log or a shear sonic waveform and say bad log? Bad data? It's virtually impossible, and we're exponentially increasing the amount of data that's coming in that people have to sift through.

Data integration and management

Theys: Critical enablers for the future of petrophysics are robust data management, data integration and managing uncertainties.

Ding: Data integration improves accuracy and reduces uncertainties of subsurface

interpretation. Data management serves as a foundation for data integration. In terms of building a data management infrastructure, I think as petrophysicists we have a natural role to serve as a focal point since we acquire the majority of the data and we deal with different disciplines throughout the life cycle of exploration, appraisal, development and production surveillance.

Beck: It's becoming more important now, particularly in the arenas that we're exploring. We have so few penetrations and we stake so much on a single well that the data is all-important. We're making multimillion-dollar decisions on infrastructures and everything else, so it's forcing us to go back and look at everything because we have to be sure of that data that we're collecting.

Bilodeau: I think the service companies just invent a new tool and say this is the right answer and everything else was wrong.

Truman: That is a good point. I think really what happens is when a service company comes up with a major breakthrough, we would like to say that this is where we want to be. It's a good improvement, yes, but it also has limitations and issues, and until you learn how to use it, you don't know what those are. Then you find out what the next barrier is.

Maybe we should be asking why our clients, oil companies, buy and use wireline or logging data. They only buy it to identify, quantify and manage their risk – reduce uncertainty. For the most part, if the information that the service companies are selling doesn't do that, then the oil companies are not going to buy it.

Well planning

Theys: What you would like to do is update the seismic while you are drilling. From the updated seismic section you would improve the geosteering model. The updated earth model goes back to the driller, and he can find a new target. I don't think that approach is far away. It just requires a lot of coordination and connectivity.

Mack: That was a monumental problem a few years ago, but more and more you are seeing a geophysicist, well planner and drilling engineer collaborating on a 3-D workstation. This has expedited the process of planning a well and has changed the traditional workflow between drilling and geology for the better. You are also seeing more geophysicists actively participate in the day-to-day drilling operation, integrating real-time LWD data and changing targets and casing points based on an evolving seismic interpretation.

Beck: What we need is a unified interpretation system where all of us can work on the same set of data. That's an objective of ours, and we're putting pressure on some of the vendors. We need integrated development where we can all sit and work on the same data such that as that data comes up we can integrate it fully into our 3-D seismic, start to look at rock properties, start to look at pore pressure and begin to really update our predictions as we're drilling and change our plan on the go. We'll only be able to do that if we all start working on the same data.

Seiler: Of course, a barrier to the development of that environment is that most of the existing legacy application and project database systems do not make that an easy process, and the cost justification of the replacement or modification of those systems is often challenging.

Theys: There is a matter of culture as well. The geologist loves core data, the geophysicist loves seismic data, the petrophysicist loves logging data, but because we don't attach uncertainties to datasets, we have a hard time reconciling data from different sources.

Bilodeau: Our tack has been to put all the data in one place, and the place it's turning out to be is the earth model. Unfortunately it's probably sampled too coarsely to really benefit us right now, but the trend is that eventually that earth model's going to be sampled about the same rate as the logging data.

LWD

Theys: I think the issue with LWD is not the measurement; it's that we don't fully understand what's going on down there during drilling – for instance, how the hole is shaping up. In a wireline environment we have a fair understanding of what's going on.

Bilodeau: And unfortunately there may be a lot of things happening that are affecting your measurements.

Theys: Absolutely. And the model and the understanding of what's happening is very useful in optimizing the LWD measurement. In wireline, we know that there's invasion, so we correct for invasion. While drilling there is also invasion, but it's different, so how do we correct for that?

Bilodeau: Actually the question that was posed to us is are we going to replace wireline? I've talked to a number of petrophysicists in my company, and the definitive answer I got was, "Well, it depends." I think to address that question there are cases where it's appropriate for LWD to replace wireline data, but in the cases where it's not appropriate, it's because of all the issues that you're talking about. Your measurements aren't reliable enough because of these unknowns.

Bruce Bilodeau

Theys: I would say the measurements are reliable, but as the model of what's going on during drilling is not very well defined, the measurements cannot be converted directly to a reservoir characterization.

Truman: But the reason the model isn't well defined is because, as always, we're dealing with an underdetermined system. You've got more variables than you do independent measurements, or you've got things going on that you can't quantify.

Seiler: I'm going to be a little radical here and say that I think that in the future, we will actually take better measurements with LWD than with wireline techniques. Better downhole depth determination, coupled with the inherently longer sampling time of LWD over wireline, will contribute to superior measurements. Recent improvements of next-generation rotary steerable drilling systems will continue to greatly improve the quality of boreholes in terms of tortuosity, dog-leg severity and rugosity, and reduced vibration, which all contribute to improved petrophysical measurements.

Ostermeier: I completely agree with you. There's also another issue, and that's the economics. My people in New Orleans would just love to log with LWD if they had all the capabilities and there were some other issues addressed like the quality of the density log and the quality of the neutron log and so on. There's still some concern about those kinds of things.

But when you look at rig rates, you can see immediately that there is a real economic push to get away from wireline logging because it might take a couple of weeks.

The future

Theys: What do we think petrophysics will look like in 25 years, the centennial of the first logging job in 1927? For one thing, I think the logging tools will not fail. So what would be the remaining issues?

Bilodeau: I like the fact that the data that I'm getting is pretty well processed by the time it gets to me, and it's more reliable. But on the other hand, the classic petrophysicist in me is saying the data that I get is impossible to quality control. I can't tell when the data's bad. So you say the tools will never fail, but I want to know if they work in the first place.

Truman: This is going to require much greater objectivity by the service companies than exists now. When they get the data in for processing, they can see if there's a problem and note it. That's going to take a big change. And then I think that the oil companies are going to have to have the software in-house so that when they encounter issues they can look at the data themselves. I think a lot of it is going to revolve around improvement in the relationship, the partnership, between the service company and oil company. We need to start treating clients better and more honestly, and the clients need to treat the service companies a little more professionally. E&P