

Finding Petroleum

The changing picture for Middle East investors

Developing oil and gas in Ras Al Khaimah

Understanding Kurdistan Region of Iraq

Understanding massive reservoirs of the Arabian plate

Re-processing the 'Persian Carpet'

Finding Petroleum Opportunities in The Middle East, May 22, 2018, London

Special report

Finding Petroleum Opportunities in The Middle East

May 22 2018, London



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Event website

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Many of the videos and slides from the event can be downloaded from the event agenda page.

Report written by Karl Jeffery,
editor of Digital Energy Journal
jeffery@d-e-j.com
Tel 44 208 150 5292

Finding Petroleum

www.findingpetroleum.com

Future Energy Publishing,
39-41 North Road,
London, N7 9DP, UK
www.fuenp.com

Sales manager

Richard McIntyre
rmcintyre@d-e-j.com
Tel 44 208 150 5291

Conference producer David Bamford
Report author Karl Jeffery
Layout by Laura Jones, Very Vermilion Ltd

Finding Petroleum Opportunities in the Middle East

Finding Petroleum's May 22 forum, "Finding Petroleum Opportunities in the Middle East" looked at the current environment for investors, and new opportunities in the region, including Ras Al Khaimah and offshore Iran

Finding Petroleum's forum on May 22, "Finding Petroleum in the Middle East," looked at new developments and potential for oil and gas exploration in the region, including the changing picture for investors, the Arab Emirate of Ras Al Khaimah, the Kurdistan Region of Iraq, the massive Mishrif, Sarvak and Natih reservoirs, and offshore Iran.

Ras Al Khaimah has undertaken a new 3D seismic survey of its entire offshore waters; the Iran "Persian Carpet" offshore seismic is being re-processed; there is much greater knowledge about how some of the reservoir and geology have been formed and how to work with the fracture networks; and companies are using advanced Google Earth technology with seismic interpretations laid on top of it, to look at outcrops and better understand reservoirs.

But what does this mean for investors? Investors generally want to see strong, rapid returns and real value, materiality and good growth potential, that they can build a strong position and can manage the above and below ground risks, before putting capital in.

The landscape of these is complex and now changing, due to shifting politics, three years of much lower oil prices and falling or disappointing production from some fields.

In the past, it was clear that investing in the

Middle East was a good decision, with its large reservoirs leading to reliable, long term returns. Today, the area still has the largest reserves and best source rocks, but is now not necessarily the best investment proposition. Accessing good investments here has got much harder.

It turns out that a critical issue in whether you get the production you expect (and in turn, lower risk, growth potential and access to good positions in future) is how well you understand the petroleum systems, said David Bamford of Petromall, in his chairman's introduction to the event.

Mr Bamford said he has recently been involved in two exploration projects, where the companies involved realised that they did not actually understand how their petroleum systems had been formed, linking together source rocks, migration, reservoir and trap. "That to me says something about the need to get back to basics and understand the rocks," he said.

Another critical issue turns out to be the understanding of fractured reservoirs. They are easy to find, but whether you can get good production is another question. "You can see one or two examples that fractured reservoirs can be enormously difficult to come to grips with," Mr Bamford said. "These fractured reservoirs behave in different ways."

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Investing in Middle East oil and gas

Before putting capital in, investors generally want to see clear potential for strong returns and real value, materiality and good growth potential, and that they can build a strong position and can manage the risks. The landscape driving these criteria for successful E&P investment is complex and changing now, due to shifting politics, three years of much lower oil prices and falling or disappointing production from some fields, as A.T. Kearney's Hugh Ebbutt explained

Before putting capital in, investors generally want to see strong, rapid returns and real value, materiality and good growth potential, that they can build a strong position and can manage the above and below ground risks.

The landscape of these is complex and now changing, due to shifting politics, three years of much lower oil prices and falling or disappointing production from some fields, explained Hugh Ebbutt, upstream director with consultancy A.T. Kearney, with a focus on portfolio and growth strategies.

A key issue for investors in Middle East oil and gas is understanding and meeting the different objectives and needs of host governments and their national oil companies, and it is not always clear what all those shifting priorities are.

Middle East National oil companies have growing technology challenges with their oilfields. Outside capabilities and help are available, where sufficient incentives attract the right investors. Key areas include better reservoir management, enhanced oil recovery, heavier oil and shales. Some also need technical assistance with deeper or offshore drilling and then development projects.



Hugh Ebbutt, director of upstream growth strategies with consultancy A.T. Kearney.

But host countries are quite sensitive to foreign companies taking over or extracting too much of the benefit from their resources, so they want to keep everything under their own control and keep jobs in their own country.

"In working with national oil companies you have to bear in mind they've been working these fields for decades. They run these large re-

sources and they are protective of that control," he said. "They want help but, after three years of lower revenues, governments don't have as much capital available to invest."

Meanwhile international oil companies today are largely looking to lock in low cost oil or gas with dependable returns, in places like Abu Dhabi, Qatar, Egypt, Iraq and Kuwait, and so reduce the overall breakeven cost of their global portfolios.

In the past, international oil companies weren't so good at building lasting relationships and trust, often leaving host country stakeholders feeling exploited. "The softly, softly approach is the best," he said.

Why the Middle East?

The Middle East has about 800 bn barrels of oil, around half the world's proven reserves. (It was 60 per cent until Venezuela and Canada found economically effective ways to produce their oil sands).

The Middle East provides about 30 per cent of the world's oil supply, from only 2 per cent of the world's producing oil wells, and from only 3.6 per cent of the earth's surface. (Mr Ebbutt here includes Israel, Lebanon and Egypt as part of the Middle East region). Most of the oil comes from a producing area which is only about a quarter of this 3.6 per cent.

The region also holds 42 per cent of the world's gas, and provides 17 per cent of its gas supply. Its gas production is rising twice as fast as oil, but the gas resources and supply are mainly concentrated in Iran and Qatar.

The reason why the Middle East has so much oil and gas goes back to the time when Arabia was part of Gondwana, when vast amounts of organic rich material were deposited on the passive margin of the Tethys Ocean. Then Arabia and Africa started spitting away in the Mid Jurassic, and this led to the collision of Arabia with Iran and the formation of the Zagros mountains and the development of a long, wide foreland basin to the SW - infilled with even more sedi-

ments in the Eocene and Miocene from the rising Zagros mountains to the NE.

As well as pushing the organic rich Mesozoic source rocks down into the oil and gas generation windows, the later sediments included extensive evaporites which provide good seals. The Zagros tectonic stresses (still ongoing) produced large anticlines and thrust fault traps, as well as the natural fractures – found so extensively in the carbonate reservoirs here.

Five countries dominate oil reserves and production: Saudi Arabia, Iran, Iraq, Kuwait and the UAE. Some people don't believe the official figures for these reserves, suspecting that they were enhanced for political reasons when setting OPEC quotas. But even if they are a little lower, the Middle East still has a "pretty chunky share". Saudi Arabia is thought to have 260-270 bn barrels still remaining.

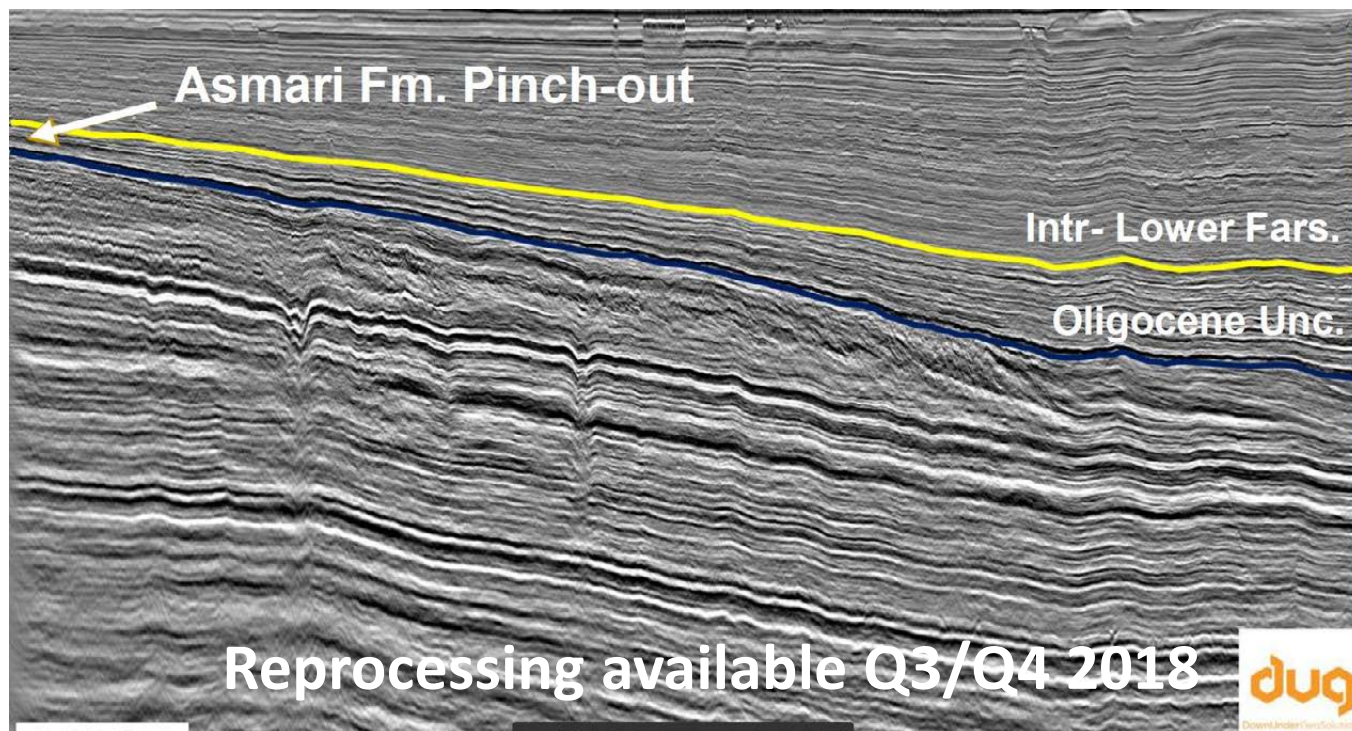
Iran has 1180 TCF of gas, Qatar has 860 TCF, together accounting for 31 per cent of the world's gas. Saudi Arabia has nearly 300 TCF of gas, the UAE over 200 TCF and Iraq 130 TCF. In Kuwait, nearly all of its estimated 60 tcf of gas is associated with oil. Despite domestic power shortages, over 1.3 TCF of Middle East gas is flared each year, mainly in Iraq and Kuwait.

The first Middle East discovery was made in May 1908, so exactly 110 years ago, by BP's forebears Darcy Exploration at Masjid-i-Sulaiman in the Zagros. Much more followed, and political events in the Middle East have had a major impact on global economies and prosperity, especially from the 1973 oil embargo onwards.

The oil price stayed relatively low from 1880 to 1973, including through the second World War and the Suez Crisis, but the price shot up after the US helped Israel in the Yom Kippur war of 1973 (and the first oil embargo), and again in the Iranian Revolution of 1979. Then it rose sharply from 2004 until the financial crisis in 2008, then back up to over \$100 from 2010-14.

What do oil and gas investors want?

Persian Carpet – Multi Client seismic data

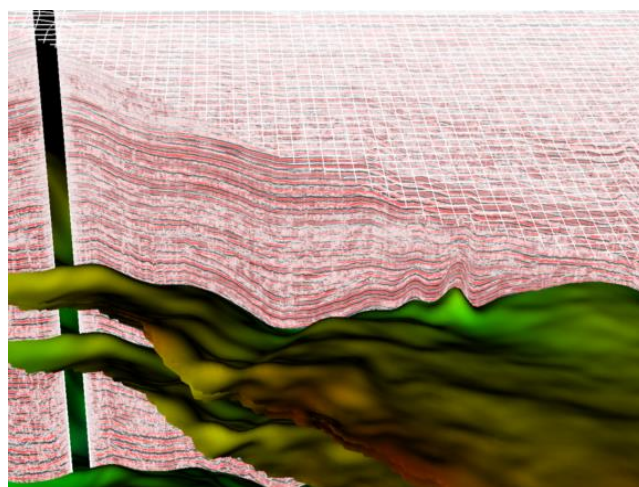


The offshore Persian Gulf is the only remaining under-explored prolific basin in the Middle East

Multiple reservoir layers.

Oil in carbonates and sands of Jurassic, Cretaceous and Tertiary age.

Giant gas reserves in Permo-Triassic



Investors are usually interested in four things – materiality and growth potential, access to a good position, returns and value, and their ability to manage risks.

There has been a big shift from volume to value, driven by the price downturn. While not all areas offer rapid returns and value growth, many parts of the Middle East have the volumes and so growth potential. Whether you get access to a strong position will “very much depend on your relationships in the Middle East,” he said.

Returns depend on the speed of payback, government take and what prices you get, plus your ability to control costs so margins achieved - all strongly driven by your relationships.

As an example, BP’s ability to negotiate a good gas price in Oman and ENI’s in the Zohr field in Egypt were crucial to making these investments attractive. ENI’s ability to get Zohr online fast was also a critical factor for the Egyptian government, who urgently needed more gas.

Key Challenges and Risks

There are subsurface technical risks – the reservoir not producing as much as anticipated – as encountered by some companies producing from naturally fractured carbonates in Kurdistan. “Some operators are producing a quarter of what they promised from some of these fields and have taken big reserve write-downs.”

It is not just fractured carbonates with low matrix porosity that are complicated. NOC producers are increasingly trying to extract heavier oil, and having to find ways to improve reservoir models and recovery, including enhanced oil recovery, as well as tapping deeper or offshore reservoirs.

Then there are surface risks – political and other delays, security issues and disruption, and now sanctions on Iran. A key attribute is whether you have flexibility to adjust the pace of investment, as these events unfold and as the oil price goes up and down.

The biggest political risk is around internal stability of the country, and the physical security of your people and operations.

There can be different factions internally within the government, which you need to deal with. For example, you might be in Kuwait getting on fine with Kuwait Oil Company “but suddenly the parliament will oppose what you’re doing

and put the project on hold,” he said. “It’s the different factions in the Middle East that make the politics hard to work with.”

There are also shifting alliances now, notably Saudi Arabia working with Russia. Russian influence is rising right across the Middle East.

Poor communication between national oil companies and their governments also hampers the progress that could be made. National oil companies do not always have a clear understanding of differing government priorities, and governments do not always understand what is achievable, with their domestic resources and capabilities, or how long projects will take.

Many of these Issues are Evident in Iraq

Iraq is now producing about 4.5m bopd and wants to get to 5 by the end of the year, with most production coming from the south of the country.

But the terms agreed a few years ago with foreign companies are proving “pretty unattractive”, with some finding it “hard to get to the production levels to trigger payments.” Some of the oil majors appear to have promised more production than they have been able to deliver.

There is also longstanding distrust of international oil companies. “They tend to have nice offices in Dubai and try to charge those costs to Iraq. Iraq still hasn’t got any money, because they’ve been fighting ISIS. So both sides have been finding it difficult to get on.”

Currently there’s lots of gas being flared, which both Kuwait and Iraq could use to fuel much needed electricity.

BP has recently signed a deal promising to triple the output from Kirkuk to over 1m bopd – although the timescale is not yet clear.

Another example is Kurdistan – a hot exploration area from 2005 to 2014. But its referendum and vote to become fully independent from Iraq last year upset Baghdad and its neighbours – concerned that Kurds in Turkey and Iran may also seek independence - as well as the US. And Baghdad cut off critical funding.

The region is very dependent on oil exports, but it lost control of Kirkuk and this oil is no longer going through the Kurdistan pipeline (and there are even plans to send some to Iran by truck).

It is a difficult situation to resolve. “If you have acreage in Kurdistan it’s now possible your contract might be declared illegal by Baghdad,” he said. “If you’ve been in a dispute with the Kurdistan regional government over delayed payments, they’ve now got no money.”

Where are Middle East NOCs and governments investing

Across the Middle East, national oil companies are investing heavily, mostly in their large onshore fields, dominated by low cost Saudi and Iraqi oil projects. And about \$25bn a year is being invested by Aramco and Kuwait Oil Company alone.

The Saudi Aramco stock offering is also supposed to be coming up as a key part of economic diversification plans, but is already delayed. “I suspect that will slip and slide,” he said. “Transparency issues and rising uncertainties, as different factions jostle for position, make private investment higher risk.”

Gas is becoming more important in the region. Qatar is looking to increase its gas output by 30 per cent, with around \$18bn of investment needed from outside, while IOCs want to lock in low cost, dependable returns.

Iran has been seeking investment, with deals signed by Total and Shell. But these are coming under threat with US sanctions coming on. Companies will have to choose between being in the US or Iran.

IOCs need to recognise Middle East NOC strengths, as well as their needs and constraints, to build real trust and strong, mutually beneficial and productive long term relationships.

Another issue is the region’s enormous population growth. For example, 67 per cent of people in Iraq and 60 per cent in Saudi Arabia are under 30 years old. “Someone’s got to give them jobs or they’ll be out in the streets protesting,” he said.

And growing oil demand won’t last forever. Global demand may plateau in the late 2020s, particularly impacting the Middle East. And more and more solar projects in this sun-drenched region are now moving forward.

The Middle East is the leading, low cost, hydrocarbon rich region – a real Aladdin’s cave. But major risks lie above ground, with political alliances shifting, and more investment and

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involvement in the region from Russia, China and others in the Far East. Political uncertainty is rising, and investors could be hit by the moves of the key powers.

Technical challenges are also growing, that need outside help – if sufficient incentives attract the right investors. Good relationships and trust are key. Smart investors will focus where they see the best returns and value, and where they can build strong, enduring and mutually rewarding relationships.

Big company territory?

Mr Ebbutt was asked if he believes the Middle East is “fundamentally big company territory”.

“Yes I do,” he replied. “For example, Kuwait is looking for help from the majors for their better recovery of heavier oil and deeper drilling and development capabilities, rather than from smaller independents. There are a number of active smaller companies, such as Mubadala Petroleum, who bring key strengths and can take good positions. But for larger or more complex assets, both the host government and many smaller players may prefer a bigger company as operator.”

“The main place you’ve seen small companies engaging in is Kurdistan. But some of these have come a cropper there, and they haven’t been able to pull it off. They haven’t always had all the technical capabilities and resources to un-

ravel and deal with the complex geology.” And even companies as big as Exxon have now left.

Flaring

Mr Ebbutt was asked why so much gas is being flared rather than produced. “In my opinion it is mostly because it is associated gas. It comes with the oil, and it doesn’t necessarily come in great quantities,” he said. “And the NOC hasn’t invested in enough gathering pipelines and processing plants to bring the gas to their domestic markets where it’s needed.” Bigger efforts are now being made to reduce this waste, for example - with Shell’s help - in the big oil fields north of Basra.

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Developing oil and gas in Ras Al Khaimah

The national oil company of the emirate of Ras al Khaimah is keen to develop its oil and gas reserves, and has commissioned a huge seismic survey with Polarcus to provide more insights into its subsurface

RAK Gas, the national oil company of the Emirate of Ras al Khaimah is keen to develop its oil and gas reserves, and has commissioned a huge seismic survey with Polarcus to provide more insights into its subsurface. The Emirate is running a 2018 licensing round.

Ras Al Khaimah, is the seventh Emirate of United Arab Emirates, located on the Northern tip of UAE, bordering the other Emirates of Umm Al Quwain, Sharjah, and Fujairah and also Oman, and at the foot of the Al-Hajar Mountain range. The current ruler is Sheikh Saud bin Saqr Al-Qasimi, who is also chairman of RAK Gas.

The Emirate contains 3 per cent of the UAE land mass, 1600km², and about 3 per cent of its population, about a quarter of a million people.

The Ras Al-Khaimah sub-basin contains continental shelf carbonate sediments moving to complex faulting found in the foreland basin.

This area has had some exploration and production activity dating back to the 1960s. Two fields have been active, Saleh, one of the main producing gas and condensate wells in UAE, in production from the 1960s to 2016, and RAK B, which has proven oil reserves.

The gas goes to the Rak Gas plant, owned by Rak Gas, currently working to 10-11 per cent of its capacity. “Rak Gas is hungry for gas, the while emirate is hungry for gas molecule,” said Thibaut Burckhart,

exploration manager of RAK Gas. Part of the licensing offer is that Rak Gas will commit to buy any gas produced in its acreage.

If oil was to be discovered, it could be exported through a single point mooring by an international oil company.

Before Polarcus was involved, there had been some sparse 2D lines in Ras Al Khaimah, and vintage 3D over each of the main fields, RAK-B and Saleh. There were still large areas without any seismic coverage, totally unexplored.

The 2018 licensing round includes 7 blocks in total, 4 of which are offshore and 3 onshore.

Seismic survey

RAK Gas has commissioned a huge 3D, triple source seismic survey with Polarcus over its entire waters from 15m water depth to the edge of national waters, to provide more insights into its subsurface.

The survey was planned to maximise coverage around the Saleh field and over the shallows. It was all towed streamer survey, no ocean bottom survey or undershoots.

The survey was constrained by borders on every side, including international borders of Oman and Iran, and the border of neighbouring Emirate Umm al-Quwain.



James Wallace, area geophysicist for Europe, Africa and Middle East with Polarcus

There were 7 fixed installations in the Saleh field and 1 in the Rak-B field, which the survey needed to navigate around. There was a red marker buoy which couldn’t be moved for safety reasons.

There was one major port, Mina Saqr, and associated anchorage areas. There were major fishing lanes going through the survey and a lot of fishing. The fishing vessels typically laid their nets after dusk, then returned in the morning to pick up their catch.

It was critical that the data processing could be started onboard, because of the tight schedule, with processed data needed in time for the 2018 licensing round which was starting in March 2018, said James Wallace, area geophysicist for Europe, Africa and Middle East with Polarcus. The hardware and software on the vessel for seismic processing was provided by Downunder Geosolutions.

The survey team wanted data from as close to the coastline as possible. The vessel had a

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draft of 7m and needed 15m depth for safety. A bathymetric and side scan sonar survey was done to map the 15m contour (area where water depth was at least 15m), and identify all seafloor obstructions – ending up identifying 9 shipwrecks, 88 boat wrecks and 126 coral heads. But only one shipwreck really affected acquisition, requiring a deviation around it, Mr Wallace said.

The port area survey was complicated to survey because it involved moving the vessels at anchorage to other areas.

The original survey plan was to steer in parallel, straight lines, or “racetrack”. This plan needed to be revised because there was a higher level of fishing activity than expected. The vessel had to do the shooting in these high fishing areas during the day-time, Mr Wallace said.

The survey did not encounter many challenges from feathering (sideways drift of the streamers from ideal cable lines) due to currents and tides), he said.

“Maybe we were lucky, we didn’t encounter very strong currents – very predictable and worked in our favour,” he said. So we didn’t find any challenges.

Final data

The final data was delivered to RAK Gas within 6 weeks of the last shot point.

The processing steps were to merge navigation and seismic data together, try to remove the ship noise, and perform deghosting and de-multiple (removing multiple energy). Then applying anisotropic pre-stack time migration.

In March 2018 RAK Gas opened data rooms and its E&P customers could look at some of the data.

The end products of the survey were delivered over cloud rather than on physical media, the first time this has been done by Polarcus.

The full pre-stack time migration data will be delivered in July by DownUnder GeoSolutions.

“A high quality data set, for a very complex geological setting, was delivered, including with coverage maximised around offshore installations, and surveying in a shallow water zone,” Mr Wallace said.

RAK Gas perspective

The UAE and Ras Al Khaimah could be considered “Middle East for beginners”, said Thibaut Burckhart, exploration manager of RAK Gas.

Rakgas believes it is offering attractive commercial terms, without forcing oil companies to enter service contracts or joint ventures.

It is an Exploration and Production Sharing Agreement (EPSA) which is “unique in the UAE and probably certainly quite uncommon in the region,” he said.

Companies bid on the “profit oil”, not their work program (which will be dictated by RAK Gas). RAK Gas has 10 per cent ownership of the project through the exploration period.

“Companies will do technical, commercial due diligence then come to us with a number which meets their requirements,” he said.

“Then there will be exploration work program to be executed onshore and offshore.”

The reason for the lack of development offshore is mainly the “lack of data” (until now), he said. There are large areas, over 100km², without any seismic data at all, not even 2D. “This is what we have addressed by acquiring a blanket 2000 km² 3D,” he said.

To make a “closeology” analysis (geology based on what is in the surrounding area), Ras Al Khaimah is surrounded by a “very large producing accumulation” with Oman’s West Bukha field to the North, a cretaceous carbonate producing field. The Saleh field within the Emirate has been a multi TCF producing field. Rak B is an undeveloped stranded oil discovery.

There is a complex burial history, with multiple source rocks. “We think the cretaceous definitely plays a role here, we also have a number of converging arguments for the Jurassic,” he said.

There are two reservoirs specific to Ras Al Khaimah, in platform fractured carbonate.

There are some other reservoirs of high interest – a Jurassic reservoir which can be seen on the new 3D, and a clastic Miocene reef shown on the 3D.

The geological shaping of Ras Al Khaimah comes from the onset of the Al-Hajar Mountains, and the thrust belt. “Think about Italy, Northwest Borneo, whichever is your favourite thrust belt. All of the structuration associated with a thrust belt is present in RAK.”

“It is actually a thrust with multiple pulses. There’s a lot of tectonic movement. We could have a lot more discussion about the interpretation of these thrusts.”

“Some of the large fields, we believe, are associated with re-activation, which creates room for more reservoir, more column, can also potentially protect the reservoir from diagenesis.”

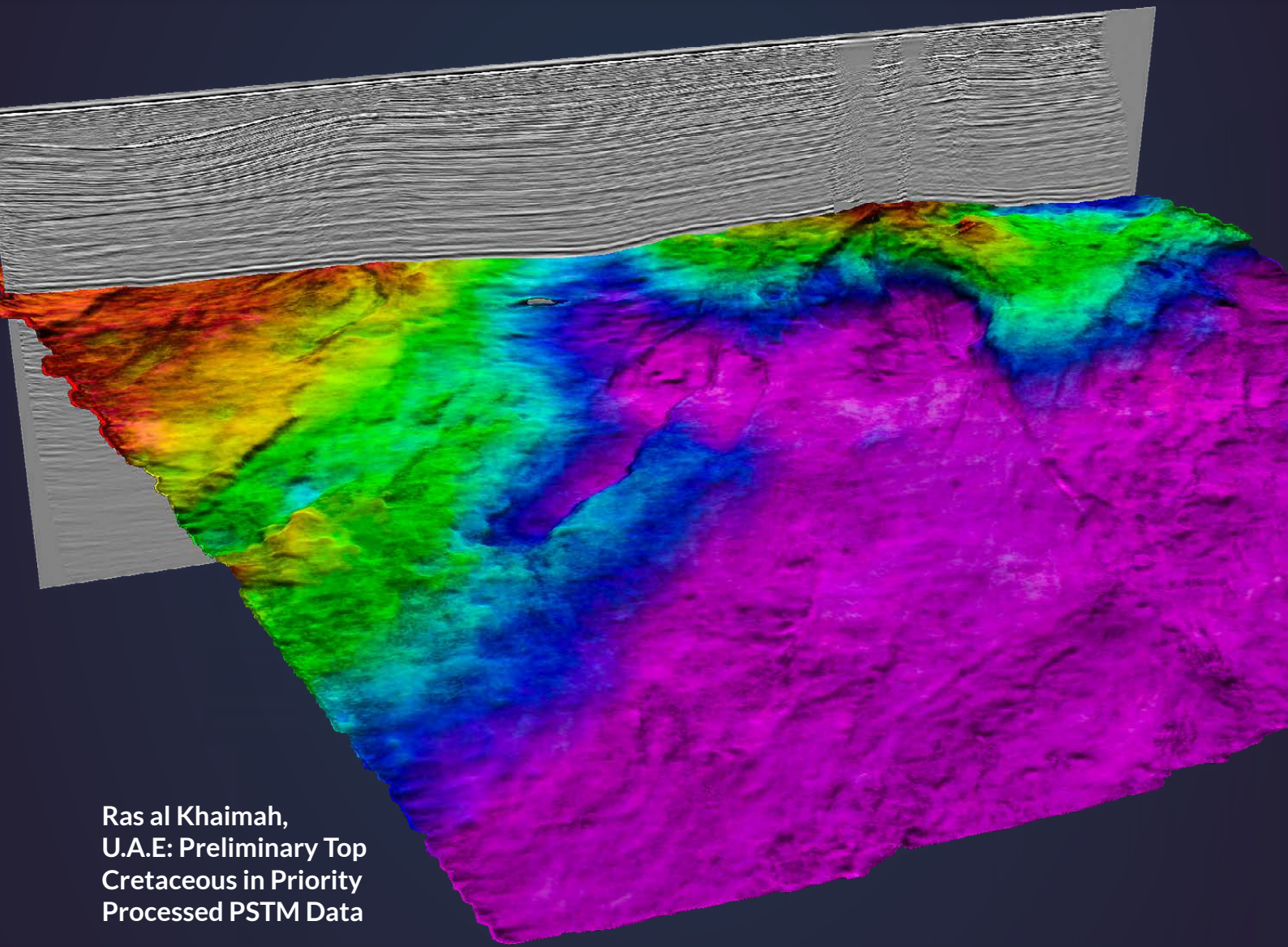
RAK Gas worked together with consultancy ERCL, to put all the building blocks of the play system together, and their study is available in the dataroom. The dataroom data is available in an ARCGIS database.

RAK Gas is also proposing to acquire 3D onshore seismic. The country is in the middle of a large thrust belt, which has been very hard to image until now, with only 2D seismic available.



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Ras al Khaimah,
U.A.E: Preliminary Top
Cretaceous in Priority
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Geospatial Research – understanding Kurdistan Region of Iraq

Geospatial Research helps companies understand geological opportunities and risks in the Zagros region of Iraqi Kurdistan with the help of Google Earth technology to ‘fly’ around the country, seeing geological interpretations together with satellite imagery

Geospatial Research is helping companies understand geological opportunities and risks in the Zagros region of Iraqi Kurdistan (as well as other parts of the world) with the help of Google Earth technology to ‘fly’ around the country, seeing geological interpretations together with satellite imagery.

The full video of the talk, including flying around with Google Earth, is available free on the Finding Petroleum website www.findingpetroleum.com/event/b4523.aspx

The talk focussed on the different aspects of the petroleum system – source, reservoir and seal, and the processes of generation and accumulation. “There’s a lot of under-explored acreage throughout the Zagros,” said Richard Jones, CEO of Geospatial Research.

Looking at a license map of Kurdistan, based on data from Kurdistan Regional Government, you can see there is lot of acreage still unclaimed, he said.

There are also a number of discoveries in unlicensed areas, and a large number of anticlines which haven’t been drilled at all, and big structures with only one well on them.

The Arabian plate is still moving northwards, so the anticlines (which hold oil) are getting bigger and charge (flow of oil into them) is still occurring. (This also means some earthquake risk).

Fields are more gas prone in the Southern part of Kurdistan, and more oil prone in the North, although there are deeper gas producing reservoirs in the North.

Looking at Northern Kurdistan on Google Earth, you can see anticlines containing “fantastic world class source rocks”. You can see organic rich limestone at surface.

The rock can be 10 to 20 per cent total organic content. “The key message here is that source isn’t your main risk factor,” he said.

Geospatial Research has done a lot of connecting well logs to subsurface sections, to identify structures, understand fractures.

The presence of reservoir is “not the risk factor in some respects,” he said. There are massive stacked systems with multiple reservoirs, multiple seals – reservoirs from Triassic to the Cenozoic. There are multiple source rocks in the region. Some reservoirs may have seals within them. But “there often isn’t a problem with seal.”

There are massive Cretaceous carbonates with a fracture system in them.

“Fractured carbonates aren’t a problem, they are a fantastic opportunity - you have to embrace them,” he said.

Understanding fracture systems

“The real risk of reservoirs in much of Middle East is whether you’ve understood the fracture systems. They are not the same as matrix supported reservoirs,” he said. “You have to be able to do the necessary legwork.”

“We’ve spent a lot of time characterising fracture systems - type 2 [fractures provide essential permeability], type 3 [fractures provide a permeability assist to an already producible reservoir]”.



Richard Jones, CEO of Geospatial Research

Taking an example of a reservoir from Upper Cretaceous carbonates, you can see variations in fracture intensity colour coded on the photo, from green (low intensity), orange and red (much higher), with a lot of variation vertically. “We need to understand that variation,” he said.

The fracture intensity and other fracture properties vary. “In order to understand vertical connectivity and lateral connectivity we need to understand that variation, we need to understand mechanical stratigraphy.”

“In typical fractured reservoirs there are some very big fractures and many smaller fractures. Fracture systems scale in a very significant way.”

If you just take a quick look at fracture systems, such as looking at some outcrop data and perhaps some laser scan and satellite data, you might not notice that you are only sampling a relatively low fracture intensity part of the system, he said.

For example, in one reservoir, the fracture spacing calculation could end up as anything from 300m to 10,000m depending on the input data used, which makes a large difference to the flow modelling.

Mr Jones showed a video of how the company captures a virtual copy of an outcrop, by combining LIDAR (laser scan) and photogrammetric (photograph measurement) data. The images can be analysed in detail, to pick out tens of thousands of fractures automatically.

If you zoom in, you see that any of the larger fractures have a huge number of smaller fractures.

This model can be used to “build really robust fracture properties.” You can see the fracture orientation, the size, the clustering, and the intensity.

The model can be modelled further in “discrete fracture network modelling” or cell based fracture models.

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Another important risk factor is the diagenetic processes and dissolution processes. They help understand why some of the outcrop sections are different to the subsurface sections – the rock goes through dissolution processes when it comes close to the surface. With a better understanding of this, it can be possible to tie the surface data with the subsurface.

The traps are a “really key part”, with the Zagros famous for huge traps, tens of kilometres long. But they have quite a lot of structural complexity.

Mr Jones presented a geological description of the region using the satellite imagery via Google Earth, showing how in neighbour-

ing Southeast Turkey you can see many anticlines, some showing on geological maps as “thrust at surface”. You can see a fractured working reservoir exposed to the surface called Ispandika.

About Geospatial Research

The company has extensive field experience in the Middle East, including in the Zagros, UAE, Oman and Turkey. It has completed 25 “field campaigns” for 14 companies in the Northern Zagros, so their geologists can see the outcrop geology for themselves.

This gives the company extensive experience of stratigraphy from the Cambrian to the Pliocene, based on looking at outcrops.

It has completed outcrop scale mapping of the Zagros, and also produces detailed quantitative data about reservoir fracture systems.

The company has also looked at seeps, with multispectral surveys – looking at different frequencies of the colour in the seeps. The data can be gathered from satellite, plane, drone (UAV) and increasingly ground / tripod based.

It offers regional vector based maps with 7000km of cross section through the region. It has detailed characterisation of fractured reservoirs from Triassic, Jurassic, Cretaceous and Cenozoic.

Finding
Petroleum

Understanding massive reservoirs of the Arabian plate

Cambridge Carbonates gave a talk on the geology of largest reservoirs of the Arabian Plate, the continental plate beneath the Arabian continent

Andy Horbury, director and founder, Cambridge Carbonates gave a talk on the massive Mishrif, Sarvak and Natih reservoirs of the Arabian Plate.

The Arabian plate covers parts of Iraq and Iran, eastern Lebanon, and the entire Arabian peninsula of Saudi Arabia, UAE, Oman, Qatar, Bahrain, Kuwait and Yemen.

These reservoirs were formed in the Cenomanian (the oldest stage in the upper cretaceous). In Iraq, 38 per cent of producible reserves are within the Mishrif formation within the Cenomanian, he said.

Mr Horbury’s talk went through the lithostratigraphy, the basis of formation, and the different parts of the system. Then he looked at the chronostratigraphic, and different ages. He showed some suggested revisions to the normally believed sequence stratigraphy of the interval, and talked about paleogeography and reservoir quality.

In Iran, many of the rock layers are given the same name “Sarak”, “which causes us a bit of a headache. It is very difficult to subdivide. It has resulted in Iranian stratigraphy being particularly difficult to characterise until recently,” he said.

For chronostratigraphy (working out the time the rock layers were created), the early

work said they were “broadly Cenomanian Turonian”, although most work Cambridge Carbonates has been involved in says it is “almost all Cenomanian”.

“People are applying new techniques, particularly in Iran, using carbon isotopic data, which demonstrates we are still within the late Cenomanian. Turonian only found in certain parts of the plate.”

If we take various wells from the same part of the basin in South East Iraq, the overall “package” of poroperm characteristics is

often similar within the same facies belt.

Today, compared to what the company worked on in 2001, there is better subdivision of the stratigraphy, which makes it possible to define two more sequences within the main part of the Mishrif. The “sequence boundaries are quite critical for development of reservoir quality,” he said.

The diagenesis is “clearly quite complex”. You can be sure what is going on in a section of a reservoir system, but can’t apply the same rule to the entire system.

Finding
Petroleum



Re-processing the “Persian Carpet”

The “Persian Carpet”, the world’s largest offshore seismic survey (when acquired in 1999) is being re processed, providing much better seismic images of the waters offshore Iran

The “Persian Carpet”, which was the world’s largest seismic database when it was originally acquired in 1999, is being re-processed, providing much better data about the subsurface offshore Iran. The survey is 105,000 line km of 2D seismic, covering the entire Iranian Persian Gulf.

The rights to the data are held by Norwegian multicient seismic company Global Geo Services, which originally acquired the data in 1999-2002. It has formed a joint venture with UK data management company Interica to manage the re-processing.

The Persian Gulf is still heavily unexplored, said Trond Christoffersen, chief operating officer of Global Geo Services AS. An indication of this is to see data about the number of discovered fields of different sizes. It shows that there is a small number of 100m barrel fields, then hardly any fields of medium size, then a large number of enormous multibillion barrel fields.

Considering the size distribution of most things in nature moves gradually from small to large, this indicates that there are probably many more fields to find of medium size, he said. This could include “upgrades” of the existing fields, discovering that they are larger than previously thought.

The “stratigraphic plays” have not been explored at all,” he said, and there has barely been any offshore exploration for decades.

We can say Iran has very low cost production, fairly high current production capacity, and definite potential to increase the production.

“There’s a huge pile of brownfield and green-field developments available, almost all are still available for discussions with an international oil company,” he said.

The original “Persian Carpet” survey in 1999 took 6 vessels 2.5 years, recording seismic in 2km x 2km grids, with four different data collection methods.

Stratigraphy

The stratigraphy is carbonate dominated, but with some important sandstone reservoir intervals as well.

GGG showed a “simplified stratigraphic key” showing the important intervals, such as the Azadegan Sands and cretaceous and Jurassic carbonates.

The Reshadat Field is producing from middle cretaceous, upper cretaceous and Jurassic, so a multi reservoir setting. “In almost any place we go we have reservoirs at several levels,” he said.

Gas is important in the area, with the Kish Gas project being offered as 55 TCF development.

“They’ve started but not got very far, they don’t have the equipment to really get it going,” he said. “But they are drilling wells in it, seeking people to go for it.”

Mr Christoffersen provided a quick tour of the oilfields and the geology (which can be viewed on the video together with the slides).

Iran oil business

The highest sales for the original seismic data were in 2000 (immediately after the survey had been taken). But sales then gradually dropped off to 2008 when there were very few sales at all. This reflects business interest in Iran exploration. The big problem was US sanctions, and the lack of a working fiscal and financial exploration environment.

As the sanctions were being lifted 3 years ago, a formula for exploration contracts was attempted which would satisfy investors.

But then the 2018 US withdrawal from the Iranian nuclear treaty has shaken up the whole scene – with European companies including Total having to make difficult decisions about whether to stay in the area, and also opening up business opportunities for Russia and China. Total has said they will pull out of Iran if they cannot get a waiver from the sanctions, writing off their investment.

The reprocessing

The data was originally acquired by different vessels with different acquisition parameters. So it made sense to re-process the data from each vessel separately, and re-process data of different geological type separately, said Katya Krylova, VP sales and marketing, GGS Interica.



Katya Krylova, VP sales and marketing, GGS Interica

For example the salt dome regions were re-processed separately to the Oman Sea region which has completely different geology. The coastal transition zone was also re-processed separately.

This is different from how the processing was originally done 12 years ago, when it was done by a number of companies, all following the same processing sequence.

At the time of the talk, only 2 blocks had been re-processed, areas 2 and 4, where the geology is relatively homogenous and straightforward. The next blocks, to be “out very soon” are the transition zone area 3 and the Oman Sea.

There is a lot of checking of the pre-stack time migration data, which is a “definite benefit”, she said.

The project identified that part of the field data for the transition zone was not very reliable, sometimes there was a need to manually correct the position. There were some mislabelled geophones and hydrophones.

There are techniques available today which enable much better noise removal than was possible in the year 2000. Ms Krylova showed some comparison images of the previous processing compared to the modern processing showing the improvement (these can be seen on the online video.)

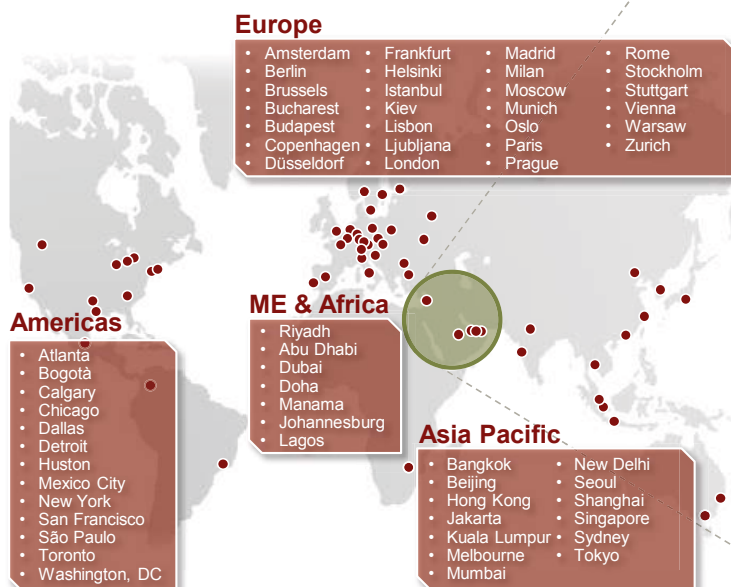
The seismic was tied with well data, with well logs provided together with the seismic.

There was work to try to identify from the seismic whether reservoirs are saturated by water or hydrocarbons, or if they are dry. The method used is called “Prony decomposition,” combined with Phase decomposition.

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Contact: Hugh Ebbutt

at: hugh.ebbutt@atkearney.com or hughebbutt@gmail.com

+44 7973 201608

Finding Petroleum Opportunities in The Middle East Event, London, May 22 2018, Attendees

Hugh Ebbutt, Director, A T Kearney	Katerina Krylova, VP sales and marketing, GGS-Interica	John Clure, Managing Director, Phoenix Hydrocarbon Resources Ltd
Julian Moore, Technical Director, APT UK	Paul Wilson, Senior Explorationist, Glencore	James Wallace, Area Geophysicist, Polarcus
David Craik, Consultant, Atlaslocal	Trond Christoffersen, Chief operating officer, Global Geo Services AS	Iain Buchan, Polarcus
Joe M Boztas, Director/Interpreter, Boz Seismic Services	Daniele Zordan, Upstream Oil & Gas Analyst, GlobalData	David Contreras, Regional Geoscience Manager, Polarcus
Katherine Welbourn, Geoscientist, BP	Geoff Marsden, Processing Geophysicist, GM Geophysical	Chris Newton, Sales Manager, Polarcus UK Ltd
James Hamilton-Wright, Geoscientist, BP	Norman Hempstead, Director, Hempstead Geophysical Svcs	John Scotchmer, Principal Geological Advisor - Petroleum Systems, Premier Oil
Robert Kennedy, Commercial Director, Caithness Petroleum Limited	Claire Jones, Analyst, IHS Markit	Daniel Buckingham, Broker, Pronto Business Funding
Andy Horbury, Director, Cambridge Carbonates	Irina Mosina, Imperial College	Josh King, Analyst, RAB Capital
Jack Turney, Cambridge Carbonates	Neil Simons, Consultant, Independent	Thibaut Burckhart, Exploration manager RAK Gas, RAK Gas
Andrew Webb, Manager, Petroleum Reservoir and Economics, CGG	Geoff Chambers, Sr Geophysicist, Independent	Nish Dighe, RAK Gas
James Andrew, Busines Development Mgr EAME, CGG	Abdalmohsin Dolaijan, Consultant, Independent	Robert Snashall, Consultant, RGSConsult
John Glass, MD, Cloverfield Consulting Ltd	Mike Hibbert, Independent consultant	Patrick Taylor, Director, RISC (UK) Limited
Peter Farrington, Geophysicist, Consultant Geophysicist	Christian Bukovics, Independent Director, JKX Oil&Gas Plc	Martin Smith, Business Development Manager - Operations, RPS Energy
Richard Walker, Consultant Geophysicist	Peter Allen, Consultant, Layla Resources	Chris Hayes, Well Operations Director, RPS Energy
Augustus Wilson, Consultant, Consulting Geologist Middle East	Jon Wix, Lloyds Register	Rob Naylor, Seismic Project Manager, RPS Ltd
Graham Cleveett, Managing Director, Cornhill Economics Ltd	Ahmed Elghorori, Lukoil	Stephen Boccioli, SCDM Energy
Dan Kunkle, Director, Count Geophysics	Anne-Mette Cheese, Exploration Geologist, Lukoil Engineering, London Branch	Tom Martin, Director, Shikra Consulting
David Boote, DBconsulting Ltd	Stephen Morse, Technical Director, Lyme Bay Consulting	David Lawton, Chief Geoscientist, SLR Consulting Ltd
Edward Prescott, Principal Geophysicist, Delonex Energy	Gerrard Spear, GeoScience Director, Lyme Bay Consulting Ltd	Glyn Roberts, Director, Spec Partners Ltd
Raffaele Di Cuia, Technical Director, Delta Energy Limited	Rupert Simcox, Data Analyst, Lynx Information Systems	Jorgen Keyser, Statoil
Brian Donnelly, Consultant Geophysicist, Donnelly	Chris Morgan, Managing Director, Lynx Information Systems Ltd	Robin Haworth, Stifel
Julian Sherriff, , Downunder Geosolutions	Paul Spencer, Senior Production & Seismic Data Manager, Lynx Information Systems Ltd	Sue Wells, reprocessing advisor, Sue Wells Associates
Johannes Sobotzki, Data Analyst, Drillinginfo	David Bamford, Director, New Eyes Exploration Ltd	Felicia Winter, Interpretation Geophysicist/, TGS
Mark Lonergan, Senior Business Development Manager, EPI Group	Sofia Khan, President and CEO, Nonlinear Seismic Imaging, Inc.	John Weston, Tecnical Director, Tridevi Energy & Resources
Richard McIntyre, Sales Manager, Finding Petroleum	David Grassick, CEO, Oil & Gas Enterprises Ltd	Alastair Bee, Westwood Global Energy
Avinga Pallangyo, Conference Organiser, Finding Petroleum	Mark Robinson, Managing Director - Geoscientist, Oil and Gas Consultancy	Todd Jensen, Middle East and North Africa Data Analyst, Wood Mackenzie
Karl Jeffery, Editor, Finding Petroleum	Grenville Lunn, Manging Director, PGA Ltd	Peter Sawyer, Business Development Director, WSS Energy Consulting
Jeremy Berry, BD Director, GCA	Frederic Yeterian, Director, Philax International (UK) Ltd	Reza Sedaghat, Director, Zagros Energy Ltd
Jonathan Long, Senior geologist, Geospatial Research		Sara Stephens, Sales Manager, Zebra Data Sciences
Richard Jones, CEO, Geospatial Research Ltd		

What did you enjoy most about the event?

“ “ The first presentation by AT Kearney. Not being a geologist (original word – geology) it was easier to follow and more insightful, but this is purely based on my knowledge and understanding. The following presentations were also very interesting but harder for me personally to follow.

“ “ The atmosphere.

“ “ Hugh Ebbutt presentation - Challenges in ME.
Joe M Boztas (Boz Seismic Services)

“ “ Networking in the tea and lunch break.

“ “ Well researched quality presentations....beyond conventional ppt format

“ “ Quality of presentations and participants.

“ “ The huge amount of data on Iran and Kurdistan very interesting.

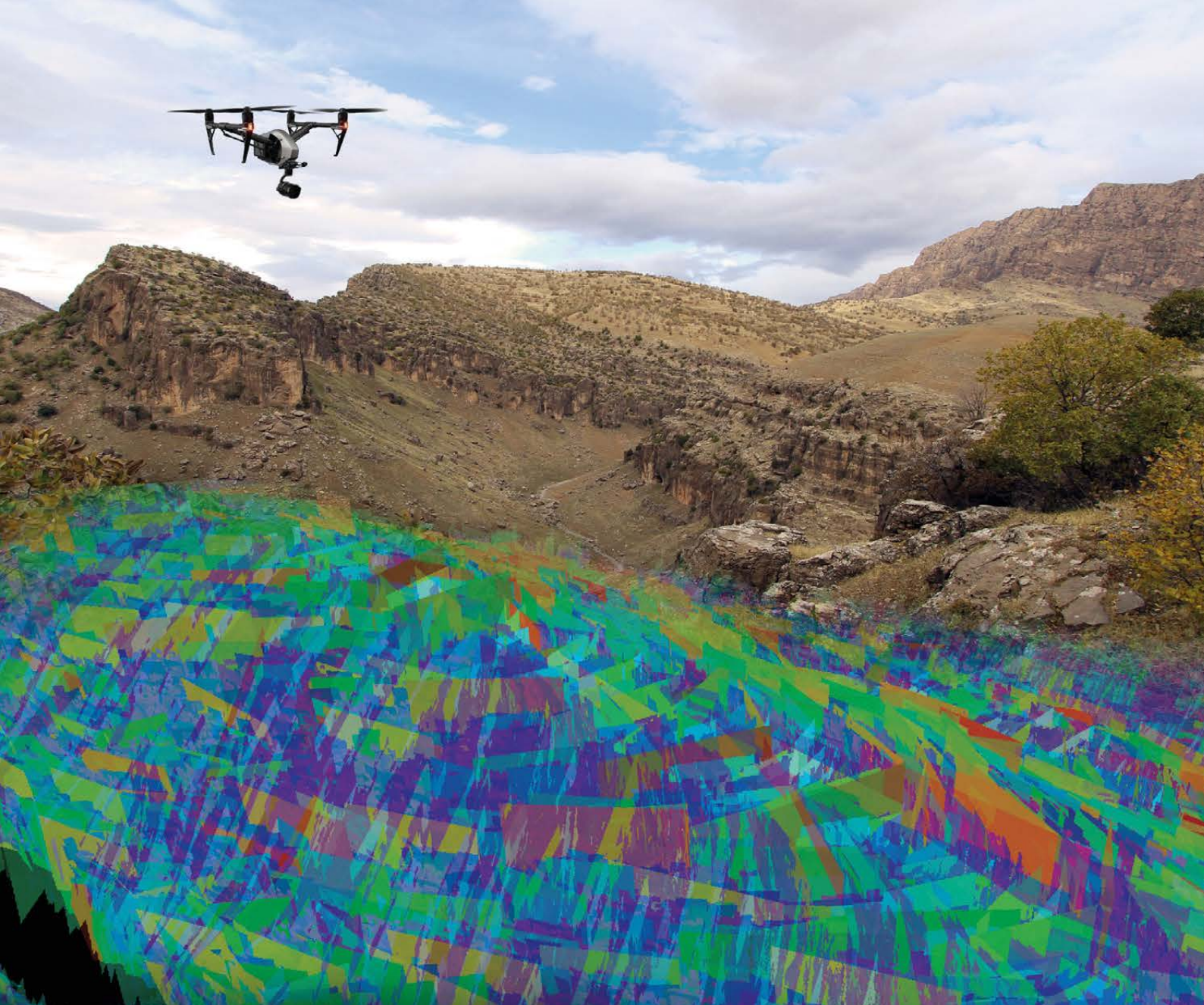
“ “ Presentations by Hugh Ebbutt and Andy Horbury in addition to remarks by David Bamford.
Abdalmohsin Aldolaijan (Independent consultant)

“ “ The overview of opportunities in various territories either present or in the future and understanding better the underlying field data gathered.
Graham Clevett (Cornhill Economics Ltd)

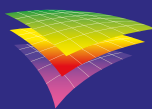
“ “ Topics were informative, but light enough. Networking.
Felicia Winter (TGS)

“ “ Interesting and informative pair of talks on the UAE.
Richard Walker (Consultant Geophysicist)

“ “ Networking and materials presented.



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