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Mapping the Red Sea

Through its Geophysical Data Acquisition Division, Saudi Aramco has undertaken an unprecedented geological task on the Kingdom's West Coast by taking on the challenge of mapping the seabed of the Red Sea. The globally unrivalled 3-D seismic data operation has already become a success story, thanks to an inspired vision and the utilization of some unique modern technology.

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New compact hydraulic tractor helps stimulate wells

The Production Technology team with Saudi Aramco's EXPEC ARC has successfully completed the development of the world's slimmest, and most compact hydraulic tractor.

This new generation of hydraulic tractor, which is rigless, was recently trial tested at Manifa with great success — marking a major breakthrough with global implications in small diameter extended reach wells.



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The Saudi Arabian Oil Company, also known as Saudi Aramco, was established by Royal Decree in November 1988 to succeed the original U.S. concessionary company, Aramco. The Aramco concession dates back to 1933.

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Technicians play pivotal role in EXPEC ARC success

Empowering employees with development and mentorship opportunities has always been a mainstay at Saudi Aramco, and the EXPEC ARC Technician Development Program is a prime example of that commitment paying dividends. With full support and guidance from leadership, EXPEC ARC technicians have delivered a number of initiatives that have provided no shortage of solutions for the company and its many facets of daily operations.



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Taking the sting out of beekeeping

An initiative undertaken by Saudi Aramco, in partnership with the Beekeepers Cooperative Association in the Baljurashi Governorate of Saudi Arabia, is equipping local residents in the area with the skills, training, and equipment necessary to successfully operate their own apiaries and augment their income levels.

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About the cover:
The Artemis, a deep-water node deployment vessel, moves through the Red Sea unleashing scores of nodes connected to a reinforced steel rope on to the seabed. The cutting-edge Marine Autonomous Seismic System with a 20-ton breaking strength is capable of operating in both shallow and deep water.

أرامكو السعودية
saudi aramco

MAPPING



WRITTEN BY
JAMSHEED M. DIN

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THE RED SEA





Saudi Aramco undertakes an unprecedented geological task on the Kingdom's West Coast as we look to first understand, and then uncover, the treasures buried beneath the waters of the Red Sea

On Saudi Arabia's West Coast is a waterway that dates back millennia, a channel of sea that formed after violent tectonic shifts in the Earth.

Below its surface are underwater canyons, valleys and pinnacles — scars of its dramatic beginnings. Swimming and dwelling among this fabulous topography are some of the sea world's most miraculous marine life.

But if you think the wonders of the Red Sea end there — think again.

It's in these historic waters that Saudi Aramco, through its Geophysical Data Acquisition Division (GDAD), is undertaking a breathtaking, globally unrivaled 3-D seismic data operation.

The ancient waters of the Red Sea are spurring an impending legacy that scientists and geophysicists believe will last for generations to come.

This is a story of unparalleled geological history, modern technology, and a vision.

But the first stage of turning that vision into reality is understanding the complex geology under the Red Sea. Only then can its treasures be explored and exploited.



MAPPING THE SEABED

The task of mapping the seabed was colossal. Almost a decade ago, Saudi Aramco made the decision to conduct the world's largest single hydrographic survey in the Saudi Red Sea waters — an area of almost 200,000 square kilometers (km^2).

Prior 2-D seismic data acquisition had revealed positive signs for the presence of hydrocarbons in geological traps. The 2-D mapping had only been conducted along straight lines of varying lengths between 20 km to 40 km, at 5 km apart. Just like the Eastern Province in the early 1940s, the Red Sea was frontier territory — unexplored. Its development would be a catalyst to spur growth and industry in the Western Region.

A large-scale hydrographic survey — never before done in these historic waters — was required to fully understand the seafloor conditions. The hydrographic survey with its close grid analysis would help support all oil field operations, including rig movements, laying of pipelines, oil field facilities,

At the rear of an air gun vessel, engineers inspect an air gun. Inspections are crucial to ensure consistency in the quality of data.

and the routes for supply vessels, just to name a few. It was a must.

"We got a good understanding, but lacked the topography of the seabed," noted Saleh A. Al-Maghlyouth, manager of the Exploration Operations Department. "So we undertook this groundbreaking hydrographic survey to help us better understand the structures and where to drill."

THE CHALLENGES WERE MANY

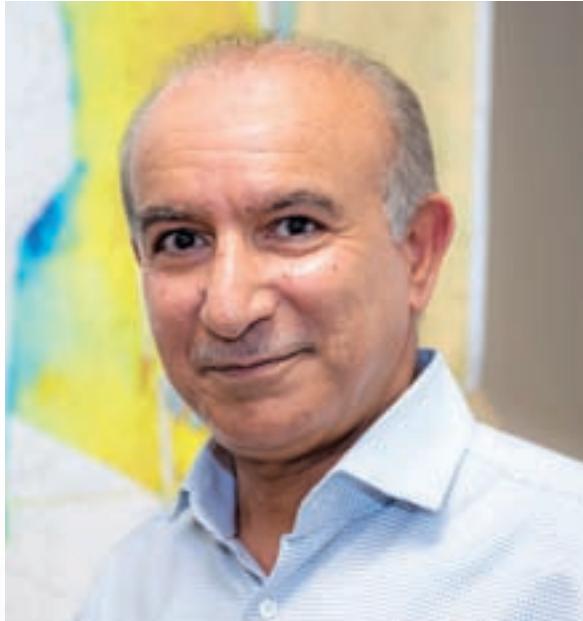
"The major concerns were the time constraints and vessel safety," observed Richard G. Moffitt, Exploration Survey Unit consultant. "These were hazardous, shallow areas previously uncharted. In fact, there were old navigation charts in existence, but from several decades ago and at low resolution — insufficient for present-day vessel navigation for exploration projects. Historically, there were many more shipwrecks in the Red Sea than there were navigation charts."

Conventional technology at the time utilized echo sounding as a means to map underwater topography, but this would have taken many years to complete. So instead, Saudi Aramco did what it always does: put at its disposal the latest technology available to get the job done.

What followed were 848 days of survey operations using

NODE-ON-A-ROPE TECHNOLOGY

Can operate up to a depth of 3,000 m.



Saleh A. Al-Maghlooth



Azizur R. Khan examines the node's robotic system on the Artemis node deployment vessel.

a combination of hydrographic vessels and aircraft. Five specially equipped ships would spend a combined total of 2,823 vessel days using a multi-beam echo sounder to collect data for water depths between 5 meters (m) and 2,400 m. This technology was supported by three aircraft using Airborne LiDAR Bathymetry systems for water depths between 0 m and 40 m, with a combined total of 1,260 survey flights completed.

"This technology promised to speed up our work by a factor of between 10 and 20 times faster than vessel operations alone. What was simply not possible prior to the advent of this technology became possible, and we were entrusted to make it happen," noted Moffitt.

The results were a new high resolution merged bathymetry grid allowing the mapping of complex geological features, including volcanoes on the seabed.

The data was encouraging for Saudi Aramco. The company was now able to move offshore rigs around and initial exploration could begin. But technology never stands still. Another breakthrough was around the corner.

Previous 2-D seismic data had been compromised in certain sections due to the unpredictable seabed topography of the Red Sea. Diffractions, trapped waves in the underwater valleys, and the poor signal-to-noise ratio at geological targets beneath the salt formations seemed unsurpassable.

If plausible, a 3-D seismic survey would deliver more definitive and detailed data, and combined with the hydrographic survey, it would yield immensely useful information for geologists and geophysicists to map geological structures and deliver a high degree of certainty.

3-D seismic operations use acoustic waves generated by marine air guns to collect data. This allows for a more detailed seismic image of geological horizons, leading to more accurate drilling of potential wells. At the time, 3-D seismic surveys had proven prohibitively expensive and almost

impossible to conduct in the Red Sea, but Saudi Aramco's willingness to think outside the box was to soon deliver unexpected results. Where there's a will, there's a way.

TECHNOLOGICAL BREAKTHROUGH

Just how do you image in a 3-D sense a geology as complicated as that found in the Red Sea? It was a puzzling question for geologists. Within a short distance, depths can vary from a just a few meters to a few hundred meters. In addition, the area is salt dominated, with shallow carbonate on the seabed, and deep targets below salt layers of variable thickness — making any seismic operation challenging and leaving behind degrading effects on the results.

Offshore seismic solutions existed in the industry, but none seemed capable of dealing with the unique features and complexity of the Red Sea. Some new technologies were being touted as possible solutions, but they were untested. Saudi Aramco needed to take a chance. 3-D seismic would offer crucial data that would be invaluable for exploration.

"The hydrographic survey and acquiring the bathymetry were crucial in the seismic survey concept," noted Turki M. Al-Ghamdi, chief geophysicist at GDAD. "This helped us identify the best location and we could move forward at speed. So we had everything in place — we just needed the right solution and technology."

The decision was made to pilot four potential technologies

NODE-ON-A-ROPE TECHNOLOGY

Can stay on the seabed for 65 days collecting data without the need to change batteries.



Chief geophysicist Turki M. Al-Ghamdi (standing) is joined by GDAD group leaders Mohammad Al-Malki, Lahiq Al-Shammery, and Saeed Al-Ghamdi, as they discuss aspects of the hydrographic survey conducted in the Red Sea. The survey was carried out in Saudi waters of the Red Sea covering an area close to 200,000 km².

that could change the face of global seismic operations.

"We required a novel approach — something never used before," said Azizur R. Khan, geophysical consultant with GDAD.

"We found four potential technologies, but we would have to test them. They had never been tried in an arena like the Red Sea, so we did our research and with management support we put them to the test."

After rigorous testing and analysis lasting almost a year, all the technologies delivered promised results — but one stood out for its efficiency and data quality: the Marine Autonomous Seismic System (MASS). The technology was cutting-edge and the data from the pilot tests convinced GDAD, and the green light was given. A solution had been found.

Utilizing a node-on-a-rope based system, MASS uses reinforced armored rope with a 20-ton breaking strength to place nodes on the seabed. In addition, its robotized mechanism



Young GDAD geophysicist Rashed M. Al Ghenaim inspects a marine air gun.

for deployment and retrieval would add efficiency to the operation.

The MASS nodes can operate in both shallow and deep waters ranging from 1 m up to 3,000 m, utilizing one hydrophone and three omnidirectional geophones to optimize the data capturing range. Incredibly, the nodes are able to stay on the seabed for up to 65 days thanks to advanced battery life technology. In addition, high-fidelity seismic signals provide excellent imaging beneath salt formations. The nodes are also one of the lightest in the industry, weighing only 7 kilograms each.

The company's calculated risk had paid off.

"We took it upon ourselves to test out-of-the-box technologies in pilot areas," noted Al-Maghrouth. "Because we

NODE-ON-A-ROPE TECHNOLOGY

In Saudi Red Sea waters,
3,000 nodes are on the seabed.



took the risk of trying new technologies, we actually drove the industry to develop such technologies.”

So successful was the technology that it eventually cut costs of the acquisition by 40%. Efficiency and technology go hand-in-hand.

All was in place. 3-D seismic operations were now viable in the Red Sea. For Saudi Aramco, it was all systems go.

IN FULL SWING

The day starts early for Tariq H. Driwish. At 5 a.m., the geophysicist heads to his office; it takes him less than 30 seconds to get there. That's because for Driwish, his office and home are almost one and the same, separated only by a room. He is crew supervisor for 3-D Seismic Survey Crew S-78.

Based out of Duba, the crew is tasked with carrying out seismic surveys in the nearby Red Sea. This is base camp for the operation, and with 346 staff, Driwish is responsible for ensuring all runs smoothly.

“We ensure that the crew and the operation, including safety, data quality, and productivity are all to Saudi Aramco standards,” said Driwish.

Duba, on the West Coast, is a long way from home for the

Taking care of the environment

The Red Sea is home to some of the planet's most incredible marine life. It has been described by English veteran broadcaster and naturalist, Sir David Attenborough, as being both “beautiful” and “flamboyant,” and judging by its inhabitants, it’s little wonder why.

Its majestic soft colored coral reefs float just beneath the surface in shallow waters. But their purpose goes beyond just aesthetic pleasure — they are vital components of a thriving local ecosystem. Deeper down, 10% of the Red Sea's recorded 1,000 species are of fish found nowhere else on the planet. Due to its unique geological DNA, the Red Sea has been described as an “ocean-in-the-making” by scientists, which is why many believe that ongoing research in its waters will help find answers to burning questions regarding the world's oceans.

It was Saudi Aramco's Environmental Protection Department that helped establish the Saudi Aramco-KAUST Center for Marine Environmental Observations at King Abdullah University for Science and Technology in Thuwal — a testament to Saudi Aramco's environmental protection policy.



Hussain N. Al Ghanim examines one of the marine nodes before deployment.



Tariq H. Driwish

Dammam native. With a degree in Systems Engineering from King Fahd University of Petroleum and Minerals, Driwish is under no illusions as to the importance of his role.

“Being in a remote area and having the responsibility for the crew’s welfare, safety, and performance is a very rewarding experience,” he commented. “There is a lot of ambition and hope in this area — it’s a new frontier. We have Jazan as an example of how an area can be developed, including the local population,” added Driwish, acutely aware of the development that is taking place in the region.

His day is often split between offshore and base camp duties. After receiving his morning report on the previous day’s operations, Driwish checks the health, safety, and environment status before heading to the Quality Control office. It’s here that the young geophysicist gets to review the data from the previous day’s seismic operation. Each week, geophysicists in Dhahran receive a staggering 14 terabytes of data to decipher. Driwish has to ensure that only the highest quality of information is transmitted to Dhahran for analysis.

From his office, Driwish makes the 80-minute trip to the offshore operations — it’s on the high seas where the real action takes place. Getting offshore requires the use of varying vessels — from a motorized zodiac dinghy in shallow waters to a fully-fledged transporter vessel in deeper waters.

“It’s important to visit the different crews,” said Driwish. “I am tasked to make sure everything is going according to plan as per our rigorous standards. There’s never any compromise.”

ALL ABOARD

Rashed M. Al Ghenaim stands at the rear of the *Artemis*, gazing out to the Red Sea waters that stretch before him.

The *Artemis*, a deep-water node deployment vessel, moves effortlessly through the Red Sea as it unleashes scores of nodes connected to a reinforced steel rope deep into the seas it traverses. This is the MASS in action.

Al Ghenaim, a 28-year-old geophysicist with GDAD, is surrounded by a dazzling array of technology that is collecting invaluable data from the seabed below. It’s this information that is reviewed by Driwish at the base camp.

A geophysical engineering graduate from the Colorado School of Mines, Al Ghenaim’s role is to act as a focal point between the survey team and operations, spending time both in Dhahran and in the field.

“Offshore operations have a lot of challenges, but the technology we have at our disposal is truly incredible,” said Al Ghenaim. “It’s amazing when you see it in action, everything is so precise and fine. It’s the Saudi Aramco way.

“In Dhahran, I work on projects involved in the survey designs, so it’s great to get to the field and see the actual operation and where the data is being generated,” he added.

“Both in the field and in the office, there are senior geophysicists that are always ready to offer advice and help. I don’t miss those opportunities.”

The opportunity to witness operations up close is invaluable for young geophysicists like Al Ghenaim.

Vessels of various sizes and purposes are dotted all around, and each has a specific role to play. The operation is carried out with military precision.

The *Artemis* robotically deploys and retrieves nodes that it lays in deep waters. Due to its size, three smaller vessels are used for node deployment in shallow waters with water depths of around 25 m, and 15 dinghy type zodiac boats for

NODE-ON-A-ROPE TECHNOLOGY

Each node can store 128 GB of data.



Firing every 10 seconds when in operation, the air gun shots, like those pictured here, reach an average of 5,000 shots per day. It is the acoustic waves generated by these shots that is picked up by the nodes on the sea floor, creating crucial seismic data.

restricted waters, which is in depths of 3 m or less.

Once the nodes are in their predetermined positions, they act as stand-alone recording systems, ready at an instant to pick up seismic signals emanating from geological layers as deep as 10 km inside the Earth, and as well as from acoustic energy traveling through the water.

The acoustic waves are generated by air gun source vessels. One large vessel is used for deep waters, one for shallow waters, and two for restricted waters.

On the seabed at various depths, are 3,000 nodes, each with the capacity to store 128 gigabytes of data. The nodes are always active.

In place, it's now down to the air gun vessels to do their business.

NODE-ON-A-ROPE TECHNOLOGY

Each node weighs 7 kg, making them among the lightest in the industry.

"Different geological layers have different densities and different velocities of seismic waves through them," observed Khan. "All the firing is done by GPS controlled devices. This means that all the data is corroborated with GPS time, and with each node having its own identification number and its own atomic clock, it all counts to give us incredible accuracy with our data."

When in operation, the air gun vessels fire every 10 seconds, reaching around 5,000 shots per day. The shots are essentially high-pressure air that is unleashed into the sea.

BRINGING IT TOGETHER

"We have a challenge making sense of all this data," observed GDAD's Hussain N. Al Ghanim. "But we work closely with the geologists and other partners across Exploration to interpret what we have — it's not easy, but we get there."

The company ensures the data is interpreted as accurately as possible.

"We are required to develop advanced algorithms, and to compute this we need a huge amount of computing capacity," said Al-Maghoul. "We work with our partners in the EXPEC Computer Center and EXPEC ARC to ensure this happens — it's a multifaceted effort."

"Everything about this operation amazes me, but what stands out the most are the nodes on the seabed floor," he continued.

"They are able to stay at such depths for more than a month at a time storing and collecting data. The speed is incredible and it's a true breakthrough in seismic. Combined with our computing technology, data that would have taken us years to acquire and process now takes only months — what a leap."

The 3-D seismic operation in the Red Sea is yielding unprecedented results.

"We have acquired two blocks for surveying, one is 800 km² and the other is 900 km²," said Al-Ghamdi. This is the largest area ever acquired with this technology and so far the data has been amazing — it's very promising."

The Kingdom and Saudi Aramco's vision are in full swing in this region, and 3-D seismic is at the heart.

"What was developed in the Eastern Province can be done anywhere in the Kingdom as long as we have what it takes to make it happen," said Al-Maghoul.

If exploring for hydrocarbons was a jigsaw puzzle, Al-Ghanim has no doubt where 3-D seismic operations would be placed on the board.

"That's easy," he said without hesitation. "It would be right smack in the middle." ☀



NEW COMPACT HYDRA HELPS STIMULATE WELLS



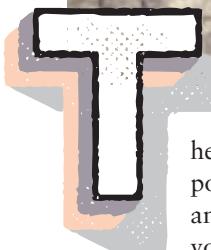
Successful yard and pull tests were conducted before field testing the tractor in October 2016, with the support of Northern Area Production Engineering and Well Services, and the Northern Area Reservoir Management departments.

HYDRAULIC TRACTOR

Saudi Aramco's Exploration and Petroleum Engineering Center – Advanced Research Center (EXPEC ARC) Production Technology Team has successfully completed the technology development of the world's slimmest, most compact hydraulic tractor, jointly developed with Western Well Tools (WWT).



Testing of the control unit for the Slim, Compact, High Pull Force Tractor was conducted before shipping the new technology out for a trial test in the Manifa field, which proved successful.



The new technology was trial tested with the support of Northern Area Production Engineering and Well Services, and the Northern Area Reservoir Management departments.

This new generation of slim, compact but strong tractors was recently trial tested with major success in Manifa field. This success represents a major breakthrough with global implications in small diameter extended reach wells. The technology is cost-effective, as it is rigless.

Extended reach wells in the Manifa field can go up to 24,000 feet in length. Available technologies to stimulate these wells cannot reach the full well depth as the coiled tubing (CT) units have a maximum reach depth before they lock up (buckle), and therefore, the pipe cannot be pushed farther.

Subsequently, there are tractors that can pull the CT unit and help reach deeper depths. What makes existing technologies unusable in Manifa is the well architecture, which has a limited access of about 2.3 inches. The reason is the presence

of what is called a Y tool, which has an electrical submersible pump in it.

Although there were several trials throughout the industry to develop similar slim hydraulic tractors, the pulling force of those developed tractors was insufficient to reliably pull the CT to total depth in the extended reach wells. With this small diameter, there was no tractor in the market that could pull the CT deep enough. EXPEC ARC took the challenge and developed this technology to address this business need.

CHALLENGE ACCEPTED

A collaborative research and development project was started by the EXPEC ARC Production Technology Team with WWT in 2013. Several concepts were tested to design and manufacture the world's slimmest, most compact, and most powerful tractor. Throughout the past couple of years, the project progressed through a series of development and operational milestones until the recently executed field trial.

The tractor is now the world's slimmest, most compact CT tractor (2.125 inch outer diameter, 20 feet in length), and it's a key enabler for intervention in horizontal extended reach open hole wells that have small inner diameters.

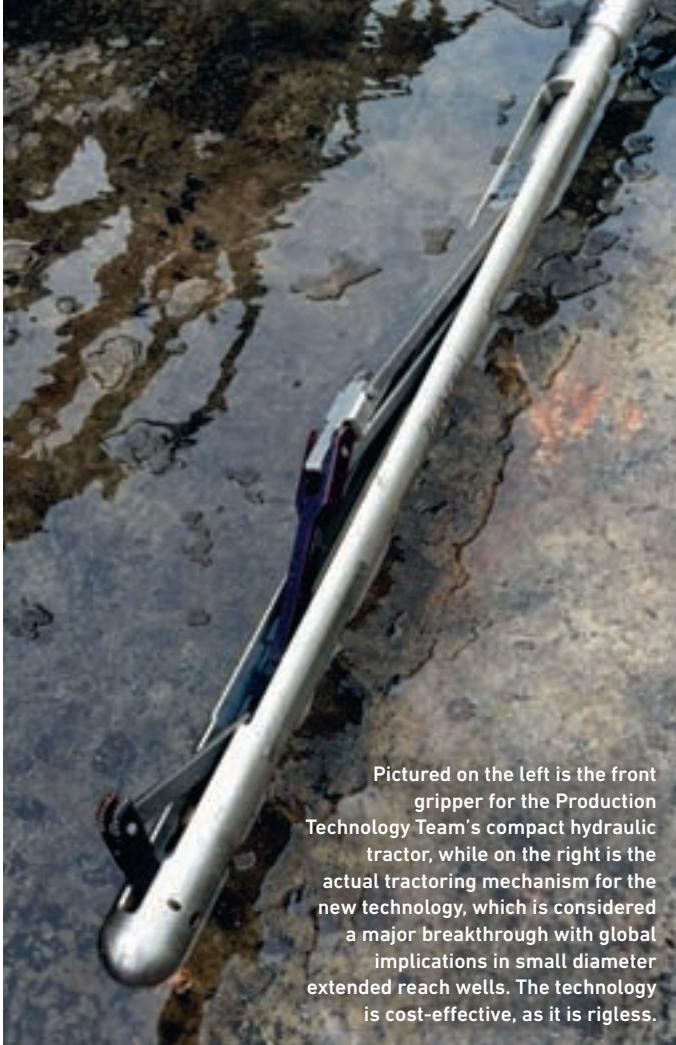
The new technology will help the engineers inject stimulation chemicals deep into the well. More stimulation means more oil production. The tool will also be modified to enable pulling logging tools deeper to areas that were otherwise inaccessible.

It should be noted that the tractor does not require electric power to operate. It is run by the hydraulic power generated by water that is injected through the CT. Water runs through uniquely designed subs creating the required mechanical energy to operate the tractor arms, which grips the rocks and pushes the tractor forward.

COST EFFICIENT, MAXIMIZING PRODUCTION

This new technology provides significant impact in supporting Upstream's goal of ensuring our operations' cost efficiency, as well as maximizing production from extended reach wells.

The Slim, Compact, High Pull Force Tractor allows reservoir engineers to have the ability to manage the reservoirs at the lateral level in terms of acidizing operations and ensure maximum pay zone coverage. It also provides production engineers with an enabler tool to more reliably conduct intervention operations, knowing with confidence that intervention will be



Pictured on the left is the front gripper for the Production Technology Team's compact hydraulic tractor, while on the right is the actual tractoring mechanism for the new technology, which is considered a major breakthrough with global implications in small diameter extended reach wells. The technology is cost-effective, as it is rigless.



possible in more complex, restricted extended reach wells.

"One major aspect of this new technology is how it was uniquely designed to go smoothly through the smallest restrictions, then expand downhole to much bigger diameters and provide reliable and safe powerful performance in cased and open holes. This was clearly reflected in the industry record pull force and tractoring results of the field trial," said Abubaker Saeed, the project leader and member of the EXPEC ARC Production Technology Team.

"Major endeavors, such as the Slim, Compact, High Pull Force Tractor, are representative of the collaborative research and development projects EXPEC ARC strives to achieve — not only to

The Production Technology Team from Saudi Aramco's EXPEC ARC performed testing of the hydraulic tractor — with the assistance of personnel from Western Well Tools, and Schlumberger — before the final field trial at Manifa.

address our Upstream challenges but also to strengthen our industrial position as a leader in technology development and deployment," said Ali A. Al-Meshari, manager of EXPEC ARC. ☉





Faisal M. Al-Sahman and Khalid M. Al-Marshad conduct viscosity measurements of used fracturing fluids for optimization.



Technicians play pivotal role in EXPEC ARC success

Photos by
Musleh J. Khathami

With an eye on empowering and engaging young employees, the Exploration and Petroleum Engineering Center - Advanced Research Center (EXPEC ARC) has launched several development programs over recent years targeting diverse niche groups (e.g., young researchers, women employees, etc.) with the goal of expanding their skill sets. The latest initiative incorporated into the department's umbrella talent program is tailored for EXPEC ARC technicians.

Technicians are a significant population of laboratory employees who play a pivotal role in the success of EXPEC ARC technology research and development, testing, and developing solutions in the laboratories. Half of EXPEC ARC's technology divisions rely on key skill sets of technicians to succeed in delivering technology solutions to Upstream proponents.

Mohammed L. Subhi



The latest initiative, incorporated into the department's umbrella talent program, is tailored for EXPEC ARC technicians.

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The EXPEC ARC Technician Development Program was created in collaboration with the Professional Development Department/Talent Assessment and Coaching to address technician development. It also includes improving management's soft skills to better engage and empower employees.

To launch the program, EXPEC ARC held the first town hall meeting in July with over 100 early career employees to acknowledge their contributions in EXPEC ARC's success, emphasize their role in achieving EXPEC ARC's vision, and seek their support in accomplishing even more. A lively question-and-answer session resulted in technicians asking questions, voicing concerns and suggesting improvements — especially in human development. The following showcases examples of the impact and how technicians contribute to Upstream's success.

Examples of success

Mohammed L. Subhi and Ahmad Al-Humaidi, with the Advanced Technical Services Division Drilling Fluids and Cement Unit, illustrate the high-impact role that technicians play. They took the initiative to conduct intensive research, innovative thinking, and comprehensive lab testing to develop the cement oil-based mud (OBM) spacer formulation.

"As technicians, we are empowered to take initiative. We observed the increasing proponents' demand for OBM and the high cost, and decided to investigate whether we could develop something better in-house to provide cost savings.

And with the freedom to innovate, we did," said Subhi.

The OBM spacer has achieved an outstanding record of over 250 field deployments, along with remarkable cost savings and field performance. It provides effective fluid separation during the cementing operation to prevent high fluid viscosity mixtures from forming, leading to a successful cement job.

"Localization and cost efficiency are two of the main drivers in our drilling operations. The locally sourced Saudi Aramco OBM spacer is a perfect example of how the innovative minds in EXPEC ARC are providing cost-effective solutions to our cementing operations," said Naheed I. Abdulrahman, manager of the Exploration and Oil Drilling Engineering Department.

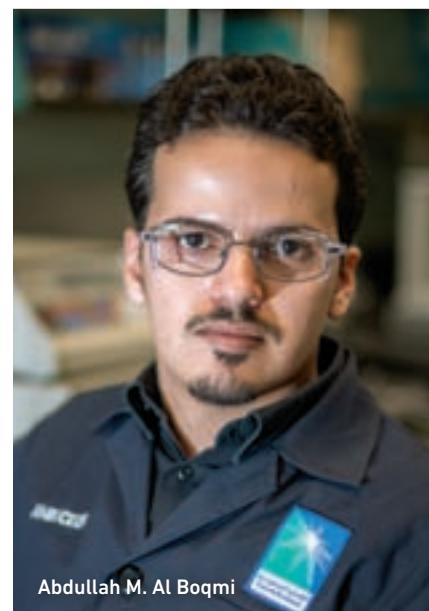
"Communications with our proponents are essential and a rewarding part of my job," noted Al-Humaidi. "Drilling and Workover were continuously asking us for a cement spacer for oil-based mud, so we designed the technology to support their specific technical challenges in Saudi Aramco fields."

As the newest addition to the Reservoir Engineering Technology Division In Situ Sensing (ISI) technicians, Hussain A. Shateeb has contributed to almost all ISI projects. He learned to handle several experimental procedures and spectroscopy techniques in a short time. Shateeb's lab contributions with the Advanced Tracers project earned him his first technical publication as coauthor and participation in two field deployment tests; his work on contrast agents for the magnetic nano-mappers project made him a co-inventor on a patent.

"Since joining EXPEC ARC, I have



Hussain A. Shateeb



Abdullah M. Al Boqmi

learned new instruments and techniques to improve data collection,” said Shateeb. “Working directly with engineers and senior researchers has allowed me to learn much about our nanotechnology projects. Such new skills have helped me develop as a person and as a technician.”

He is also heavily involved in nano-surfactant core-flooding testing to evaluate the new class of surfactants in enhancing oil recovery.

Abdullah M. Al Boqmi of the Reservoir Engineering Technology Division is a coauthor of four Society of Petroleum Engineers (SPE) conference papers and two SPE journal papers covering research in bio-based chemical enhanced oil recovery, gel-based conformance control, and SmartWater/polymer synergies. He is a co-inventor of two patent applications related to determining trace amounts of oil via spectroscopic absorption. Such work serves as a clear indication of Al Boqmi’s mastery of experimental techniques and strong contribution to the team.

“For me, the need to regularly think outside the box is most motivating. When we face a problem with the research or a lab experiment doesn’t go as expected, we need to apply our innovative creativity to discover a new way to solve it. It is truly a satisfying field of work,” commented Al Boqmi.

Abdul-Aziz Al-Ghamdi’s work in developing a new procedure to enhance the hydrogen sulfide testing procedure in the Formation Damage and Stimulation labs led to his abstract for Lab Tech 2017. Another paper for the SPE International Conference and Exhibition covers product evaluation, which correlates laboratory investigation to field trials. His lab work has

supported the deployment of many technologies, including seawater-based fracturing fluid and a new acid recipe that improves well productivity. “With citizenship being one of our top values, I take pride in delivering high-end technological inventions,” Al-Ghamdi said proudly. “It is a really rewarding experience to be part of the high-impact solutions that help our country’s economy. And to contribute to that cause is, on its own, a reason to wake up energized every single day.”

Al-Ghamdi was recognized for his overall high performance with the outstanding employee award in his division’s annual meeting.

Badr H. Zahrahi contributes to reservoir technology development and is an expert in assessing select surfactant and polymer (SP) potential impacts on production facilities and the efficiency of separation of produced fluids resulting from chemical flooding operations. He is a key technician in the evaluation and development of SP formulations and has completed the screening of over 35 formulations. “I have grown in my career due to two things: Finding out what training I need, and pursuing it. No one cares about my career as much as I do, and EXPEC ARC provides the support and tools that allow us to direct our careers and development to best match our interests,” said Zahrahi. He has also assessed the Beijing Research Center’s experiments for SP interaction effects prior to laboratory commissioning and coauthored several publications.

Mustafa R. Satrawi is one of the main developers in many reservoir technical areas and also takes a lead in safety initiatives. Since joining Saudi Aramco in 2015, he has contributed to the successful completion of projects from the laboratory to the field and developed high standards of laboratory safety.

“EXPEC ARC provides a challenging environment that requires technicians to continuously gain knowledge and hands-on training. The work drives me to become a confident, self-motivated technician who actively contributes to the rewarding success of new scientific research projects,” he said.

Satrawi created and manages the lab safety bulletin



Abdul-Aziz Al-Ghamdi



Badr H. Zahrahi



Mustafa R. Satrawi



Salman M. Al-Qathami



Ali M. Al-Safran



Turki T. Alsubaie

board and updates the monthly safety tip to raise the standard of daily lab activities, and he implements daily safety exercises within the Pore Scale Physics focus area.

Salman M. Al-Qathami provided technical support and field testing for the Pyrolytic Oil Productivity Index (POPI) technology, including troubleshooting electronic components and computer software. He trained colleagues and service companies in implementing POPI technology in the field for geosteering, the use of GC-ROX software and interpreting data. Al-Qathami coauthored four abstracts, provides expertise with the sulfur sequential extraction lab, and has improved methods to analyze elemental sulfur in the Wasit Gas Plant.

"I didn't imagine a career in lab work would take me to the field, but the POPI project has required extensive involvement on-site. Geochemistry research has grown tremendously, bringing many exciting challenges and opportunities for me to lead, challenge myself, and grow professionally," said Al-Qahtami.

He improved protocols for controlling black powder in sour gas fields, and protocols related to geosteering applications using GC-ROX software.

Ali M. Al-Safran is a co-inventor of over 10 drilling technology applications related to localization research. His reliable work in resin helps the team expeditiously achieve all required lab testing, and his skills in calculation, measuring, and deploying technologies are valued by proponents. Al-Safran has coauthored several papers related to drilling fluids and cementing, and he develops lab procedures and required testing to simulate field conditions for deployment. "Being a key contributor to drilling fluid technologies has instilled a great deal of confidence in me and made me eager to work on more cutting-edge technologies," he said. "I find tremendous satisfaction with the drilling products localization team, contributing to the country's vision 2030."

Al-Safran is the division rep in driving safety and is pursuing a college degree part-time as self-development.

Turki T. Alsubaie is a highly skilled technician who has contributed to the development of several drilling related

patented methods and products for the drilling fluids lab, including the date seed-based ARC Plug. He provides training to Professional Development Program (PDP) employees and new technicians. Given his solid knowledge of lab and work place safety, Alsubaie also instructs on safety rules for testing and evaluating products, and the safe operation of lab equipment.

"It is exciting that everything we develop in the lab impacts the company. My greatest challenge was testing the new gel-based loss circulation materials when no method was available in the industry. I suggested a novel technique that led to inventing new methods and several patents."

Ali A. Radhwani completed the technical lab evaluation of the ARC Plug and ARC Eco-lube and evaluates products with drilling technology. He makes valuable observations in the testing and evaluation of products, and his methods were acknowledged in several technical papers by the team.

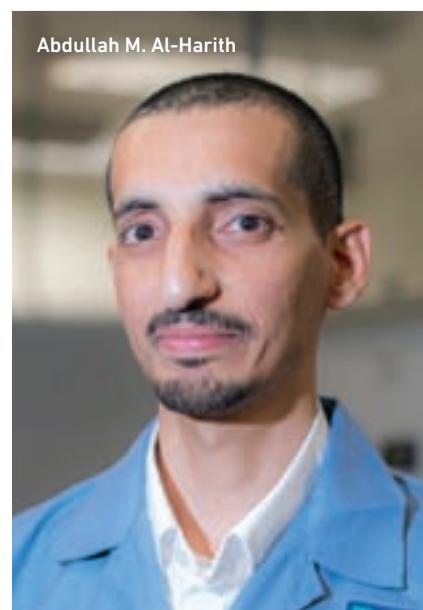
"Playing such an important role in the research of novel technologies is exciting. Our lab work in the ARC Plug project was critical; once proven, the technology was successfully field tested, resulting in a big success for us. I wouldn't have imagined we could provide such cost savings by using date seeds in the field," Radhwani said.

He prepares the team's laboratory procedures, contributes to maintaining a safe working environment, and provides practical training to PDPs and new technicians.

Abdullah M. Al-Harith achieved outstanding academic performance during his associate degree program and was so dedicated that he earned both an associate degree and bachelor's degree in science. He is the main



Ali A. Radhwani



Abdullah M. Al-Harith

“Working directly with engineers and senior researchers has allowed me to learn much about our nanotechnology projects. Such new skills have helped me develop as a person, and as a technician.”

— Hussain A. Shateeb

technician with the Production Technology Division, works on production enhancement, and has contributed to several publications related to production stimulation, productivity enhancement, and water treatment. Al-Harith coauthored and presented a conference paper at MEOS 2017 about water treatment challenges.

“With EXPEC ARC, I feel teamwork synergy when conducting experimental analysis. Working with multidisciplinary experts has helped me learn different aspects of the petroleum industry. Today, I’m able to come up with new ideas, write research studies, technical papers, and even initiate patentable studies.”

Esmael A. Albelharith supports productivity enhancement and smart fluids by conducting experiments and sharing knowledge. He demonstrates excellent housekeeping of chemical inventories, coordinates lab safety activities, and took initiative to develop procedures. Albelharith has trained summer students in operating lab equipment and prepared technical results for analysis. In under a year, he was

involved in three field trials, participating in collecting field samples and analyzing them in the lab. “EXPEC ARC is a highly stimulating and appealing working environment. The mixture of specialties and responsibilities causes the day to pass by without even realizing it! EXPEC ARC provides continuous opportunities for gaining experience and knowledge sharing through lab work and actual field trials.”

Khalid M. Al-Marshad and Faisal M. Al-Sahman of the Formation Damage and Stimulation Unit play a valuable role as lab technicians in conducting experiments that mimic fluid flow and interactions with rocks at reservoir conditions. They are also an outstanding team in conducting quality assurance and control for all injected fluids in over 1,200 fracturing stages in collaboration with Southern Area Oil Operations.

“Upon graduating, I thought maybe my career would be just mixing chemicals to produce another,” noted Al-Marshad. “However, EXPEC ARC’s state-of-the-art lab instruments and facilities encouraged me to develop my competencies and explore field challenges. My knowledge is enriched every day.”

“In the beginning of my career as a technician, I wasn’t sure what effect I would have on the company,” added Al-Sahman. “However, my organization has many ideas and methods that support the company, and I can contribute every day to deliver cost savings and a safer environment with chemicals.”

“Given the pivotal role of our technicians to the success of the technologies we deliver to Upstream and the power of innovation, the development of lab technicians’ skill sets and career is a major priority,” said Ali A. Al-Meshari, EXPEC ARC manager. ☀

Esmael A. Albelharith



Khalid M. Al-Marshad



Faisal M. Al-Sahman



Busy as a **BEE**

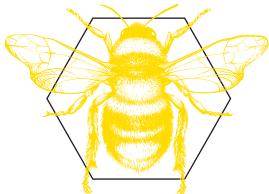
SAUDI ARAMCO INITIATIVE TO DEVELOP
HONEY INDUSTRY TAKES THE STING
OUT OF BEEKEEPING FOR LOW-INCOME
EARNERS IN THE BALJURASHI AREA

BY NAGY AWAD





Saudi Aramco's corporate social responsibility program to assist beekeepers in the southwest area of the Kingdom included the planting of 50,000 tree seedlings to help support a larger population of bees.



Saudi Aramco's initiative to train low-income earners in honey production begins its third consecutive year in the Baljurashi Governorate where the mountains embrace the clouds at an altitude of 2,450 meters above sea level.

This initiative has achieved great success, made a significant difference in the lives of many young people there, created many new jobs, and has contributed to the improvement and development of honey production.

Supporting people and communities

As part of its citizenship efforts, Saudi Aramco has implemented a number of initiatives that advance the concept of “learning for application” with a goal of providing members of the community with the necessary knowledge and skills to set up, manage and develop sustainable micro-industries.

Some of the micro-industry projects include training new beekeepers in modern beekeeping methods, helping young people find an additional source of income, contributing to the creation of jobs in new handicrafts, and spreading the profession of beekeeping in the community.

This initiative, undertaken in partnership with the Beekeepers Cooperative Association in the Al-Bahah and Al-Majdouli Group, includes six projects: Study and evaluation of the status of beekeeping in Al-Bahah, diversifying bee products, boosting the income of beekeepers, equipping the Beekeepers Cooperative Association in Al-Bahah and beekeepers to produce organic honey, establishing a training center for bee production, training young people in beekeeping and helping them start production, and finally, developing the main pastures of bees.

The center has, after its completion, trained more than



Young Saudis and others new to beekeeping receive thorough training from experts in the industry through a partnership between Saudi Aramco and the Beekeepers Cooperative Association.



The southwestern area of Saudi Arabia has a long tradition of honey production and Saudi Aramco's support is helping to raise the standards of the beekeeping industry while also increasing production.



1,000 low-income earners in beekeeping over the last two years, and they have already started their projects after having received training, the bees, and production requirements. The natural bee pastures have been prepared through the cultivation of some of the best sources of good honey such as Sidr trees, as 50,000 Sidr seedlings were planted.

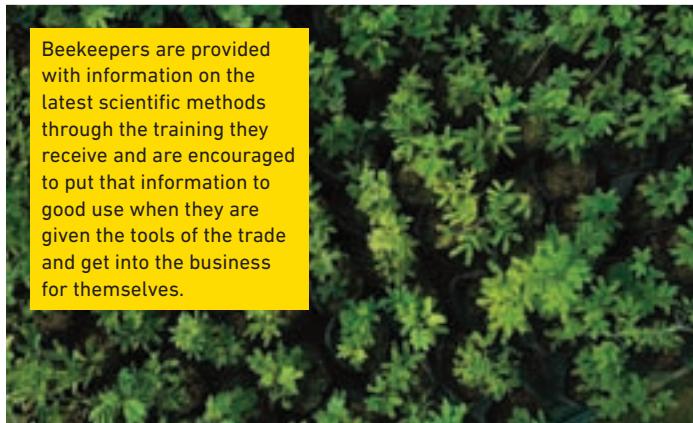
Partners Development

Saudi Aramco's role goes beyond project planning and implementation to involve the development of civil society partners as well. For example, part of the project involves collaboration with the Beekeepers Cooperative Association to help it achieve its goals in society.

Training courses are also available to all participants from

all over the Kingdom. However, small enterprises are only for trainees from all governorates of Al-Bahah, and transportation is provided for groups of more than 10 trainees from any governorate to the training center.

Trainees will receive an intensive applied training course, and a certificate authorized by both the Technical and Vocational Training Corporation, and the Chair of Engineer Abdullah Ahmad Baqshan for Bee Research at King Saud University. They will also receive a small apiary containing five hives with bees, hive inspection tools, and two course books that were designed to match trainees' different professional and knowledge levels. In addition, the association's technicians will provide supervision and free visits to the project, the association will undertake honey sorting, packag-



The planting of 50,000 Sidr trees, which are sturdy, deep-rooted, and grow to about eight meters in height, was just one aspect of the Saudi Aramco initiative to support beekeepers in Saudi Arabia. In addition to extensive training, the beekeepers receive support in the form of periodic visits from experts in the industry who are available to offer advice and answer questions.



ing and marketing at nominal rates, or purchase the whole production if the project owner so wishes. The association will also help the beekeepers participate in the annual honey festival in Al-Bahah.

Latest Beekeeping Methods

Speaking the role and objectives of the Beekeepers Cooperative Association, Dr. Ahmed Al-Khzem, the association's chairman of the board, said: "One of the most important objectives of the Beekeepers Cooperative Association in Al-Bahah is to attract new young people and train them in the latest beekeeping methods, instead of the traditional methods used by most beekeepers these days, leading to low honey production and quality. With Saudi Aramco as its supporter and partner, the association is executing this project which provides young people with free training and small businesses once they have

successfully completed the intensive training course."

"Over the past two years, the project has had a significant impact on the lives of young people in the region by enabling them to start their own projects on a sound scientific basis and with the full support of the association and the institute," said Mohammed Al-Shadawi, director general of the association.

Young people are provided with all production requirements, technical and scientific support, and production marketing, thereby contributing to the creation of employment opportunities in the region. Competition is also encouraged among young people to produce the finest types of honey through the latest scientific methods.

Within the institute, a number of side projects have been established to support the honey industry, such as a carpentry workshop that produces beehives instead of importing them, bee food, and a honey-keeping refrigerator. ☺

abbrev.

Saudi Aramco news in brief



HE Shri Dharmendra Pradhan is greeted by Amin Nasser in the Aramco Asia-India office in New Delhi. The opening of the office represents the increased importance of India, not only as a valued customer or a major supplier of services and materials, but also as an investment priority.

Saudi Aramco expands presence in India with opening of new Aramco Asia-India office

NEW DELHI, INDIA — Saudi Aramco marked another significant milestone in its international portfolio expansion with the opening of Aramco Asia-India's new office in New Delhi in October.

The office was inaugurated by Saudi Aramco president and CEO, Amin Nasser at an event attended by HE Shri Dharmendra Pradhan, India's Minister of Petroleum and Natural Gas and Skill

Development and Entrepreneurship, Saudi Ambassador to India HE Dr. Saud Alsati, Indian government officials, heads of Indian major oil companies, as well as business and industry partners.

"For Saudi Aramco and the Kingdom of Saudi Arabia, India represents much more than a valued customer or even a major supplier of services and materials. Today, India is an investment priority," Nasser said in his welcoming remarks at the inauguration.

The New Delhi office will assume major roles in attracting more Indian manufacturers and investors to participate in the company's In-Kingdom Total Value Add program.

Aramco Asia eyes intensified downstream engagement with local governments

BEIJING, CHINA — Aramco Asia has pledged to increase efforts to expand engagement in the downstream business with the Chinese provinces of Fujian and Yunnan, as part of the company's commitment to promote



Aramco Asia president and CEO Nabil A. Al-Nuaim held talks with Pei Jinjia, secretary of the Communist Party of the China Xiamen Municipal Committee, in Xiamen.

regional economic growth and ensure energy security.

The move is considered the latest endeavor under Aramco Asia's business plan to support the flow of reciprocal investments between China and Saudi Arabia, in line with Saudi Vision 2030 and China's "Belt and Road" Initiative.

Remarkable progress has been made under Saudi Aramco's downstream strategy in strengthening

petrochemical business and boosting regional economic integration through partnerships with local stakeholders.

EXPEC ARC recognized with three Hart Energy Awards

HOUSTON, TEXAS, USA — The EXPEC Advanced Research Center (EXPEC ARC) was awarded three Meritorious

Daniele Colombo, Multi-Physics group project lead, Alberto F. Marsala, RET Deep Diagnostic focus area champion and Crosswell EM project lead, and Mohammed Alaskar, RET In Situ Sensing and Intervention focus area champion, display the Meritorious Awards for Engineering Innovation from Hart Energy the company received at the Offshore Technology Conference in Houston.





Awards for Engineering Innovation from Hart Energy during this year's Offshore Technology Conference in Houston, Texas.

This is the 47th year Hart Energy has honored engineering excellence and achievement in the upstream petroleum industry. The award program recognizes technologies that demonstrate innovation in concept, design and application, reflecting the best in technological advancement. EXPEC ARC's achievements were in the categories of exploration and formation evaluation.

"Seismic and EM Joint Inversion for Accurate Depth Images" by the EXPEC ARC Geophysics Technology team was the winning entry in the Exploration category.

In the Formation Evaluation category, the EXPEC ARC Reservoir Engineering Technology team received two awards for its "3D Mapping of Reservoir Saturation from Crosswell Electromagnetic in Horizontal Wells" and "Multifunctional Nanotracers with In Situ Detection."

Saudi Aramco is the first company in the oil industry to use nanotechnology to completely modernize the practice of oil well tracers, making it not only efficient, but also safe and easy.

Ahmed S. Khogeer is presented with a Fellowship Award by David Eckhardt, vice chairman of the American Institute of Chemical Engineers Fellows Council.



From left are Hassan Babiker, Gautum Kalghatgi and Jihad Badra. The trio were recognized for their "outstanding" SAE technical paper at an award ceremony at the Society of Automotive Engineers' 2017 World Congress.

Khogeer Fellow elected as the first Arab Fellow of the American Institute of Chemical Engineers

SAN ANTONIO, TEXAS, USA — Ahmed S. Khogeer, a senior project engineer with Saudi Aramco's Special Kingdom Projects Department, was recently elected to the degree of Fellow of the American Institute of Chemical Engineers (AIChE) — the highest degree of membership an engineer can reach in the institute. He is the institute's first Fellow from the Arab region.

In addition, Khogeer is the first person from outside the United States to receive the Distinguished Services Award from the Fuels and Petrochemicals Division of AIChE.

He received the fellowship certificate,

pin and the award plaque during the AIChE 2017 spring meeting in San Antonio, Texas. At the conference, Khogeer presented a paper on Saudi Vision 2030 and its impact on oil, gas, petrochemicals and infrastructure projects in the region.

Fellowship in the AIChE can only be attained by election after being sponsored by a Fellow member and supported by at least five other Fellows, who are required to demonstrate the knowledge and services the nominee added to the field of chemical engineering and his competencies before the nomination is sent to the Fellows' Council for election.

Scientists scoop top award

DETROIT, MI, USA — Scientists from Saudi Aramco's Fuel Technology Program recently won the prestigious 2017

Harry L. Horning Memorial Award: a sign that the company's Research and Development Center is well on its way toward changing the way automakers design future car engines and the fuels they use.

At the award ceremony, held at the Society of Automotive Engineers (SAE) 2017 World Congress in Detroit, Michigan, Saudi Aramco scientists Gautam Kalghatgi, Hassan Babiker, and Jihad Badra were recognized for their "outstanding" SAE technical paper, "A Simple Method to Predict Knock Using Toluene, N-Heptane and Iso-Octane Blends (TPRF) as Gasoline Surrogates."

Named after SAE past president Harry L. Horning and established in 1938, the Horning Memorial Award recognizes accomplishments and acknowledges contributions through research and development to the better mutual adaptation of fuels and internal combustion engines. ☈



Saudi Aramco



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worldview



Corny Point Lighthouse, Spencer Gulf, South Australia

Michael L. Pittman took this image just as the beacon light came on at the Corny Point Lighthouse in Spencer Gulf, South Australia. The last of the sunset can be seen just behind the clouds over the water. Pittman was on vacation with his wife, Karen Lake, visiting relatives in South Australia, where they spent several days enjoying the rugged beauty of the Yorke Peninsula.

The lighthouse was commissioned in March 1882 to assist southbound shipping avoid hazards on the West Coast of the peninsula south of Corny Point. In 1920, it was converted to automatic operation and has been on the South Australian Heritage Register since July 1980.

Pittman took this photo with a Nikon D7000 camera, using a Tamron SP 24-70 mm F2.8 Di VC lens, at 24 mm. He is a senior geophysical consultant, working in the Geophysical Technical Services Division of Saudi Aramco's Exploration Technical Services Department. Pittman has been with the company for 20 years, while Lake has been with the company for 19 years and currently works in the Office of the Corporate Secretariat.