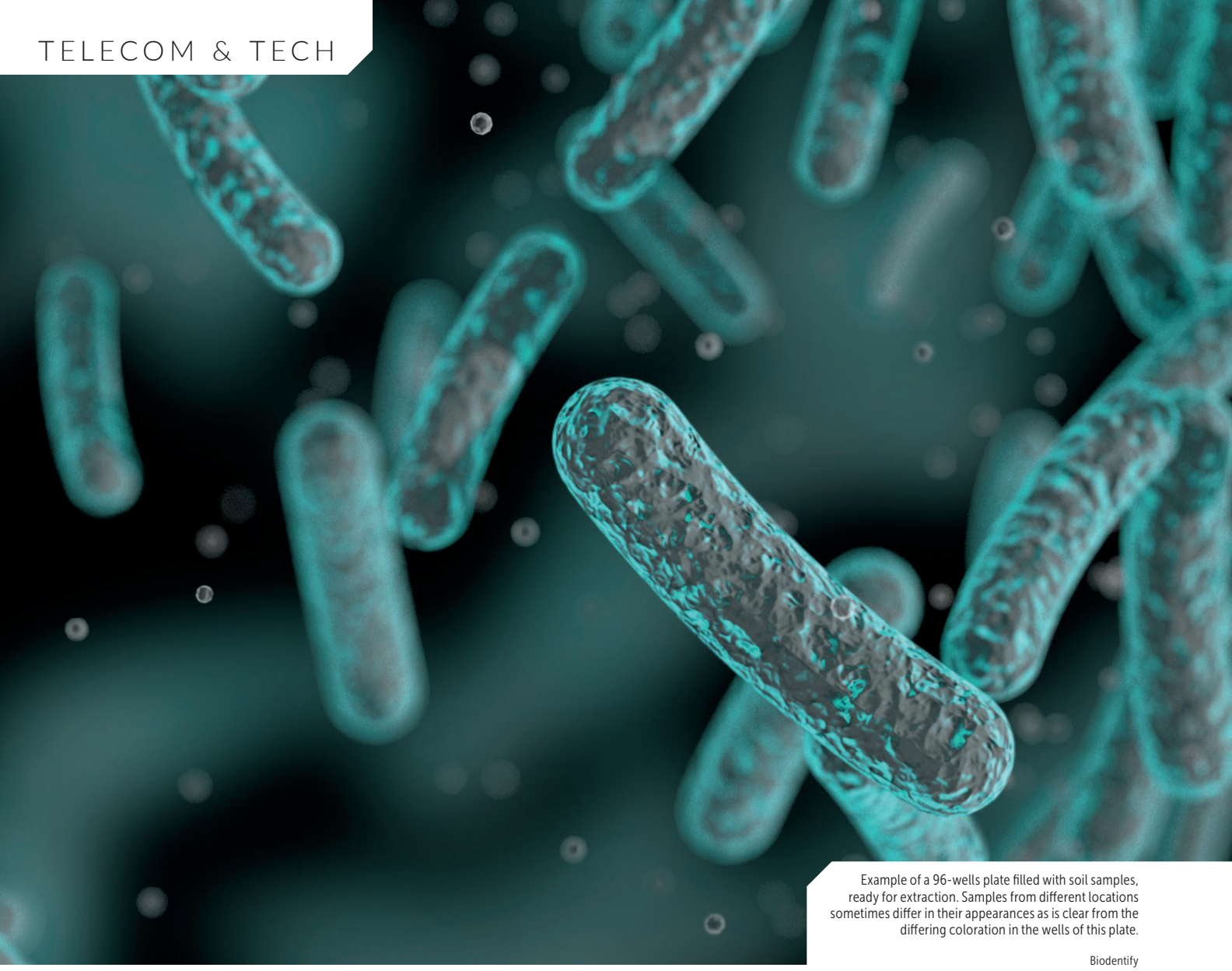

Example of a 96-wells plate filled with soil samples, ready for extraction. Samples from different locations sometimes differ in their appearances as is clear from the differing coloration in the wells of this plate.

Biodentify

New Tech, New Oil

Maximizing legacy fields and identifying new plays

By Isaac Stone Simonelli

Technology developed over the last few years—and which continues to be developed today—is helping oil and gas exploration companies discover and access a wealth of new resources.

This technology ranges from ConocoPhillips Alaska's steerable drilling liner and BP's proprietary digital rocks technology program to Netherland-based Biodentify's patented technology developed to analyze surface soil or seabed samples, recognizing otherwise undetectable hydrocarbon microseepage from prospective areas.

Biodentify

Biodentify combines modern technology developments in its patented workflow to take advantage of microseeps: small amounts of gas that leak from a reservoir and make their way to the surface.

"[Microseeps are] too small to measure with any direct detection device. Biodentify has put a new spin on this, which has been made possible due to recent innovations and breakthroughs in DNA sequencing and machine learning," Biodentify Director of Technology and Operations Chris Te Stroet says. "The overall workflow is protected with a patent. The lab work to extract bacterial DNA and the exact algorithm to identify the biomarkers are trade secrets. The database that contains the biomarker samples used for training and identifying

the potential reservoirs is a collection of information for Biodentify use only."

Biodentify's carefully-guarded workflow was not possible ten or fifteen years ago, says Stroet. The company's approach is effective because the sensors used are incredibly sensitive, albeit indirect, as they collect data from the microbial ecosystem in the shallow soil.

More than 340,000 different species of microbes can be found in soil, of which a small number (50 to 200) react to these microseeps of gas. Some microbes—that oxidize the gas—flourish while others find it toxic and die.

"We take incredibly detailed 'fingerprints' of the soil—DNA analysis of the microbial ecosystem—and compare this with a large database of samples with known productivity," Stroet says. "Our machine learning algorithms, run on a very large supercomputer, find the small but critical differences in these microbes that tell us whether the new samples have seen 'microseep' or not, thus if they are above a reservoir or a dry area."

Traditional geochemistry techniques that make use of microseep as an indicator for potential prospects typically search for and count the cultivated species of known microbes that oxidize hydrocarbons, providing ten to fifteen biomarkers, a much smaller number than can be deduced from the complete DNA fingerprint. Other companies use a material that, when left at a shallow subsurface for weeks, "collects" gas molecules, a direct indication for microseep.

There are other innovative companies that use similar DNA-analysis technology, but they focus on post-drilling, analyzing cuttings to maximize reservoir performance, Stroet explains.

"We focus much earlier in the process, on exploration or pre-drilling, taking only shallow surface soil samples to minimize the risk of drilling unsuccessful wells or to rank existing prospects from highest chance of success to lowest chance of success. It's relatively straightforward and not too expensive versus drilling a well or shooting seismic data," Stroet says.

The accuracy of the tests depends on the geological setting and the complexity of the subsurface. Studies and pilot projects of the workflow generated initial predictions of greater than 70 percent accuracy.

"If local data is added into this process, the robustness of the predictions

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"Acquiring seismic and drilling is still required, but with Biodentify being added to the workflow, you can be more focused on the prospective areas of where a reservoir is, avoiding areas where the reservoir is not."

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Biodentify

increases, as well as the accuracy," Stroet says. "It is especially effective to de-risk areas where you are expecting possible reservoirs or have a number of prospects in the subsurface and you want to de-risk or rank these various prospects against another, or you want to understand which part of the area most likely has hydrocarbons—or a charged reservoir—in the subsurface."

Biodentify provides its services at a number of stages in the exploration and development of reservoirs, both onshore (shale and conventional) and offshore, Stroet says.

"First in exploration, Biodentify can be used as a precursor to acquiring seismic or drilling any exploration or appraisal wells. The methodology can determine if there is a charged reservoir in place, or, when prospects are already identified, possibly based on seismic data or other, we can help rank these prospects from most likely to succeed to least likely to contain hydrocarbons. In case of a shale play, near-field exploration play, we can point out where the 'hot' areas are versus the less economic areas," Stroet says. "In the extraction stage, once a reservoir has been partially depleted, our workflow can determine if there are any bypassed reserves that remain and could potentially be produced."

Despite its utility, this technology isn't a replacement of previously existing technology but more of a new method available to exploration companies to decrease the risk of drilling marginal or dry wells.

"Acquiring seismic and drilling is still required, but with Biodentify being added to the workflow, you can be more focused on the prospective areas of where a reservoir is, avoiding areas where the reservoir is not," Stroet says.

Biodentify identifies the areal footprint of the reservoir but cannot determine the zone or depth of the hydrocarbons. This means seismic data and drilling an exploratory well are still required to determine the formation and depth of the reservoir.

The company currently has no pilot projects in Alaska, though Stroet sees plenty of potential.

"Alaska contains many environmentally sensitive areas with respect to nature and wildlife, and we all need to keep these areas as pristine as possible. Biodentify can be used to focus activities in only the areas that contain those reservoirs and minimize the use for seismic and drilling, which could be harmful and destructive to the environment and the ecosystem," Stroet says. "A second benefit is that this focused activity can reduce the risks and the capital costs of doing those activities, which allows companies to be more profitable and have additional funds to expand to additional prospects."

As usual, there are additional challenges to operating in much of Alaska, as organisms from which DNA is collected flourish in warmer soil conditions. Nonetheless, they are present in frozen soil, Stroet confirms.

"The fingerprint varies over the seasons because of the influence of temperature, moisture, and pH. The algorithms are using machine learning to look for small differences in the DNA fingerprints related to microseepage and they neglect the influences of the climate," Stroet says. "Yes, this technique can be feasible in Alaska,

but local sample collection will need to be done and added to the database to have a good robust training set for the projects to be worked in this region."

Digital Rocks Tech

Key upgrades to BP's proprietary digital rocks technology program in 2017 were another tech step forward in oil and gas exploration.

After signing a commercial agreement with Exa Corporation, BP's ability to predict the flow of oil and water in digital images of reservoir rock was enhanced.

"This new capability—known as multiphase flow simulation technology—will help engineering teams to make more informed decisions on wells, production facilities, and resource progression, including enhanced oil recovery," a BP release states.

Exa Corporation's multiphase fluids simulation solution for digital rocks was co-developed with BP during a three-year technology collaboration agreement.

"After years of cooperative research and development, this breakthrough represents an important step forward for BP and for our industry," says Ahmed Hashmi, BP's head of upstream technology. "It underscores BP's continued leadership in digital technologies and their increasingly important role in helping us to develop energy resources safely, effectively, and economically."

According to the release, the technology uses rock core samples acquired from exploration, appraisal, and development wells that are imaged with ultra-high resolution CT scans to create a 3D digital model of the rock.

These digital images are then put through proprietary algorithms that simulate the physics necessary to characterize rock properties. The algorithms are run at BP's Center for High Performance Computing in Houston, which is one of the largest supercomputers in the world dedicated to commercial research.

Steerable Drilling Liner

During the exploration drilling phase for Greater Mooses Tooth 1 (GMT1), it became apparent that ConocoPhillips Alaska would need to implement new technology to face challenges yet to be encountered on the North Slope. The development of GMT1, which has opened the door for tapping oil reserves at Greater Mooses Tooth 2, hinged on the development and implementation of new steerable drilling liner technology.

The steerable drilling liner technology was needed because the geological bedding, rather than laying relatively flat, was jumbled, making it unstable.

"When they started drilling two exploration wells, both had problems, but one had severe problems," Manager of Drilling and Wells Shon Robinson explained earlier this year. While drilling, the company intersected a portion of earth that had rotated roughly 90 degrees, which drastically changed the stress and pressure in the well.

Generally when drilling a well, the drill is pulled out before inserting a metal well lining, which is then cemented in place; however, with these geological conditions, that process created a window of time in which the well collapsed before the metal lining could provide stabilization.

The steerable drilling liner developed with Baker Hughes—a full-stream provider of integrated oilfield products, services, and digital solutions—allowed ConocoPhillips Alaska to drill and run the casing down at the same time. Once at the target depth, workers are able to

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—Joe Marushack
President
ConocoPhillips Alaska

release the drilling gear and pull it back out, while leaving the casing in place.

Horizontal Drilling and Production

New technology for oil extraction has serious impacts on oil exploration, as it can make projects that were once financially unfeasible attractive propositions.

Interest in the Nanushuk formation—long known as a source of oil—has increased with advancements in horizontal drilling, which allows for the extraction of oil from deposits miles from the drill rig.

In 2016, a drill's reach extended 55 square miles from a 12-acre gravel pad on the North Slope.

"Now we're moving toward an extended reach drilling rig where we think we can drill from one location up to 154 square

miles," ConocoPhillips Alaska President Joe Marushack said during a presentation.

The advancements are expected to be rolled out in 2020 on Fiord West.

Part of the reason that the company can expand its reach is because of geo-steering technology that allows it to stay within the required zone—zones as small as five feet, according to the presentation by Marushack for the Resource Development Council.

Improving the Oilfield

Technological advancements in oil and gas exploration have varying impacts on the Last Frontier. Some of the most innovative technology such as that being rolled out by Biodentify has yet to be tested in Alaska, but could prove to be a game changer, especially as oilfield operators work to ensure legacy fields and resources are approached as effectively and efficiently as possible while exploring the potential of new sites. But modern technology and methods, such as the steerable drilling liner being used by ConocoPhillips Alaska, is already having a huge impact on the company's ability to access resources.

And ConocoPhillips Alaska is looking for innovation in other areas as well: "We are continually innovating and improving our core exploration and production business by developing and applying state-of-the-art seismic data acquisition and processing techniques, such as life-of-field, time-lapse seismic data collection, which monitors long-term performance and development of subsea producing reservoirs. We are also able to create better reservoir images beneath salt and other sound-blocking materials, using detailed geological architecture and hydrocarbon quality analyses. The development and application of these geologically integrated seismic-imaging technologies produce higher-quality images that help reduce exploration risk and maximize resource recovery."

As Marushack explained during his presentation, "Technology is really a game changer for us and allowing us to compete with the Lower 48, where their transportation costs are a lot less than ours and where access to land, access to roads is a lot easier than ours. And where, historically, there has been a lot more stable tax environment."