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2008 – Issue 6

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SRAK

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South Rub Al-Khali Company Ltd.

A Shell-Saudi Aramco Joint Venture

Exploring for Gas in the Rub Al-Khali

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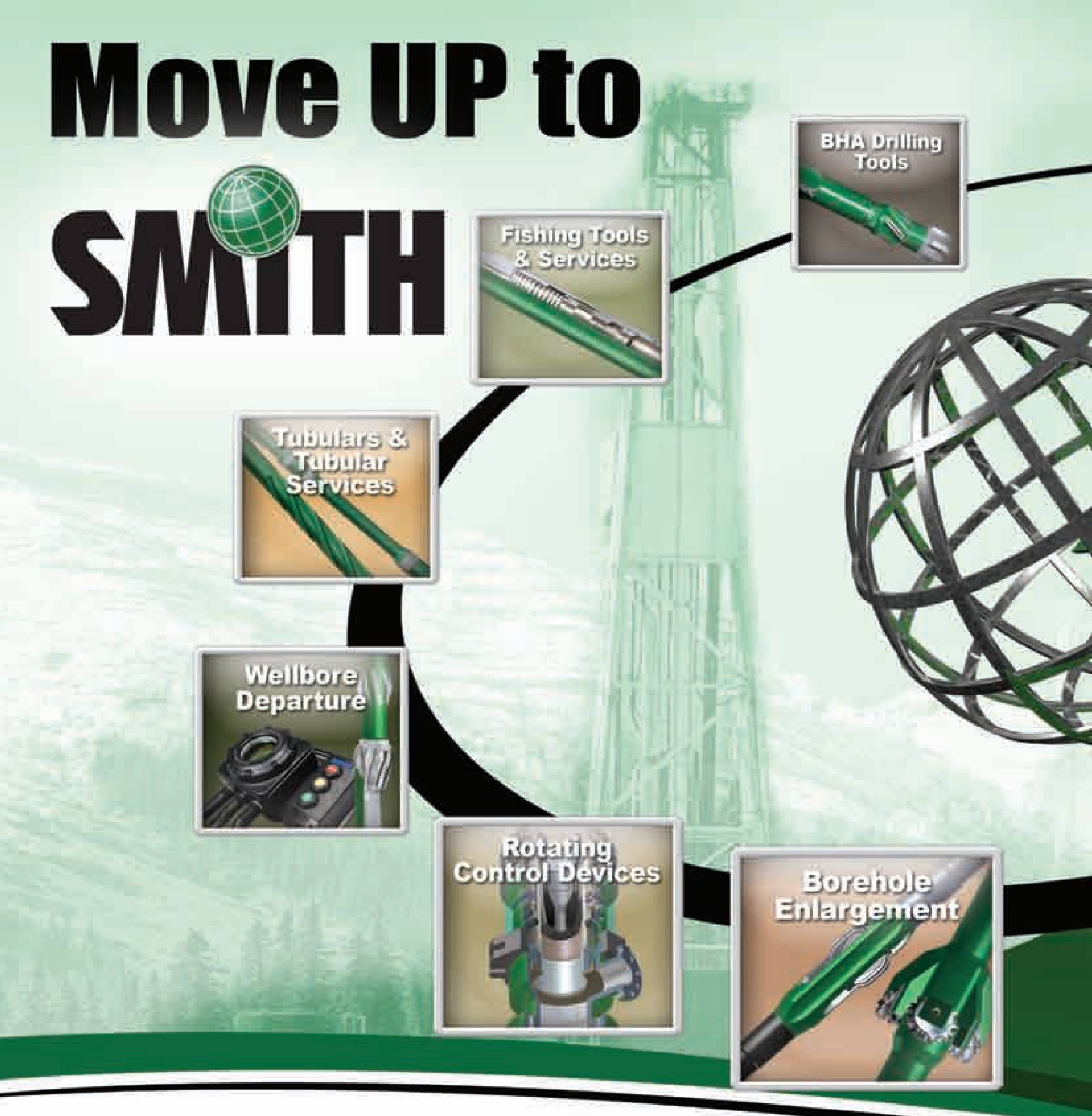

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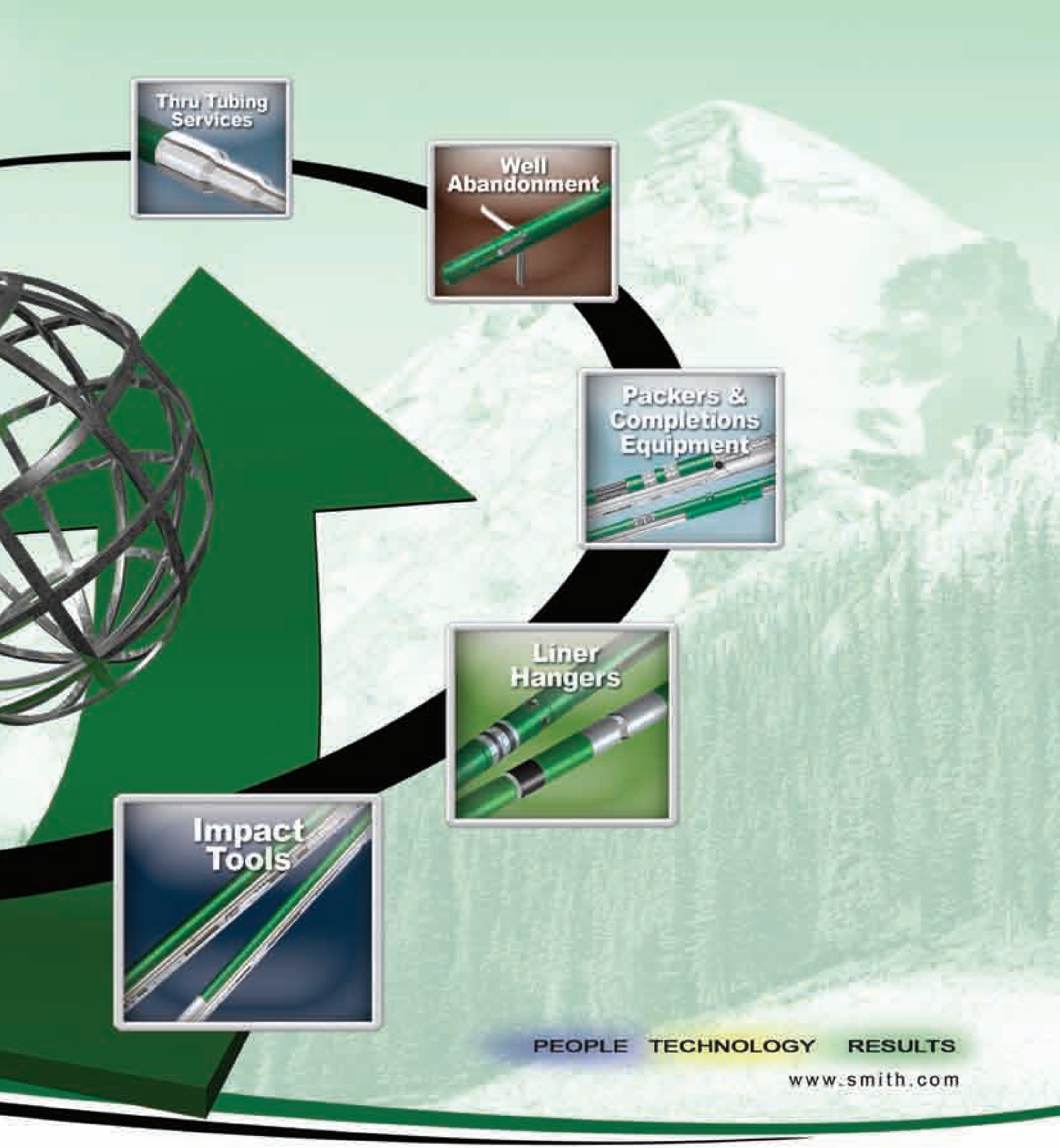

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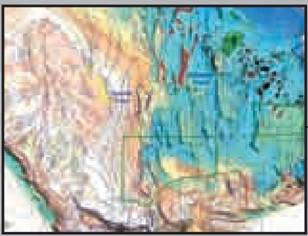

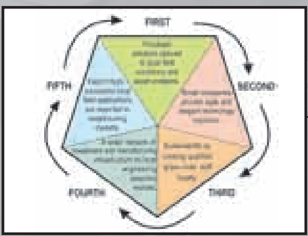

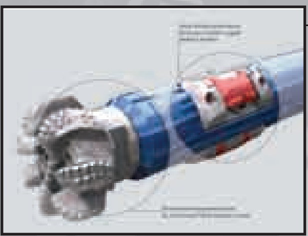

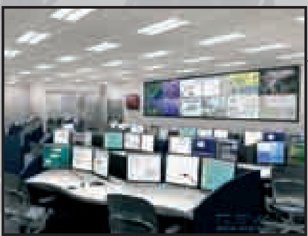

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NOTE FROM THE CEO

Welcome to issue 6. We have a solid editorial line-up that includes frontier exploration in Rub Al-Khali to local technology companies as well as rotary steerables and a keynote speech on Upstream Challenges.

The South Rub Al-Khali Company Limited (SRAK) was formed as a Joint Venture on 17th December 2003. Current Shareholders are Shell Saudi Ventures Limited (50% share) and Saudi Arabian Oil Company (50% share). SRAK was formed to explore for non-associated gas in the South Rub Al-Khali Basin in the Kingdom of Saudi Arabia and our editorial looks at the company's technical operations and some associated challenges.

While a jointly authored article with Dr Tariq Al-Khalifah Director of the EPT 2025 plan considers the question: local technology companies an unattainable dream or realizable goal? Clearly, many critical factors exist already within the Kingdom such as a highly developed E&P industry, a pool of local talent, nascent test facilities, worldwide links and a champion for the cause – KACST and EPT 2025. What is missing, however, is a tradition of technology transfer across the service industry and a culture of local technology development for services and equipment. This article considers the challenges, opportunities, and benefits of having local technology companies. It also presents ideas for technology transfer and a model for technology development that successfully ties the critical factors together.

Bringing readers up-to-date with the latest in directional drilling, there is an extended feature on how Rotary Steerable Systems (RSS) enable maximum reservoir contact. The article overviews some of the RSS that are on the market today. Each offers a host of benefits, with simple and sophisticated systems complementing one another. Each can be selected to match the full spectrum of needs and scenarios ranging from deepwater exploration frontiers to intermediate applications to mature onshore assets. There aren't many technologies capable of revolutionizing drilling and completions. Or making a startling difference to field economics. Rotary steerables are one of them.

Saudi Aramco is continuously implementing many new innovative techniques and approaches to assist in meeting the industry's increasing challenges. One of these innovations is the new study approach "The Event Solution." The approach leads to better synergy among different stakeholders and enables faster decisions that fully encompass the complex uncertainties associated with today's projects. This article written by Emad Elrafie et al showcases the event solution approach.

The Center for Petroleum and Minerals is the arm of KFUPM's Research Institute and is focussed on responding to the upstream industry R&D requirements. Center Director Dr Abdulaziz Al-Majed spoke to Saudi Arabia Oil and Gas about the Center's R&D capabilities.

Our regional events feature includes "The Upstream Sector: Tackling the Pressing Issues of Our Time a speech made by Khalid A. Al-Falih, Saudi Aramco Executive Vice President for Operations at GEO 2008 as well as photo montage of the event.

Saudi Arabia Oil and Gas Magazine is pleased to be the official magazine of The Society of Petroleum Engineers (SPE) Saudi Arabia Section 2008 SPE Technical Symposium which will be held at the Le Meridien Gulf Hotel, Al-Khobar, on May 10-12, 2008. The symposium will have keynote speeches, technical sessions, poster sessions, and a panel discussion with local and international participation.

We look forward to your comments – ultimately our readers' guidance will help make Saudi Arabia Oil & Gas a success.

So pick up your pen - write to:
wajid.rasheed@eprasheed.com

Enjoy the magazine.

"EPRasheed's aim is to consider global EP Markets in a strategic manner and foster balanced coverage and commentary on the International Oilfield and key EP technologies. Saudi Arabia Oil & Gas intends to help bring together local Saudi experts and international people to remove barriers and promote interaction."

Wajid Rasheed

Founder EPRasheed and Saudi Arabia Oil & Gas

Skill and Serendipity

Exploring for Gas-Condensate in the South Rub

By Staff of South Rub Al-Khali Company Limited (SRAK)

The South Rub Al-Khali Company Limited (SRAK) is an incorporated Joint Venture formed on 17th December 2003. Current Shareholders are Shell Saudi Ventures Limited (50% share) and Saudi Arabian Oil Company (50% share). SRAK was formed in order to explore for non-associated gas in the South Rub Al-Khali Basin in the Kingdom of Saudi Arabia.

The SRAK Venture started operations on 26 January 2004. The operational areas in the South Rub Al-Khali Basin are extremely large (equivalent to 10% of the land mass of Saudi Arabia) and remote (more than 1,000km distant from the Company's head office in Al Khobar), see Figure 1. In its first 5 years exploration term SRAK committed to acquiring a minimum of 16,000km of 2D seismic data and to drill 7 Palaeozoic exploration wells, some of which are more than 17,000 ft deep and target hot and overpressured reservoirs. To date, SRAK has exceeded its seismic commitments and spudded its fourth exploration well.

The realities of the business environment and conditions of operations in the Kingdom of Saudi Arabia, the size, remoteness and challenging terrain of the Contract Areas, and the limited availability of pre-existing data, represented a particularly tough set of challenges unique to the SRAK Joint Venture.

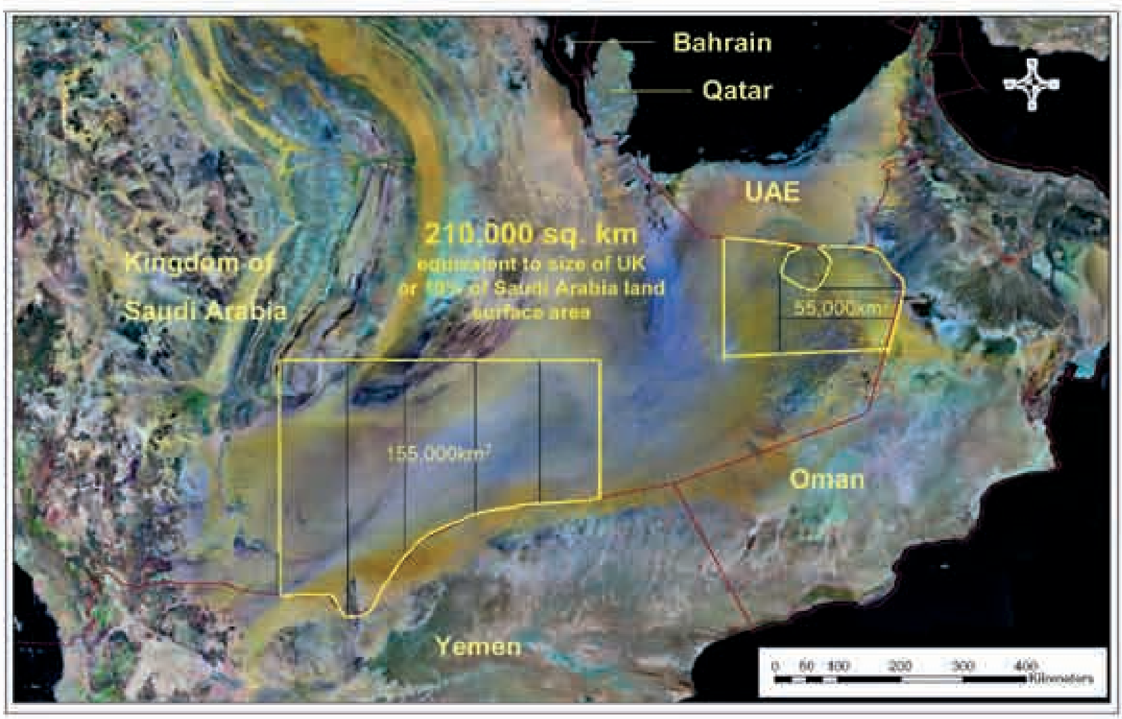


Figure 1 - SRAK Contract Areas Location Map.

Al-Khali Basin, Kingdom of Saudi Arabia

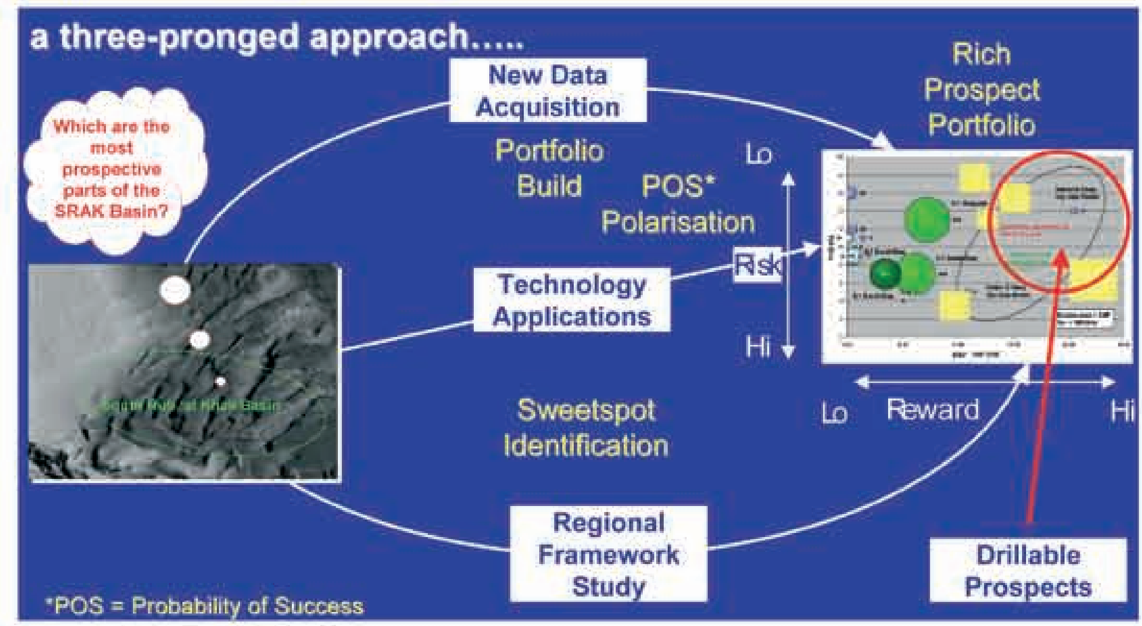


Figure 2 - SRAK's approach to exploring in the Rub Al-Khali Basin.

In order to maximise the chances of achieving its commitments within the timeframe of the First Exploration Period, a play-based rather than prospect-based exploration strategy has been devised during the start-up of the Venture to maximise the chances of identifying working hydrocarbon systems and to optimally position the Company for a Second Exploration Period.

Within its overall exploration strategy and methodology, SRAK has followed a three-pronged approach of "Sweetspot Identification" (Regional Framework Studies), "Portfolio Build" (Potential Field and Seismic Data Acquisition and Processing) and "POS Polarisation" (Technology Applications) in an attempt to define a Portfolio of Choice for the Venture to select from during the drilling execution phase (Figure 2).

As there is very limited relevant subsurface data available from within SRAK's Contract Areas, it was imperative to assess their prospectivity within the overall plate-wide framework. Figure 3 shows a depth to basement map resulting from an integrated evaluation of regional potential field and structural geology data, thereby highlighting structural trends that may be significant in the understanding of the tectono-stratigraphic evolution of the exploration area.

SRAK is not alone in its effort but was able to benefit from a wealth of knowledge, expertise and relevant and complementary exploration experience within its Shareholding Companies. This play experience stems from the areas in close proximity to the South Rub Al-Khali Basin thereby providing a first order prospectivity assessment by generating regional Play and so called Common Risk Segment maps. Together with the seismically generated structural and trap maps, this enabled SRAK to generate a risk polarized prospect portfolio.

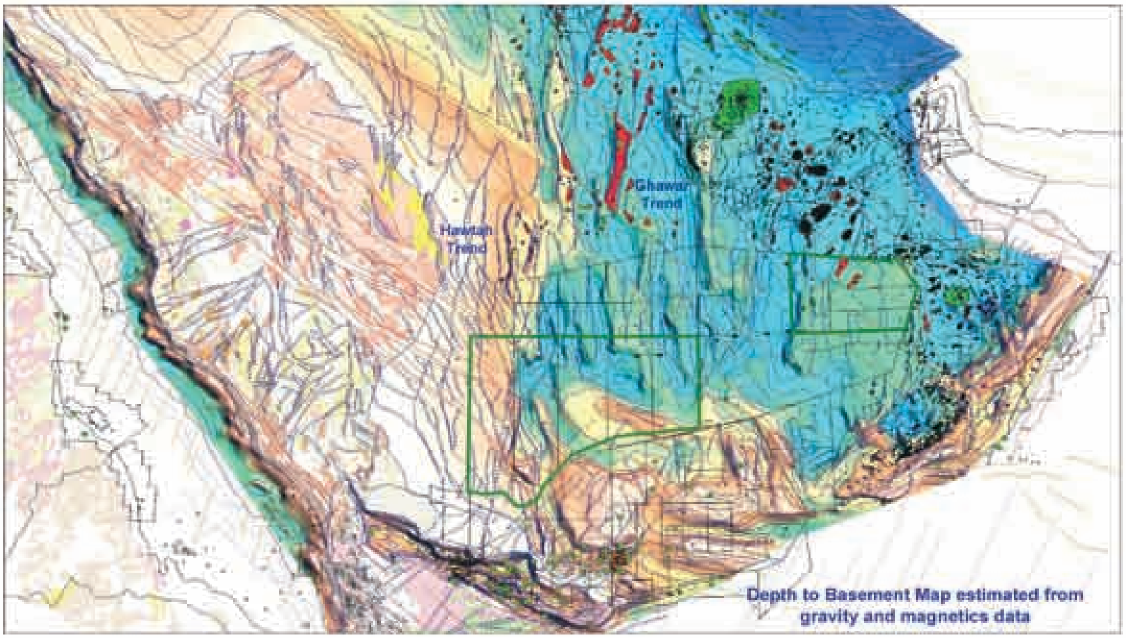


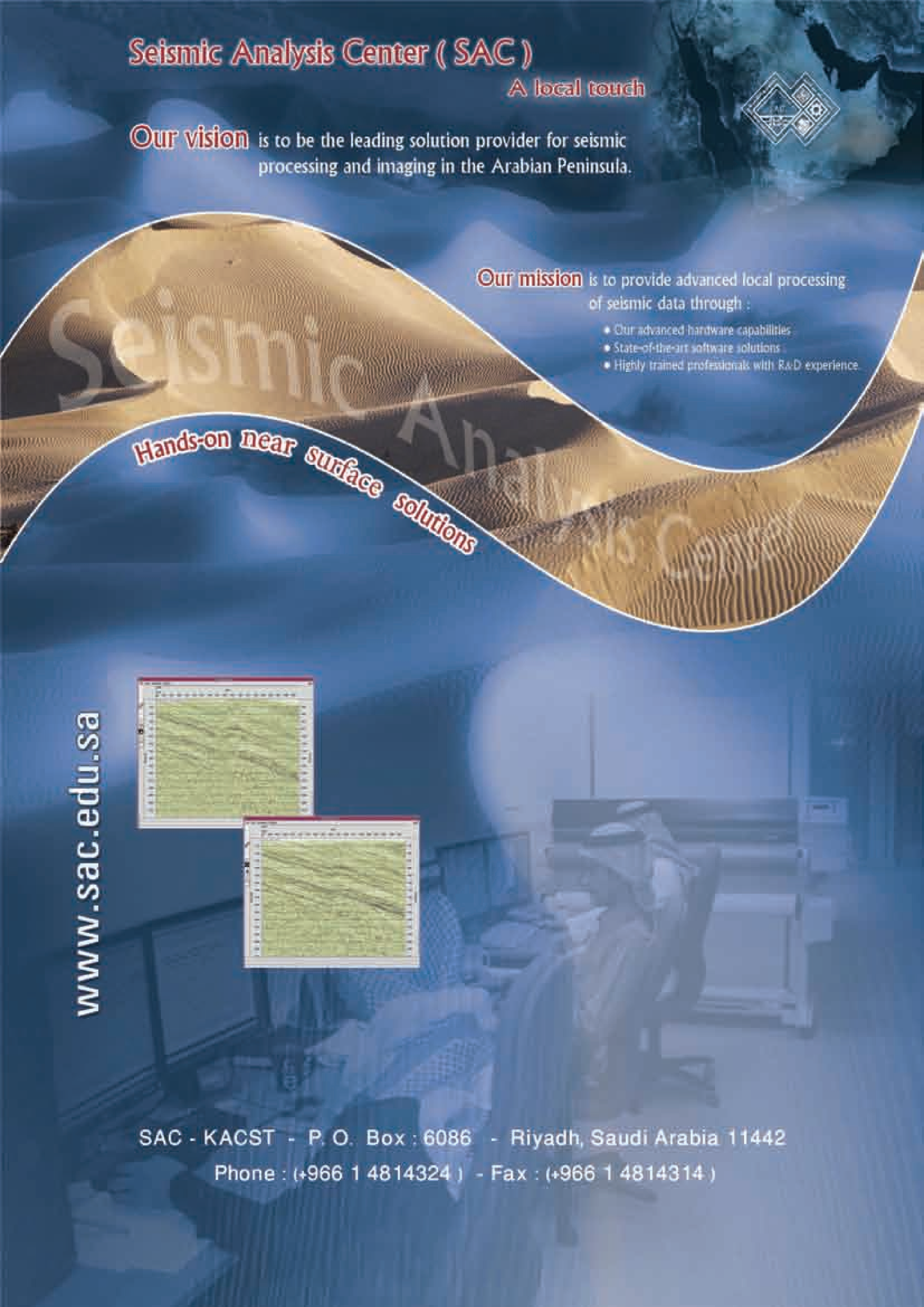
Figure 3 - Plate-wide depth to basement map based on potential field data.

In 2006, SRAK entered a new exploration phase with the spudding of the first of up to seven exploration wells. The Isharat-1 well (Figure 4) proved the presence of critical play elements and viability of the Paleozoic hydrocarbon plays in the South Rub Al-Khali Basin.

In conclusion, SRAK believes that building relationships, creating & maintaining effective partnerships, Leveraging shareholder strengths, selective deployment of key technologies, Flexibility, Resilience & Endurance and Building of staff capabilities will continue to be the key for a successful exploration campaign in the South Rub Al-Khali Basin.

SRAK would like to thank the KSA Ministry of Petroleum and Mineral Resources for their continued support and permission to publish this article.

Figure 4 - Isharat-1 Well in the Rub Al-Khali Area.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Saudi Arabian an unattainable dream

By Tariq Alkhalifah and Wajid Rasheed

The Kingdom's Exploration and Production Technology strategy states that by 2025, half of all Oil and Gas technology services should be available locally. Although this goal at first glance seems insurmountable, it is in fact perfectly realizable given proper planning, funding and a reasonable level of collaboration from Oil companies.

Clearly, many critical factors exist already within the Kingdom such as a highly developed E&P industry, a pool of local talent, nascent test facilities, worldwide links and a champion for the cause – KACST and EPT 2025. What is missing, however, is a tradition of technology transfer across the service industry and a culture of local technology development for services and equipment. (Ref 1)

This article considers the challenges, opportunities, and benefits of having local technology companies. It also presents ideas for technology transfer and a model for technology development that successfully ties the critical factors together.

What is a local technology company?

Service and equipment providers are commonly called 'technology companies' simply because they sell equipment or services that utilize or harness some form of technology. However, this is somewhat misleading. A more accurate definition hinges on the ownership of Intellectual Property (IP) or on the value added by developing or improving a given product or service based on practical field applications.

In other words, technology companies must own the IP outright, or at the very least, hold local IP rights. Agency or representation agreements are inadequate; the implication is that R&D is central to the mission of a technology company.

Think development - not supply.

Consequently, product and design engineers ideally need to be based in the local market or at least make their

Technology: or realizable goal?

product modifications or designs based on local oil company asset problems rather than importing off-the-shelf solutions developed for other assets in other markets. (Ref 2)

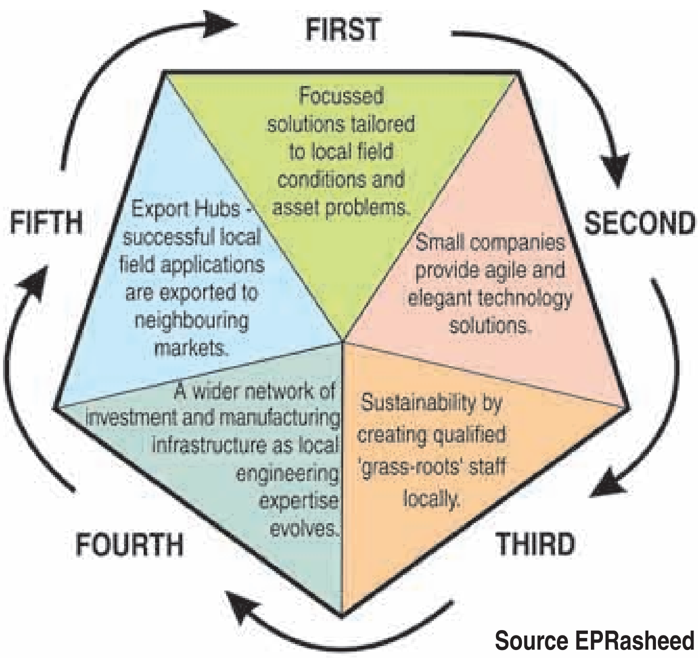
In Saudi Arabia, there are few companies that can provide product development and service improvement for the oil and gas sector. In fact it is hard to name a single small sized company (below 50 employees)in the Kingdom that can truly be called a technology company. How many companies are capable of taking a conceptual design, patenting it and securing IP, drawing up a prototype design, testing a lab prototype, making modifications for field testing and realizing successful field tests? Not many. And last but not least, how many service companies can scale up a design to meet the needs of a fully commercial fleet and roll-out manufacturing in country. Even fewer.

Do we really need Local Technology Companies?

The answer is a resounding 'yes' and the rationale behind the creation of local technology centres on five inter-related staged factors. (Ref 3)

See above diagram The Staged Role of Local Technology Companies.

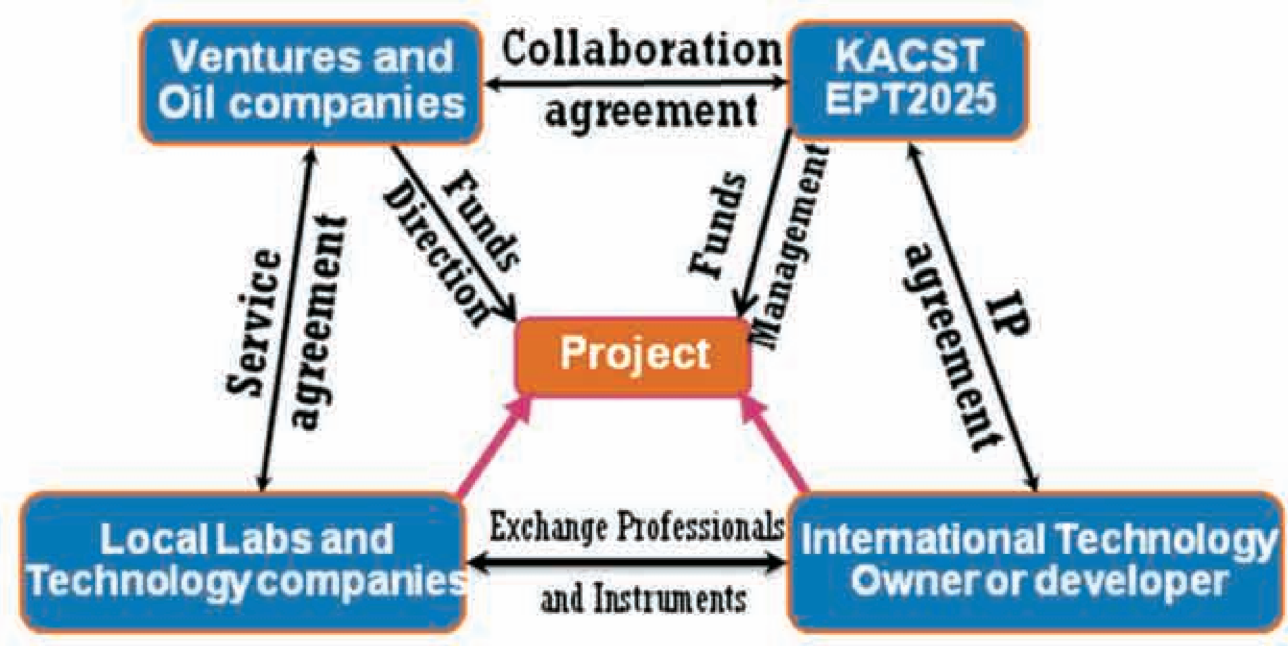
The Staged Role of Local Technology Companies



Source EPRasheed

First, local technology companies can develop focussed solutions tailored to local field conditions and asset problems. For example here in Saudi Arabia these would be related to the carbonate challenge, horizontal drilling and EOR. Second due to their smaller size, such companies can produce technology solutions with an agility and elegance that is often faster than their larger service company counterparts. Third, they enable sustainability by creating locally qualified 'grass-roots' staff that are capable of designing, manufacturing, running tools and services, recording and evaluating their performance in a service database. Fourthly, they set in motion a wider network of investment and manufacturing infrastructure as local engineering expertise evolves. Lastly, such companies eventually serve as export hubs as successful locally proven field applications are exported to neighbouring markets - here this could apply to the wider Oil and Gas producing Gulf countries.

Typically, this approach is clearly seen in mature producing areas such as Aberdeen, UK, Stavanger, Norway which act as technology hubs with exports worldwide. Those countries created a series of incentives to promote national technology even providing seed capital where necessary. Result - a strong tradition of technology start-ups that are successful. Driven by the necessity of solving local EP challenges a long list of vibrant service companies have emerged. Subsequently, these companies have been floated via IPO, taken over by venture capitalists or bought out by larger service companies. Standard oilfield procedure – the founders of the start-ups get bought out and make a small fortune. Then what happens? Do they



Source EPT 2025 Plan

retire on a yacht in the mediterreanean? Occasionally, but more often than not, they take the proceeds of the sale and guess what? They start-up another technology company. This leads to a culture of innovation. (Ref 3)

Technology Import

The EPT 2025 strategy utilises a model for technology transfer that includes an exchange of professionals and students between the technology owner or developer and local content entity. (Ref 4)

The model fits mostly with transferring developed technologies or products that require minimal to moderate development for application to our local conditions and geology and, as a result, it includes an additional component corresponding to the end user and practical field applications.

The project is managed and funded mainly by KACST and the national plan with a collaboration agreement between KACST and the end user such as Saudi Aramco, SRAK, TAQA. End users may contribute additional funds as well as provide direction for the project, signpost applications and make available facilities such as test rigs and flow loops.

Signposting Applications

Increasingly, petroleum engineers are becoming risk-averse project managers rather than specialized drilling, completion or production engineers looking for technology solutions. So it lies with the service provider to effectively market service benefits to the operator.

This is where small (read young) companies trip up. Without established marketing channels, small companies regularly miss out on developmental opportunities. Operators can help by focusing a small company's resources on specific projects where applications are plentiful and test facilities can be availed. Cynics would argue operators are not in the business of making small companies richer. But this misses the point.

Sign-posting a project helps accelerate product development and operator benefits. To that end, small companies must improve their marketing to demonstrate service benefits.

They also must develop partnerships with operators and be service-oriented rather than supply-oriented. Operators need to keep on the lookout for small companies, invest in their technology and encourage integrated service providers to use their services. And last but not least, all must reassess how the reward is spread across the hydrocarbon machine. (Ref 5)

In return the end user gets a preferential service agreement that guarantees the access to the developed product or service. An IP agreement is arranged between KACST and the international owner or developer of the technology, which will provide the local entity the rights to in-Kingdom use and additionally develop the technology in the region. The local technology company will be the technology 'host' and of the IP rights by direct interaction with original developer.

> Remarkably, however, almost all of this enabling EP technology is considered an outsourced commodity marketed by service and supply companies, which means the principal source of technology is the service sector.

Where do we get technology from?

Here we should distinguish between fundamental research and improving existing technology. The first leads to revolutionary or game–changing technology ie 3-D rotary steerables and horizontal drilling. The second leads to evolutionary or incremental technology and improvements in existing know–how such as second generation tools that enable greater directional precision and longer laterals.

Both types of technology alter the definition of what is deemed uneconomic or unreachable at a given time. Operators do develop certain technologies in-house and set up major technology development projects. Remarkably, however, almost all of this enabling EP technology is considered an outsourced commodity marketed by service and supply companies, which means the principal source of technology is the service sector. The billion-dollar think tanks and research and development facilities that major service companies own are continually creating new technologies that help access reserves that were uneconomic or unreachable. Service companies and operators develop technology in-house, through joint industry projects and with best-in-class companies. The buzzwords of 'ultra-deepwaters, digital oilfield and barrel-chasing' may first be heard in oil company offices due to the engineering challenges and risks oil companies 'buy'.

But they resonate most loudly throughout the service-side; in product development, in research facilities and on test rigs before technology is commercially run in field applications.

Small companies may not achieve large economies of scale but at the same time they do not have large overheads. Because they can act rapidly, they often can beat the giants when it comes to developing new technology.

Yet how do small compete against the billion dollar think tanks and research and development facilities that major service companies own? And how do they succeed without the benefit of marketing channels or the influence of larger service companies?

Small companies can distinguish themselves by providing a service that includes applications analysis, technical recommendations and rig-site support through end-of-well reporting.

And if they can maintain market leadership, they will attract the attention of operators interested in new technology. Certain oil companies, select market leaders in what they deem essential technology and work with those leaders to develop technology. (Tough luck if you're not Nº 1.)

The Challenge

Because very few companies can provide all the required services or meet all contractual requirements, the concept of integrated contracting became commonplace. An integrated contractor or contracting alliance allows for each party to calculate their share of the development cost and price. These calculations are then used as performance targets, with the gain or pain of reaching the target or not being shared. But for operators fed up with

Small technology companies, unlike their big counterparts, require a supportive environment that allows 'incubation' additionally there has to be the wider industry and infrastructure so that certain non-R&D tasks such as building prototypes, and manufacturing capability can be outsourced.

the tangled thicket of contracts and contractors, the easiest course may lie in integrating outsourced services. This certainly reduces some of the complexity and numbers of service providers by providing a single point of contact. However, integration stymies innovation.

This is because integration tends to discourage small-company services, as the main service provider will fulfill most technology requirements in-house. Only where technology is unavailable can a small company enter the project, filling a gap that no other business can. Even then small (read young) companies may be asked for a slew of historical figures ie minimum number of years trading, financials and be required to meet wide-ranging legal or other tender requirements, many of which are applicable only to the major service provider. While safety is non-negotiable, it seems unfair to insist on the same levels of financials or insurance liability for two different scopes of services. This asks small companies to bear more project risk without an accompanying increase in the reward.

Many of the major service providers deal with all seismic data (good quality or poor, complex area or low relief) in a bulk mentality, not giving the data the care and attention it requires. Each data set is unique in its makeup, method of acquisition and the impact of the subsurface geology on it. The bulk mentality may work on a big portion of the data but not on all the data, especially not those that come from areas that have special problems.

Small technology companies, unlike their big counterparts, require a supportive environment that allows 'incubation' additionally there has to be the wider industry and infrastructure so that certain non-R&D tasks such as building prototypes, and manufacturing capability can be outsourced.

Conclusion

Successfully establishing a local technology development and service industry means that the necessary environment for start-ups and small companies must be created. Much of this already exists as we have seen albeit in differing stages - what remains is to integrate this. Chief among the integration process is the support and input of the major Oil companies and their recognition of the value of having such technology companies. A business culture that includes the support of the service industry, proper technology transfer models, HR talent and funding are also necessary for the success of start-ups and small companies.

The EPT 2025 program seeks to act as a catalyst by helping to bring together all concerned.

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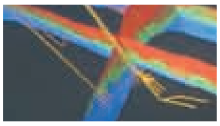
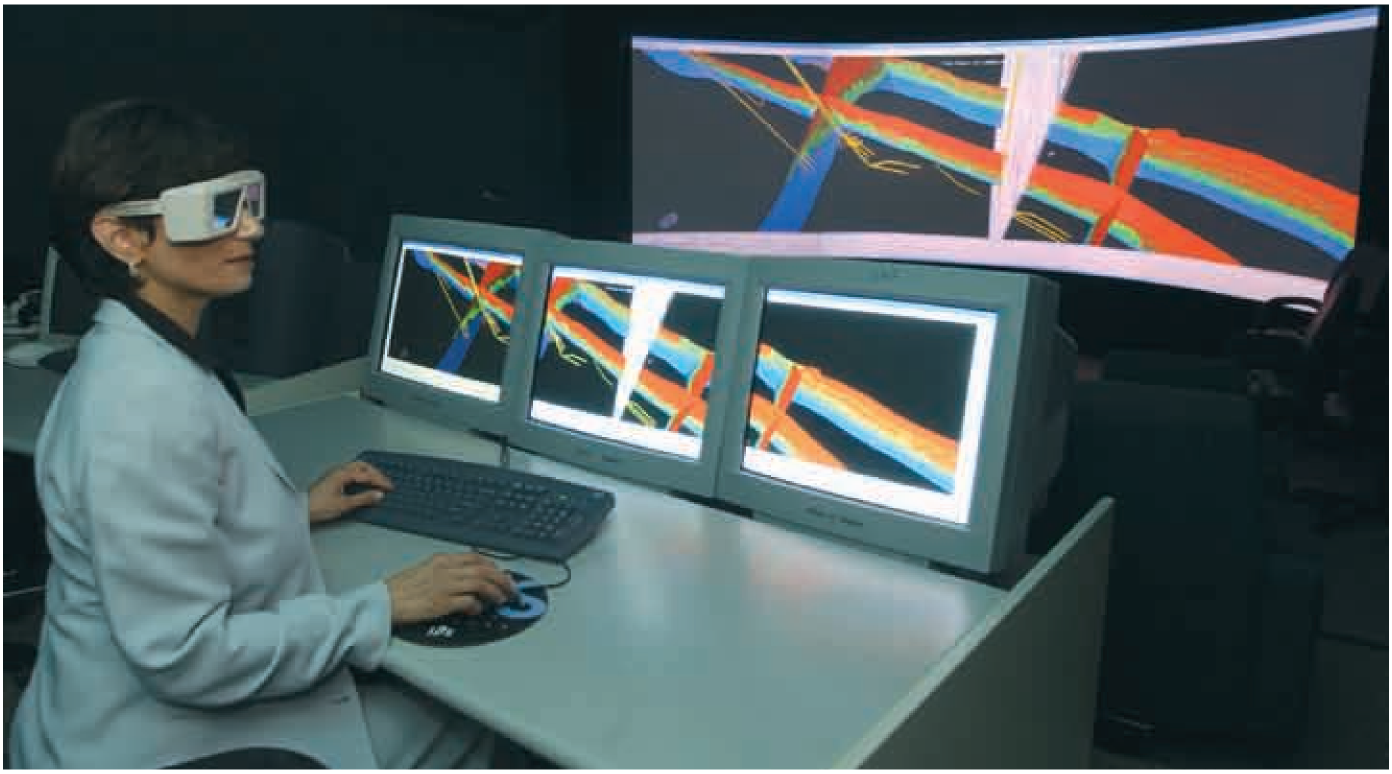


Rotary Steerables

By Wajid Rasheed



Courtesy of Saudi Aramco

There aren't many technologies capable of revolutionizing drilling and completions. Or making a startling difference to field economics and enabling Maximum Reservoir Contact (MRC) wells.

Rotary steerables are one of them.

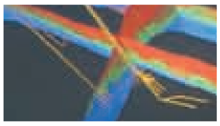
The various rotary steerable systems available on the market today offer a host of benefits, with simple and sophisticated systems complementing one another. Each can be selected to match the full spectrum of needs and scenarios ranging from deepwater exploration frontiers to intermediate applications to mature onshore assets.

Advances in rotary steering, logging technology and digitalization are bringing autonomous systems ever closer. Although systems capable of finding and accessing reservoirs on their own are still some years away, several types of rotary steerables exist today that can maximise drilling in the reservoir.

High-tech electronic solutions are sophisticated and costly by nature, these systems are especially suited to costly complex designer wells. However, suppliers are offering a modular or combo approach which allows the degree of system sophistication to be determined by drilling engineers. This has already helped export some of the higher-end systems into certain intermediate cost shelf and onshore applications by tailoring certain BHA combos to well needs.

A different approach is being adopted by a number of smaller service providers who are developing simpler and more cost effective systems for the low rig cost market. The majority of these systems still rely upon electronics, but have fewer features such as lower DLS capability for instance and are aimed at 'simpler' lower cost wells. Simple or sophisticated - this much is clear - all systems can generate cost savings and offer the potential to improve recovery from compartmentalized or horizontal reservoir sections.

But less clear is the criterion that makes one system 'better' than another. Reaching a consensus will always be



enable MRC wells

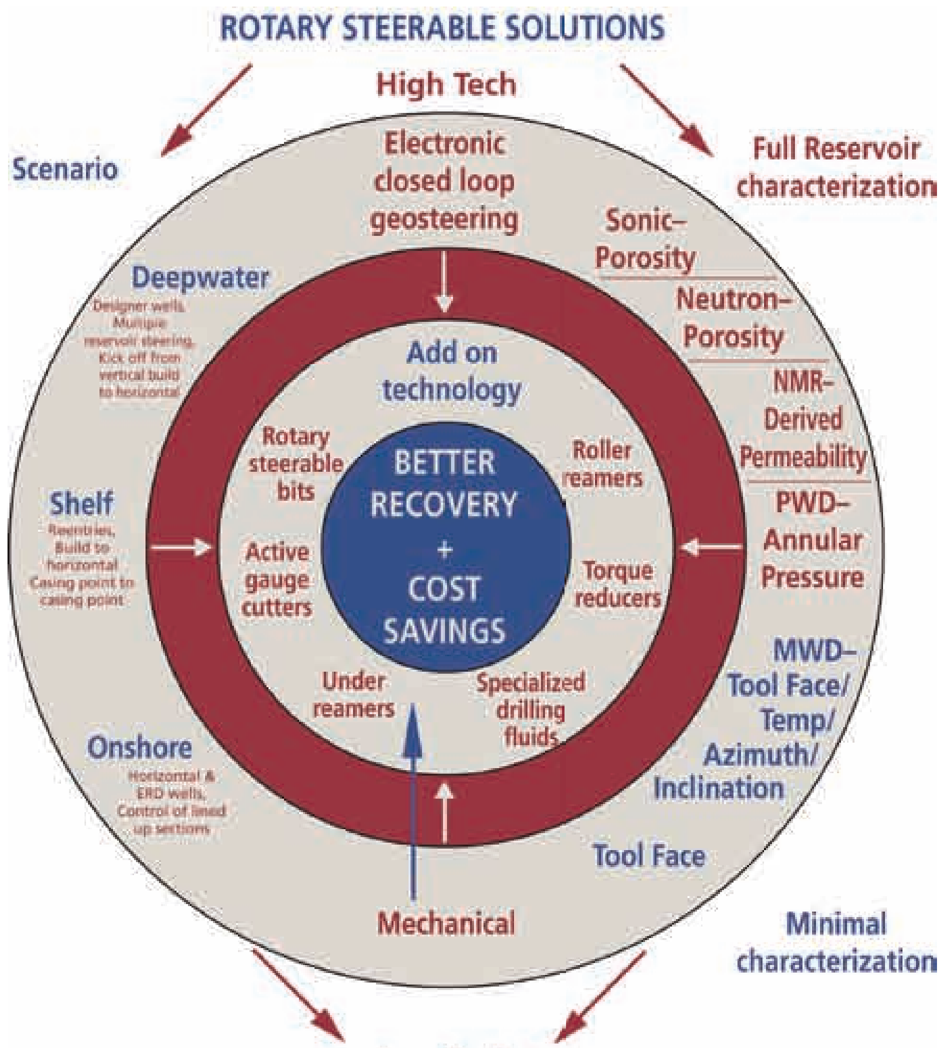


Image EPRasheed

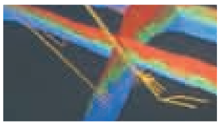
contentious but an objective way of determining the best fit is to broadly 'match' rotary steerables with the varying dictates and expectations of deepwater, shelf or onshore drilling and completions. Drawing these variables together, (See diagram above) depicts deepwater, shelf and onshore sectors and matches technology appropriately.

Certainly, a RSS must help reach the reservoir and optimize footage within it (the concept of maximising reservoir contact) but beyond this there are many reservoir and well dependent variables. For example, the Dogleg severity performance of a rotary steerable system should be matched with the complexity and number of targets involved. In complex designer wells, sophisticated systems shine. In less complex horizontal wells, simple systems suffice.

Add on Technology

Representing opportunities for reducing casing wear torque reducers can help overcome concerns of the effects of increased rotation on tubulars. Also roller reamers aid BHA stabilization and reduce down-hole vibrations. While under-reamers, enable the diameter of production holes to be increased (especially important in deepwater scenarios where narrow pore pressure fracture gradients can jeopardize reservoir hole size) by allowing casing to be telescoped without sacrificing production. Also specialized drilling fluids exist to reduce torque and improve rotary drilling efficiency.

Similarly costs also drive system choice. It is well known that the tight economics of onshore or shelf assets cannot withstand high rig-rates let alone expensive down-hole



> "RSS increase the effectiveness of drilling by improving reservoir exploitation."

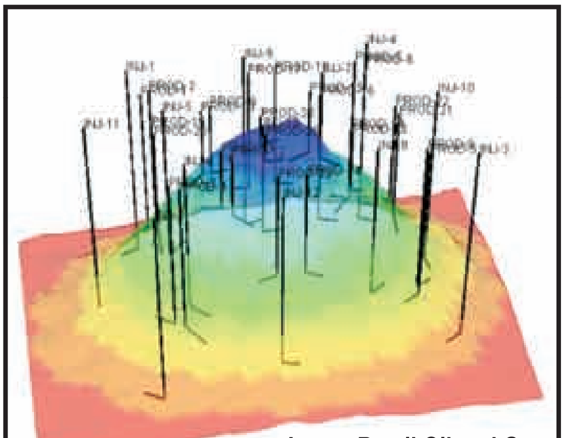


Image Brazil Oil and Gas

equipment. Here a match depends as much on reservoir needs (DLS required to reach optimal reservoirs) as it is driven by costs. Consider deepwater versus onshore trip costs. In the former an average round trip will cost $500,000. Yet, the same trip onshore hardly makes a tenth of this figure. In the first instance, it makes commercial sense to minimize trips. However, onshore it might make better commercial sense (depths and profile permitting) to induce trips by using conventional steering technology to line up sections and run in with rotary steerables where they have best effect.

Deepwater exploration frontiers are characterized by the highest rig rates in the industry and extreme exploration risk. This means contingency planning is a key component of deepwater operations. Relatively straightforward activities such as logistics can be rendered complex due to the remote and specialized nature of operations. Consequently, sophisticated rotary steerable systems that maximize efficiency and minimize risk, are not only desirable, they are necessary.

In these deepwater instances, a full range of reservoir characterization tools is also required. Sophisticated systems coupled with full logging capability reflect and meet deepwater frontier needs as offset data is often scarce and further asset development is dependent on data acquisition and interpretation. Therefore, the general rule is the more data acquisition and characterization the better. Data gathered 'while drilling' supplements the pre drill seismic package by increasing footage drilled in optimal reservoir zones.

Conversely, because mature assets are usually well characterized and offset data is plentiful, the same degree of data acquisition may be unnecessary. This makes mature or onshore fields ideal candidates for simpler rotary steerable tools. As we move down the characterization list, there is a diminished need for complete characterization. Intermediate or mature shelf assets may not require neutron magnetic resonance or sonic logging. While, in a marginal onshore context it is highly likely that a full logging while drilling suite becomes redundant. Little more than tool-face, azimuth, inclination, temperature and formation identification is required in this context. In exceptional onshore cases, the uncertainty associated with complex targets may require further logging but often a MWD plus Gamma system provides ample data.

In this way, technology can be pared down to bare essentials and costs lowered. What may have once been considered a marginal or mature field can be revisited with new economic parameters and perhaps be revitalized.

RSS Improve Drilling Effectiveness

RSS increase the effectiveness of drilling by improving reservoir exploitation. This comprises;

1. The certainty of precise inclination and azimuth control over the planned horizontal or directional section (the responsiveness of the system will be dependent on factors such as formation, the length of time a particular trend has been established and such like).

2. In cases an extension of the effective horizontal section drilled which would previously not have been possible using slide drilling. 1200' extensions as compared to offset have been documented in the US, North Sea and Middle East.

Increasing Drilling Efficiency

The argument for increasing drilling efficiency is based on the following attributes of the RSS;

1. The elimination of difficulties associated with oriented drilling.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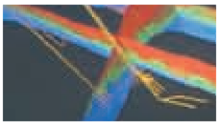


"There aren't many technologies capable of revolutionizing drilling and completions. Or making a startling difference to field economics. Rotary steerables are one of them."

2. Improved hole cleaning as Sanchez et al detail. Rotary mechanical agitation of cuttings beds and the orbital motion of the drillstring means that cuttings are less likely to form cuttings beds as they are continuously exposed, agitated and circulated out. It is recognised that this leads to better hole cleaning. This in turn reduces the time spent circulating at section TD to improve hole condition.

3. Synergy with PDC bits. Orienting with a PDC bit is recognized as being difficult; this can limit optimal bit choice in certain formation types. PDC bits can be used with a Rotary Steerable System to optimise bit selection. This has led to reduced rock bit trips, better ROP's and improved directional response. It is worth considering that the majority of horizontal sections appear to be drilled with PDC bits.

4. Increased average ROP. Rotary drilling consistently yields higher ROP leading to a reduced time in drilling the section.

5. Fewer trips, Wisenbaker concludes this is highly attractive in an under-balanced drilling situation as each trip saved obviates the need to kill the well using expensive kill mud.

6. Improved Borehole Geometry - Fewer instantaneous changes in well-bore curvature means a smoother well bore. This means reduced hole tortuosity and an improved well profile. This is because rotary - build or drop - trends take time to break. Therefore, well-bore curvature is smoothed out over entire sections. Consequently, casing can be set more easily and there is reduced potential for work-overs, and interrupted production. This highlights the reduction in Casing or Tubular wear due to smoother wellbores. There is also a reduced requirement for reaming. This is because of fewer transition ledges and less potential for keyseating. Lower well-bore tortuosity reduces the need for reaming to decrease tortuosity or well-bore curvature. Kristiansen et al link consistent gauge hole with improved resistivity readings.

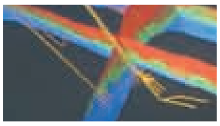
7. Reduced Torque & Drag - as quantified by Mims. Less need for BHA Torque Reduction devices. Less need for mechanical Drill-string torque reduction devices such as NRDPP or Subs. Less need for drilling fluid based torque reduction such as polymer beads or other additives.

8. Literature shows reduced potential for mechanical & differential sticking.

9. The absence of a motor allows improved bit hydraulics, annular velocity and higher flow rates.

10. Ability to withstand bottom hole temperatures higher than 150 degrees centigrade dependent on each RSS.

The various rotary steerable systems available on the market today offer a host of benefits, with simple and sophisticated systems complementing one another. Each can be selected to match the full spectrum of needs and scenarios ranging from deepwater exploration frontiers to intermediate applications to mature onshore assets. There aren't many technologies capable of revolutionizing drilling and completions. Or making a startling difference to field economics. Rotary steerables are one of them.



Autonomous Closed Loop Directional Drilling Delivers Efficiency, Productivity & Ultimate Recovery

Introduction

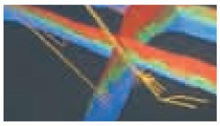
Twenty years ago, Baker Hughes INTEQ commenced development of an automated directional drilling system to meet the exacting demands of a record breaking vertical well to be drilled by the German government. The well was drilled to a total depth of 29,564 ft (9,011 m) with minimal lateral displacement and low tortuosity. It was determined by the engineers that this well would have been impossible to drill without automated steering control to minimize tortuosity. The success of this project was therefore largely attributed to the closed loop automated steering control provided by INTEQ's "Vertical Drilling System" (VDS).

Since then, the company has continuously developed closed-loop automated steering control and implemented this into the heart of a wide range of directional drilling systems. The proven benefits of the company's closed-loop steering versus non-automated steering control include increased efficiency, lower operational risk and improved production and field recovery.

Benefits of Closed Loop Steering Control

The closed loop steering control of the company's automated directional drilling systems uses advanced algorithms to continuously monitor the wellbore's trajectory and automatically adjust the steering parameters to reach and maintain the desired trajectory. This is performed autonomously within the downhole tool without the need for human intervention. When it is necessary to communicate changes to the trajectory or make changes to any other parameters used by the downhole system, these are communicated from surface via a process called "downlinking". Depending upon the particular service level selected, this downlinking process can also be automated, controlled remotely from the cabin or even from an operations centre located in either the company's or the client's office. Through automation of the downlinking process, more complex instructions can be transmitted to the downhole tool with greater reliability and efficiency than can be attained via manual downlinking – saving significant time over the course of drilling a well.

Through extensive experience, automating directional drilling control has proven to deliver enormous benefits. These include time and cost savings, more productive wells placed more precisely in the reservoir, improved hole quality resulting in fewer problems, greater reach and ability to drill complex, 3D well profiles to tap otherwise stranded reserves. Another benefit of automating directional drilling is that it allows the Directional Driller to focus more attention on monitoring other aspects of the drilling operation, thereby using their experience to



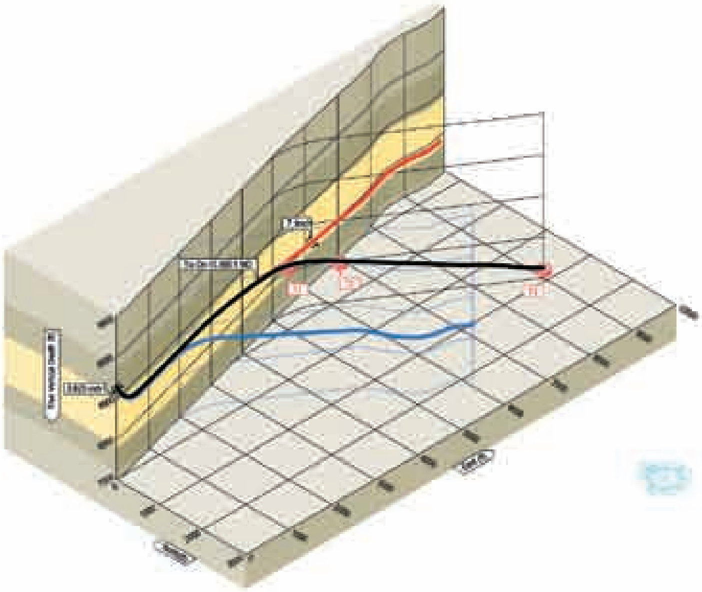


Figure 1 - INTEQ's automated directional drilling systems are used to precisely position maximum reservoir contact wells in the Kingdom of Saudi Arabia for improved production and field recovery.

optimize the entire process. Figure 1 shows an example of how the company's closed-loop steering control precisely steers wells to target for maximum production and recovery in the Kingdom of Saudi Arabia.

The advantages of the automated closed-loop control steering control is also widely recognized in extended reach drilling (ERD) applications. By drilling a low tortuosity, highly accurate wellpath, intersection of distant targets is achieved at lower operational risk. To date, at least 15 of the world's top 20 ERD wells (described by either reach or measured depth) have employed INTEQ's automated rotary steerable technology. This includes the new ERD record on well Z-12 from Sakhalin Island which was drilled to 38,322 ft (11,680 m) md. Using leading edge technologies, this well was drilled in half the time it would have taken if drilled conventionally.

The data in Figure 2 illustrates how effectively automated closed-loop steering places a well on command for optimum production and recovery. Enhanced Wellbore Placement techniques such as Dual Inclination and Way Point Intermediate Inclination Service are key components for the provision and management of accurate vertical wellbore placement applications (ERD, etc.) prior to and within the reservoir. Automated steering control is relied upon worldwide to steer wells more precisely for maximum recovery and lower operational risk.

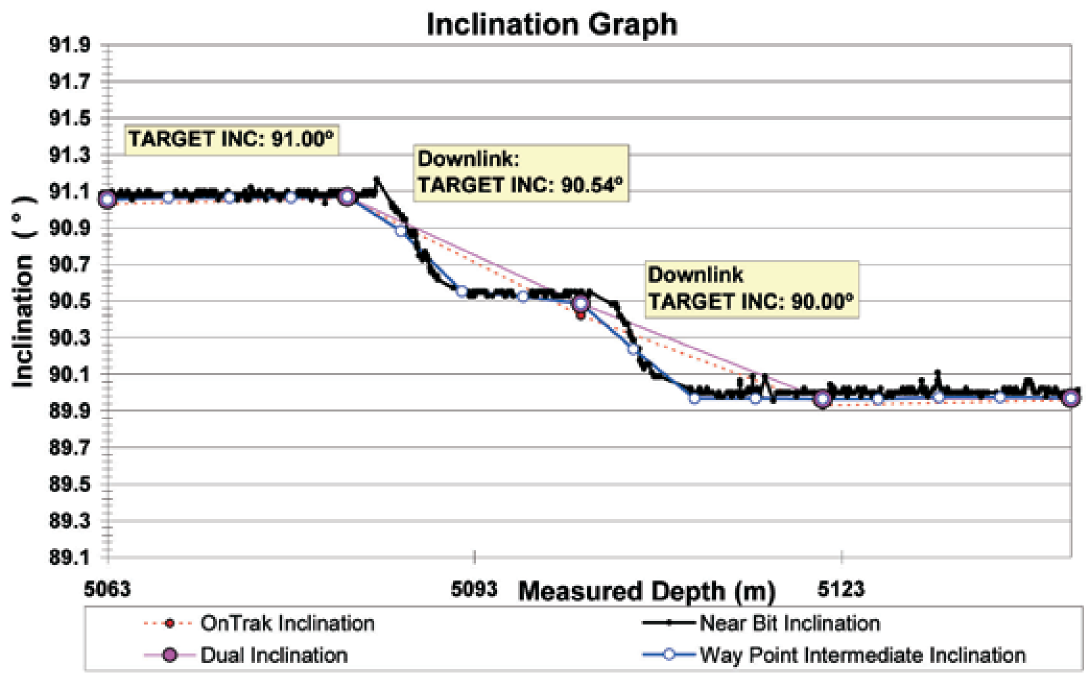
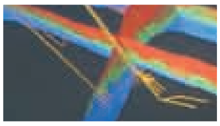


Figure 2 - The black curve shows "Near Bit Inclination" (NBI) data which is measured and reported continuously close to the bit at high speed. Inclination provided by the directional survey sensors (red curve) is subsequently combined with this NBI data (blue curve) using proprietary Survey Management algorithms to provide a more accurate definition of the wellbores vertical position and its associated uncertainties.



> One advantage of the company's family of rotary closed loop steering systems is that they physically reference the steering vector direction to the wells' trajectory.

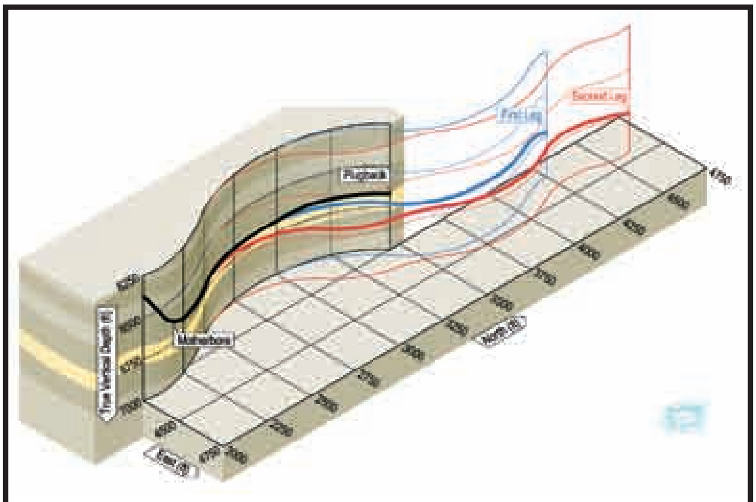


Figure 3 - Using the closed-loop steering control of INTEQ's CoilTrak service, wells drilled on coiled tubing can extend further and be more precisely positioned than ever before for improved drilling efficiency and optimized recovery.

Automated Steering Available in a Wide Range of Services

Closed loop steering control is central to the functionality contained in a wide range of the company's directional drilling services for application to suit different well types in different physical and fiscal environments. These services include:

Specifically designed to drill perfectly vertical wells with high efficiency and hole quality. This is a non-rotating system driven by a high powered drilling motor using automated closed-loop steering control. VertiTrak systems drilling vertical wells at high ROP to target and deliver outstanding hole quality. They are especially suited for use in areas where local geology has a tendency to force vertical wells off planned trajectory or poor hole quality leads to other operational problems.

Specifically designed to efficiently and accurately drill low angle wells (typically <30º inclination), TruTrak is a non-rotating system using automated closed-loop steering control driven by a high powered drilling motor. These systems are ideally suited to wells having basic trajectories of relatively low inclination and are a highly cost-effective method of drilling them precisely to target.

AutoTrak™ G3.0 RCLS – INTEQ's workhorse rotary closed-loop steerable (RCLS) service, efficiently delivering precise wellbore placement and excellent hole quality in a wide range of applications and environments including complex 3D wells, multilaterals and ERD projects. This system is also ideal for geosteering applications when run in conjunction with the company's formation evaluation LWD services by expert geosteering engineers.

One advantage of the company's family of rotary closed loop steering systems is that they physically reference the steering vector direction to the wells' trajectory. This allows steering control of AutoTrak to remain precise and reliable even when torsional stick-slip vibration is present while drilling ahead. Torsional vibration is frequently unavoidable in complex or ERD wells as well as simpler profiles drilled with lower specification rigs. As a result, it is critical that the drilling system's steering vector direction is physically referenced to the borehole wall to ensure precise steering is maintained even when stick-slip torsional vibration is present. Unfortunately, many RSS's promoted as 'fully rotating' lack this critical capability and risk missing targets or adding unwanted tortuosity to the wellbore.

Another advantage of AutoTrak systems is that their steering mechanism is neither wholly "push-the bit" nor

"point-the bit". The mechanism used in all AutoTrak systems is described as a "hybrid" of point and push, floating between these two operating extremes as the requirements of the well dictates. When initiating a change to wellbore trajectory (eg end of a tangent, commencing a 3D turn), the bit is immediately pushed to the side by applying precisely controlled continuous forces against the borehole wall. This is operating predominantly in the "push-the-bit" mode. Once a few feet of the new curvature is drilled, the steering mechanism is then used to bend the bottom hole assembly into the new curvature and effectively "point-the-bit" in the direction to be steered, thus operating in a predominantly "point-the-bit" principle. This "hybrid" principle provides more precise steering than pure "point-the-bit" systems while simultaneously providing better hole quality than pure "point-the-bit" systems. In multi-lateral wells, this hybrid steering principle is also proven to facilitate efficient and on-depth sidetracking operations.

As of March 2008, INTEQ's automated directional drilling systems have been used to drill over 600,000 feet of hole in the Kingdom of Saudi Arabia, positioning wells precisely for the long term value of improved production and increased field recovery.

Summary

With 20 years experience in developing, implementing and refining automated directional drilling, INTEQ have a long track record in this field.This technology is available in a wide range of service offerings and is not reserved for only the most demanding wells in the highest cost environments. Closed loop steering is now utilized widely from vertical wells and "simple" low angle trajectories in low cost environments right through to the most complex wells on the worlds highest cost and highest profile projects. As testament to the benefits delivered by INTEQ's range of automated closed-loop directional drilling capabilities, these services have been utilized on at least 15 of the worlds' top 20 ERD wells and the worlds' most demanding multi-lateral field development projects (see Figure 4).

This industry-leading capability has been solidly built over time and continues to advance. Looking to the future, with the introduction of high-speed wired drillstring telemetry from IntelliServ Incorporated, it is anticipated that another step change in the automation of directional drilling control will be enabled. Using the company's core competency in this area, this will include driving further improvements to safety and operational efficiency of the drilling industry while simultaneously enhancing the quality of the delivered wellbore for gains in production and ultimate field recovery.

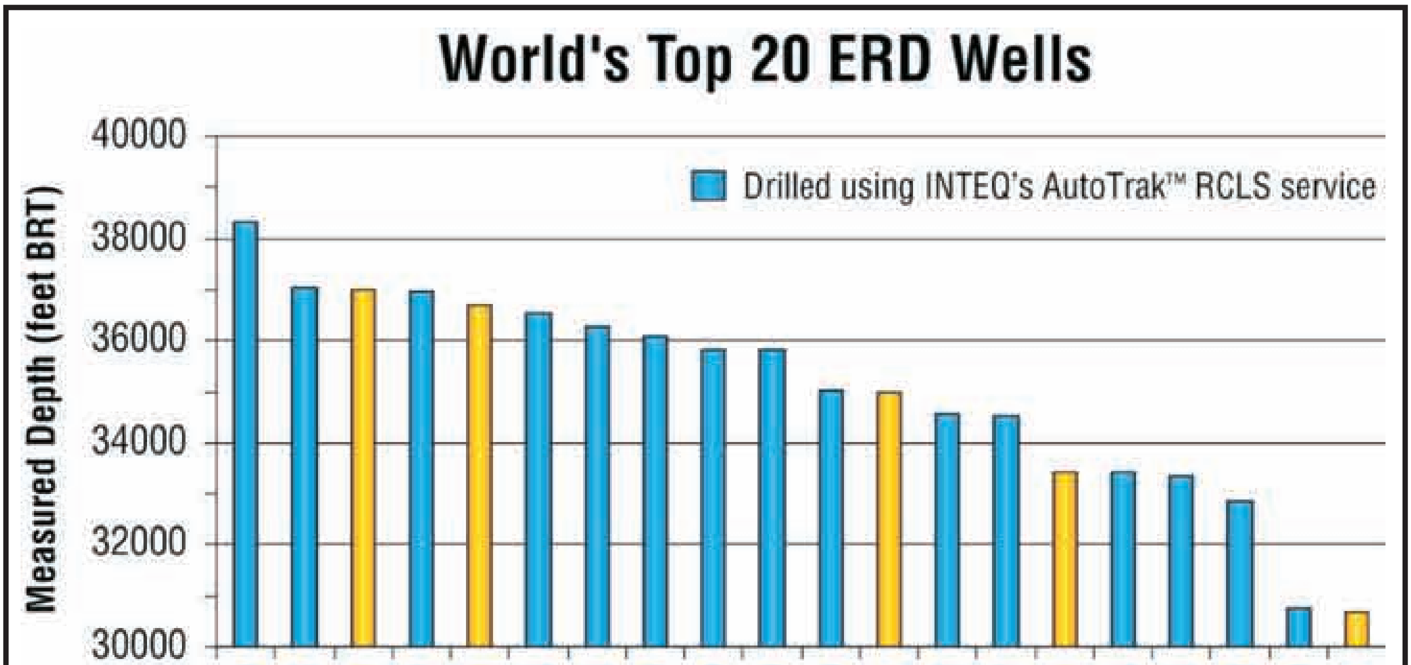
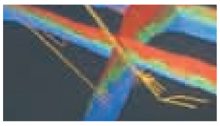


Figure 4 - As testament to the unique value delivered, INTEQ's automated directional drilling services have been used to drill 15 of the worlds' top 20 ERD wells.



Rotary Steerables Drill Faster, Better Holes

When combined with modern logging-while-drilling tool systems, rotary steerable systems are unmatched in their ability to steer wells to the best place in the least time.

The advantage of rotary steerable systems is found in their name - they rotate to their targets. By eliminating the sliding drilling mode required for directional drilling using mud motors and adjustable bent subs, penetration rate is increased and borehole trajectory is optimized. Better quality holes result because drillstring rotation facilitates hole cleaning and results in smoother wellbores. This in turn enables casing to be run and cemented more efficiently. Drillpipe sticking risk is greatly reduced as is the axial friction which helps drill long lateral sections. The world's record extended reach boreholes were all drilled using rotary steerable systems.

The Powerdrive family is an extensive line of rotary steerable drilling systems (RSS) whose system's parts all rotate at drillstring RPM. This enhances hole cleaning efficiency, wellbore quality, and reduces lost-in-hole potential due to mechanical or differential sticking. They can drill hole sizes ranging from 3 7/8" to 26".

The systems can be used in virtually all drilling applications including coiled tubing drilling, casing directional drilling, conventional and expandable liner drilling, deepwater drilling, extended reach drilling, vertical drilling, river crossings and thru-tubing rotary drilling.

Flexible bottomhole assemblies are available for any application. The family contains specially-engineered rotary steerable systems that address operators' unique requirements. For example, the PowerDrive Xceed* system is for harsh, rugged environments, and is suited for openhole sidetracking, steering in over gauge hole and in soft-formations (Fig. 1). With internal steering mechanisms, the system is particularly adapted for drilling highly-abrasive formations that cause problems for traditional steerable systems. Minimal wellbore dependence also allows the system to directionally drill and steer with bi-center bits. In 2006 Xceed 900 was added to the range and covers 311.15 mm (12 ¼ in.) to 374.7 mm (14 ¾ in.) hole sizes.

One of the many features of the technology is a "hold-the-line" capability. A closed-loop system allows the system to follow the desired wellbore trajectory and automatically corrects inclination and azimuth. The feature enables accurate, efficient drilling of long tangent sections or staying inside tight target windows to place wells optimally within a narrow formation. Drillers can focus on drilling efficiency and reach TD in less time, confident that the well has been steered properly. In addition, the system does not require a pressure drop across the bit to operate. This feature gives drillers the flexibility to optimize hydraulics and drill extended-reach wells without exceeding rig pressure limits.

In Qatar, the system enabled drillers to stay within a thin sand body of the Nahr Umr reservoir for a distance of 2,006 m (6,581-ft.) representing 99% coverage of the sand, and more than 90% of the drainhole section was placed within the highest quality portion of the reservoir. During drilling, the rotary steerable system turned the wellbore trajectory through 90° at an extended step-out from the surface location. Under extreme drilling

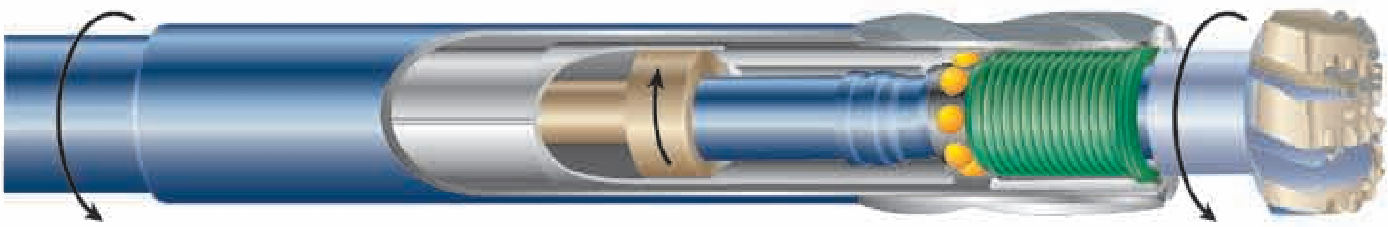
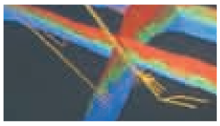


Figure 1 - At the heart of the fully rotating technology is a continuously rotating internal cam that changed the angle of the drive shaft, keeping the bit pointed in the desired direction at all times.



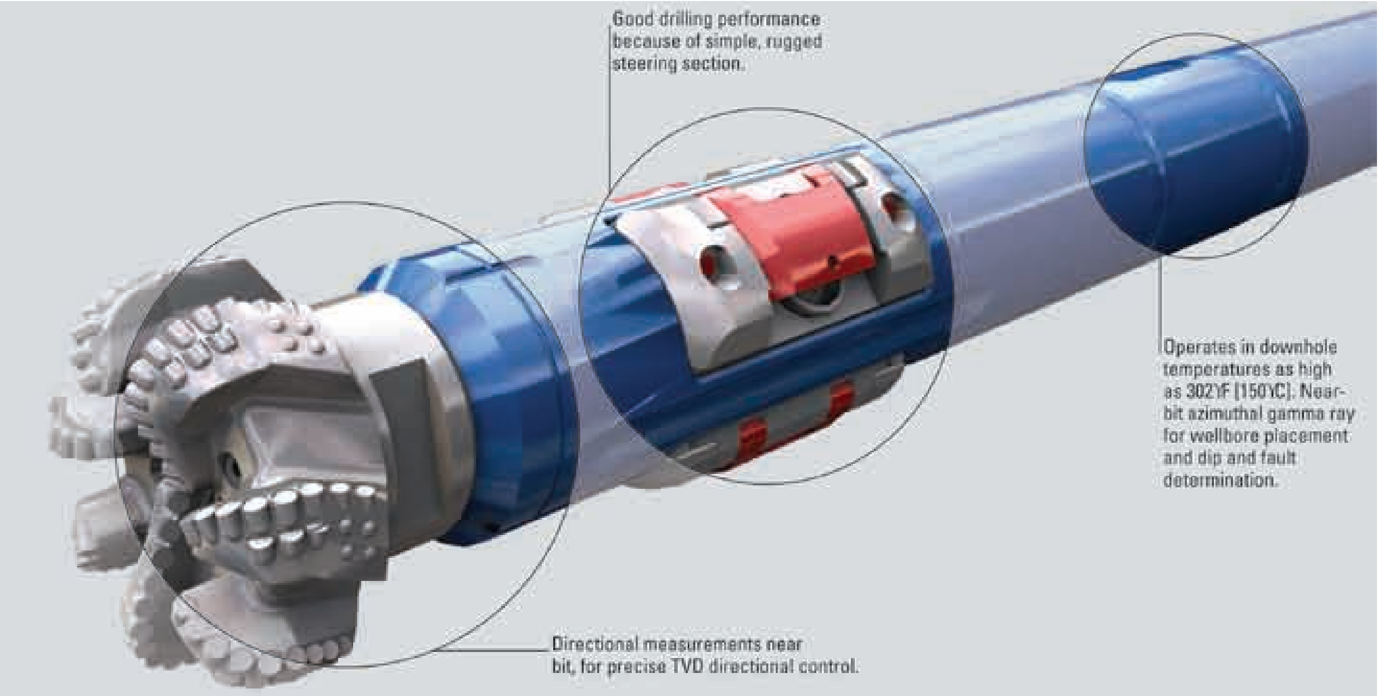


Figure 2 - PowerDrive X5*.

conditions, the system routinely exceeds the limits of conventional technology.

The rotary steerable system (Fig. 2) is designed and engineered to drill from the casing shoe to TD (or to the next casing point) in a single trip at maximum penetration rates. These benefits evolve from a robust steering section and advanced coating materials that protect against wear under a wide range of drilling conditions, as well as optimized flow profiles inside and outside the tools that reduce erosion of downhole components and facilitate hole cleaning.

These systems feature near-bit measurements, including azimuthal gamma ray and triaxial azimuth and inclination directional information. These are available in real-time, to give the driller "eyes" downhole. Near-bit data helps detect bed boundaries, coring and casing points.

Another family member, PowerDrive vorteX* powered rotary steerable system integrates a high torque power section with rotary steerable technology for optimum performance in hard-rock. The system also prevents downhole vibration damage, and lowers the risk of drillstring fatigue and excess casing wear in hole sections with high doglegs. It also enables efficient drilling using rigs with lower power specifications.

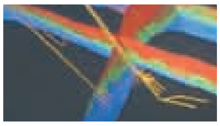
PowerV* is a fully rotating vertical drilling system that automatically drills an optimized vertical well. It senses if borehole inclination is building and automatically steers to vertical. Once vertical, any deviation is corrected automatically. Therefore, little to no directional interaction or supervision is needed to operate the system.

It requires no MWD system to function, although such systems or simple inclination-only devices can be used to provide directional information. Drilling operations can be simplified because dedicated rig site personnel can be reduced. This adds to the system's cost efficiency and reduces HSE exposure to personnel.

The system also can run below a motor power section. It permits bit selection and weight on bit to be optimized for specific formations rather than be compromised through the need to slide with a conventional motor or to avoid deviating from vertical. Cost savings are realized through increased ROP and elimination of potential correction runs.

Fully compatible with all logging-while-drilling systems, the technology enables precise geosteering. Geosteering allows the directional driller to react to actual downhole geological conditions as they are encountered. In one recent well completed on Alaska's North Slope, the objective was to drill a horizontal well for a distance of 2,036 m (6,678-ft) through a thin sand body that varied from 3 m (10-ft) to 1.5 m (5-ft) in thickness. Unknown to the operator and the members of the drilling team, the sand body contained undulations and faults not visible on the seismic section. Seeing these obstacles in real time using PeriScope bed boundary mapper before drilling out of the reservoir, the directional driller was able to make 13 separate steering changes to stay in the sand body. As a result, the well achieved 92.5% coverage in the target reservoir. The smooth wellbore trajectory and excellent hole conditions provided by the RSS make rapid steering changes easy, and prevent the necessity to drill side tracks to stay within the reservoir body.

*Mark of Schlumberger



Drilling Suite Delivers High ROPs, Improved Hole Quality, and Optimal Wellbore Placement

Advances in rotary steerable drilling technology in the past decade have enabled tremendous gains in directional drilling efficiency, achieving significantly faster ROPs (rates of penetration) while optimizing hole quality and wellbore placement to enhance the production from reservoirs in an ever-expanding range of geologic settings.

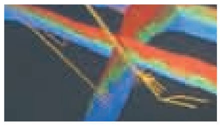
Sperry Drilling Services, a product service line of Halliburton, in collaboration with Japan Oil, Gas, and Metals National Corporation and Security DBS, developed a rotary steerable drilling system that can produce the highest-quality wellbore in demanding directional drilling applications. The Geo-Pilot® rotary steerable system, a second-generation, point-the-bit technology, is combined with a Security DBS extended-gauge PDC or roller cone bit to create the patented FullDrift geometry, yielding smoother wellbores and lower vibration. The technology combines with the company's new LWD (logging while-drilling) sensors and real-time rig information monitoring to create a fast and accurate rotary steerable drilling system.

In some cases, the full functionality of the system may be too much for the application, while the functionality and efficiency of a conventional directional assembly may not be enough. For these applications, the company offers a performance drilling solution which combines an enhanced performance range motor with new 3D-i drilling optimization software. This pulls together all critical drilling parameters and limit alarms on one computer screen, while also providing a downhole motor simulator to model, measure, and optimize motor performance every foot of the way. This powerful combination of downhole technology and computer modelling allows the Performance Drilling system to achieve superior performance over conventional motor assemblies. The result: faster ROP's, especially while sliding, and significantly reduced NPT (nonproductive time) and overall well cost.

The systems are typically run with LWD services and ADT® Drilling Optimization services using pressure-while-drilling and drillstring dynamics (vibration) sensors to provide a complete pre-well planning and real-time drilling and formation evaluation package.

State-of-the-Art Rotary Steerable Technology

Considered by many to represent the state of the art in rotary steerable technology, the system was designed specifically for complex well trajectories in which limitations in hole cleaning efficiency and excessive torque or drag are known to inhibit drilling operations. Sensors near the bit transmit continuous downhole data streams that enable operators to evaluate formations and monitor well trajectory in real time, better tracking the directional behavior of the drilling assembly and helping to ensure that the wellbore is optimally positioned in the targeted reservoir.

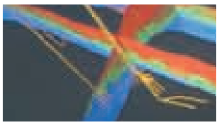


The FullDrift concept, employed on both the RSS and Motor systems, has consistently demonstrated in numerous applications the ability to minimize non-constructive bit behaviors caused by short-gauge, side-cutting bits, thus increasing daily footage drilled, helping eliminate hole spiraling, and improving directional control.

The rotary steerable system eliminates drilling delays associated with controlling or adjusting competitive systems. In the course of a day, such small delays can add up to a significant amount of NPT; just one to two hours of downlinking each day in an area of high well spread costs can result in $25,000/day or more in hidden rig costs. In contrast, the system is adjusted "on the fly" while on bottom drilling, making it virtually invisible to the drilling operation. The Geo-Span® downlinking system provides two-way communication with the system, and can be controlled from a Remote Operations Center (ROC™) hundreds of miles away while the system is on bottom drilling.

The high-quality wellbores produced by these systems also minimize rig time by allowing operators to eliminate circulating time and conditioning runs, reduce the frequency of short trips, and eliminate bit trips and downhole failures. In some instances, open-hole friction factors in wells drilled using the system have been lower than calibrated cased hole values. Hole quality is especially critical for lean casing programs, in which, for example, an operator might run 13-5/8-inch flush joint casing in a 14-3/4-inch hole. Some operators have specifically recommended the FullDrift drilling concept in their internal best practices documents for running expandable casing or completion screens. In addition, excellent hole quality can make wireline logging in wells with inclinations of up to 60° much more successful. On one project for a major Gulf of Mexico deepwater operator, pipe-conveyed logging had become standard practice on wells drilled above 50° with push-the-bit rotary steerable systems prior to the introduction of the system. After seeing the consistent hole quality improvement produced by the RSS system with the specialised RSS bit, the operator chose to conventionally log the well, which resulted in significant savings by eliminating rig time and costs associated with pipe-conveyed logging.

The FullDrift concept, employed on both the RSS and Motor systems, has consistently demonstrated in numerous applications the ability to minimize non-constructive bit behaviors caused by short-gauge, side-cutting bits, thus increasing daily footage drilled, helping eliminate hole spiraling, and improving directional control. This enables more precise wellbore placement while increasing drilling efficiency through easier casing runs, fewer short trips, less NPT, and reduced overall time required to achieve drilling objectives.



Rotary Steerables:
From Routine to Extreme

Rotary Steerable Systems (RSS) outperform conventional directional systems by significantly improving the drilling process through better hole cleaning, higher rates of penetration (ROPs), precise directional control and extended reach of horizontal wells. Weatherford's Revolution RSS uses "point-the-bit" technology to deliver a gun-barrel in-gauge wellbore. The high-quality wellbore provides significant benefits, including improved formation evaluation, reduced drilling-fluid costs, easier installation of tubulars and enhanced production.

Enhancing the capabilities of the rotary steerable system is the company's logging-while-drilling (LWD) system, which provides key downhole data to optimize wellbore placement.

Deep and High Pressure Well

In the Green Canyon section of the Gulf of Mexico, a major operator was drilling a vertical exploration well from a drillship, the daily operating costs of which approached US$500,000.

At close to 29,000 feet (8,839 meters), the 8 1/2-inch hole started to drift away from the vertical position. To solve the problem, Weatherford deployed its RSS combined with its MWD and LWD systems, and within 24 hours drilling was once again back on target. Successfully operating the Revolution RSS at this extreme pressure and depth remains a Gulf of Mexico drilling record.

The well ultimately reached total depth at more than 34,000 feet (10,363 meters) - nearly 6.5 miles, or 10.4 kilometers. This achievement broke the previous record depth of 32,727 feet (9,975 meters) - 6.2 miles, or 10.0 kilometers - set earlier in 2005 by Shell, which also used the company's LWD system. The RSS and LWD systems performed without incident, transmitting real-time data at 99 percent pulse efficiency and recording triple-combo log data in these extremely hostile conditions. (Temperatures reached 280°F, or 138°C, and pressures exceeded 30,000 pounds, or 207 megapascals, the official pressure rating of the LWD system.)

Using a conventional mud motor rather than the RSS to bring this well back to vertical would not have been successful, say the operator's engineers involved in this project. The RSS saved millions of dollars in rig operating costs and accomplished the drilling objectives without failure.

Extended-Reach Application

An operator in Libya wanted to drill a long, 6 1/2-inch lateral in the Al Jurf field offshore Libya, but previous attempts had been unsuccessful. Drilling with a mud motor past 12,000 feet (3,659 meters) was extremely difficult because sliding the drill bit forward - necessary to orient the mud motor - was impossible beyond 11,873 feet (3,619 meters).

The solution utilised the company's rotary steerable and a move up from 3 1/2- to 4 -inch drillpipe. The Revolution system was brought in for the build and the lateral, drilling to a total depth of 15,569 feet (4,745 meters). The ROP through the El Gueria limestone averaged 31.2 feet (9.5 meters) per hour in the build section (which included a 16-degree left-hand turn) and 29.5 feet (9.0 meters) per hour for the entire section.

The record depth set for this well exceeded that of the previous well by 2,411 feet (735 meters) and gave the operator access to reserves that had previously been unreachable.

The company's RSS is designed specifically for directional, extended-reach, short-radius performance in deeper and hotter drilling environments.

Weatherford's point-the-bit technology uses a near-bit stabilizer to orient the axis of the drill bit with that of the hole. This technology improves wellbore quality by reducing ledging, spiraling, tortuosity and gauge problems.

Drilling Fluids

An Innovative Manganese Tetra-Oxide/KCl Water-Based Drill-in Fluid for HT/HP Wells

By A.S. Al-Yami, H.A. Nasr-El-Din, Saudi Aramco, A. A. Al-Majed and H. Menouar, King Fahd University of Petroleum & Minerals, All SPE members

Reservoir Characterization

Ginest showed reservoir characterization of Pre-Khuff Unayzah reservoir. The pre-Khuff Unayzah gas reservoir is sandstone formation with two sand units Unayzah-A and B with a siltstone in the middle of them. The Unayzah-A reservoir is around 200 ft thick consisting of fine to coarse grains. Also cross bedded dunes sands are presented that prograding toward the east possibly due to winds blowing east to west. The prograding results in strong permeability anisotropy. Quartz overgrowth is observed in Unayzah-A reservoir, which results in reduction in porosity. Some literature states 7-8% average porosities. The average permeability in the Unayzah-A ranges from 1 to 6 md.

The siltstone unit that varies Unayzah–A and Unayzah–B has different range of thickness from 10 to 155 ft. It is composed of fine sandstones and siltstones. It is considered to be a barrier between the two reservoirs.

Below this barrier, Unayzah-B reservoir is present. It has a gas water contact. The depth of the Unayzah-B reservoir depends on the varying of well bore penetration compared to the gas water contact. Unayzah-B reservoir composed mainly from sandstone of fluvial origin. Sandstones are the main components of the reservoir with extensive quartz overgrowth and very frequent horizontal to low angle fractures. Unayzah-B has slightly lower porosity than Unayzah-A. However, it has lower content of clays and thus it is considered to be more productive than Unayzah-A reservoir. Low content of clays in general means more permeability. It is not clear that the fractures in the Unayzah-B improve productivity. Average permeability of Unayzah-B ranges from 10 to 30 md.

The condensate to gas ratio averages 150 bbl/MMSCF. The initial reservoir pressure is 6,300 psi and the gas dew point is 300-400 psi below that. When bottom hole flowing pressures falls below the dew point, condensate banking will result in a short time. Due to the above two reasons, MRC wells were drilled to to reduce draw down. Also the MRC wells will reduce water conning by isolating Unayzah-B from Unayzah-A.

In general, the bottom hole static temperature of this pre-Khuff reservoir ranges from 280 to 305°F. The reservoir depth is greater than 14,000 ft and the initial reservoir pressure is almost 8,500 psi. Wells drilled in the Unayzah reservoir have the potential to deliver large quantities of sweet gas and condensate, but surely can be damaged during drilling.

Results and Discussion

In this article, the characterization of the typical drill in fluids is discussed. The typical water based drill-in fluids discussed are potassium formate/$CaCO_3$ and KCl/$CaCO_3$/barite fluids. Then, the designing steps of the KCl/Mn_3O_4 water-based drill-in fluids are explained. Several KCl/Mn_3O_4 water-based drill-in fluids were designed and their performances were compared to the the typical drill-in fluids mentioned above. The performance characterization of the three drill-in fluids included testing of rheological properties, filtration (API and HT/HP) and thermal stability.

KCl/$CaCO_3$/Barite Drill-In Fluids

Although the use of barite is not recommended to drill reservoirs, it is used to formulate high density drill-in fluids. Table 1 shows a typical drill-in fluid's formulation used to drill Unayzah-B reservoir. The table also shows the function of each additive used and its amount to formulate one bbl.

$CaCO_3$ medium and fine were used almost in 1:3 ratio. A previous study suggested that a use of 1:3 ratio is recommended to rapidly bridge the reservoir.

The presence of oxygen in drill-in fluids can accelerate corrosion rates. Oxygen scavenger can be to remove the oxygen. Sodium sulfite is an example of oxygen scavenger as shown in equation 1:

$$O_2 + 2\ Na_2SO_3 = 2Na_2SO_4$$

Additive	Function	Field Unit	Field Amount	Lab Unit	Lab Amount
Water	Base	Bbl	0.8	grams	280.0
Deformer	Anti-foam	Gal	0.01	grams	0.83
XC-Polymer	Viscosifier	Lb	1.0	grams	1.0
Starch	Fluid loss	Lb	6.0	grams	6.0
PAC-R	Fluid loss/ Viscosifier	Lb	0.75	grams	0.75
KCl	density and shale inhibition	Lb	41.0	grams	41.0
KOH	pH control	Lb	0.5	grams	0.5
Lime	pH control	Lb	0.25	grams	0.25
Barite	Weighting Material	Lb	205.0	grams	205.0
$CaCO_3$ (fine)	Weighting Material	Lb	7.0	grams	7.0
$CaCO_3$ (medium)	Weighting Material	Lb	3.0	grams	3.0
Sodium Sulfite	Oxygen Scavenger	Lb	0.75	grams	0.75

Table 1 - Conventional $CaCO_3$/barite drill-in fluid formulation used to drill Unayzah-B reservoir.

The drill-in fluid properties were measured. These properties include: PV, YP, Filtration (API and HT/HP), filter cake thickness, and drill-in fluid pH. Table 2 gives the properties for the $CaCO_3$/barite drill-in fluid before hot rolling.

To assess thermal stability, the drill-in fluid was aged for 16 hours at 300 °F and the properties were measured again as shown in Table 3. Exposure of drilling fluids to temperature might change the fluid's rheology and filtration. After aging the $CaCO_3$/barite drill-in fluid, its rheological properties (PV, YP and gel strength) were reduced. PV was reduced from 29 to 15 cp and YP from 29 to 12 lb/100 ft^2. Gel strength reading for 10 seconds was reduced from 8 to 4 lb/100 ft^2. Gel strength reading for 10 minutes was reduced from 15 to 4 lb/100 ft^2. However, the drill-in fluid was used to drill reservoirs at 300°F with success. A previous study showed similar range of rheological values at 300°F for drilling fluids used in the field. The filtration increased from 7 to 10 ml/30 minutes as a result of the reduction in the rheological properties. Phase separation was observed after hot rolling the drill-in fluid sample for 16 hours.

Potassium Formate Drill-In Fluids

Potassium formate is also considered as a typical drill-in fluid for Unayzah-B reservoir. Table 4 shows a typical drill-in fluid's formulation used to drill Unayzah-B reservoir. The table also shows the function of each additive used and its amount to formulate 1 bbl.

The properties of potassium formate were measured. These properties include PV, YP, Filtration (API and HT/HP), filter cake thickness for each filtration test and pH. Table 5 shows the properties for the $CaCO_3$/barite drill-in fluid.

Similar to $CaCO_3$/barite drill-in fluid, $CaCO_3$/ potassium formate drill-in fluid showed reduction in PV, YP and gel strength, Table 6. PV was reduced from 28 to 20 cp and YP from 22 to 9 lb/100 ft^2. Gel strength reading for 10 seconds was reduced from 4 to 2 lb/100 ft^2. Gel strength reading for 10 minutes was reduced from 6 to 3

Property	Conditions	Unit	Value
Density	75 °F and 14.7 psi	pcf	95.0
600 rpm	120 °F and 14.7 psi	Dial reading	87.0
300 rpm		Dial reading	58.0
200 rpm		Dial reading	45.0
100 rpm		Dial reading	30.0
6 rpm		Dial reading	7.0
3 rpm		Dial reading	6.0
10 seconds gel		lb/100 ft^2	8.0
10 minutes gel		lb /100 ft^2	15.0
PV		cp	29.0
YP		lb/100 ft^2	29.0
API filtrate	75 °F and 100 psi	ml /30 min	3.2
Filter Cake Thickness		inch	1/32
HT/HP filtrate	300 °F and 500 psi	ml /30 min	7.0
HT/HP Filter Cake Thickness		inch	2/32
pH	75 °F and 14.7 psi	------	10.0

Table 2 - Conventional $CaCO_3$/barite drill-in fluid used to drill Unayzah-B reservoir properties before hot rolling.

Property	Conditions	Unit	Value
Density	75 °F and 14.7 psi	pcf	95.0
600 rpm	120 °F and 14.7 psi	Dial reading	42.0
300 rpm		Dial reading	27.0
200 rpm		Dial reading	20.0
100 rpm		Dial reading	13.0
6 rpm		Dial reading	3.0
3 rpm		Dial reading	2.0
10 seconds gel		lb/100 ft^2	4.0
10 minutes gel		lb/100 ft^2	4.0
PV		cp	15.0
YP		lb/100 ft^2	12.0
API filtrate	75 °F and 100 psi	ml /30 min	3.5
Filter Cake Thickness		inch	1/32
HT/HP filtrate	300 °F and 500 psi	ml /30 min	10.0
HT/HP Filter Cake Thickness		inch	2/32
pH	75 °F and 14.7 psi	-----	10

Table 3 - Conventional $CaCO_3$/barite drill-in fluid used to drill Unayzah-B reservoir properties after hot rolling.

minutes. PV value did not change greatly and YP was reduced from 72 to 55 Lb/100 ft^2. HT/HP filtrate was 13.5 ml/30 minutes compared to 10 with KCl/$CaCO_3$/barite and 7 ml/30 min with potassium formate drill-in fluids. There are two limitations of the formulation. The first one is the high rheological properties that should be reduced to improve drilling performance. The second limitation is the high fluid loss which should be reduced to minimize formation damage.

In order to overcome the above limitations, $CaCO_3$ weighting materials were added in different concetration and in different ratio. Also, different polymers were used such as resinex, soltex and starch to investigate their affects on Mn_3O_4 water-based formulations.

lb/100 ft^2. However, filtration control did not change. It showed much lower filtration loss compared to $CaCO_3$/barite drill-in fluid.

Phase separation was also observed after hot rolling at 300ºF the drill-in fluid sample for 16 hours.

Mn_3O_4 Drill-In Fluid Formulations

The first formula, shown in Table 7, contains 41 lb/bbl of KCl which is the common concentration used in the field. KCl is used for clay inhibition.

Manganese Tetraoxide was used only in the formula without $CaCO_3$ to evaluate its filtration performance. XC-polymer, PAC-R and Resinex were used to evaluate their rheological performance, Table 8.

The API filtrate was almost double the amount of filtrate from the two typical drill-in fluids. Rheological properties (gel strength, PV and YP) were much higher than the typical drill-in fluids' properties. The use of drilling fluids with too high rheological properties can decrease penetration rate, high swabbing and gas flow. Table 9 shows the properties of the fluid after aging for 16 hours at 300ºF.

The API filtrate increased from 7.8 to 11 ml/30

Data Analysis

Yield Point Measurments

Yield Point measurements for 17 formulations tested in designing the Mn_3O_4 drill-in fluids. In formulations (1st-4th), resinex polymer was used. It resulted in high YP values more than 80 lb/100 ft^2 in some formulations. Therma check polymer was used in the 5th-7th formulations resulting in high YP values. Starting from the 8th formulation, using PAC-R, YP values were reduced to acceptable range (30-40 lb/100 ft^2). This

Additive	Function	Field Unit	Field Amount	Lab Unit	Lab Amount
Water	Base	Bbl	0.14	grams	48.65
Potassium Formate	density and shale inhibition	Bbl	0.86	ml	301.14
Starch	Fluid loss	Lb	6.0	grams	6.0
Deformer	Anti-foam	Gal	0.01	grams	0.08
XC-polymer	Viscosifier	Lb	0.5	grams	0.5
PAC-R	Fluid loss/ Viscosifier	Lb	1.0	grams	1.0
PAC-R-Low	Fluid loss/ Viscosifier	Lb	4.0	grams	4.0
Soda Ash	pH control	Lb	1.0	grams	1.0
Sodium bicarbonate	Buffer	Lb	0.5	grams	0.5
$CaCO_3$ (fine)	Weighting Material	Lb	15.0	grams	15.0
$CaCO_3$ (medium)	Weighting Material	Lb	5.0	grams	5.0
Sodium Sulfite	Oxygen Scavenger	Lb	0.75	grams	0.75

Table 4 - Conventional CaCO3/potassium formate drill-in fluid formulation used to drill Unayzah-B reservoir.

Property	Conditions	Unit	Value
Density	75 °F and 14.7 psi	pcf	95.0
600 rpm	120 °F and 14.7 psi	Dial reading	78.0
300 rpm		Dial reading	50.0
200 rpm		Dial reading	39.0
100 rpm		Dial reading	26.0
6 rpm		Dial reading	6.0
3 rpm		Dial reading	4.0
10 seconds gel		lb/100 ft^2	4.0
10 minutes gel		lb/100 ft^2	6.0
PV		cp	28.0
YP		lb/100 ft^2	22.0
API filtrate	75 °F and 100 psi	ml /30 min	3.5
Filter Cake Thickness		inch	1/32
HT/HP filtrate	300 °F and 500 psi	ml /30 min	6.5
HT/HP Filter Cake Thickness		inch	1/32
pH	75 °F and 14.7 psi	---	10.5

Table 5 - Conventional $CaCO_3$/potassium formate drill-in fluid formulation used to drill Unayzah-B reservoir properties before hot rolling.

indicates that using PAC-R provided YP values close to typical drill-in fluids used to drill Unayzah-B.

API filtration measurements for the 17 formulations tested in designing the Mn_3O_4 drill-in fluids. In formulations (1st-4th), resinex polymer was used with different ratios of $CaCO_3$. The filtration did not change significantly due to the addition of $CaCO_3$ with values ranging from 7.2 to 7.8 ml/30 minutes.

Therma check polymer was used with different ratios of $CaCO_3$ (medium and fine) in the 5th-7th formulations. The filtration control did not improve with values ranging from 7.5 to 6.5 ml/30 minutes before hot rolling and 11 to 7.5 ml/30 minutes after hot rolling.

In formulations (8th-15th), PAC-R was used with different ratios of $CaCO_3$ (medium and fine). $CaCO_3$ was added after Mn_3O_4 in the 8th-11th formulations resulting in high fluid loss values up to 13 ml/30 minutes. In the 12th formulation, $CaCO_3$ was added before Mn_3O_4 material. This change in order of addition resulted in a reduction in fluid loss from 13 to 10.6 ml/30 minutes. Mn_3O_4 has smaller particle size than $CaCO_3$, so the efficiency of $CaCO_3$ bridging materials will be less if being added after Mn_3O_4.

Soltex polymer was added in the 14th and 15th formulations resulting in 9 and 8.5 ml/30 minutes. However, the fluid loss values were still high and more filtration control is needed.

Starch was added in the 16th formulation with 3.5 lb/bbl $CaCO_3$ fine and 1.5 $CaCO_3$ medium resulting in 5.5 ml/30 minutes before hot rolling and 6.5 ml/30 minutes after hot rolling. In the 17th formulation, $CaCO_3$ was not added and fluid loss values of 9 ml/30 minutes before hot rolling and 11 ml/30 minutes after hot rolling were recorded. This shows the need of using $CaCO_3$ material with starch to control the filtration in Mn_3O_4 drill-in fluids.

Optimum Concetration of $CaCO_3$ Weighting Material

Additional three formulations similar to the 16th and 17th formulations were prepared. The variable in these five formulations was the amount of $CaCO_3$. The objective of this testing is to find the optimum concentration of $CaCO_3$ needed with Mn_3O_4 drill-in fluid.

Property	Conditions	Unit	Value
Density	75 °F and 14.7 psi	pcf	95.0
600 rpm	120 °F and 14.7 psi	Dial reading	49.0
300 rpm		Dial reading	29.0
200 rpm		Dial reading	20.0
100 rpm		Dial reading	12.0
6 rpm		Dial reading	2.0
3 rpm		Dial reading	1.0
10 seconds gel		lb/100 ft^2	2.0
10 minutes gel		lb/100 ft^2	3.0
PV		cp	20.0
YP		lb/100 ft^2	9.0
API filtrate	75 °F and 100 psi	ml /30 min	3.5
Filter Cake Thickness		inch	1/32
HT/HP filtrate	300 °F and 500 psi	ml /30 min	7.0
HT/HP Filter Cake Thickness		inch	1/32
pH	75 °F and 14.7 psi	-----	10.5

Table 6 - Conventional $CaCO_3$/potassium formate drill-in fluid formulation used to drill Unayzah-B reservoir properties after hot rolling.

Additive	Function	Field Unit	Field Amount	Lab Unit	Lab Amount
Water	Base	Bbl	0.822	grams	287.7
Deformer	Anti-foam	Gal	0.01	grams	0.08
XC-polymer	Viscosifier	Lb	1.5	grams	1.5
PAC-R	Fluid loss/ Viscosifier	Lb	1.25	grams	1.25
Resinex	HT Fluid loss	Lb	6	grams	6
KCl	density and shale inhibition	Lb	41	grams	41
KOH	pH control	Lb	0.5	grams	0.5
Mn_3O_4	Weighting Material	Lb	205	grams	205

Table 7 - Mn_3O_4 drill-in fluid (1st formulation).

The gel strength measurements (10 seconds and 10 minutes). The addition of $CaCO_3$ increased the gel strength of the drill-in fluid. The highest gel strength was obtained with using 5 lb/bbl $CaCO_3$.

The plastic viscosity relationship with the amount of $CaCO_3$. A similar trend to gel strength is observed in the plastic viscosity. The optimum point was obtained at 5 lb/bbl $CaCO_3$. Yield point was reduced by the addition of $CaCO_3$.

The addition of 5 lb/bbl $CaCO_3$ reduced the fluid loss by 39%. However, there was no more reduction as the concentration of $CaCO_3$ was increased to 20 lb/bbl.

The optimum point is using 5 lb/bbl of $CaCO_3$. Using 5 lb/bbl $CaCO_3$ resulted in the highest gel strength and plastic viscosity. It also resulted in a high Yield point and low fluid loss. The highest yield point was obtained with the formulation without $CaCO_3$. However, the fluid loss was higher by 39%. Thus using 5 lb/bbl of $CaCO_3$ formulation should be used in next phases.

Therma check or resinex polymer was selected initially because of their high temperature stability. However, both polymers provided too high YP. As the YP increases, the carrying capacity will increase. However, the pressure losses and equivalent circulation density will also increase and these can cause swabbing and lost circulation. Oxygen scavenger was added to PAC-R to extend its stability and provide good rheological properties. However, the filtration control was not good. The use of PAC-R and XC-polymers did not provide good filtration control. The addition of soltex to PAC-R and XC-polymers did not improve the filtration control. Starch should be added with PAC-R, XC and $CaCO_3$ materials to provide good rheological properties and filtration control. The

Property	Conditions	Unit	Value
Density	75 °F and 14.7 psi	pcf	95
600 rpm	120 °F and 14.7 psi	Dial reading	138
300 rpm		Dial reading	105
200 rpm		Dial reading	91
100 rpm		Dial reading	71
6 rpm		Dial reading	25
3 rpm		Dial reading	20
10 seconds gel		$lb/100\ ft^2$	11
10 minutes gel		$lb/100\ ft^2$	14
PV		cp	33
YP		$lb/100\ ft^2$	72
API filtrate	75 °F and 100 psi	ml /30 min	7.8
Filter Cake Thickness		inch	1/32
pH	75 °F and 14.7 psi		9.2

Table 8 - Mn_3O_4 drill-in fluid (1st formulation) properties before hot rolling.

Property	Conditions	Unit	Value
Density	75 °F and 14.7 psi	pcf	95
600 rpm	120 °F and 14.7 psi	Dial reading	111
300 rpm		Dial reading	83
200 rpm		Dial reading	69
100 rpm		Dial reading	52
6 rpm		Dial reading	28
3 rpm		Dial reading	15
10 seconds gel		lb/100 ft^2	10
10 minutes gel		lb/100 ft^2	12
PV		cp	28
YP		lb/100 ft^2	55
API filtrate	75 °F and 100 psi	ml /30 min	11.0
Filter Cake Thickness		inch	1/32
HT/HP filtrate	300 °F and 500 psi	ml /30 min	13.5
HT/HP Filter Cake Thickness		inch	3/32
pH	75 °F and 14.7 psi	-----	9.2

Table 9 - Mn_3O_4 drill-in fluid (1st formulation) properties after hot rolling.

best formulation to use has 5 lb/bbl $CaCO_3$ fine and medium in 3:1 ratio. $CaCO_3$ material should be added before Mn_3O_4 to improve filtration control.

Performance Comparsion of Mn_3O_4 Water Based Drill-In Fluid to Typical Fluids

The high values of gel strength of Mn_3O_4 fluid before hot rolling might be due to foaming while mixing. Additional deformer concentration can address this problem. The gel strength is a measure of the shear stress required to initiate flow of a fluid that has been quiescent for a period of time. It is indicative of the drilling fluid ability to keep the drilled cuttings and weighting materials in suspension when circulation is stopped. Mn_3O_4 fluid has higher gel strength value than that of typical drill-in fluids after hot rolling for 16 hours at 300°F and 500 psi.

The plastic viscosity shows the viscosity at high shear rates. All three drill-in fluids showed similar values before hot rolling. However, after hot rolling, Mn_3O_4 drill-in fluid was the only fluid that showed minimum reduction in PV. $CaCO_3$/barite drill-in fluid's PV reduced from 29 to 15 cp, potassium formate's PV reduced from 28 to 20 cp and Mn_3O_4 drill-in fluid's PV reduced from 30 to 27 cp.

The yield point reflects the drilling fluid ability to carry the drilled solids out of the hole. After hot rolling, Mn_3O_4 drill-in fluid was the only fluid that showed no reduction in YP. $CaCO_3$/barite drill-in fluid's YP reduced from 29 to 12 lb/100 ft^2, potassium formate's YP reduced from 22 to 9 lb/100 ft^2 and Mn_3O_4 drill-in fluid's YP reduced from 35 to 38 lb/100 ft^2.

The HT/HP fluid loss test results of the three drill-in fluids. The fluid loss reflects the amount of fluid that will be filtered from the drilling fluid into the formation. The fluid loss values of the three drill-in fluid were similar before hot rolling. After hot rolling, Mn_3O_4 drill-in fluid showed similar results to $CaCO_3$/Barite drill-in fluid's (10 and 11 ml/30 minutes). The fluid loss of potassium formate was the lowest after hot rolling (7 ml/30 minutes).

From the results above, Mn_3O_4 drill-in fluid showed better thermal stability compared to the typical drill-in fluids used in the field since YP and PV values were not changed much after aging for 16 hours at 300°F and 500 psi. There was no phase separation in the Mn_3O_4 fluid because its gel strength measurements were higher than typical drill-in fluids. The fluid loss result of Mn_3O_4 was similar to the $CaCO_3$/barite drill-in fluid which shows its potential to be used in the field.

The Event Solution: Integrated Studies Covering Risk Assessment

By Emad Elrafie, Jerry White, Fatema Awami, Saudi Aramco

Saudi Aramco is continuously implementing many new innovative techniques and approaches to assist in meeting the industry's increasing challenges. One of these innovations is the new study approach "The Event Solution." The approach leads to better synergy among different stakeholders and enables faster decisions that fully encompass the complex uncertainties associated with today's projects.

Abstract

The Event Solution is a short, intensively collaborative event that compresses major decision cycles, embraces uncertainty and provides a wider range of alternative solutions. The Event Solution approach has been implemented successfully on 24 major studies world wide, with the last 8 projects conducted on mega Saudi Aramco reservoirs. It always added significant value in terms of improved reserves recovery.

The concept is simple: identify the most important objective and focus the collective skills and creativity of a team of experts on meeting that objective in a special event that lasts just for a few weeks. The team is enabled with the latest hardware and software in a large team room, specially designed for collaboration, where they can work together. A facilitator leads the team with the process that helps them to see "The Big Picture" and understand what matters to the bottom line. The team composition is enriched with representatives from all of the stakeholders (including technical experts, management, facilitators, and some times government and Joint venture partner's representatives) so that the results can be concluded and implemented immediately, with maximum buy-in.

The Event Solution process includes a detailed uncertainty analysis and risk assessment that has been successfully implemented in many events. The most important deliverable of the Event Solution, however, is that all the stakeholders develop a clear and common understanding of the critical uncertainties, project risk, and the agreed plans to move forward the decisions. This volume of work, which traditionally requires months or years, is completed in weeks using the Event Solution process.

This paper presents the elements and processes of this new approach. Critical elements to a successful Event Solution include software, workroom, team members, and a facilitator. Once the elements are in place, the facilitator leads the team through processes that include project preparation, parallel workflows, uncertainty analysis, critical information plans, project risk assessment, and mitigation plans. Note that uncertainty analysis is not a simple by-product of the study; it is an integral component of success.

Introduction

Our industry spends over US $130 billion in capital and exploration worldwide each year[1, 2] on complex and uncertain ventures; highlighting the significant added value that can be achieved through processes that create synergy while reducing the decision cycle time.

Joseph Warren notes that the success of individual teams can be variable when he states, "The fundamental idea of cross functional teams and goals appears to surface

a New Approach for Fully Uncertainty Analysis and

about every 10 years with a new label. Usually, attempts to implement this concept in the E & P business ended with utter failure for a variety of reasons."[3,4] The Event Solution extends the multi-discipline team concept by formalizing key success factors: (1) identifying the most important objective, (2) focusing the collective skills and creativity of a team of experts on meeting that objective, and (3) collaborating via a special event that lasts weeks rather than months or years.

In the 1980s, the concept of asset teams was introduced by E & P companies around the globe to downsize and streamline operations. Unfortunately, integrated software was too immature at that time to enable real integration of the asset team members. As integrated software became available and hardware became more powerful in the early-to-mid 1990s the asset teams began showing more success.

In the late 1990s, common processes were adapted by most major oil and gas companies to ensure consistency and repeatable success across teams. Highly formalized processes, often employing gatekeepers, were developed to integrate the management (decision makers) and technical (asset) teams.

Although integrated software and formalized processes enhanced the quality of the decision process, generating fully synergized analyses from a wide variety of data and skills was still a lengthy study. Furthermore, the decision makers often received different messages from different disciplines that may not incorporate a comprehensive image of uncertainty surrounding the decision.

Between 2004-2005, several synergized study approaches[5, 6] were introduced to the industry as a means to bridge the gap between the technical asset teams and the decision makers. These approaches were set either as workshop style projects or detailed focused teams that are facilitated to focus on the business objectives.

In the early 2000s the Event Solution approach was introduced to the industry[7]. Like asset teams, the Event

> "The fundamental idea of cross functional teams and goals appears to surface about every 10 years with a new label. Usually, attempts to implement this concept in the E & P business ended with utter failure for a variety of reasons."
> (Joseph Warren)

Solution is a group of multi-discipline professionals creating better synergy among all stakeholders (asset teams, managers, decision makers and partners) by enabling faster decisions that fully encompass the complex uncertainties associated with today's projects. The focus is on specific, well-stated business objectives that are fully inline with company strategy. The team follows a process where each team member assesses uncertainties within their own analysis, which is subsequently rolled up into an uncertainty assessment.

The Six Building Blocks for the Event Solution

The Event Solution is enabled by 6 elements which are not separate structural blocks, but are goals which are integrated throughout the Event Solution approach. These elements are: The site or Event center; the hardware and visualization media; the integrated software; the facilitation team or the Event team; the project teams, and the Event Solution process.

This article will shed light on each of the 6 elements for the Event Solution with main focus on the 10 Steps Event Solution process. Also in each element we will briefly review the challenges that might be encountered and suggested solutions that were applied. We will then present the reservoirs / fields categories best suited for applying the Event Solution approach. Finally, we will present the areas that are still under improvement.

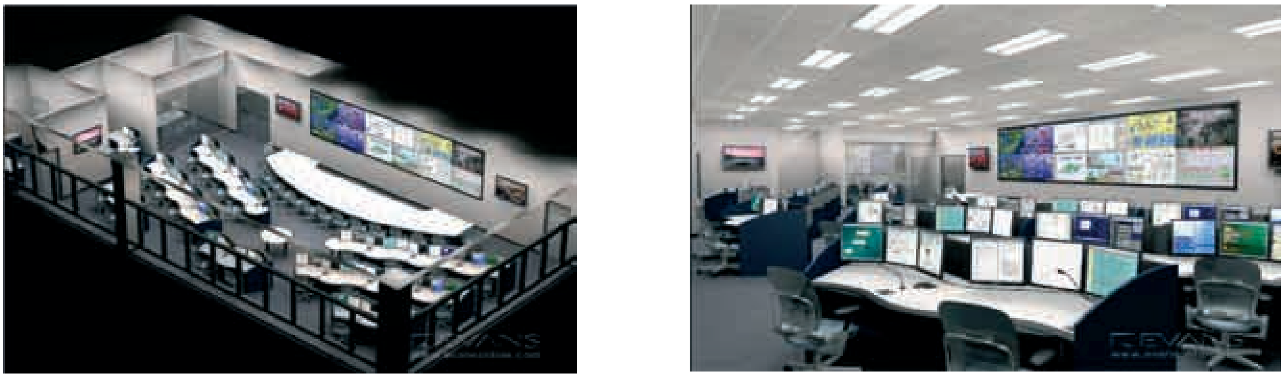


Figure 1 - Possible layout for an Event Solution Center.

1. The Event Solution Site

Effective collaboration centers became visible in the past 3-5 years in most major oil and gas companies. These are neither conference nor board rooms. Collaboration rooms are centers that includes hardware that enable fast computing power with parallel computing capabilities; software that enables all different disciplines to work together in an integrated way, visualization media to project all the different application in real time with capability to integrate them into one big-picture, and a meeting area with appropriate media to share these applications and insights with decision makers.

The meeting media enables the decision makers to present their feedback and directions to the working team. Figure 1 presents a possible layout for an Event Solution Center.

2. The Event Hardware and Visualization Media

The hardware for the Event Solution projects enables: parallel processing to speed up all computing calculations, multi-windows and platforms capabilities to enable integration among many applications; and multi display visualization media that enables all attendees to view numerous displays of most applications applied during the Event. Also hardware is required to enable visualizing management feedback onto large displays during the Event meetings.

Dedicated computing clusters are also available running million cells simulation models in few hours.

3. Event Solution Software

To enable real synergy among all Event team members, easy-to-use yet powerful software is required. The synergy and parallel workflows can only be achieved if all the Event team members can at least browse all applications. As an example all disciplines should be able to browse the geological model (structure, properties, fractures, etc), the simulation results (i.e. flood front with time), the facilities layout, and the wells production profiles regardless of their disciplines. To enable this ease of use, customized templates were setup for the used software to enable browsing capability without the need to know the software in detail.

Also a final roll-up media that will roll-up the 100s of simulation runs combined with different static realizations is required. The roll-up tool enables the review of all concluded output and insights. Figure 2 shows a possible structure for the software used in the Event solution projects.

4. Event Solution Facilitation Team

The Event Solution facilitation team conducts and facilitates all Event Solution projects in the company. There are many elements to a successful Event, the event participants are especially important for performing the work, shaping the outcomes, and making decisions.

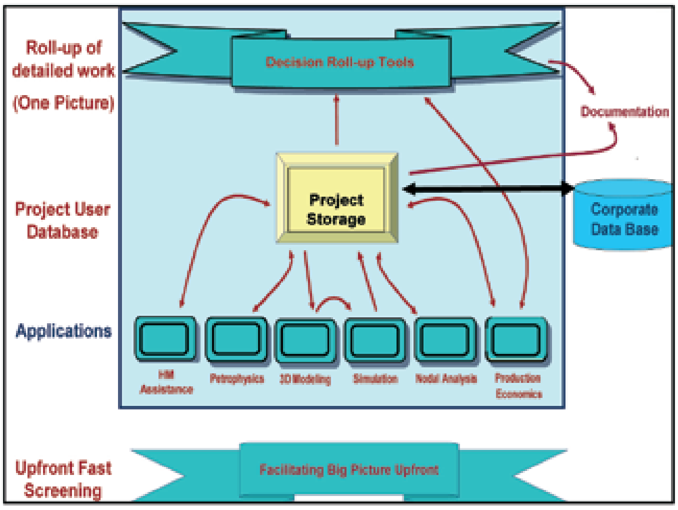


Figure 2 - Possible Software structure in an Event Solution.

To avoid any major re-engineering or organization restructuring, the Event Solution was designed to have a small facilitation team that we call the Event Team. This team has around 10 members covering most major disciplines and is the only team that covers all company events. Each of the ten members of the Event team is trained to facilitate Event Solution projects. In some Events all ten members might be working together and in other situations multiple Events might take place facilitated by several members of the Event team.

5. The Event Solution Project Teams

In addition to the Event team who conduct and facilitate all Event Solution projects in the company, once an Event Solution projects starts three teams are formed to develop synergy among the various stakeholders. Following is a summary of the structure and the duties of the three Event Solution teams: the Core Team, the Extended Team, and the Decision Team.

Core Team

The main working teams for the events are gathered for the short duration from the different departments and from existing asset teams. Once the Event is completed all members return to their organization slots. So the Event Solution doesn't require any organization re-structuring, and can / does co-exist with the conventional asset teams.

Consultants or outside experts are also candidates for the Core Team to ensure including latest technology and having a non-biased process. This team is 100% dedicated during the Event. They conduct all the work and are excused from normal duties that may distract from full participation with the rest of the team.

Extended Team

The Extended Team contributes through formal weekly interaction sessions from project kick-off to project completion. This group normally consists of mid-level managers and subject-matter experts that require full integration on all aspects of the project. They receive work output from the team, help shape the direction of the work, and provide insights to the decision makers between Decision Team meetings. The Extended Team is also asked during Event milestones to conduct peer-review sessions for quality assurance. Also a Gate-keeper is assigned from the Extended Team to approve the final results of each Event milestone as well as set directions for the rest of the Event milestones.

Decision Team

The Decision Team consists of high-level managers and some times business leaders or vice presidents depending on the significance of the decision. In specific studies, government and partner representatives will also be included in this Decision Team. This team signs off on all decisions made by both the Extended and Core teams. The power of the Event Solution is providing the Decision Team with full analyses, along with uncertainty and risk assessment, in a short time. The Decision Team in the Event Solution is involved through 3 to 4 study reviews from project kick-off to project completion.

6. Event Solution Process

The Event Solution process is very involved and includes ten-steps from project start to completion. Although some of the Event Solution process steps probably re-quire a separate feature on its own to fairly describe and provide examples, we will try here to shed light on some of the important elements of these steps. In future Event Solution publications we will focus in detail on each of these process steps. Before we present the Event Solution ten-process steps, we first like to discuss how the team manage to focus on what matters: the critical factors for an Event.

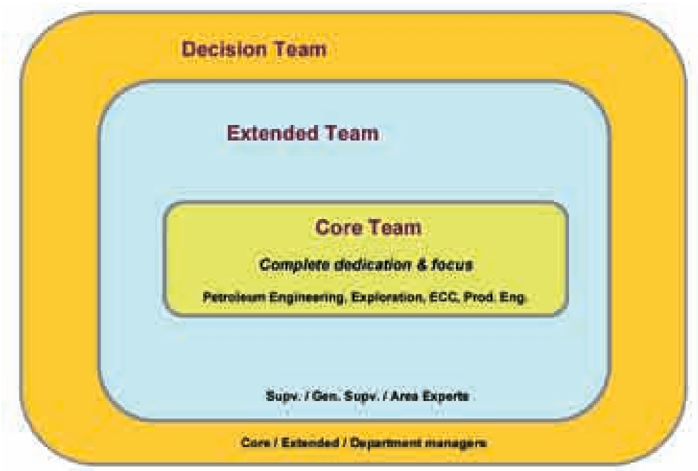


Figure 3 - Event Solution teams and study mechanisms.

Focus on What Matters

Rather than placing a Core Team of experts in a room and with a simple mandate to "go get results", the Event Solution utilizes a facilitator that leads the team to rapidly identify and focus on key issues. These key issues are reinforced by the Extended and Decision Teams. Each team member works in parallel on several tasks. Every day the results are rolled up and summarized by the facilitator for review and debate by the Core Team. As this routine continues, the entire team, regardless of their discipline, comes to a common understanding of "The Big Picture" and the true importance of various issues begins to surface.

This is an important exercise since the team often comes away with a completely different perspective of where the focus of the study should be. As an example, early on the team may have the notion that permeability distribution has the most impact on maximizing production plateau duration. Later in the project the team might gain insights that the facility (a factor that we can control with additional cost) has the highest impact on plateau duration and that the whole system is actually facility constrained. So when the Event starts the team reviews all aspects affecting the project objective, and as the Event progresses the team becomes more focused on those critical elements that affects the project deliverables. The strength of this approach is that this progress in understanding is shared continuously with both the Extended and Decision Teams and critical factors are agreed upon with full buy-in.

Another aspect of the parallel work effort is completing segments of the documentation as each issue is closed. By the last work day the entire documentation package is consolidated, agreed upon by the Extended and Decision teams and ready for delivery with full buy-in among all stakeholders.

Overview of the Event Solution Process

Each Event Solution has three main stages: (A) Data Gathering and Scoping, (B) Understanding and Model Preparation, and (C) the Events. The Event ten-step process includes all three stages. Following is a brief description of the three stages:

Stage A: Data Gathering and Scoping
The Event Solution team begins gaining familiarization with the candidate asset. The specific objectives of the study are finalized and documented. The high level technical issues are identified and the composition of the three Event teams; Core, Extended and Decision teams are set. All pertinent electronic data are gathered and stored on a common drive accessible by all three Event teams. Pertinent hardcopies are borrowed and stored in the Event workroom library for the duration of the project and returned to their previous owners at the end of the project. Past studies are identified, gathered, reviewed and summarised. This stage is normally conducted by the Event team and the typical duration is around 2 weeks.

Stage B: Understanding and Model Preparation
The Event Core Team begins meeting continuously at this time and team members work in parallel on their tasks. Experts review past work and perform independent evaluations. A common understanding of the reservoir is developed and incorporated into the construction of the numerical models. Note that the models are not only simulation models; they may also include geological, production, Petrophysics, operations, first-water arrival, uncertainties, and risk models. In this stage many fast mechanistic models are constructed to provide insights on physical concepts (i.e. water movement in fractures corridors, the impact of Tar on aquifer support, etc). Also, investigation and learning starts with the simplest models and simulators then details are added as learning and understanding progresses. This stage normally can take 2 – 3 weeks depending on the complexity of the reservoirs under study.

Stage C: Events
After data gathering, the reservoir characterization is independently evaluated, and the models are constructed, thus the Event Solution work begins. Although the process and techniques will be described in detail later, the objective of the Events stage is: (1) to produce an optimized action plan for the field, (2) develop numerical estimate of uncertainty on, say, plateau duration, (3) evaluate the risk of achieving that plateau, and (4) define a time-sensitive information plan that reduces and mitigates project risk. Figure 4 shows an example of a typical Event Solution project schedule duration and general steps.

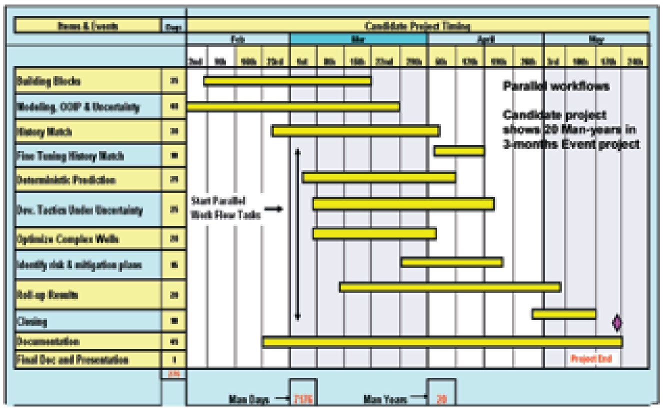


Figure 4 - Example of an Event Solution project plan.

The Events stage is divided into three Sub-Events. As described in Figure 4, these sub-events study duration overlap in a semi-parallel workflow.

Sub-Event (1) focuses on the "Most Likely" Original Oil In-Place (OOIP) estimate, the uncertainty associated with it, and the key parameters affecting that uncertainty (static uncertainty, and critical factors). The realizations and Oil In-place are then used in Sub-event (2).

Sub-Event (2) focuses on achieving not only the "Most Likely" history match but as many others likely matches

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as possible. The critical factors affecting the match quality are determined and carried forward into Sub-Event (3). As an example, of the thirty parameters considered initially to assess history matching, only vertical permeability and fracture characterization may be determined to be vital, the others are not critical to the quality of the match.

Sub-Event (3) focuses on defining, evaluating, and optimizing alternative development plans. Simulation prediction runs under the most-likely realization are used to quickly test and improve development ideas. The most promising alternatives are tested under both dynamic and static uncertainties, while integrating the history matching insights. The most robust plan to uncertainty is selected for rigorous optimization. Once optimized, final development plan is studied under uncertainty again and the risk/mitigation plans are developed. More detail on this process will be provided later.

Event Solution Ten-Step Process

This section provides more specifics about the ten-steps employed during a typical Event Solution project. These ten steps can be implemented effectively as well as in a conventional study approach. In a conventional approach the added value, reduced study duration and synergized decision, however, is better achieved once these steps are conducted in a semi-parallel workflow. We will here describe the 10-steps process briefly, but then focus more on the steps that includes uncertainty and risk analysis.

Following are the 10-steps Event Solution process:

1. Gather data and models into one shared drive;

2. Understand the reservoirs, clean-up models, and update;
• This stage may include many mechanistic and deterministic models to assist upfront in the understanding of the reservoir characterization and behavior.

3. Develop static and dynamic uncertainties matrix for all variables and notion of critical ones;

4. Evaluate OOIP and its uncertainty (static uncertainties);
• Output - "Most Likely" OOIP along with estimates of the practical low and high uncertainties. The parameters affecting that uncertainty are identified and key parameters noted. The uncertainty matrix (static part of the matrix) which was used initially as a guideline for this step is fine-tuned showing critical factors and narrow-down ranges.

5. Achieve History Match and Its Critical Factors;
• Output - multiple history matched models and a list of critical parameters and their ranges which were required to achieve that match.

6. Construct Development Strategy Analysis;
• List the development criteria (plateau, estimated ultimate recovery, drilling/facilities constraints, well types, and so forth).
• Construct alternative development strategies. These strategies typically include water injection, gas injection, water-alternate-gas, peripheral or pattern floods, etc.
• Rank alternatives with deterministic reservoir simulation runs based on the "Most Likely" history match.
• Output - list of selected alternative strategies and their ranking.

7. Test the most promising alternatives under uncertainty;
• In this step reservoir simulation, the narrowed critical factors listed under step (5) are used to select preferred strategy(s).
• Output - selection of the most robust alternative, termed the Preferred Development Strategy (PDS).

8. Optimize the preferred development strategy (PDS) by giving that one scenario the full focus of the team. More detailed optimization is included at this point

> With the concepts of uncertainty and risk in hand, we are now ready to describe how they are handled in the Event Solution process.

and typically includes lateral design, workover strategy, perforation targets, injection/production ratios, complex well design (equalizers, down-hole control values, etc);
• Output - Optimized Field Development Plan (OFDP).

9. Determine the impact of uncertainty on the Optimized Field Development Plan (OFDP) and list the information plan required to narrow down the uncertainty range for the critical uncertainty factors;

10. List project risk based on step 9, and risk mitigation plans for the Optimized Field Development Plan.

The terms "uncertainty" and "risk" are sometimes used interchangeably. Although the terms are related, the Event Solution uses specific definitions and it is worthwhile to pause here and clarify what we mean by uncertainty versus risk.

Uncertainty is the reasonable range of parameter values that are input to the various models. Sometimes lack of data or poor data quality influences uncertainty. For instance the free-water level may be known within a few feet in some fields, yet unknown within a hundred feet in other fields. Other times the interpretation of the data is uncertain no matter how good the data. As another example, pressure transient analysis and well performance data may suggest the presence of a fault yet seismic data cannot confirm it. Rather than ruling out the presence of the fault, the Event Solution brings the fault into the reservoir characterization as an uncertainty. The history match will either provide additional confidence about the presence of the fault or the interpretation may remain uncertain if it neither hurts nor helps the history match.

Risk, specifically project risk, is the chance that the field performance will have bad outcome. Risks, once identified and quantified, can be handled through mitigating actions.

Some parameters may be highly uncertain, but they may not cause much project risk. For instance, the average initial water saturation may be between 5% and 15%, but the field development shows it to be robust in either case.

Other parameters could subject the field performance to a great deal of risk. Recall the earlier example where the presence of the fault is uncertain, and suppose that the history match could not definitely rule it either in or out. Further suppose that the fault isolates the planned water injection from the rest of the field. The chance of a bad outcome, i.e. poor field performance, is very real. Of course, the plan could be slightly modified to mitigate the risk by either obtaining more information or changing/modifying the pressure support mechanism. The presence of the fault here is a critical uncertainty factor. Information plans will target narrowing down this uncertainty. If we can't narrow down these uncertainties then the mitigation plan will address the risk of the bad flood performance by modifying the recovery scheme.

With the concepts of uncertainty and risk in hand, we are now ready to describe how they are handled in the Event Solution process.

A Practical Approach to Quantifying Uncertainty

The approach used to handle uncertainty in the Event Solution is to combine both the probabilistic and deterministic approaches.

This approach lies in between the conventional deterministic approach where the team agrees on one realization or value for each input variables, and the probabilistic approach where a whole family of realizations are included covering all possible outcomes. The problem with the deterministic approach is that the output results can't be evaluated relative to the possible uncertainty range. On the other hand, the problem with the probabilistic approach is that it becomes overwhelming and, in many cases, the reservoir physics might get lost.

The teams, throughout their work, agree on the most-likely (ML) values for all input elements, set boundaries for these elements, and test the effect of these boundaries on the outcome thus concluding the critical uncertainty elements (the 80% impact). Once the critical uncertainty elements are identified, the team then focuses only on these elements. Through more detailed understanding, plans are set to narrow the uncertainty range on these elements (through better understanding, identifying critical static uncertainty factors, history matching and its critical factors, etc), and agree on which combination can represent a practical low, and a practical high relative to the most-likely estimate. Applying this approach the team agrees on the most-likely and two boundary realizations which are the practical low and the practical high estimates. Figure 5 shows an example of the different uncertainty categories related to static volumes, dynamic values representing recovery elements, cost and price elements and finally the timing as another uncertainty element.

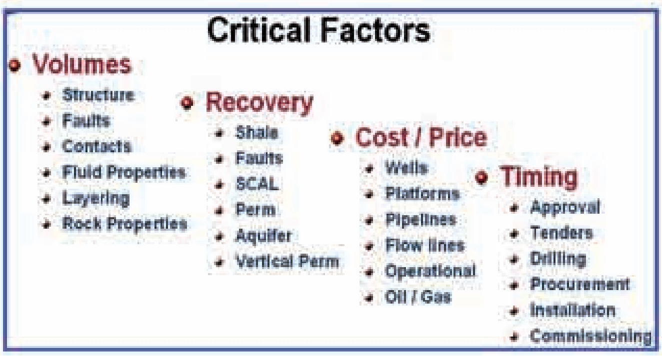

Figure 5 - Uncertainty Categories.

Details – Step 4

After data gathering and reservoir understanding (steps 1 & 2 in the ten-step process), the initial estimate of OOIP is conducted. The OOIP is finalized after the simulation history match and that concluded value becomes the "Most Likely OOIP" (ML). Once the team agrees on this value, the uncertainty analysis is initiated.

The ML OOIP is not necessarily the P50 or the mean value of the OOIP. The volumetrics uncertainty starts with the collected uncertainty matrix (step 3), then nested geological simulation are conducted to estimate the relevant critical factors affecting the OOIP estimates. Once the critical uncertainty factors are concluded, the team then focuses only on these critical elements, and another group of nested simulation is conducted to conclude the practical low and practical high for the OOIP most-likely case.

Details – Step 6

In step 6 the development criteria is designed with respect to field constraints or company policies that need to be followed (i.e. number of drilling rigs, gas available for injection, etc).

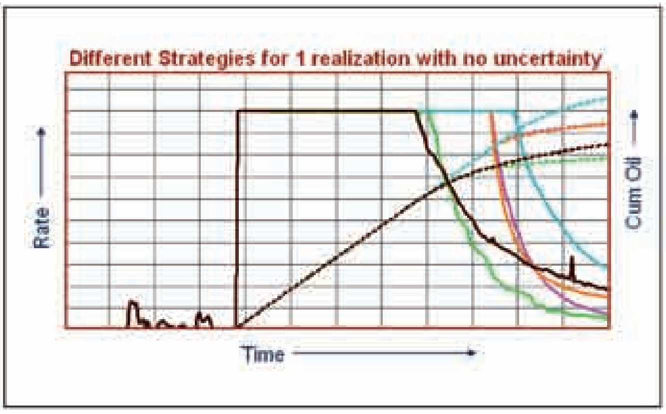

Figure 6 - Deterministic analysis of alternative development strategies.

From a listing of alternative strategies prepared, the alternative strategies are then deterministically simulated using the most likely geological realization. These alternative strategies are then ranked and the outliers are excluded. It is important to use the results of these deterministic simulation runs only as insights since the impact of uncertainty on the results has not yet been identified.

It has been found that the deterministic analysis normally are very misleading, as an example; the longer production plateau illustrated by one of the strategies in a traditional manner as shown in figure 6, was not the strategy that provided the longest plateau under uncertainty seen in figure 7. This step is, however, needed to identify the outliers and eliminate these strategies from the uncertainty runs explained in step (7) of the event process.

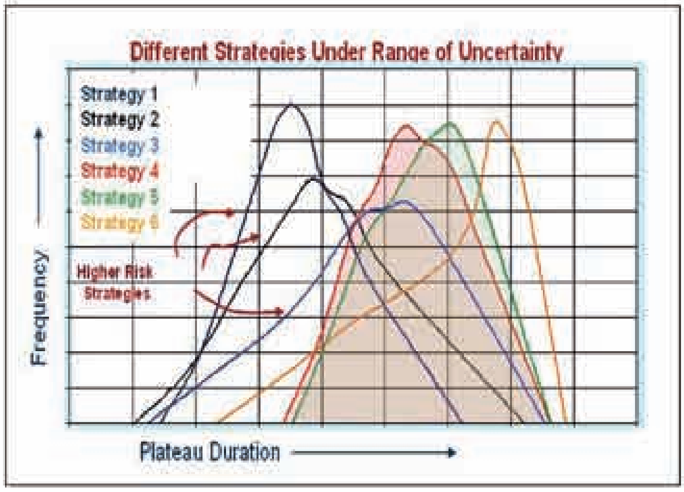

Figure 7 - Methodology used for selecting the Preferred Development Strategy (PDF) under uncertainty.

Details – Step 7

In Step 7 of the ten-step Event Solution process, the team is required to select the Preferred Development Strategy (PDS) under uncertainty. The Core team will set all alternative strategies to run under uncertainty and will show all the runs through a probabilistic view. The team combines all the simulation runs with the statistical runs and uses a proxy to estimate the probability of the outcome. Since normally these uncertainty runs are based on 20 to 30 variables each with uncertainty ranges, the required number of simulation runs to cover all uncertainties is large. To overcome this problem, parallel clusters are used to enable running as many runs as possible and the proxy which creates a 3-D solution surface reference to all these simulation runs cover statistically the remaining required information. There are many commercial tools that provide these proxies (i.e. Enable, Cougar, Mepo, etc) that can bridge the gap between the runs we can afford and the requirement needed to conduct uncertainty analysis.

Figure 7 shows the range of possible outcome and the likelihood of the outcome in relation to plateau duration and relative to all possible uncertainties and their ranges. These plots are also created for other targets including recovery, water handling, and economic indicators. From this figure, as an example, it becomes very clear that the runs that are skewed to the left are more risky and have a higher probability of shorter production plateaus than those skewed to the right. This is the methodology used in the Event Process to select the Preferred Development Strategy (PDS) for optimization in Step 8.

Details – Step 8 & 9

Once the Preferred Development Strategy (PDS) is selected in step 7, optimization starts. Many levels of optimization can be conducted, some are mentioned below:

- Wells level
- Well placement
- Well type (vertical, slanted, horizontal, multi-laterals)
- Well numbers and spacing
- Completion type (tubing size, equalizers, etc)
- Artificial lift type
- Injection to production ratio (IPR)
- Reservoir depletion pressure level
- Maximum oil rate per well
- Maximum injection rate per well

Once the selected strategy is optimized, the Optimized Field Development Plan (OFDP) is finalized. The final step is to run this OFDP under uncertainty once again but now to understand its risk level. If the most likely OFDP, comes as in blue on Figure 8, above the 50% probability relative to a certain target (i.e. plateau duration or ultimate recovery, combinations, etc), this means that uncertainty (change from the most likely case) will only provide worse performance results. This OFDP still needs to include mitigation plans to avoid such possible bad outcomes. The critical factors are then used (80% impact) to understand the mitigation action required. On the other hand, if the most likely OFDP is below the 50% probability, as represented in red on Figure 8, then any uncertainty change from the most likely case will only make the outcome better. This means that the development plans already includes many of the mitigation factors. It can also mean that there is room to improve this plan through taking more risky strategies. Figure 8 presents illustration of two optimized cases ran under uncertainty and in turn the risk level for these cases.

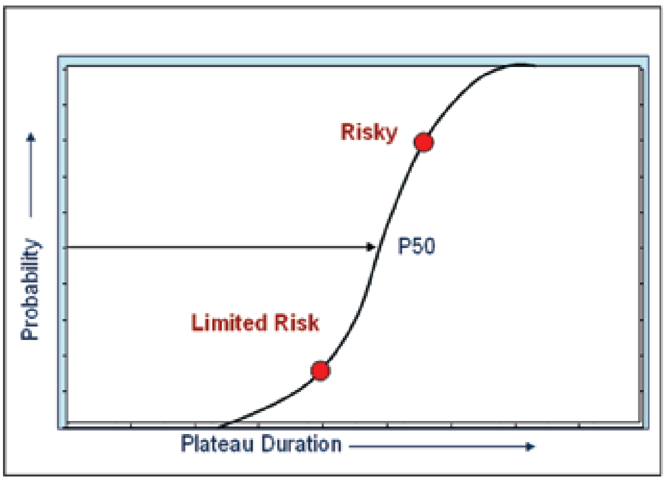

Figure 8 - Optimized case run under uncertainty (Risk).

Details – Step 10

A list of project risks is used to quantify risks as high, medium or low in four categories: risk level, probability, urgency and manageability. The risk that scores 3 or 4 on the risk scale (meaning high in 3 or 4 categories) is flagged and mitigation plans are then addressed. This process is presented in figure 9.

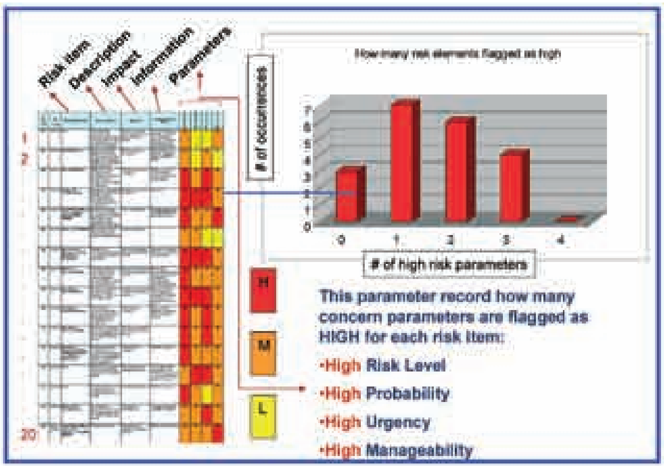

Figure 9 - Risk analysis.

Finally, the process is completed, by staging out through time, the development plan, the information plans, and the mitigation plan.

Event Solution Deliverables

An Event Solution produces valuable results that are both tangible and intangible. The most important tangible results are, of course, three or four alternative solutions to the business problem that originally prompted the work. In addition to the alternative solutions, a final optimized field development plan is concluded. The tangible deliverables also include an analysis of the critical decision and uncertainty factors, with recommended actions to mitigate the key risks. All the results are fully documented.

The intangible results relate to the professional development of the team members.

Implementing the Event-driven work style is much simpler than reorganizing into the multi-discipline asset teams of the last decade. Simply, a team is assembled for an Event from different disciplines within the organization, and dissolved when the Event is over. The Event teams, as mentioned earlier can also co-exist with asset team environments.

Event Solution Challenges and Suggested Solutions

There are areas of challenges in the Event Solution that will face companies trying to apply such approach. Some of these challenges are:

• Dedication and focus of the Event Core team.
A main challenge here is to keep the entire Event Core team which covers all disciplines from seismic to facilities, interested, focused and dedicated throughout the project. This is achieved through facilitating from start the concept of one team with one objective (project objective). The facilitator has to continuously provide that message by moving the team members to conduct some tasks beyond their area of expert. Letting them understand that they are part of the solution and accountable for the project deliverables even if that deliverable is not in their area of expertise. This approach added significant value. In all of the events conducted, having all disciplines throughout the entire project ensured that the team iterate back on all disciplines and that all outcomes are sound from all aspects.

• Full Involvement of Management team.
Another challenge to the Event success is not getting all Managers at the same time due to their heavy work load. This of course will be a major set-back to the project success. In the Event we were able to overcome this through: (1) ensuring that each Event projects have a project VP sponsor; (2) to organize at the initial stage all Decision team meetings with the management upfront; (3) to always have a delegate assigned to attend in the case of the manager's absence; (4) include pre-meetings and post-meetings review messages with the meetings results; (5) in the kick-off meeting of the project, clarify that a decision will be made at the Event conclusion. By applying the above, full involvement of the management team is achieved in all of our Events.

• Long-term task conducted during the Event.
There are several long-term tasks that can bottleneck the Event Solution approach which depends on study cycle reduction to enable synergy. Examples of such long-term tasks are: seismic interpretation, geological modeling with static uncertainty analysis, history matching, and dynamic uncertainty analysis. In the Event Solution, we used four elements to overcome the above long-term tasks; (1) Pre-Event tasks, where we conduct some of these tasks over long durations before the Event. This is normally done for the seismic interpretation and the geological modeling. (2) Parallel clusters hardware for faster runs. We normally use 100s of nodes (Cluster hardware) to run geological uncertainty modeling and

simulation models in parallel. (3) We use data-mining, assisted history match and visualization software to enable faster analysis of the modeling results. Finally (4), we use the large staff in the Event team to work in parallel on all the analysis. As an example, we have 10 to 15 staff working on analyzing the history match. With the use of the assisted history match and data-mining software and with the capabilities of running 100s of runs in parallel using cluster hardware, history match for mature reservoirs are achieved in weeks compared to years when applying the conventional approach. The same approach can be applied to any long term tasks in the Event.

Applications for the Event Solution Approach

As previously discussed, the Event solution has been successfully implemented on 24 large projects varying from prospect, green fields to brown fields including the largest on-shore and off-shore fields in the world. So the process can be implemented on any scale. The Event Solution, however, is very costly (man-power, hardware, software, site, etc). Normally, the Event Solution targets high investment projects where timely decisions are critical and the expected added value is significant, regardless of the field size or field life-cycle (brown or green fields). Due to the parallel tasks involved in the process, the Event Solution normally conducts 20 man-years in 2 to 3 months; it should only be applied to high-investment decision projects.

Conclusions

1. The Event Solution is a novel study approach that integrates a new process with new tools and involves the stakeholders from all domains to quickly solve important problems during a special team event that lasts for weeks rather than months or years.

2. This new approach is flexible and scalable enough to cover problems ranging from one reservoir to an entire business unit with multiple assets, infrastructure areas and marketing issues, if needed.

3. The Event Solution is the step beyond conventional asset teams, where the Event has been distinctively designed to create better synergy among all stakeholders (asset teams, managers, decision makers and partners) and enable faster decisions that fully encompass the complex uncertainties associated with today's projects.

4. Implementing this new approach does not require re-organization. Simply assemble a team for each event, and dissolve it when the event is over.

5. The Event solution includes a new and successful approach for handling uncertainty and project risks.

“The Event Solution is a novel study approach that integrates a new process with new tools and involves the stakeholders from all domains to quickly solve important problems during a special team event that lasts for weeks rather than months or years.”

6. The Event Solution has been a proven success in projects that have spanned the entire spectrum of asset numbers, complexity, and maturity.

Acknowledgments

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KFUPM Research Institute

The Center for Petroleum and Minerals is the arm of KFUPM Research Institute responding to the upstream industry R&D requirements. Center Director Dr. Abdulaziz Al-Majed spoke to Saudi Arabia Oil and Gas about the Center's R&D capabilities.

Q: Saudi Arabia Oil & Gas *- How is the Research Institute structured and what are its principal areas of interest?*

A: Dr. Abdulaziz Al-Majed - The Research Institute has a unique structure which enables R&D in seven major areas of science and engineering. It consists of Center for applied Physical Sciences, Center for Communication & Information Technology, Center for Economic & Management Systems, Center for Engineering Research, Center for Environment & Water, Center for Petroleum & Minerals, and Center for Refining & Petrochemicals. Two support offices, Support Service Office and Research & Innovation Support Office, provide administrative support to the technical centers of the Research Institute as well as to research projects from the academic departments.

Q: Saudi Arabia Oil & Gas *- What does the centre for Petroleum and Minerals specialize in?*

A: Dr. Abdulaziz Al-Majed - The center offers wide varieties of R&D and consulting services related to the petroleum and minerals industries. It draws on about three decades of business and research experience with many important projects completed for the Ministry of Petroleum and Mineral Resources, Saudi Aramco, clients

outside the Kingdom and most recently with the joint venture companies exploring for gas in Rub Al Khali.

The center activities concentrate on three major areas of specialization. These are Oil & Gas engineering, Petroleum geology and geophysics, and remote sensing. Most of the research projects are interdisciplinary where the rich human and laboratory resources of different centers as well as the university departments are utilized to achieve optimum solutions.

Q: Saudi Arabia Oil & Gas *- What does the Petroleum Geology and Geophysics program involve?*

A: Dr. Abdulaziz Al-Majed - The program contains wide variety of R&D and consulting services related

to both explorations for natural resources and reservoir characterization and management. Consultation and services include petrophysical analysis, core analysis and description, petrological studies, palynostratigrapic studies, basin analysis and geochemical modeling. The services which focus on reservoir characterization and management includes thin section manufacturing and semi- quantitative petrographic description of reservoir rock, geostatistical modeling, well log analysis and correlation, and geophysical modeling.

***Q: Saudi Arabia Oil & Gas** - What areas does the Oil and Gas Engineering cover?*

A: Dr. Abdulaziz Al-Majed - The oil and gas engineering program has versatile R&D and consulting services that include a wide variety of research capabilities. Research projects includes improved oil recovery, dry gas and gas-condensates reservoir engineering, fluid/rock interaction wettability, numerical reservoir simulation, well testing, production and well completion, sand-production control, horizontal well studies, PVT analysis, petroleum related rock mechanics, artificial intelligence & neural network, and visualization of fluid flow in porous media.

Several specialized labs provide scientific and technical support to these research projects such as fluid properties, core analysis, electrical properties measurements, CT scanner, etc.

***Q: Saudi Arabia Oil & Gas** - What does the remote sensing program involve?*

A: Dr. Abdulaziz Al-Majed - Remote sensing services provide vital information to the oil and gas engineering and environmental impact assessment studies. The program completed research projects to several important clients such as Saudi Aramco, Royal Commission, and Ministry of Transportation inside the Kingdom as well as other clients outside the Kingdom. Satellite Image Library Archived images of the Arabian Peninsula are available in both digital and hard copy. Provisions for acquiring the most recent data from Landsat, SPOT, RADARSAT, IKONOS and other satellites exist through arrangements with King Abdul Aziz City for Science and Technology (KACST), Riyadh. Facilities include State-of-the-art image processing system for processing, analyzing and printing remote sensing data acquired from space platforms and geographic information system (GIS) for development and design of geographic information databases.

DR. ABDULAZIZ AL-MAJED

Dr. Abdulaziz Al-Majed is the Director of the Center for Petroleum and Minerals, Research Institute, at King Fahd University of Petroleum and Minerals, Dhahran. Prior to that he was Chairman of the Department of Petroleum Engineering .

He received his Ph.D. degree from the University of Southern California, MS degree from Stanford University, and BS degree from King Fahd University of Petroleum and Minerals, all in Petroleum Engineering.

Dr. Al-Majed is teaching courses in drilling engineering, reservoir engineering, and petroleum engineering economics. He has supervised many M.S. theses and Ph.D. dissertations research, and won Best Advisor Award of College of Engineering Sciences in 1993-94.

Dr. Al-Majed supervises client funded research projects in the Petroleum & Gas Engineering Section in the Research Institute. His main research interests include development and adaptation of technologies to fit local oil and gas fields environments to enhance effectiveness of drilling, production, and reservoir engineering applications.

Dr Al-Majed's industrial experience includes working in Saudi Aramco in the drilling and work-over, reservoir, and production engineering departments.

Dr. Al-Majed was Chairman of the organizing committee of Gas Condensate Workshop held at KFUPM in 1998, and has participated in various Standing and Ad-hoc committees in the university. He was a member of Council of Education of Eastern Province in 1998-2001. He is a member of the Board of Directors at SPE Saudi Section.

The Upstream Sector: Tackling the Pressing Issues of Our Time

This is the full keynote speech delivered by Khalid A. Al-Falih at the GEO 2008 conference in Manama, Bahrain reprinted with the permission of Saudi Aramco.

By Khalid A. Al-Falih, Saudi Aramco Executive Vice President for Operations

Your Highness, Your Excellency, distinguished guests, ladies and gentlemen: good afternoon. It's a great privilege to be with you today, and I would like to thank the GEO organizers for inviting me to take part in this year's opening session.

Ladies and gentlemen, this week you will be discussing new exploration and production technologies and techniques, sharing best practices, and exchanging ideas and information with your upstream peers. That is very critical work, and it is essential to the continued success of our companies and of our industry. And yet to my mind, the significance of your discussions over the next few days goes well beyond that.

In fact, considering the fundamental nature of energy in our daily lives, the preeminent role that petroleum plays in ensuring continued global economic prosperity and social development, and our need for energy production and consumption to coexist with environmental protection, I believe GEO is about nothing less than tackling one of the most compelling issues of our generation.

At first, that may sound like some nice words to make you and your colleagues feel good about your role as geoscientists. But ladies and gentlemen, I am convinced that when future generations look back at the early part of the 21st century, they will focus first and foremost on issues related to energy and the environment, and the ways in which we collectively address those issues.

Today, the world of tomorrow is being shaped most profoundly not in the political centers of the post-war era, but in the new centers of energy, and particularly within the leading companies, institutions and organizations that make up the petroleum industry. Every day, the future is taking shape on the frontiers of petroleum exploration and production; at work stations and learning centers; and in visualization suites, research labs, collaboration rooms, and wherever else men and women are working hard to find, manage and produce the energy which powers our societies - all while serving as wise stewards of our precious natural environment. I say this because if we take note of the world around us - from land, air and sea transportation to the fertilizers that help grow our food, the medicines that heal the sick, and the fabrics and materials that clothe and house humanity - we see that nothing works without oil and gas.

But how can we meet these extraordinary expectations, and the enormous challenges that accompany them?

in many parts of the OECD, the world will increasingly look to us and our companies to translate our massive conventional reserves into reliable supplies, even as the industry enhances its ability to tap the vast resources of non-conventional oil found elsewhere around the globe. Another major driver of future upstream success is, of course, advanced technology, whether in the form of improvements and enhancements of existing technical tools, or a whole new suite of applications, techniques and equipment designed to unlock the precious treasures of the earth. Today, high-end technologies such as satellite imaging, 3D visualization rooms, I-Field development, remote control centers, real-time drilling data transmission, and megascale parallel computer systems are increasingly commonplace. And looking ahead, even

First, there is the matter of the hydrocarbon resource base, which is the indispensable starting point for all our upstream endeavors. When it comes to resources, clearly this region is the place to be. The BP Statistical Review of World Energy estimates the Middle East region's total proven reserves of conventional oil at roughly 60 percent of the world total. Also, despite the impressively vast proven reserves of oil and gas in the region, the future of discovery remains promising.

Furthermore, many of our region's reservoirs have been produced at more gradual depletion rates than comparable fields elsewhere around the world - while some have never been produced at all. The combination of the prolific nature of our reservoirs and lower production costs serves to make the region's resource base an even more attractive play. As other fields around the globe begin to mature and decline, and production decreases as a result

more sophisticated technology will be indispensable to the success of our companies, whether they are national oil enterprises, multinational majors, or specialized service companies and technology development firms.

But new technology doesn't just happen, nor does it emerge fully formed overnight. Instead, the next generation of upstream technical tools and applications will stem from sustained R&D programs based on specific strategic objectives and technology targets. These R&D programs will require us to commit a high level of human and financial resources over the next few decades. In my view, successful programs will also need to be flexible enough to adapt to changing needs and new research paradigms, and to harness emerging technologies from beyond our own industry - a topic I would like to revisit in a few moments.

Courtesy of Saudi Aramco

At Saudi Aramco, we're pursuing such blue-water technologies with an eye toward finding, managing and producing our hydrocarbon resources more effectively and more efficiently. Our strategic goals in this regard are simple but clear: maximizing the pace and scale of discovery and the rate of recovery of oil and gas. For example, the future of discovery in the region is promising, especially that there are many under-explored areas and substantial resources associated with novel play concepts that are still untapped. The future will see us tackling such resources as gas in tight sands and basin-centered gas. Moreover, technology development to facilitate more effective discovery is also underway. These include low-frequency seismology for direct detection of hydrocarbons, seismic inter-ferometry, and passive seismic monitoring, as well as numerous non-seismic methods for assessing hydrocarbon potential.

For improved recovery we aim to move in the next few years from MRC wells to next-generation Extreme Reservoir Contact wells, which will feature 10, 20, perhaps even 50 laterals snaking through the payzone. Other future technologies on our books include the use of nanorobots to enter reservoir rock pores and pore throats. My colleagues will be discussing these exciting technologies during this week's technical sessions.

But for all these high-tech tools, the upstream sector is still at heart a people-centered business, and it takes a keen eye and a sharp intellect honed by years of experience to make sense out of mountains of data, and a leap of human imagination to develop new technologies to solve problems both large and small. And no matter how fast the rate of technological change accelerates, the upstream will continue to be about big brains, strong character - and lofty dreams. That's what you and your upstream colleagues bring to the table, and as an industry leader, I'm glad that you're here.

At Saudi Aramco, we believe strongly that the quality of people is the main source of differentiation between those companies that will lead in the future, and those that will follow. In keeping with that belief, our value proposition to our E&P staff is this: our company is a place where your work is focused underground, but where we want you to reach for the stars. We believe in the immense power of integrated teams, and hold that bringing people together from different professional and engineering disciplines makes us a stronger organization, and is ultimately more rewarding for the individuals involved.

Now we're making an even more substantial investment in our E&P talent pool, with the construction of a new Upstream Professional Development Center to promote hands-on learning in an intensive, immersive and integrated setting. When it is complete in 2010, this center will have 3D visualization rooms, drilling and I-Field simulators, and other learning facilities designed to keep our professionals up to speed with the latest developments and technologies in their various fields, and to do so in an interdisciplinary manner. Our goal for the facility is to help cut the skill development time for top-notch upstream professionals from years to a matter of months, by immersing them into a richer variety of information, techniques and technologies in a hands-on manner.

But even with the combination of plentiful reserves, cutting-edge technology and highly qualified people, there must be something more. To be truly successful we also must have a clear vision for our exploration and production activities, and a solid strategy or “game plan” to achieve it.

In my view, a winning upstream strategy focuses first and foremost on maximizing our resource base for the benefit of our nations and their peoples, as well as the wider global economy - or in other words, to do our part in meeting the pressing energy challenges of our era. To that end, we at Saudi Aramco have challenged our earth scientists and engineers to set their sights high and add nearly 200 billion more barrels of oil-in-place, and to recover up to 70 percent of the original oil-in-place from our major producing fields - clearly stretch targets considering that the world currently recovers on average around half of that.

Of course, a long-term perspective is also a vital part of our strategy, and while short-term commercial considerations are important, so is building for a future that will continue to run on petroleum. It’s hard to escape the talk in the popular press about “peak oil” and the impending decline of petroleum as a fuel source in the near future, and yet the consensus forecast is for fossil fuels to account for 80 to 90 percent of the worldwide energy mix in the year 2030. Given that total energy demand will continue to increase, largely as a result of growing populations and rising living standards in the developing world, the call on our energy will certainly remain strong for many, many decades to come. And by implementing sound upstream strategies and a sustained commitment to maximizing our resource base, I know our region will be prepared to answer the call.

But living up to the responsibilities that come with such close engagement on the great issues of our time mean that

no company - no matter how large, how sophisticated or how capable - can go it alone. Instead, cooperation and collaboration are essential for a meaningful long-term strategy for the upstream sector. Petroleum companies in this part of the world are already working closely among themselves, and with leading peer companies around the world in a variety of fields and disciplines. But we must also recognize that cooperation and collaboration go well beyond these corporate relationships, and include professional societies like the AAPG, EAGE, SEG, SPE and others, as well as events such as GEO which are important forums for the exchange of ideas and information among upstreamers.

These societies are also doing essential work to bring along a critically important new generation of E&P professionals through their student programs, and to show the best and brightest of the youth that ours is a sunrise industry, not a sunset business. Universities, research institutions and other entities are also exerting tremendous efforts to supply these young people with the technical skills and knowledge they need to contribute to our future success, and I would like to thank those of you here tonight who come from the world of academia. Saudi Aramco is proud to support a range of professional societies and to collaborate with many different institutions of higher learning, and I know we are not alone among the region’s petroleum companies in doing so.

But as I noted earlier, we should not close our eyes to the benefits of working with companies, research centers and universities whose primary focus is not oil, or even energy. For example, there are tools and technologies developed in the medical field which may have widespread applications for our business. As most of you know, computerized tomography, or the CT scan, was originally designed to improve on medical X-ray technologies and is now routinely used in our business to analyze core samples. By the same token, the aerospace, material science, bio-technology, nanotechnology, IT and telecommunications industries may also be in the process of developing innovative products, tools and techniques which could one day be indispensable in our work. In other words, just because a new technology wasn't designed with oil and gas in mind doesn't mean it can't be of immense value to us in our operations, and I encourage you to keep scanning the inter-industry horizons and to take a wider perspective on the issue of collaboration and integration.

Ladies and gentlemen, such an approach is important in part because some of those technologies may help us in tackling what is perhaps the biggest challenge facing our industry at the moment - and some have argued, the most pressing issue currently facing mankind: the protection and preservation of the natural environment. Make no mistake: environmental issues affect every aspect of our business, and worries about safeguarding the natural world are present at every step of the petroleum production, processing, transportation and consumption cycle. Like it or not, concerns among both the general public and policymakers over greenhouse gas emissions, global warming and conventional pollution are changing the overall context in which our organizations operate, and in which global energy policies are being debated and formulated.

But these concerns may also create new technical and commercial opportunities in fields such as carbon management and pollution mitigation, and enable us to raise our commitment to environmental stewardship to a whole new level—issues which you are best qualified to manage. I believe energy and the environment represent two important and intertwined imperatives for humankind, and that technology can help further reduce the amount of energy needed to generate the maximum benefits to society while also minimizing the negative impact on the environment. In my mind, this is the way forward if we are to realize a sustainable and successful future.

And because I believe that talent, technical skill and a passion for innovation will be indispensable in achieving those twin goals, I also think that E&P has a leadership role to play here. For example, many of the new tools and techniques designed to optimize the discovery, recovery and production of hydrocarbons also hold significant environmental benefits, and can lighten our industry's environmental footprint. I think we can do more to leverage these new technologies for the benefit of the environment while still fulfilling our mandates as energy providers, and as we need our best minds and most experienced hands at work on these pressing issues, that means we need people like you and your upstream peers.

Regional Events - GEO 2008 - Keynote Speech

"I realize that what I have outlined is a bold and even audacious vision for the future, but this is a role that we together must play, and that future generations of petroleum professionals must continue to fulfill if we are to indeed resolve the most compelling issues of our century."

Ladies and gentlemen, before closing today let me propose to you a collective vision for our industry not just in the next several years or decades to come, but for the remainder of the 21st century - and beyond.

I believe that the petroleum industry should not only be the most sophisticated and technologically savvy business on Earth, but also act as the primary engine and indispensable enabler of global economic growth, serve as the fundamental driver of sustained social development, and be the acknowledged leader in environmental protection and stewardship. Thanks to us and our efforts, every man, woman and child on the planet should wake up knowing they will have ready and reliable access to the energy they need as they make their way through their world, and thus have the ability to move a little faster, push on a little farther, and soar a little higher. And those same men, women and children should be able to sleep soundly at night knowing that - again thanks to us - the incredible beauty, diversity and magnificence of our natural world is protected and preserved, and that our planet will remain healthy. Over the last century and more, petroleum professionals have proven themselves more than equal to the challenges they have confronted, and I believe that all of this is within our grasp, if we simply recommit ourselves to realizing our enormous potential both as an industry, and as individuals.

Next, I would like to suggest that our professional societies consider going a step further and set specific stretch goals for the global petroleum industry and the bright men and women in our science and engineering disciplines. As an illustration, here is what I have in mind in terms of conventional oil:

• First, accept the challenge of increasing the global average, economic recovery rate for conventional oil to a minimum of 50 percent with an eye toward 70 percent;

• Second, discover most of the remaining in-place conventional oil resources over the next quarter century, taking the total discovered oil to the upper-end of the global endowment estimated at 8 trillion barrels;

• Third, devise a suite of readily usable, commercial technologies for the capture and sequestration of carbon; and

• Lastly, work jointly toward creating an enabling environment – accounting for the economic, regulatory, environmental, technological and policy dimensions – that will help turn the resources into supplies as dictated by demand growth.

Similar goals should also be established for unconventional liquid fuels, such as extra heavy oil, tar sand and oil shales.

My friends, I realize that what I have outlined is a bold and even audacious vision for the future, but this is a role that we together must play, and that future generations of petroleum professionals must continue to fulfill if we are to indeed resolve the most compelling issues of our century. Already you are helping us to realize the incredible opportunities that face our companies, our industry, and in fact our societies as a whole. Each day, you and your peers influence every corner of our society and touch the daily lives of billions of energy consumers. But I want to take this opportunity to challenge each of you to go beyond that, to transcend the definition of your professional discipline or job title, and to play your individual as well as collective part in delivering the next century of energy - and with it undaunted progress, unimaginable prosperity, and unlimited promise.

Ladies and gentlemen, fulfilling that vision is both a tremendous responsibility and a unique privilege, but I am confident that this outstanding group of professionals is capable of taking on such a challenge - and more. Thank you.

Left to Right: Wajid Rasheed , Tariq AlKhalifah - KACST, Panos Kelamis - Saudi Aramco, AbdulMohsin Dulaijan - SRAK and Mohammed Al Mazrui - Geological Society of Oman.

David Jones, EPRasheed (Houston) and Misfir AzZahrani, Saudi Aramco.

Regional Events - GEO 2008 - Images

Shivaji Dasgupta, Saudi Aramco, presents the company's microseismic site in Haradh.

Left to Right: Wajid Rasheed, David Charles, Juan Carlos Serrano and Kevin Jafry, Baker Hughes.

Regional Events - GEO 2008 - Images

Wajid Rasheed, Jaleel Alkhalifa, Saudi Aramco together with GEO 2008 visitor.

Left to Right: Jens Ole Koch, Qatargas, Finn Roar Aamodt, President EAGE and Wajid Rasheed.

Regional Events - GEO 2008 - Images

Left to Right: Ibrahim Zainiddin, Robert Kuchinski, Tom Bliznik and Rahul Mahajan of Weatherford and CMI tool.

Hasbi Lubis, Hafez Kamal, Craig Stolz (seated), Boff Anderson and Gen Herga of Western Geco, Schlumberger.

Regional Events - GEO 2008 - Images

Russell Croley, Halliburton presents the new ADR™ - Azimuthal Deep Resistivity tool and Geosteering concepts.

Ana Felix, EPRasheed Brazil and Colin Frost.

Regional Events - GEO 2008 - Images

Courtesy of DGS

Sulaiman Al-Sulami (DGS Academic Development Chairperson) and Thereze Ward (DGS member and past DGS board member) in the DGS booth.

Courtesy of DGS

The DGS executive committee invited GCC geoscience society presidents and committee members to dinner during the GEO 2008 conference in Bahrain.

2008 SPE Saudi Arabia Section Technical Symposium
May 10-12, 2008
Le Meridien Gulf Hotel, Al-Khobar

"The Ultimate Challenge: Unlocking Hydrocarbons Through Optimum Exploitation Strategies"

Technical Program

Saturday, 10 May

Al-Dana Hall- 08:00 to 09:15

Opening Ceremony

Invited Speakers:

- **HRH Prince Abdulaziz Bin Salman Bin Abdulaziz Al-Saud**
  Assistant Minister for Petroleum Affairs, Ministry of Petroleum & Mineral Resources
- **Mr. Dave Lesar**
  Chairman of the Board, President & Chief Executive Officer, Halliburton
- **Mr. Amin H. Nasser**
  Business Line Head, Exploration & Producing

Al-Dana Hall - 09:30 to 11:15

Session 1: Reservoir Management - 1

Session Chairpersons:	Hussain A. Al-Faddagh, Saudi Aramco Ali S. Al-Muallem, Saudi Aramco
Invited Speaker:	Intelligent Reservoir Management: Combining Technology, People and Process, Dr. Jeff Spath, President of Reservoir Management, Schlumberger
SPEKSA-08099	Enhance Reservoir Performance through Effective Horizontal Wells Placement in Complex Sandstone Reservoir: Case Studies, H. B. Al-Qahtani, Saudi Aramco
SPEKSA-08081	First High Pressure and High Temperature Digital Electric Intellitite Welded Permanent Down Hole Monitoring System for Gas wells, Muhammad Shafiq, Schlumberger
SPEKSA-08098	I-Field Capabilities Enable Optimizing Water Injection Strategies in Saudi Arabian Newly Developed Oil Fields, Said S. Al-Malki, Saudi Aramco
Alternate SPEKSA-08080	New Hydrogen-resistant Optical Fiber for Harsh Environments, Will Hawthorne, Schlumberger, The United Kingdom
SPEKSA-08049	Cyclic Production: Successful Application to Mature areas of Ghawar Field, Saad M. Al-Mutairi, Saudi Aramco

Regional Events - SPE Symposium

Okaz Hall- 09:30 to 11:15

Session 2: Drilling & Completion Technology - 1

Session Chairpersons:	Adib A. Mumen, Saudi Aramco Mohammed. A. Abduldayem, Weatherford Saudi Arabia
Invited Speaker:	Why Do We Damage The Reservoir? Why Not?, Dwight Strichland, Vice President Technology, Baker Hughes Drilling Fluids, Houston
SPEKSA-08057	A New 5-1/2" Solid Expandable Technology Launched and Successfully Implemented as an Effective Workover Tool in Saudi Arabia, Mohammed I. Al-Umran, Saudi Aramco
SPEKSA-08065	Integrating ESPs with Intelligent Completions: Options, Benefits and Risks, Mohammad Athar Ali, Schlumberger
SPEKSA-08088	Improved Wellbore Clean Up - Successful Case Histories in Saudi Arabia from Development to Field Implementation, Chad Christian, Baker Hughes
Alternate SPEKSA-08085	Kuwait Employs a Systematic Approach to Ensure Successful Underbalanced Drilling Pilot Project-Case Study, Hani Qutob, Weatherford International

Al-Dana Hall - 12:35 to 14:15

Session 3: Formation Evaluation

Session Chairpersons:	Mohammad Amoudi, Saudi Aramco Saleh B. Ruwaili, Saudi Aramco
Invited Speaker:	Benefits and Limitations of Geosteering in Complex Geology Reservoirs, Roland Chemali, Halliburton-Sperry Drilling Services
SPEKSA-08048	Potential Saudi Standard Sandstone for Applied Studies of Petroleum and Natural Gas Engineering, Musaed N. J. Al-Awad, King Saud University
SPEKSA-08064	A New Deep Azimuthal Resistivity LWD for Optimal Well Placement and Reservoir Exploitation; Successful Validation with Saudi Aramco, Ramez M. Shokeir, Halliburton
SPEKSA-08028	Accuracy Analysis of Water Saturation Models in clean and Shaly Layers, Gharib Moustafa Hamada, King Fahad University of Petroleum & Minerals
Alternate SPEKSA-08094	Enhanced Gas/Oil contact identification while drilling using Neutron and Sigma measurements in highly deviated wells, Saudi Arabia, Parvez Butt, Schlumberger
SPESA-08070	Improved Well Placement and Real-Time Decisions Using LWD Resistivity Imaging, Ramez M. Shokeir, Halliburton

Regional Events - SPE Symposium

Al-Dana Hall - 14:30 to 15:45

Session 4: Drilling & Completion Technology - 2

Session Chairpersons:	Naji A. Al-Umair, Saudi Aramco Dr. Mohammed M. Amro, King Saud University
SPEKSA-08095	Enhanced Injector Well Placement in Reservoirs with Varying Formation Water Salinity; Case Study from Central Saudi Arabia, Parvez Butt, Schlumberger
SPEKSA-08025	Case Histories of Improved Horizontal Well Cleanup and Sweep Efficiency with Nozzle Based Inflow Control Devices (ICD) in Sandstone and Carbonate Reservoirs, Ahmed H. Sunbul, Saudi Aramco
SPEKSA-08029	New technique for addressing SIMPOPS challenges during installation of new offshore platforms, Zaher Ataya, Qatar Petroleum
Alternate SPEKSA-08085	Kuwait Employs a Systematic Approach to Ensure Successful Underbalanced Drilling Pilot Project-Case Study, Hani Qutob, Weatherford International

Sunday, 11 May

Al-Dana Hall - 08:00 to 09:45

Session 5: Production Enhancement - 1

Session Chairpersons:	Muhammad A. Khawajah, GPED, Saudi Aramco Dr. Mohammed Badri, Schlumberger
Invited Speaker:	Refracturing; A potential Solution for Declining Productivity from Mature Reservoir, Dr. Mohamed Y. Soliman, Halliburton
SPEKSA-08039	The Use of StageFrac New Technology to Complete and Stimulate Horizontal Wells: Field Case, Hamad M. Al-Marri, Saudi Aramco
SPEKSA-08060	Successful Multi Stage Horizontal Well Fracturing in the Deep Gas Reservoirs of Saudi Arabia - Field Testing of a Promising Innovative New Completion Technology, Aidah Al-Zahrani, Saudi Aramco
SPEKSA-08059	Field Trials Of Fiber Assisted Stimulation in Saudi Arabia - An Innovative Non Damaging Technique for Achieving Effective Zonal Coverage During Acid Fracturing, Maytham Ismail, Saudi Aramco
Alternate SPEKSA-08026	Scale Formation in Oil Reservoir during Water Injection at High-Barium and High-Salinity Formation Water, Amer Bin Merdhah, University of Technology, Malaysia
SPEKSA-08079	Innovative Horizontal Directional Drilling (HDD) Pipeline Network Improve Productivity, Carlos Alvarez, Saudi Aramco

Al-Dana Hall - 10:00 to 11:15

Session 6: Reservoir Management - 2

Session Chairpersons:	Dr. Fahd A. Al-Ajmi, Saudi Aramco Ali M. Al-Shahri, Saudi Aramco
SPEKSA-08006	Pressure Transient Analysis Data Collected by the Use of a Retrievable Gauge Hanger in Saudi Arabian Gas Wells, R. Zbitowsky, W. Nunez Garcia, A.M. Al-Shawaf, H.M. Al-Hussain, Saudi Aramco; and B. Bill, PI Intervention A/S
SPEKSA-08097	Success Story of Discovering Upside Gas Potential as a Result of Deepening Shallow Horizons and Smarter Completion Deployment, Bandar Al-Malki, Saudi Aramco
SPEKSA-08069	CO_2 Miscible Oil Recovery at Different Flooding Conditions Using Saudi Crude Oils, Eissa M. Shokir, King Saud University
Alternate SPEKSA-08083	Case History: Effective Water Production Control through Utilizing ECP & ICD Completion Technology, Hasan A Al-Ahmadi, Saudi Aramco
SPEKSA-08055	Multidisciplinary Challenge for Microbial Enhanced Oil Recovery (MEOR), Mohammed M. Amro, King Saud University

Banquet Corridor - 12:30 to 13:00

Poster Session

Al-Dana Hall - 13:10 to 15:25

Panel Discussion: "Smart Well Completion Unlocks Volatility"

Panel Moderator:	Dr. Abdulrahman S. Al-Jarri, Saudi Aramco
Panelists:	Rustom Mody, Vice President, Baker Oil Tools Mohammed I. Sowayigh, Saudi Aramco Saleh M. Dawas, Saudi Aramco Suresh Jacob, WellDynamics Stuart Mackay, Schlumberger

Monday, 12 May

Al-Dana Hall - 08:00 to 09:45

Session 7: Reservoir Description

Session Chairpersons:	Khalid A. Zainalabedin, Saudi Aramco Dr. Abdul-Aziz Al-Shaibani, KFUPM
Invited Speaker:	Efficient Detection of Productive Intervals in Carbonate Reservoirs, Jerry L. Jensen, University of Calgary
SPEKSA-08001	Detection of Fracture Corridors from Dynamic Data by Factor Analysis, Sait Ismail Ozkaya, Ozkaya Geoscience
SPEKSA-08087	TOTAL Successfully Employs under Balanced Drilling Technology for Reservoir Characterization in Non-Conventional Fractured Granite Reservoir in Yemen, Hani Qutob, Weatherford International
SPEKSA-08062	Comprehensive Horizontal Well Diagnostics and Reservoir Characterization with Advanced Production Logging, Ahmed S. Al-Muthana, Saudi Aramco

Al-Dana Hall - 10:00 to 11:15

Session 8: Reservoir Simulation & Characterization

Session Chairpersons:	Abdullah M. Al-Ajmi, Saudi Aramco Dr. Muhammad Al-Marhoun, KFUPM
SPEKSA-08066	Computation of Average Well Drainage Pressure for a Parallel Reservoir Simulator, Usuf Middya, and Ali H. Dogru, Saudi Aramco
SPEKSA-08024	Economical Modeling of CO_2 Capturing and Storage Projects, Meshal Algharaib, Kuwait University
SPEKSA-08078	Evaluation of Oil-Water profiles through Inflow-Control Devices with advanced production logging, Ahmed S. Al-Muthana, Saudi Aramco
Alternate SPEKSA-08030	Visualization of Steam Zone Advancement during Heavy Oil Recovery, Abdullah Alajmi, Kuwait University

Al-Dana Hall - 12:35 to 14:15

Session 9: Production Enhancement - 2

Session Chairpersons:	Khalid Omairen, Saudi Aramco Nicholas Gardiner, Halliburton
SPEKSA-08023	Management of Wastes Associated With Offshore Oil and Gas Facilities, Located Offshore Abu Dhabi, UAE, Zaher Ataya, Qatar Petroleum
SPEKSA-08027	Distributed Temperature Sensor (DTS) System Modeling and Application, Shawn Wang, Baker Hughes
SPEKSA-08054	Investigation of Polymer Adsorption on Rock Surface of High Saline Reservoirs, Mohammed M. Amro, King Saud University
SPEKSA-08067	NGPD Disposal Water Systems Enhancement: Birds Eye View, Hani Khalifa, Saudi Aramco
Alternate SPEKSA-08086	Applying Under-Balanced Drilling Technology Improves Productivity and Enhances Recovery in Libya, Hani Qutob, Weatherford International

Al-Dana Hall - 14:30 to 16:10

Session 10: Drilling & Completion Technology - 3

Session Chairpersons:	Dr. Abdulaziz A. Al-Majed, KFUPM Adam Anderson, Baker Oil Tools
SPEKSA-08061	Collaboration Breeds Success in the Khurais Mega-Project in Saudi Arabia, Mohammad Swadi, Baker Hughes
SPEKSA-08082	Slim Intelligent Completions Technology Optimize Production in Maximum Contact, Expandable Liner and Quad Laterals Complex Wells, Muhammad Shafiq, Schlumberger
SPEKSA-08089	Learnings from the Phase-1 Trial Test of Drilling-with-Casing Technology Application in Saudi Arabia, Qamar J. Sharif, Saudi Aramco
SPEKSA-08092	Cementing High Pressure Formations in the Kingdom of Saudi Arabia, Shawn Berg, Schlumberger
Alternate SPEKSA-08068	An Approach for Drilling Wastes Control (Case Study), Eissa M. Shokir, King Saud University International

Poster Session

SPEKSA-08080	New Hydrogen-resistant Optical Fiber for Harsh Environments, Will Hawthorne, Schlumberger, The United Kingdom
SPEKSA-08049	Cyclic Production: Successful Application to Mature areas of Ghawar Field, Saad M. Al-Mutairi, Saudi Aramco
SPEKSA-08085	Kuwait Employs a Systematic Approach to Ensure Successful Underbalanced Drilling Pilot Project-Case Study, Hani Qutob, Weatherford International
SPEKSA-08094	Enhanced Gas/Oil contact identification while drilling using Neutron and Sigma measurements in highly deviated wells, Saudi Arabia, Parvez Butt, Schlumberger
SPESA-08070	Improved Well Placement and Real-Time Decisions Using LWD Resistivity Imaging, Ramez M. Shokeir, Halliburton
SPEKSA-08026	Scale Formation in Oil Reservoir during Water Injection at High-Barium and High-Salinity Formation Water, Amer Bin Merdhah, University of Technology, Malaysia
SPEKSA-08079	Innovative Horizontal Directional Drilling (HDD) Pipeline Network Improve Productivity, Carlos Alvarez, Saudi Aramco
SPEKSA-08083	Case History: Effective Water Production Control through Utilizing ECP & ICD Completion Technology, Hasan A Al-Ahmadi, Saudi Aramco
SPEKSA-08055	Multidisciplinary Challenge for Microbial Enhanced Oil Recovery (MEOR), Mohammed M. Amro, King Saud University
SPEKSA-08030	Visualization of Steam Zone Advancement during Heavy Oil Recovery, Abdullah Alajmi, Kuwait University
SPEKSA-08086	Applying Under-Balanced Drilling Technology Improves Productivity and Enhances Recovery in Libya, Hani Qutob, Weatherford International
SPEKSA-08068	An Approach for Drilling Wastes Control (Case Study), Eissa M. Shokir, King Saud University

جمعية الظهران لعلوم الارض
DHAHRAN GEOSCIENCE SOCIETY

The purpose of the Dhahran Geoscience Society (DGS) is to help provide for the technical and professional development of its members - in geology, geophysics, and related sciences, especially in exploration and development of petroleum and mineral resources within the Arabian Peninsula. The Dhahran Geoscience Society is affiliated with the American Association of Petroleum Geologists (AAPG), the Society of Exploration Geophysicists (SEG), and the European Association of Geoscientists and Engineers (EAGE).

Activities of the Dhahran Geoscience Society include regular monthly dinner meetings, field trips to local and out-of-Kingdom locations, technical seminars, special projects, and publications. Membership includes subscriptions to the society's monthly newsletter "The Oil Drop", and a quarterly geoscience journal. The society is a co-sponsor of the regional "GEO" conferences.

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