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INDONESIA

JAVA SECTION

October - December 2014

Indonesian Domestic Oil and Gas

A Snapshot

Oilfield Review app now available for the Android† platform

Oilfield Review Apps

The Schlumberger *Oilfield Review* app for Android† devices is now available free of charge on the Google Play† store. This new app complements the iPad‡ app, which is available at the Apple‡ iTunes‡ online store. For Android devices, including phones, this is a stand-alone app; accessing content on the iPad device is done through the Newsstand. An iPhone‡ compatible version is in development and will be available in the near future.

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Available on the App Store

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Dear SPE Members;

SPE Java Section Newsletter is issued every other month; they are printed 1,500 copies per issue, circulated among members, industry leaders, stakeholders (staff and manager), and students.

In order to improve the content of our Newsletter, we urge you to send us an article worth sharing to update and enrich our reader (at no cost to you), with application of certain technology, and/or CSR activity which made an impact on our industry.

We would also like to invite your Company to place an Advertorial, which serves as a showcase, at the same time to cover the cost of printing the Newsletter accordingly to the following fee structure with effect July 2012:

	Printing Charges in USD	
Old Rate	No. of Issue	New Rate
385 **Full page**	1	400/issue
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Old Rate	No. of Issue	New Rate
220 **Half-a-page**	1	250/issue
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	3	210/issue = 630
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	5	190/issue = 950
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Note:

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Chairman's Note

Dear Readers,

I would like to wish you and your families a Happy New Year and all the best for 2015!

The SPE Java Section had a very successful 2014, for which I would like to thank everyone involved sincerely – without all your hard work, dedication and enthusiasm, this would not have been possible.

For example:

- 28 students from 8 student chapters received a SPE scholarship; 3 students from each UI, Trisakti, UGM, ITS, UNPAD and UNDIP as well as 5 students from each UPN and ITB.
- 3 large scale social events have been organized and extremely well carried out:
  - "Fish Fry" in February was with 400 tickets completely sold out and a fantastic event– thanks a lot to Steve Caron and his team for the excellent job; the next Fish Fry will be held February 28th, 2015 (mark your calendars!).
  - "SPE Golf Tournament" in April was again a great success with over 240 participants – Bob Shearer, Brad Sincock and the team did as always an outstanding job organizing this huge event; the next SPE Golf Tournament is scheduled for April 2015.
  - "Shrimp Boil" in November was with 700 participants fun pure and delicious – Doug Slusher and his team did again a brilliant job in making this event so nice and enjoyable; the next Shrimp Boil will be in November 2015.
  - The events above raised substantial funds for the support of Indonesian students, student chapters and University activities.
- 4 editions of the "SPE Java Newsletter" have been distributed with a record of 11 published interviews!
- 4 Technical Discussion Groups and 4 Young Professional Workshops have been organized and performed through the year.

Also some important recognitions have been received – the SPE Regional Service Award for Bambang P. Istadi (SPE Java Section Chairman 2012-2014) and Steve Caron (SPE Java Fish Fry Chairman 2012-2014); and the Bandung Institute of Technology Student Chapter is the 2014 Award Recipient for "Outstanding Student Chapters". Damian Dion Salam (ITB SC) has been the winner of the 2014 SPE Asia Pacific Regional Paper Contest and is invited to present his work at the SPE International Student Paper Contest, to be held at the 2015 SPE Annual Technical Conference and Exhibition (ATCE), scheduled 28-30 October 2015 in Houston, United States of America.

I look forward to another exciting and successful year!

Yours sincerely,
Dr. Thomas Schievenbusch
Chairman 2014-2015

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Interview with Adriansyah

President Director of PT. Pertamina E&P

Mr Adriansyah, or Ancha, was born in Palembang on 18 July 1960. He graduated from the Geophysics department at ITB in 1987. He joined Pertamina through its very first Bimbingan Profesi Sarjana Teknik (BPST) EP in 1988. He holds a Masters Degree from ITB and a Doctoral Degree from the University of Texas in Dallas. Ancha was appointed VP of the Pertamina Upstream Technology Centre (UTC) in 2009, SVP of Upstream Business Development in 2011, President Director of Pertamina Geothermal Energy in May 2013, and since 20 November 2013, he has been President Director of Pertamina EP. Ancha received SPE in his office to share insights on Pertamina EP and his vision.

Can you share with us your career journey?

I grew up in South Sumatera. My village was close to Prabumulih, the backbone of Stanvac back then, so I was very familiar with the oil and gas industry. However, initially, I wanted to study Astronomy and become an astronout. But I backed off and decided to have a career in oil and gas industry instead. So I started Geopyhiscs at ITB in 1979. At that time, explorationists came from a geology background, with very few geophysicists. After I graduated, I worked for Geco-Prakla (Schlumberger) for a year before joining Pertamina in 1988. I was in the first BPST batch with Pak Salis Aprilian and Pak Syamsu Alam. We were, as it was planned by Pertamina then, to be the new generation of professionals in Pertamina, equipped with strong technical capabilities. As part of this first generation, I feel we have a responsibility to deliver. I consider this as my first principle for success: be responsible.

I was assigned to Pangkalan Brandan, for seismic acquisition and processing. We designed our own first seismic acquisition paramaters. Throughout my career in Pertamina, the company has been my parent, in the sense that I was sent to many training courses and schools as their child. Pertamina sent me to ITB for my Masters degree and then to the University of Texas in Dallas for my Doctoral degree. The education has more value than just a monetary benefit. I will repay that by dedicating my time and skills for Pertamina, solely, as good corporate governance dictates. I urge all to have the same level of ethics and responsibility.

Prior to the Oil and Gas Law 2001, all technical aspects of Pertamina were centralized under the EPTC division (now UTC), where I was assigned until 2009 before moving to Business Development. In the latter role, I had to learn and master non-technical aspects of the business such as commercial, appraisal, evaluation, financial, regulatory, and law. It was quite a contrast. At UTC, I led the team for unitization negotiation of Jambaran with ExxonMobil. Perhaps our Board of Directors considered this experience before assigning me to the Business Development function to develop a new and working Merger and Acquisition machine. Earlier, the M&A division acquired ONWJ, but was not successful for an Australian asset. I was there for 1.5 years, during which time we setup and shaped the division to only acquire assets with great value to Pertamina. Since then, we have secured overseas assets in Algeria and Iraq. In Indonesia, we knew we had to start with a small acquisition, but a successful one, to catalyse the future efforts. We won Talisman's and Anadarko's Nunukan and Ambalat assets. Our team comprised young and energetic people, unfamiliar with the Pertamina system and capabilities. Hence, my job was to bridge this gap. We improved our assessment system. Before, asset evaluation could take up to eight months for one asset. We methodologically reduced it to three weeks. Overall, I enjoyed the role as I learned a lot from it, with precise deliverables and exposure to our Board of Directors and Boad of Commissioners.

In 2013, we had several urgent issues in geothermal. All the Pertamina Geothermal Energy management was replaced, and I was assigned to fix the problems. Geothermal projects are different to that of oil an gas. The electricity price was set by law. Hence we knew how much revenue we would get for the 30-year duration of the contract. We

therefore have to manage costs. During my six months there, the Geothermal law was being formulated, and I provided input to many stakeholders including Pak Bambang (now Finance Minister) and his team on risk, cost recovery and other financial matters for geothermal.

In November 2013, I was assigned to Pertamina EP. I realized this is not a small boat like PGE. EP is a large boat, so it takes time to change the direction. I am doing my best with my team here. We have a responsibility to deliver.

In addition to being responsble to deliver, do you have another recipe for success?

Focus on what you are good at and be the best at it! I will fight the best I can to be the best in what I do. This will bring you other things. In my career, I never thought to be in Business Development or President Director. I am a technical person, with a Doctoral degree in a technical discipline. I am a geoscientist first and foremost, and definitely not a politician.

What is the vision of Pertamina EP, and what are your critical challenges?

We are one Pertamina, therefore our Vision and Mission is the same as that of Pertamina Corporate. We will be a world-class energy company, a Fortune top 100 company, by 2025. The challenge is massive. Pertamina's role prior to 2001 was as a regulator. Now we are an operator. In the big picture of Pertamina Corporate, Pertamina EP is the core. The working areas, fields, even the people are the same as during the Directorate EP era. People do not really see the change in their surroundings and still think it is business as usual. We need to change the culture to support a mind set. That is the main challenge.

I would like each individual in our company to have an acountability in whatever he/she does. The mind set I want is they are professionals, competing with their colleagues in other companies, including mutlinational energy companies. They have to look for each opportunity to improve, and to deliver by themselves at the same or higher quaility as the competition. Pertamina EP is no longer a regulatory body. We increase our own production, not relying on others. We need to be proactive, not passive.

I think the best people with the right mind-set come first; then the best system. I believe Pertamina EP has had a good or comparable system, through benchmarking and certification. I need to awaken Pertamina EP employees to realize that field maturity is real. Hence we need to do primary, secondary, or tertiary recovery, starting from now, and by ourselves. I also need them to take ownership in building and adding new capacity in Pertamina EP that we have not had before. Exploration and production will be more difficult. We need to acquire more advanced technology and apply better risk assessment, mitigation and management.

The other challenge is infrastructure. Pertamina EP only has one PSC, but it spreads from Sabang to Merauke. Our current production is around 120 kbopd, but the biggest field, Sukowati, contributes not more than 20 kbopd. We have hundreds of other fields that producing marginally, with aging infrastructure such as piping and pumps. The consequence of bundling all PSC's into one, which expires in 2035, is that we cannot sell non-productive fields or swap them with other PSCs.

The key producing assets act as the backbone of our operation, and the majority of investment will be channeled to them. We more or less understand how to efficiently operate these backbone assets, and cannot afford to halt their operations for the sake of experimenting with new but unproven technology. Marginal fields, which we have attempted to produce but which have yielded low returns, will be operated through Kerja Sama Operasi (KSO), whereby a third-party will come along and invest and introduce new approaches to operations.

Unlike Pertamina Hulu Energy (PHE), where new assets and acquisitions are pooled and operated, Pertamina EP has the same portfolio over time. In fact, we may need to relinquish some of the acreage prior to PSC expiry in 2035. Therefore, our main role is to ensure the level of production is maintained. Exploration will naturally come second.

Do you see upsides for Pertamina EP?

Yes. Currently we may be seen as under-achieving. It is not entirely incorrect. Many of our fields are producing below their potential. There is plenty of room for improvement, in the technology to implement, infrastructure to renew, and other matters. We do have value in our assets and resources. Many parties see this as well; hence the strong interest of cooperating with us in KSO's.

Are our fields really mature? One thing we know for sure is that our knowledge of their subsurface is relatively mature, and that we have sat on them for a long period already. We are familiar with the basins, and the bypassed oil layers. It is our responsibility – my responsibility – to instill a sense of urgency and accountability in each Pertamina EP employee, from the General Managers, Field Managers, down to the office boy, to collectively own the company and think of a better way forward. We have a strong sense of belonging, but we have been unable to go together in the same direction.

I take the analogy of some multinational companies that have a mind-set as a river. Regardless of your swimming skill, once you are in that river, you flow to the same direction. Once you master swimming, you flow even faster, or lead the pack. Pertamina EP is more like a lake. Even if you can swim, you do not know where to swim. My role is to make sure that, first, we know where to swim – this is the mindset I have been talking about.

How do you develop people's mindset and capability?

I am not that worried about the technical quality of Pertamina EP employees. We recruit the best employees from the best institutions. We also have strong technical support from UTC. We need to focus

on developing engineers to become the best engineers, well designers to become the best well designers, etc. They need to be not only technically sound, but also proactive in managing the work and leading the teams. We will develop them to work collectively so that they can deliver the results proportional to their individual capability.

Pertamina EP will continue the 6-month BPS program that goes beyond technical graduates. Upon completion of the BPS, new employees will be assigned as interns and assessed again for their future placement. We will improve on the way we monitor their deliverables. This is currently the challenge in developing people to become experts.

We have various experts in the company. Take one example - Enhanced Oil Recovery (EOR). We have never done the EOR from A to Z. I ask our employees to implement what they know best and deliver to the expectations. For those challenges where we need better technology and expertise, for example heavy oil and underbalanced drilling, we will get it from reputable KSO partners. I would like to see the composition of our KSO partners change to include the companies such as Conoco Phillips, ExxonMobil and Petronas.

The Government of Indonesia expects a lot from Pertamina EP. We have answered that challenge by showing that we are able to minimize the production decline, better than other operators in Indonesia. Imagine what we can do if we fix the challenges above.

What do you do outside your professional world?

I like audio and audio equipment. This is something that I spend serious time on. I find a close connection between audio, and its technicality including its audible frequency, to seismic processing. I cannot play a musical instrument but I like to listen to many genres of music, in particular hard rock. I also like sports, from golf to bridge.

I have two sons. The elder one initially wanted to take social studies. After consultation with us, with a little bit of persuasion, he chose natural science. He even goes further to choose the subject that I liked best long ago: astronomy at ITB. Be careful what you wish for. My second son takes Chemical Engineering at UI. As parents, we can only guide and advise, and create the environment that they are comfortable to explore their potential. At the end it is their life, not ours that they will live in.

Were you also active as a student?

Yes, I was chief of our Himpunan Mahasiswa (Student Community), and had experienced various student leadership roles while I was in university. I was also the chairman of our Alumni organization. In sport, I was also the leader of the 1988 National Bridge team, and even ran for president for National Bridge Association. I also frequently teach at the Graduate Program at UI. I like the interaction with students and professionals. My message for the students: be active, but always focus to your core competency.

Do you have any other message to young professionals?

The oil and gas industry is getting tougher. Fossil energy is limited and not renewable. In Indonesia, the era of oil and gas is getting closer to an end, which means we, as professionals, need to work harder to explore and exploit new energy sources. This tremendous challenge will require professionals with a pioneer mindset, equipped with new play concepts, breakthroughs and ideas.

The future will also see the requirement to master multiple disciplines. A petroleum engineer needs to understand geology, geophysics, production, reservoir, management, and business. We need professionals with open minds, that are quick to find solutions, and that are able to identify the technology that will help him/her deliver the solutions.

Furthermore, we need to embrace unconventionals: CBM and shale hydrocarbons.

ITB student wins Regional Student Paper Contest in Australia - next to Houston

SPE coordinates 10 regional student paper contests at the undergraduate, master's and doctorate level. The students compete against other students from their region for the opportunity to participate in the International Student Paper Contest, held during the Annual Technical Conference and Exhibition (ATCE).

Currently, the 11 regional contests are recognized by the Society: Canada, Russia & Capsian, Europe, Gulf Coast North America, Rocky Mountain/Mid-Continent/Eastern North America, Latin American & Caribbean, Western North America, Africa, Asia Pacific, Middle East and South Asia.

The 2014 SPE Asia Pacific Regional Student Paper Contest received 33 submissions from 12 academic institutions representing 6 countries for the Undergraduate Division; and 44 submissions for the Postgraduate Division representing 12 academic institutions from 8 countries.

This year, one of ITB students, Damian Dion Salam (PE'12) has been selected as a finalist for the Undergraduate Division of the Regional Student Paper Contest to be held at the SPE Asia Pacific Oil and Gas Conference and Exhibition in Adelaide, Australia October 14-16, 2014. Therefore, Damian Dion Salam (PE'12), together with lectures from petroleum engineering department, conducted a number of preparations and stimulations to compete in that Asia Pacific Regional level. After those hard work preparations, Damian Dion Salam was sent to Adelaide, Australia on October 13, 2014 and having the competition the next day.

During the competition, there were 12 participants from 12 academic institutions representing 6 countries that present their research project. There were 4 judges from various backgrounds such as academic institution, research & development institution, and oil & gas industry. Each participant was given the presentation that last 12 minutes, plus an additional 5 minutes for question & answer session. Fortunately, our delegation from ITB, Indonesia as well, presented impressively in front of the judges and audience. Therefore, Damian Dion Salam became the winner of the 2014 SPE Asia Pacific Regional Paper Contest and would be invited by SPE to present his work at the SPE International Student Paper Contest to be held at the 2015 SPE Annual Technical Conference and Exhibition (ATCE) scheduled 28-30 October 2015 in Houston, United States of America. Currently, Damian Dion Salam is still working further on his research project, titled "Novel Analysis to determine the Gas Permeability without using Klinkenberg Correlation", with Ir. Asep Kurnia Permadi, M.Sc., Ph.D. to improve the quality of the paper. Congratulation and good luck!

Trisakti Student Chapter

EVENT I (OCTOBER 2014)

PETROWEEK 2014

In October 2014, SPE Trisakti University Student Chapter has successfully held its biggest annual event of the year, PETROWEEK 2014, with the theme "The Energy Compass". It was with the hope of understanding where the world's energy development is going in terms of technology advancements and environmental awareness that this theme is thoughtfully made.

PETROWEEK 2014 was divided into its series of Pre-Events, Main Events, and Closing Events. Participants of this event vary from High School students, Undergraduate Engineering students, to professionals in the oil & gas industry.

The Pre-event consisted of SPE Goes to School and SPE Earth Day. SPE Goes to School was held with the purpose of introducing the oil and gas industry to the young generation, hoping that there would be more of the young generation interested in choosing the energy industry as their career path. Schools visit was to SMA 8 Jakarta and SMA 82 Jakarta. SPE Earth Day was held as an act of giving back to nature after the countless benefits that we humans had all received. Mangrove Reforestation and Coral Planting was done during the event.

The Main Event, consisting of a 2-day Grand Seminar, Team Building Session, International Conference, and the Energy Debate. On the 2-day Grand Seminar, we were honored to be joined by valuable key speakers from Schlumberger, Weatherford, Halliburton, and YCAB (Ms. Veronica Colondam). The International Conference and Energy Debate were also held successfully, involving Engineering Student Invitees from other student chapters.

Then finally, PETROWEEK 2014 was

closed with 2 activities, SPE Fun Day and the SPE Cultural & Family Dinner. Everyone took pictures, shared their experiences with their student chapters, and their hopes of better teamwork and bonding among chapters in the future. Positive appraisals given by Sponsors, Speakers, and Participants validated the success of PETROWEEK 2014 and made all our hard work worth-while.

See you in next year's PETROWEEK 2015!

EVENT II (NOVEMBER 2014)

SPE TRISAKTI Field Trip 2014

On November 10th-11th, SPE Trisakti University Student Chapter successfully held a Field Trip to Star Energy Geothermal Wayang Windu. Sponsored by Pukesmigas Trisakti, Prowell Energi Indonesia and SPE Java Section, this event garnered much attention and applicants. A total of 14 students (8 of them members) and 2 accompanying lecturers were welcomed on the first day by the representatives of Star Energy.

We started with an Overview of Wayang Windu presentation, continued by visiting some well pads and the Separation System. Late in the afternoon, we visited the Control Room and Turbine System. The participants spent the night in Citere Hotel Resort. On the second day, we had a presentation from the Subsurface Division to know more about the reservoirs and geological landscape of the region. Later on, the weather got worse and it rained heavily. But we managed to look around the Warehouse area and Coring samples. Finally, Mr. Timothy Stefan Darsana, the Project Manager, gave a memento to Star Energy for the outstanding hospitality and valuable knowledge given during the Field Trip.

EVENT III (NOVEMBER 2014)

Company Visit 2014

On Wednesday the 12th of November 2014, SPE Trisakti student chapter got the chance to hold an annual event that is Company Visit. We got the opportunity to witness the employees working in PGN SAKA (Perusahaan Gas Negara) located in SCBD the Energy building. Some of the experience was transferred to us on that day. It was a very special event as only few people could ever saw what we will do if we ever going to work in a company such as PGN. By visiting PGN, we also learned to be ready in any circumstances because the HRD were so nice to teach us if we were going to be interviewed by their company. A certain examples were given to us by them on how to improve our soft skills, technical skills, and social skills. We were very grateful for this opportunity and to PGN who managed to give such an inspiring speech, we looking forward to hold an event like this again in the future.

Interview with
Firman A. Yaman

Chief Executive Officer of PT. Saka Energi Indonesia

Pak Firman, thank you very much for making time for us. Our readers would like to know about your background, starting with how you came to go to an Australian university.

My father was in the Foreign Service, and we were stationed in Canberra in 1969, as I finished my high school. I aspired to study shipbuilding, but the only university that offered the course was in Sydney, a long way from Canberra. However, my father didn't allow me to be out of his sight. "Stay here so I can watch you". At that time, mineral exploration was booming in Australia and my father had friends in the mining industry that said, "your son should go study geology". As a good son I followed his wishes.

It took me almost 4 years to complete my undergraduate study, as I spent the first half-year adjusting to the new environment and improving my English. I graduated in 1974 and went straight to Brisbane to work for an Australian company called Associated Australian Resources (AAR). It's a small company operating and drilling gas fields in Queensland. When I presented my father with my employment papers, he was very pleased.

After my first paycheck, my manager told me "Firman we now have an office in Jakarta, Indonesia and an oil production operation on Seram Island. What do you think?" I did not want to move so quickly because I wanted a few years of Australian experience on my CV, thinking it would make it easier to jump to a bigger company later on. But around that time, my father was back in Jakarta and his health was deteriorating, he had to go for kidney dialysis twice a week. My family asked me to come home because you never know what would happen to him. So I took the Jakarta job offer, because of family concerns.

So after enjoying one month of Australian salary, I came back here and got my Indonesian salary. When I showed it to my father he was very proud because at that time my salary was Rp 175,000, whilst his salary, as a high-ranking staff member of the Foreign Service with 35 years of experience, was Rp 75,000. So he got to know that his son has succeeded, by getting more than twice what he earned.

Shortly after, my father passed away in 1975, just 1 year after I graduated. When I remember him I always get a bit emotional. He had very high hopes for me to succeed.

I worked and stayed in the Bula Field, Seram until 1978. That was quite an experience for a young geologist. AAR was a small company so I was involved in everything including managing the drilling operation. At one stage, I spent four months on a small remote island east of Flores called Lomblen or Lembata. We drilled 1.5 inch core holes looking for copper mineralization. The closest village was several hours away by foot.

I got married in 1978 and needed to work in Jakarta. I sent my application and Atlantic Richfield (Arco) and Caltex responded. Caltex was interested because the exploration manager was related to me, but the process of interviews and medical took forever. Meanwhile, Arco said "This is your salary. Start tomorrow". That lesson lives with me till today.

I worked 20 years for Arco from 1978-1999. I started as a well-site geologist, and slowly moved up the ladder. During my time, Arco reached 215,000 barrels oil per day production from the Java Sea but no gas sales. Gas at that time had no value, so the Parigi gas accumulation was handed over to Pertamina. They paid Arco something like 20 cents per thousand cubic feet to process and deliver the gas to Cimalaya.

During my time, we discovered the Bima (Zulu) Field and we call it "the sleeping giant". Everyone got excited and we built huge platforms and facilities. Unfortunately production was not up to the name. The reservoir is a carbonate, very heterogenous and difficult to produce.

Arco also discovered the Tangguh gas field in Papua. The operator at that time was ConocoPhillips and they didn't want to drill the deeper section. So we sole risked to drill the deeper formation and found the Tangguh reservoir. The well and follow-up wells were classified as tight-holes. People tried to get information. A friend of mine from a competing oil company wanted to know the results. He fished for information here and there, and

typed this information into an email memo but sent it to the wrong recipient, a high ranking government official. At that time email was a brand new tool to exchange mail. They traced the email back, and they fired him. My friend however, decided to bring this to court as he did not violate any company regulation. He only sent the email to the wrong person. He won and was compensated a substantial amount of money. This shows that one stroke of a button can do a lot of damage or in his case a financial reward.

I spent 1995-1996 in Los Angeles. All senior staff had to spend time in another operating unit of Arco. Some went to Alaska, others to Arco R&D facilities in Texas. I went to Arco HQ in LA. That was my wife's first time overseas. I enjoyed this job. It was easygoing, to coordinate and to relay projects in Indonesia, and to present them to the Board.

In 1999, Arco downsized due to the very low oil price; it was $10 a barrel. We were given the chance to resign with extra incentives. Unlike when I joined Arco, now there were 30-50 companies operating in Indonesia, so I was confident to find a new job. I took the package and moved on.

With friends, I formed a consulting company called Geotama. That was tough, visiting potential clients to search for projects and clinch the deals. We got a few jobs from small companies but none from the big companies.

Then I worked for two years with Pertamina on their Production Enhancement Project in Prabumulih, South Sumatra.

In 2003, a friend of mine, an ex-geophysicist in Pertamina (I did a few projects with him) called and said "Firman, I need a geologist to be my working partner for Elnusa. They want to go upstream. Here are tenders for two blocks: Malawi and Bangkanai. Can you help me to evaluate them?" I said of course, so we submitted the tender and Elnusa won the Bangkanai block. As Elnusa didn't have a Geoscientist, I joined them. We put together the Kerendan gas discovery POD, which was approved by BPMIGAS in 2006. Unfortunately Elnusa didn't have the money to develop the field.

So I joined Pertamina again: this time in Libya, North Africa, as exploration manager for two blocks. It was an exciting and new experience for me. We completed a seismic acquisition program in the onshore block, but never had the chance to drill, so I resigned in 2009.

I came back to Jakarta and for a while joined my friend from ex Mobil Oil working on two TAC's in Jambi area and then for a friend ex Unocal working on the Pasir PSC in Kalimantan and Puri PSC in Central Sumatra.

Lastly I joined Saka at the end of 2011. PGN had been looking for an upstream business since 2009, but never got far because they didn't have people to manage it. They hired an ex Arco commercial analyst with an engineering background to start the operation. I knew him quite well as we worked together on the ONWJ PSC extention proposal in 1996. He started to gather ex-Arco people to build a technical team. "Firman, are you available?" "No I'm working". "We are with PGN, and you will be paid more than what you are making now". A good start. We talked, and I became convinced that PGN was serious and had funds to run this upstream company. Then we assembled our friends from different companies like ConocoPhillips, BP,Chevron and Shell. People we knew well so we could start working right away. Its comfortable to work with when you know the people for a long time. In our first 6 months in 2012 we were mostly people who had 20+ years of experience. We were kind of an old people congregation. The only young ones were our two secretaries. PGN were short of office space, so they stuffed us in their conference room. We partitioned it into cubicles, and we worked from there for the whole of 2012. There were people from two backgrounds; oil and gas professionals that we hired from our network, and the administration, finance and procurement people given to us by PGN. It worked quite well because PGN had its eye on finance, procurement and HR, and let us go freely on the technical side. PGN Directors never interfered. They almost gave us a blank check to do whatever is necessary to run this company and to acquire producing and under-development assets as soon as possible. By the end of 2013 we already had 3 assets. The first one was a 20% participating interest in the Ketapang PSC. Then we went on to acquire a portion of Bangkanai PSC from Salamander, as we already knew what's in there. Then we continued on to acquire 25% of Pangkah PSC from Kufpec, which was good because now we had production to generate cash flow for the company. Bangkanai and Ketapang were supposed to start production this year but are now delayed for at least 6 months.

Then we acquired the other 75% of Pangkah from Hess. Our Directors said that if you feel that this is an asset that we can rely on, then do it. So in January 2014 we were suddenly an operator with people and a building. Being an operator was not our primary objective at that time. We were looking for gas to fill PGN transmission and distribution pipelines as PGN doesn't want to rely on gas sources that they cannot control. But then there are regulations that say gas allocation is by the government, and PGN is at best third priority behind PLN and fertilizer. So for now we can't supply to ourselves, but at least we can make money. I'm sure the new government will change the regulation. PSC's like to be independent. As businessmen, they want to sell for the highest price or to get a strategic advantage. So hopefully, the new government will allow PSCs to sell gas to whoever they want.

Will Saka be carried through into the next SES PSC?

Saka currently is in seven PSC's including a part of the South East Sumatra PSC we bought from KNOC. There, we have uncontracted gas that we can sell if the regulations open up. For the next PSC's extension or renewal, the government will of course prioritize Pertamina but I believe the government will give the national oil companies like Medco, EMP and others a role to play.

So yes, we are confident that we will be part of the next SES PSC.

I'm interested with Bangkanai. It was discovered a long time ago. It's far from everywhere. How do you commercialize the gas?

Yes it was discovered in 1976. We will sell the gas to PLN at their new nearby gas plant. They are in the process to complete

the power plant and the high voltage transmission line connecting to the East Kalimantan power grid.

In addition, in the next few years PGN will build a gas distribution network in Balikpapan. We have uncontracted gas in Bangkanai, plus there was a discovery early this year, about another 700 bcf of gas that can be utilized. The discovery is less than the 1.5 – 2.0 tcf needed to justify a pipeline to Bontang.

We also have a 100% interest offshore in South Sesulu PSC. So now we operate two PSC's: South Sesulu and Pangkah. We're also in the Muara Bakau Jangkrik and NE Jangkrik development with ENI and GDF Suez. That's big money, a US$3.8 Billion gross capex investment. IDD has been temporarily stopped but Jangkrik and NE Jangkrik are still moving along.

Jangkrik and NE Jangkrik are located offshore Mahakam, just south of IDD. Even though it's small it's still big money. We hope to produce LNG so we can ship it to our LNG regasification facility in Lampung. PGN has two LNG regasification facilities,: in Jakarta Bay and in Lampung. We need LNG cargos. We are interested in PSCs with LNG potential, because unlike gas, you can sell LNG to whoever you want to. There's no allocation.

Saka has yet to met the expectation of PGN to be a gas supplier for their pipeline infrastructures. Most of our participating interest has gas as a major product. Bangkanai and Muria are 100% gas, Ketapang and Pangkah are 50:50 oil:gas. In May 2014, we acquired a shale gas interest in Texas. We're 36% and it's producing 100 million cubic feet, and will climb to 220 million cubic feet by mid 2015. We are partnered with Swift Energy. It's a small, public company owned by a Texas family. They only operate assets in Texas and Louisiana.

The strategy there is just to get a foothold in the US and expand and hopefully we can utilize some of the upcoming LNG liquefaction capacity in the Gulf of Mexico to bring the gas to Indonesia. Ten years ago the US wanted to import LNG because they were short of gas. But now they have more than enough gas so they are converting regasification plants into LNG plants so they can export it outside. We hope that we can take advantage and export the LNG here to Indonesia. With a $4 Henry Hub price, adding the piping cost to the LNG plant, taxes and transport to Indonesia, we can land LNG here at $12-13/mmbtu. By then, we expect the domestic gas price will be that high. Pipe gas now is about $9/mmbtu.

Why is gas so expensive in Indonesia?

Supply and demand. There is still a gas supply shortage.

Just curious, the name Saka, what's the story behind the name?

Saka is Sanskrit for Pillar or Column. So Saka is a pillar for PGN. It's the truth. We are only 3 years old, but we already contribute quite an amount of revenue to PGN after the Pangkah acquisition. They already see us as a cash-generating entity. The holding company is quite small with 45 people. The operated blocks are a separate entity with about 260 employees including South Sesulu PSC. All non-operated blocks like Bangkanai, Ketapang, Muara Bakau and South East Sumatera are overseen by Saka Energi corporate.

What do you do in your free time?

I used to scuba dive. I participated in the 2009 Guinness World Record for the most divers at one time under the water, part of the Sail Bunaken activities. This was up in Menado along the beach with 1,545 divers. We had to stay 45 minutes underwater, 20 meters below the surface, and wait while the lady official from the Guinness World Record counted us. Unfortunately in 2013 I had a heart condition and so no more diving.

I love tinkering with mechanical things, like repairing electronics and cars. Whatever is broken in the house, I'm challenged to repair it. I also used to play tennis, but not golf because it takes too much time and it breaks your weekend.

Now I have grandchildren so I like to stay more at home talking and playing with them, going to malls, or Waterboms. My oldest grandchild is 16, the second one just turned 9. I have watched them since they were small. It's a different feeling between grandchildren and children. My son and his wife live behind my house, back to back with a connecting door so I can see them everyday if I want to.

For Saka, my ambition is still to procure gas for PGN, and I hope I can see that before I retire. We're now amongst the top national oil companies, alongside the established ones such as Pertamina, EMP and Medco

Why there are not more Indonesian oil and gas companies ?

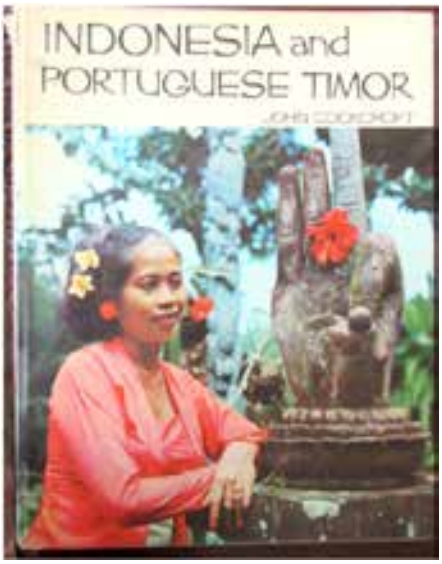
Oil and gas business is high risk and requires large capital outlay. Even producing assets require a large influx of money. People who manage investment funds in Indonesia are reluctant to invest in high risks and businesses that requires large capital. These are long-term investments, typically 10-15 years before we can see the results. PGN and Saka will be here for a long time and we will hopefully get bigger and be a competitor to Pertamina, in a good sense, growing in parallel.

Interview with
Peter Cockcroft

Independent Consultant, Cockcroft Co.

Peter, you have been in and out of our country for a long time.

Yes. I first came here in October 1965. My father was writing a book. You can still buy it second hand from Amazon, called "Indonesia and Portuguese Timor".



I was around 15 years old. I had a long school vacation from Australia, so I came up and joined him and we stayed at the Intercontinental Hotel, which is now known as Hotel Indonesia. He had been in Indonesia during the Second World War and in fact he come back and allegedly fought on the Indonesian side against the Dutch, but we can't find official records on that. That's why I first came here. We spent part of October, November, December and a bit of January 1966 in Jakarta, then we went on to Timor. Do you know one thing that people were complaining about? The traffic on Jl. Sudirman!

So were you here when Soekarno passed away in 1970?

No, I was only here for those few months, then I went back to Australia. I came back during the 70s, and worked as a development geologist and petrophysicist, working under the Lemigas/CoreLab umbrella. I didn't live here. I was in and out, and worked also with Cities Service and a brief stint with Basic Earth Sciences (Bessindo) in Prabumulih. I only moved to Jakarta permanently in the early 80s (1981), then again worked as a development geologist - or of a petrophysicist really. I worked for various companies for Kodeco in the East Java Sea, Petromer Trend, mostly in Salawati Basin, and for Pertamina. In 1987, when I was with Husky Oil, we won the first EOR JOB the Limau fields of South Sumatra. After that I did the same thing with Asamera with Jambi EOR project. Both of those projects made money for both the companies and for Pertamina (These were basically "bypassed" pay projects). Then I left Indonesia as I was offered a job as Country Manager for a New Zealand company (Fletcher Challenge Petroleum) in Thailand and the Philippines. We had a discovery and a small onshore field development in Thailand, which we brought onstream, selling our oil to the Bangchak refinery in Bangkok. It is still on production, I am advised. We were quite proud of that discovery, as the wireline logs did not indicate hydrocarbons, but we had a very alert wellsite geologist (David Waghorn) who insisted that we test, based on "shows". We also had an offshore carbonate discovery in the Philippines, but that was sub commercial at the time.

I came back to Jakarta and my daughter was born in 1992. I was in charge (as Operations Manager) of a startup of a producing field in South Sumatra called Air Sedang. We had to be very close with Pertamina because it was unitized, as well as a JOB. Because I had worked inside Pertamina, working in JOB's were not too hard for me (this was third!). And of course I still mix with some of those old Pertamina guys. For example, Dr. Priyambodo Mulyosudirjo was my "Saksi" when I got married in 1986.

After the OK Block (Air Serdang) I started a little company in Indonesia called Energy Equity (an Australian public company which was founded by an innovative entrepreneur, Maurice Brand). We had two projects. One was the Sengkang PSC in South Sulawesi, which we bought from BP and Chevron (Amoseas), which contained Kampung Baru undeveloped gas discovery. BP asked us, "What do you want there? What do you want this for? There is no gas market." And I said, "Well that's my problem". And they reminded us "by the way the PSC finishes in 2000" and I said, "Well that's our problem too. We will take that risk". We went to the Director General of Energy, Electricity, and Development (DGEED) to apply for an IPP. they said, "Why do you want a power plant in South Sulawesi? There's no fuel". I said, "That's our problem". So we got the PSC for a cheap price of US$4 million dollars, with a reserves certificate of 514 BCF. We had to join with a local company called PT Triharsa whose major shareholder was the oldest daughter of President Suharto. They were pretty good and the people were excellent, and I am still in contact with their key guy, Raymond Bernardus. We had good assistance and advice from the Makassar business community, especially with Pak Jusuf Kalla, who was a significant local businessman at the time.

The other advantage was that we negotiated the gas sales agreementin just one meeting. The reason for that, the minister at the time was Pak I.B. Sudjana, and his right hand man was a guy named Dr. Poernomo Yusgiantoro, who just recently came back from doing his doctorate at Colorado

School of Mines, who not only had practical experience (through his days at Bessindo), but was very knowledgeable, even then, about the commercial side of the business. He was trying to find solutions. We agreed on parameters, and we agreed on a pricing, and it was done just like that. We could do that in those days. Previously in 1987 when I was with Kodeco, we made a GSA to bring gas to the Gresik power station in East Java, which was being converted from coal to gas. At the same time, ARCO was doing the Bali North project. We agreed on the price after only three meetings. The person who had that job then was the adviser to the minister, Pak Wijarso. We agreed on a price of US$2.53 per million BTU. The beauty of that, from both Wijarso and Poernomo, we got approvals very quickly, so we could start the project very quickly. Nowadays when people discus about what can be done better, we don't have to reinvent the wheel here. We just have to look at Indonesia's own history. Having someone who has the authority to make those decisions is very important. Poernomo was given that authority. In my time, neither of these fine "bureacrats" used that authority in a bad way.

Energy Equity also had another project, which was the Lematang PSC. I was familiar with Lematang because I had worked in South Sumatra a lot and I knew the original people who got the block (Enim Oil) that was originally run by Larry Barker, who was one of the original partners of IIAPCO. The Indonesian counterpart was a guy named Ismet Akil. He should be a lot better known than he is, because without him, probably IIAPCO and ARCO may have never started. I was told that he was the first geologist to join the predecessor of Pertamina back in about 1957. The anecdotal story was that he was on a trip in Billings Montana, and he met these guys (Todd, Barker, Donohue, Dodge), and that became IIAPCO, with great support from Pak Ibnu Sutowo. What we did in Lematang was really interesting, as we had a field that was declining. The previous company that had it had run into financial problems and were in liquidation. We bought it from the liquidator in Hong Kong. The other 50% was owned by a property magnate by the name of Bapak Jan Darmadi. We bought that from him because it really wasn't his business. He didn't really understand the oil and gas risks. We did a little bit of engineering and reservoir work and looked at the Harimau field. We determined that it was basically a gas field with an oil rim. We sold the gas to Pertamina for one dollar delivered. Everyone in the industry said to me, "You are crazy, you are giving this away". The answer was yes ,we were giving it away so we can co-produce the oil. When we took over the PSC everyone said it had a life of about 2 years. It kept going for another 20!, Another example of creative engineering to extend the life of a "marginal" field. The people we dealt with in Pertamina, they could make this deal happen in only a few weeks. That was a tremendous advantage. We did not have any lawyers involved. We made the GSA without any lawyers and this was never an issue. We eventually turned the Enerqy Equity Sengkang project into a 135 megawatt IPP. I left in 1995 and then joined BHP (at that stage, Australia's largest company). All the people involved with the Sengkang Gas/Power project are very proud of it, as it was one of the first combined gas and power projects in Asia. It would never have happened without the drive and enthusiasm of the Australian Managing Director of Energy Equity, Maurice Brand, as well as the professionalism of the ESDM officers (Pak Purnomo) and the DGEED (Pak Moeljadi Oetji). Some of the expats from Energy Equity (they were fine young engineers at the time) such as Kevin Moore (now with Husky) and John Grant (Mitra) are still in Jakarta.

When I joined BHP, they were trying to expand in the power business (like many other major oil companies), and of course oil and gas. BHP had two oil and gas discoveries in the Timor Gap. One was the big LNG project called Bayu-Undan, together with Phillip Petroleum. Another one was called Elang-Kakatua. It was in the disputed area (ZOCA) between Indonesia and Australia.

Again we had good people from the Government side. At the time in charge of that joint body was Pak Djek Zahar, who was not only a fine diplomat but an extremely good engineer - detailed and honest. Then we had a guy called Dr. Bona Situmorang (who unfortunately passed away in 2007) He had a PhD in structural geology from the Royal Holloway, and did a fine job Director of the Joint Authority, and then Iin Arifin Takhyan. Of course Pak Iin became Director-General of Migas, then Kepala of BPMigas.

It all got a bit funny when 1998 came around, when President Soeharto resigned. I had to look after all BHP's issues in that difficult time of May 1998.. We had about 120 expats, amongst our 3000 employees all the way from Aceh to Irian Jaya (BHP had businesses in coal, minerals, steel, building materials as well as oil and gas). In 1999 Timor went independent and BHP were still operating Elang-Kakatua oilfield out of Jakarta, even after the independence of East Timor.

I left Indonesia towards the end of 98 and went on to India with BHP. I was offered a job in Pakistan as Managing Director of a substantive company that had two shareholders; Shell and Premier Oil. Political upheavals seemed to follow me around, as in October 1999 there was a military coup in Pakistan. General Musharraf took over and became President Musharraf. For us in the oil and gas sector it was a very positive change as President Musharraff installed experienced technical people as key people. For example, the Minister was Usman Aminuddin, a 25 year Shell veteran. President Musharraff had a high work ethic and demanded the same from his cabinet (similar to Fidel Ramos when he was president in the Philippines). Interestingly, President Musharraf asked all his Ministers to travel in economy class domestically! The improvement in the upstream sector was fantastic because the industry brought on one BCF a day gas production within four years. We participated in three of these projects. One was Zamzama, another one was called Bhit (both about 3000 mmscfd), and another one called Kadanwari. We also increased production in a field called Qadirpur, which was increased to 700 mmscfd. Unfortunately, my young daughter was starting high school, and Pakistan was getting a bit more dangerous. We loved the place and people were fantastic. I was Chairperson of the SPE in Pakistan, and Vice Chairman of PPEPCA (similar to IPA).

I then went to Singapore and joined Premier Oil. We had two operations; one in Indonesia and one in Myanmar. I was more involved in finding new projects. Our effort in the Ragay Gulf in the Philippines didn't work out but Vietnam has been extremely successful – over 100 million barrels of

oil reserves I think. This was initiated by reviewing an undeveloped discovery - Shell had drilled a well in 1975 but pulled out because of the war, thus knew there was a petroleum system there. A few of the key guys involved in this successful project were Wayne Spencer (a long term South East Asian geologist), Dr. Chris Kenyon, Mike Pillow and Phil Maclaurin (who had worked with me in Pakistan).

I tried to semi retire in 2005. I went onto a few different boards around the world. I was a founder and director of a company in Kuwait, called Kuwait Energy, who have mostly concentrated in Iraq and Egypt. That was a great success because we did not have any government shareholders. I was involved with a similar company in India where we got into some old fields in Gujarat and tried to increase production. Then in 2007 into the coal bed methane (CBM) world. I was a director for a CBM company in China for a while, then I was the chairman of a CBM company for four years, called Blue Energy, in Queensland. I then ran a company who produced gas from coal in France (European Gas Limited). When I gave a luncheon talk on CBM at IPA in 2008, I was on the board of an Australian company who has drilled a few wells in South Sumatra for CBM.

I was also Chairman of a US listed company that had production in Sharjah, and was on the Board of Advisors with a company specializing in rejuvenating old fields in Southern California.

Nowadays I spend my time teaching courses on Oil and Gas Reserves, Bypassed Pay, Reservoir Engineering for Geoscientists and Risk (I was an SPE Distinguished Lecture on Risk in 2004-5)

People think the heyday of oil in Indonesia has finished, what do you think?

I am a bit old fashioned – I still think you can only find oil by drilling. It is a bit like football, the more shots at goal, the higher your chance to score. Thus we need to have a regulatory environment that encourages drilling, not only exploration wells, but appraisal wells as well.

Remember "Omnia bona quoad perfora" – which is loosely translated as "All prospects look good until drilled" – a motto used by Anadarko in 1994 following their sub-salt drilling in the Gulf of Mexico.

I think we need to be a bit more creative with stratigraphic (and "non-structural") plays. For example, we have quite a few fractured "basement" fields in Indonesia, such as Suban, Tanjung, Jatibarang, and many more – but they were mostly found by accident. We have seen from Soco in Vietnam and Hurrican in the North Sea that fractured basement and meta sediment exploration can be successful as an exploration objective. We have also seen the significant success of Total in SW Peciko and Tunu (East Kalimantan) with hydrodynamically trapped gas fields with little structural trapping. Let's just be creative and look at non-structural traps. We know that there is oil being generated in the Indonesian mature basins and that petroleum systems exist.

On the pure exploration side - the unexplored basins, I can't comment too much, because that's not really my game. Historically you've had some really good proponents of that. Pak Nayoan, for example. One of the things he tried to promote was Tangguh, and that has worked very well.

Some of the exploration risk takers like UNOCAL, HESS, and Murphy are spending big money. When they are not finding, people feel uncertain regarding the future. Because of that, no other company dares to spend another quarter billion dollars.

Yes and no. You have to put this in context. If you find something, how quickly can you get back your investment? In some other countries, you can fast track this. If you find something, you can do your appraisals, go through your POD, development plan, or even a module of the development plan, which is a much more sensible to do, in a hurry. If you make a discovery in Thailand, you can be on production in 2 years. The time value of money for investors is very important, and the current Indonesian regulatory system affects these bottom line economics.

What about the history on how things worked in the past that led Indonesia to its peak production?

There are two forgotten parts of the history of Indonesia in the last generation: one is the IIAPCO-ARCO SES and ONWJ PSC. That wouldn't have happened without the push of someone like Ibnu Sutowo. This is an area which was thought to be geologically barren, just north of Jakarta. Back in those days, it was thought to be not very productive. They had to go find money, running around the world. Just think about it, in 1965-66 the country was in bad shape. There was a change of government, there were great political risks, no contracts, the geology was unknown, and they got a deal done in months. People like Pak Mahmud were directly involved with that. He was the young lawyer involved with that first PSC and was involved with the whole process. His (and others) advice should be listened to. Required reading should be his book on PSCs. I wonder why it's not in everyone's bookshelves.

The other thing is LNG. Here in the early 70s, it's the end of the world. Then you had this small cap company called Huffington that made a gas discovery (Huffco). Then you had other companies. You had a French company called TOTAL, then you had an independent company called Union of California, then you had a new Japanese company called INPEX, who is a non operating partner of all of them. When the gas was found, there was no market. So they put together an LNG project (Bontang) which became the biggest LNG project of the world. They had to get those 3 companies to work together. Huffco was operating the pipeline. Pertamina went broke in 1976, right in the middle of this LNG project. The project was done in 5-6 years from discovery to first delivery! This is a fantastic story, and a lot of that came about because you empowered people to make decisions and implement. It's a fantastic story, and that should be in every oil and gas guy's history books, because that puts Indonesia on the modern post-war map in the gas business as a pre-eminent LNG player in the world. Because you empower good people to work together with foreign companies, in this project you had Japanese, French, Americans, and Indonesians. Could you do that today? Unlikely! The problems with giving bureaucrats authority, is that they are often not trying to find solutions, sometimes they are trying to find ways to impose their will. That's not just in Indonesia - that is a feature of bureaucrats all around the world. So I think there are some really great

analogies in the Indonesian oil and gas business, and you should be very proud of that heritage.

What about the subsurface standpoint?

What you need to do now, you need the creativity of people. You need creative people who are rewarded fairly. In this world when a geologist finds an oilfield, he or she doesn't get much of a bonus, whereas a banker who does a deal gets millions of dollars. There's something wrong here. People are not being rewarded for being creative in the subsurface as individuals. They are rewarded for not making mistakes. When you have 80% chance of failure in exploration wells, you are going to make mistakes. It seems that the people who climb in the organizations are the ones who don't make decisions. So reward for creativity, that's something we need to think about. That's probably something that organizations like SPE, IAGI, IPA can help with, because that's a matter of exposure to new ideas.

It brings to mind Parke Dickey's famous 1958 quote: "Several times in the past we thought we were running out of oil, whereas actually we were only running out of ideas."

The other problem is availability of data. A friend of mine came to me a few weeks ago. He's about my age -really old - in his early 60s. He lives in New Zealand. What he's been doing is looking at some old data, including the seismic lines, which has all the navigation data, etc. And he gets that for free, from the public domain. He said he's found 60 Bcf of prospects ("bypassed" pay). The reason he can do that is, it doesn't cost him anything. He sits at home, and generates geological concepts with this data. So now, what he wants to do, he will go to the operator and say I want to re-drill this, because the well has been abandoned. You can't do that here. You don't have the data available.

So when we want to start looking at new ideas, how do we get the data? The archives are pretty poor, aren't they? Commercial data cost a lot of money, doesn't it?
So have all the operators hand over all their data, immediately after it is acquired. They should be enforced to do that. In other countries, when you cut a core, you give half to the government. I recommend that the cores should be available for a period from the time you drill a well. Not 30 years later when the PSC is finished. They should be available now. Then people can work out new plays, creative plays, and if an external company wants data, then they can then apply for it (or even better, download from a free site). We have so much data in this country. The industry is 120 years old now. There is a lot of data, in various different physical places, and the format is not all digital. If that was accessible, you will have more creative thoughts, local creative ideas. That's within the power of the Ministry to do that. Don't worry about the short term benefits of selling data, but the long term benefits of finding oil. We also need to cut out the "black" market that exists for data. Oil consumption is now 1.6 million barrels a day. So we need to find almost 500 million barrels a year just to break even. We need another Cepu every year, without delaying the project like in Cepu. And this is just to break even.

The last oil giant was Cepu (Banyu Urip) – wasn't this found in 1992 or thereabouts?. We haven't found anything (that size) since. Now the average discovery is around 3 million.

As I said, we've not entered the "non-structural" phase of exploration yet, because I don't think the technical environment allows that. How hard will it be to get approval to drill a non-structural play exploration well? Very difficult I think! Because the regulator doesn't have that experience. He's never been exposed to this stuff. He wants to see closing contours. What if there are no closing contours? What if we have a fractured basement play? We can't get an approval, because some bureaucrat has never seen how that works. So now these sorts of new plays are usually discovered by accident, by serendipity.

Bureaucrats stifle creativity. Why is that? I think you can go back to the PSC. People like Pak Mahmud can explain this better than me, but the main idea is that the contractors are risking their own money to test these ideas. We get hung up on cost recovery -maybe we should forget cost recovery. The majority of exploration wells are failures anyway. So don't bother about it. Just take it out of the equation. You can still have a PSC. You just have to change the fiscal terms accordingly, to make it attractive for investors, both domestic and international.

In 2007, Nassim Taleb published The Black Swan: The Impact of the Highly Improbable". He coined the term "Black Swan Event" for surprising, high-impact, hard-to-predict events. The Black Swan is a statement of impossibility from the 16th century. Black Swans were believed not to exist until 1697 when one was found in Australia.

Taleb says that Black Swan events have three features,

- they are outliers – they lie outside the realm of normal expectations
- they carry extreme impact.
- they have retrospective predictability – they appear explainable and predictable after the fact.

We need this sort of thinking – where are Indonesia's "black swans"?

I think we need to get back to the question of "is there any oil left" in the discovered areas. Back in the late 80s I wrote a paper on EOR with guys from Husky. What we did in the study was, we looked at all the Indonesian fields, and looked at their current recovery factor. They were below the worldwide average by a lot. There are all sorts of reasons for that. We came up in this paper with how much oil is being left behind with current technology. It gets to billions of barrels. Has my opinion changed on how much bypassed pay is in Indonesia? Not much.

The director of E&P at that time was Pak G.A.S. Nayoan. He was very enthusiastic on EOR/IOR. He tried to get better commercial terms for the contractors, but unfortunately he wasn't able to do that.

Nowadays I have to change my opinion on EOR, because in this country, not many of these EOR projects have worked. There's only a handful of good secondary and tertiary recovery projects. One of the reasons for that is that there's no fiscal incentives to inject anything. The other one is geological, you guys have seen this, the more wells you drill in the field in this part of the world where you have active tectonics, the more complex the fields get. It's interesting. The first couple of wells you drill, you have beautiful contours. Then after another hundred wells you get faults going everywhere. You try to inject in those

fault blocks, and you don't know where the fluid is going I think the structural geology in Indonesia is very complex. For a young guy to learn on Indonesian geology from the structural side, is very difficult. So injecting fluids is a bit of a lottery because you don't know where the fluid's going.

One of the problems we have in every organization in every industry, is that when we get into production we have different KPIs. Production guys are not judged not whether they can produce from a one foot sand. They are judged on keeping the stock inventory low, and making sure the operating costs are low. It's more of a cost control exercise rather than an oil recovery exercise. Talking about sands, we have often got commingled sands. Do we know where the water is coming from? No! These guys have got some new fancy tools nowadays. The NMR you can use in fresh waters. Analytical methodologies don't always suite the problems we have here. One of the problems we have here, we have freshwater. Freshwater really screws up your log analysis. So much that even the underlying formula, Archie equation might not even work. (SPE: But we have the Indonesian Formula). If you look at the history, the Indonesian (Poupon – Leveaux) formula is based on very few wells.

Let's talk about so called bypassed pay. I'm not talking about in Indonesia, I'm talking about in general. I think there are 4 types. Type 1 is stuff that we knew about, but we don't (or didn't) have the technology or commercial ability to recover it. Shale gas, for example. We didn't have the technology, the horizontal wells, the fracking in lateral wells, we didn't have that till recently. Type 2 is the oil and gas we just missed, we didn't know enough, or we didn't have appropriate technology. Type 3 is the result of dynamic information after production. A good example of this is Apache's takeover of the mature Forties Field in the North Sea from BP, where with additional mapping and further high definition seismic. Another example is if perforated a 40 ft sand interval, but you are not producing from the whole 40 ft. Where is the production coming from? The best permeability sand has been drained which is is now producing water. So you're probably leaving some oil behind in the other lower-permeability sands. Maybe you can just go back and reperforate? Or do a squeeze job, and isolate the higher-permeability sand. It just takes a little bit of creative thinking. Simple mechanical issues, such as scale buildup, can also be a problem (or an opportunity for the bypassed pay specialist).

How do you map faults? Software doesn't handle that very well. I many oil companies you don't see people looking at the structural complexity of a field. That's part of the problem here. Our fields in Indonesia are usually quite structurally complex, and I think we're leaving isolated oil behind. We don't need high technology for this.

Maybe we look at cheap seismic, non-explosive seismic in the fields to have a better picture. Maybe we run cased-hole logs and downhole video. Maybe we should look more critically at the cement jobs. But it's such an important process - the formation damage, the restriction to flow, all this sort of stuff. It's boring and mechanical to the normal geoscientist!. It's usually put in the hands of Halliburton or other cementing company, who have got a pretty different mindset. A cementer is not really concerned about the reservoir. He is concerned about getting his cement down the hole.

What I'm saying is, I think we can look at some of these existing fields. To me, this is the "low hanging" reserves in Indonesia!

Think about new technology, your phones. What do you have in your mobile phones? Wireless and long life batteries. Let's say we want to acquire some more seismic, you want a better reservoir definition. Wireless geophones are more commonly used now. Why don't we run wireless logs (i.e. with a battery rather than a cable)? I know you guys don't like that because you want to sell your cable. Why don't you run your logs on a battery? Maybe we can run our logs on a slickline and save time and money.

I was with a guy all day, and he's got a well design for a well that goes down for 1500 meters. And I say what's your best chance for this? Maybe 1000 barrels a day. So I asked him why is he running 7 inch casing across the proposed reservoir? Why don't you drill with a slim hole rig? Because you can produce 1000 barrels a day through a 3 inches wellbore. So why don't you run a slim hole rig? You don't need as much cement, as much mud, as much footprint, as many loads.

I am impressed with some of the creative ideas of Cairn India in western India. Cairn has applied the concept of pad drilling using custom built Rapid Rigs that allow fast and efficient drilling operations on multi-slot well pads (up to 28 wells on a single pad). Cairn built special purpose rigs with wheels for quicker movement for rig moves for example (less than 12 hours for rig moves). They have drilled in excess of 300 wells this way.

Type 4 Bypassed Pay Category is projects which had been stopped for external reasons. Wars, commercial reasons, like the Dutch wells and fields in many parts of Indonesia for example.

The problem is access to data. But the data is not available. The current contracts, whether it's a PSC or KSO, doesn't really allow that.

I'll give you an example. It's not in Indonesia, but it happened last month. I was giving a lecture about bypassed pay and missed pay. New oil in old areas, near-field exploration, etc.

So after the talk was completed a guy came up to me and said they were doing a reservoir simulation of an old field that is on production at about 400 barrels a day. They asked me to review the simulation. So we go to their office. They have a workover rig in operation. They have a simple cased hole logging tool gamma ray basically. I said why don't you just run your cased-hole log, just to see where the sands were? It turns out that they were off-depth, the perforations were in the wrong place! That's why they were not getting optimal production. The driller's depth was different from the geophysicist's depth.

I said we can now see the sands, why don't we just go back and re-perforate? They told me - that's not scientific, we need to do simulation. However, they agreed to reperforate and they increased production over 100 bopd almost immediately!

I think one of the things that we don't do very well here is look at the data, we should be going back to this. What about navigation coordinates? Many companies use different navigation systems. I have seen examples where well locations are off by a kilometer, for this simple reason. Let's tie all that back together, then worry about

datums and depths. This is simple stuff, but when you see a lot of data packages often we don't even have navigation data.

I remember a story back in south Sumatra where they got different projection, they drilled it anyway and found oil in the wrong place. Then they go back to the right location, drilled it, and it's a dry hole.

Absolutely. All I'm saying is, I think most people would agree that there is a lot of oil in the ground that is not being tapped. The first time we did the Limau EOR project, we looked for un-drained sands

You mentioned complexity of reservoir because of faults and tectonics. That adds complexity to the EOR effort. Some believe because of our low RF factor, we are still in primary or most secondary, not tertiary yet.

I don't think much about tertiary – maybe in a very well defined field such as Minas, but not in other Indonesian fields. We get this primary/secondary/tertiary from our textbooks - I don't believe those textbooks work here. I think we should be looking at reperforating, relogging, recompleting, remapping, etc. before we think about those fancy tertiary recovery. The beauty of a bypassed pay focus is, as it is in existing fields, we don't need difficult environmental approvals, we don't have land acquisition issues - they are already done. Infrastructure is usually in place. If you find something, it's quickly on production. You don't have to wait 5 years. The question we have is, how do you rejuvenate abandoned wells? The first thing you want do is have access to information, to come up with a fancy idea; remapping, re-perforating, do more seismic. You can't do that before you have all the information.

It's an important issue when you talk about openness of data. In IAGI we talk about data, openness, but the government has a strong hold of this data. Open data means loss of revenue.

What's the revenue from selling data? Do an NPV of selling data versus the drilling one successful well. It doesn't compute.
One example. We were in Thailand. I was the country manager. We drilled a well in meta-sediments, volcanic. We had a well-site geologist who has a PhD. He saw some shows. He was convinced they would flow oil although the logs showed little. We tested it. It became a successful field, which is still producing 20 years later. The next day, our big boss came from head office. He wanted to go to the field because this was the first discovery for our company. It was only few hundred barrels a day, onshore Thailand. We tested because I trusted the wellsite guy, and because he's closest to the raw data. If we had a young inexperienced geologist there, he would not have done the analysis, and we would not have tested.

What is the shale revolution giving us? That we can now produce from impermeable rocks, nano-darcy rocks. Thus, maybe we need to review our net pay determinmation methods? For example, that are we learning from the geothermal world? Small footprint rigs. The way they look at the importance of structure before they drill. As an industry we don't share this sort of information very much. Maybe this is something that the associations can help with. SPE worldwide does that very well.

I'll go back to multiple hypotheses for exploration projects. Different teams working with the same data will come up with different maps. Three geophysicists working with the same data will come up with 4 different maps, and they can justify all of them. People are cheap, compared to drilling dry holes.

I was a SPE Distinguished Lecturer on risk. I went around the world, giving the same talk. I was part of the SPE Reserves Committee worldwide from 1992 to 1997 (the first Asia Pacific guy to be in this committee). I have been teaching a course on reserves since the late 80s and have noticed that the major uncertainty is reservoir mapping. I am a great believer in multiple hypotheses, where different geoscientist teams work on the same data. Unfortunately the current system of approved organization charts restricts this.

SPE in Indonesia is divided into 3 sections, Sumatra is based in Pekanbaru, Java section covers the whole of Java, about 8 Student chapters, and Kalimantan is based in Balikpapan.

The first time they opened SPE in Jakarta, it was mainly a bunch of expatriates. I was trying to look for a more Indonesian connection. We invited Pak A.K. Soejoso, the head of Pertamina Litbang at the time. I remember we had a meeting at the Hilton Executive Club and Pak Joso came along to support the SPE. No one knew him, because Pertamina in those days didn't mix much, particularly with foreigners who were working for service companies. He was very highly regarded by his peers, and he became the President Director of PGN. I had to try to bridge that gap a little bit between the Indonesians and the foreigners. After I was the chairman of the section, I think the next Chairperson was Frila Yaman, who was, I think, the first Indonesian Chairperson.

Our student members are very active, and there are always student activities. The young professionals, when they get to the industry, it's hard to get them active in SPE. Then you have the senior ones like Pak Priyambodo, a strong supporter of SPE. It's very hard to get people come to luncheon talks, because of traffic in Jakarta.

How does the IPA handle luncheon talks, why does IPA get full house?

Full house only when they get a new SKK Migas chairman for example.

I suppose I'm biased, since the talks I've gone to for the last few years are the ones I've given. So the IPA has the same problem?

Yes, but SPE Java has this TDG, there are more people coming to TDG, 30-40 people. Lunch and place are sponsored.

Do any big bosses come?

Not anymore.

I was sitting this morning with John Grant, he's been here for 20+ years. He was a well tester for BP, many years ago, a very good one. He was complaining about "nowadays I don't test wells" (he is a big boss!). I said why don't you get up and tell some stories and explain what a good test is or what a bad test is?. There is knowledge around, but these guys are not motivated to participate and pass on their experience I think that is an opportunity for the SPE in Indonesia – to tap the knowledge of these experienced engineers.

Interview with Sigit Rahardjo

VP Upstream Technology Center PT. Pertamina (Persero)

Thanks for your time Pak Sigit. In this edition, we are going to showcase local power. Pertamina is the flagship of Indonesia, and for technology, the leader in Pertamina is your Upstream Technology Centre (UTC). What is the plan going forward?

In a company or in a country, there must be an engineering team or science team or think tank. If the think tank is weak, automatically the business is not strong. Therefore, we are not only talking about NOW, but also about the FUTURE. The future of Pertamina is already planned for the year 2025; we are aiming to be the Asian Energy Champion. This is very strategic, since now almost all national oil companies are talking about energy, not just oil and gas. Energy has more opportunities, for example in PT Bukit Asam (a coal mining company), their vision is not to be the biggest coal producer, but an environmentally friendly company. I know the Director very well. In my opinion, this vision is thinking out of the box. Industry, especially mining, has traditionally been anti-environment, but now it's the contrary. Pertamina wants to be something like that. We are not going to copy that kind of perspective, however, we want Pertamina to be the backbone of the country. Going forward, the backbone will not just be oil and gas, although it is for the moment, since that is our main product and we are the biggest in Indonesia. We are hoping that moving forward, Pertamina is not only about oil and gas. We are aiming to be the energy company.

What about UTC? We are preparing the human resources to support this initiative. In our technical disciplines, we have S1 (Bachelor's degree) up to S3 (PhD's). We have new energy and green technology experts also with S1 to S3 profiles. Pertamina is preparing all this. Even though it is not yet powerful, this is ongoing. To fulfill the requirement for 2025 in terms of human resources competency, we need to increase the number of resources in UTC by 50-60%. For PhD's, currently we have about 7, with 2-3 prospective talents, making a total of 10. The earlier ones included Pak Alam, Pak Andriansyah and Pak Salis. We are preparing to send more staff to universities. It is the duty of UTC to develop people according to their competency. It is not easy, because we have very high standards. We are targeting 3 universities: Tulsa University, the Colorado School of Mines, and Texas A&M.

We are very fond of Pak Trijana Kartoatmodjo, who collected close to 1200 well samples, from which an equation was found (Kartoatmodjo and Schmidt / KS correlation). Today, we have 18 staff studying. Six of them are PhD candidates, and the rest are Masters candidates. Some of our Masters candidates are taking their degree in ITB and UI. We are hoping that they will support our initiative for 2025, since we have a great challenge going forward.

We are currently preparing for the Mahakam PSC handover from Total to Pertamina. Next, we will receive the East Natuna PSC, where I am also a Director. We can say that the administration is moving ahead full speed. Since 1997, Natuna has not been going anywhere, and now they call us to hit the ground running. We also need to handle 12-15 expiring concessions in 2017. We are also going after overseas opportunities. We are pretty successful in Algeria at the moment, producing around 23,000 bpd. We shipped around 300,000 barrels recently to Indonesia in our first shipment. This is the first production abroad for Indonesia from our own operation. We are working on a proposal to increase production to 28,000 bpd.

How does UTC help with M&A?

The M&A process is lengthy. However, to simplify we can divide the process to three parts: Pre, Current, and Post. UTC is involved from Pre to Current, which is the decision time to (or to not) buy (or sell). During Pre, we judge and assess from materials in the data room. We are the think tank. On subsurface, we handle geophysics, geology and reservoir. On the surface, we handle production, facilities and drilling. UTC has 9 departments, studying the block from A to Z, from exploration until operations. For example, before we bought ONWJ, we assessed everything. Once the deal was done, we handed ONWJ to PHE. Later, during operations, we play the role of advisor. As an example, during development of fields GG and YY, we are involved. When PHE submits a POD, we conduct a process called funneling. We review everything from subsurface to surface, to the location of the proposed wells. After approval by SKKMIGAS, the POD will be executed by PHE, and we are not involved. We are different than Pertamina's assets, in that UTC is a research center, although we are not fully a research company. We conduct research and assess technology. Then the Operations implement.

During operations, does UTC monitor as well as advise?

Yes. We monitor operations on a monthly basis. We provide human resources, the experts to guide the process. For example, we have an expert in drilling. So when we have a drilling problem, we advise to do this or that. If the mud weight is inappropriate and risks damaging the reservoir, we have reservoir experts who can quickly advise them that it is incorrect. We always invite our assets to discuss technical issues, for example when the mud weight is overbalanced in a depleted reservoir, causing plugging of the reservoir. We are currently helping EP to select the technology to build a platform. They

provide inputs to UTC, which we review. Some of our roles include Technology, Monitoring, and Standardization.p Our subsidiaries can't just use any technology as they please. We provide SOP references. The exception is for common technologies, such as gas lift, pumping unit, where we give them the prerogative since it is already common. UTC is involved more in new technologies, supported by S2-S3 human resources. We are currently aiming to be like the Exxon and Chevron Research Centers. We are building towards that, where UTC will be fully utilized as the think thank. When our assets/business units require, we can provide advice/advisors for operations, technology, and management. Therefore, we are working to develop our capability and competency. For example, we are working on an Early Professional Development Program (EPDP). After BPS (Bimbingan Profesi Sarjana / Graduate Professional Training), candidates will enter as fresh engineers, and they will follow the EPDP for 2-3 years. We currently have a program for reservoir, and are developing programs for geoscience, drilling, production, facilities, new energy, and green technology. We are working with PCU (Pertamina Corporate University). We provide content and experts, while PCU provides execution, such as facility and logistics. During EPDP, the candidates will still be working in their own functions. We have the syllabus for the entire 2-3 years. The program has been running for 2 years. We are mirroring programs from Shell and Exxon. We have 2 EPDP alumni, doing internships with Shell and Statoil. We also have an internship with Petrofac in Aberdeen. We are working on more internships; 4 persons in reservoir and production, 2 for G&G, and 2 in drilling. We are looking for cooperation, probably in Algiers where we have established operations.

Can you tell us more about your early days?

I was born in Wonogiri, 35 km south of Solo, a dry area. Around 1965 I moved to Klaten, 25 km out of Yogya. I spent elementary to high school in Klaten, although my parents came from Solo. They work here and there, and resided in Klaten. I spent my education at TK Aisyah (kindergarten – red), SD Ngepos (Elementary school –red), SMPN 2 (Junior high school –red), and SMA 1 Klaten (High school –red). One of the teachers for elementary school was my mother. I spent 2 weeks at SMA Santo Yosef Solo, where they taught morality, very disciplined. I went to university in Yogya in 1981. A friend of my elder brother took me to UPN. I had no idea what geology was. However, I tried to enjoy it, and Alhamdulillah it was a good fit for me. I finished the degree by end of 1987. Out of 150 students, I was one of only 25 students that graduated on time. My Rector asked me to join and teach at the university. I spent 2 years teaching at my almamater. Then I realized I was not suited to continuing education. I complained to my boss and he was angry. I decided that I couldn't continue. I needed to fulfill my obsession. I discussed with few seniors about the option to take it or leave it, and I left it. I joined Pertamina in 1990. First I was placed in Pendopo, South Sumatra. Despite my background in geology, I was sent onsite as reservoir / production engineer. I had no idea even what was casing. I kept learning, and when I joined BPS, I did not fail any subject in petroleum. In Drilling, I was in a JOB as senior drilling engineer, reservoir engineer, production geologist, PE (petroleum engineer), field engineer. That's the way to do it, since we can experience everything. I designed gas lift, ESP, drilled with 2-joint stands. I have an obsession to be decent at what I do. I took a Master's degree on my own in Management, and another in geology. I'm currently finishing my doctoral program in Padjadjaran University. I know about oil and gas, since I have experience in everything.

What about your children?

My first child just entered university in Trisakti, taking management. He asked me if he can become a docent. I told him that it's ok, but he has to finish his degree in 3.5 years. The second child is in high school, and the third one in the elementary school.

Earlier, do you aspire to be a docent?

My apiration always changes. When I was a kid, I have a neighbour working in a bank. My friend's parents seem happy being doctors. When I reached university, my only aspiration was to finish my education.

However, when I was finishing my degree, I realized the problems around me: drought in the provinces, underemployment, lagging development. I tried to think on how to change this situation. Since I was in geology, what can be utilized from the knowledge?

When I was a docent, I was also a consultant working to increase income in the area. In Klaten at that time they have "batu gamping" (limestone –red). That can be good to make cement, so I thought that was a simple way to increase income for the community. At the end of the day it was hard, since it had to be economical, and will not work otherwise. There is a lime factory in Klaten, however the limestone material is of poor quality, so it can't make a good cement.

What is developing now is the creative industry, not based on natural resources. These concepts should enter Pertamina. Our basis used to be oil and gas, and now we are heading towards geothermal. Our geothermal potential is 29 gigawatts - and we utilize less than 3%. Before I came to UTC, I spent 1 year in geothermal as director of operations. However it seems that we don't have the "hidayah" yet. This is out of the box thinking. That is why it is important. Why do we import? Why can't we switch from electricity from coal and hydrocarbon, requiring hundreds of trillions of Rupiah each year. Why can't we use Geothermal? Power from oil costs 30 cent/kwh. Power from geothermal now costs 6-7 cents/kwh. Hopefully the new President will make the switch.

Hopefully Pak Sigit will drive change, holding a very strategic position in UTC. We can see great potential, and Pak Sigit is an inspiration for our young readers.

From left to right: Amin Hartoni, Servia Arben, Sigit Rahardjo, Mega, Hasbi Lubis and William Ongseputra

Interview with

Tumbur Parlindungan

Chief Operation and Commercial Officer of PT Saka Energi Indonesia

Pak Tumbur, thank you for your time. This interview is about yourself, your background, university and career.

I went to Trisakti University in Jakarta and majored in Geology. In 1992, I got my first job was as a Geologist in a TAC (Technical Assistant Contract). After five years, I moved to Schlumberger and stayed for seven years, working mainly as a geoscience consultant and then in economics. I have been commercial ever since. I moved to the Netherlands and worked for Shell in upstream commercial for 4 years. I lived in the Netherland but my field was in Kazakhstan. Our job not only involved the oil field, but also the pipeline and how to ship oil to market.

So coming back to Indonesia was easy. When we came back from the Netherlands, Indonesia was growing, whereas Europe was dead at that time.

I moved back to Jakarta and joined BP in upstream commercial for the Asia Pacific. We covered both CBM and conventionals. CBM was booming at the time. Vico had a dream of CBM from Sanga Sanga to LNG as a world first. Facilities were there, so they just needed to drill and produce CBM gas.

Then three years ago, PGN called me to run commercial at Saka. When I joined Saka the dream was to develop CBM. We talked with many international operators including Origin Australia. They said it's impossible for Indonesia. So we sold our CBM blocks we focus on conventional business (non-CBM). It's better for Indonesia to move to shale gas instead of CBM, starting with Chevron in Sumatera because they have facilities and infrastructure already.

Saka is young. You have people from different cultures coming in. How to get the team work?

I agree with you that's the problem. Hess people have a different culture from Arco, Shell, Total and others. So we make one objective. Saka is an Indonesian company, all Indonesian except one expat. People are welcome to bring on their own workflows, so long as the spirit is lively, and the projects are done right and with no hanky panky. That's what we emphasize when we have meetings. If you start hanky panky then you start to hide something, you don't want to talk honestly, and then the project goes downhill.

We have managed to stay clean for the last 2.5 years. We tell our people that speed for finalizing the project and closing the deal is number one in Saka. Otherwise, people will come to distract and try to stop our projects.

So usually we close an opportunity within less than 6 months. Sometimes our people make wrong decision, because you need to decide as soon as possible and think deeply later on. We still need to follow the bureaucracy as a state owned enterprise, so we do this in parallel with evaluating the opportunity. So when we are ready to sign for the opportunity, our Directors are also ready to sign. That's the way. We are like other state owned enterprise such Pertamina, only smaller.

When you acquired Pangkah, you became a real operator for the first time. How did that change Saka?

We didn't want to become operator initially. We talked to Pertamina and offered them Pangkah in exchange for Natuna. But Pertamina said no they wanted both.

When we took over Pangkah from Hess, 25% of Hess's staff took the package and quit. To maintain the spirit of the remaining people, we explained what Saka can do, and that we have good prospects.

Hess staff are paid better than Saka staff. How did you manage this?

Simple. We adjusted the salary of Saka staff to match ex-Hess. It was easy because Saka only had 40 people at that time, compared to Hess with 250 people. Everybody was happy. Some people got a 100% salary increase, others a 50% increase.

Do you employ fresh graduates?

Yes. We just hired 11 geologists and petroleum engineers with 0-3 years experience, and we are developing them. We have a development plan for fresh graduates. We hire senior guys to train and develop them through projects. We

have 10 blocks right now. For Operations experience, people go to Pangkah and South Sesulu. Others learn as non-Operators in deep water, shallow water or onshore like in Salamander. We give them projects on interpretation, then we send them offshore to Pangkah. That's the only way.

Our facility in Pangkah is one of the best in Indonesia, in terms of operations and maintenance. It is over-capacity, huge. Next year, we plan to build a commercial training center inside the Pangkah complex and offer a 3-month Operator training course, covering LPG plants and offshore operations. We will retain the best graduates for Saka. SKKMigas supports our plan. We have big facility and we try to utilize that. PGN is happy to invest in that.

You have shale gas in the USA. Do you look elsewhere internationally?

Our philosophy is like this: if we can bring gas molecules back to Indonesia, we are interested. In our opinion, USA is the best fit and it is a transparent country. So we have invested in the USA. We could invest in Africa but it's much more difficult. It is cheaper to get LNG from the USA than from Domestic LNG. From Bloomberg, yesterday the US price was $11.36 delivered to Indonesia, while from Tangguh it was at least $12.

Did you look at LNG in Australia?

Yes, but it's too expensive at $13.50. The domestic slope is $12 from Bontang or Tangguh. LNG from the USA is cheaper because there is no slope only Henry Hub + 15% + shipment = $11.50. We can waive the tax because it's energy. Plus the gas can go to PGN directly with no government allocation. That's the reason we go to USA. A secondary reason is we want to learn about shale gas, so we can copy how they operate. We plan in 2018 to have our own shale gas operation over there by buying small companies. Operations over there are very efficient as everything is handled by service companies. The 2018 date is also when the US will start exporting LNG. Better to start with equity, to start to understand the market and how they operate. Later, you can become an Operator. That's the way should be. You cannot charge into shale gas over night. It doesn't work. That's why we don't want to become operator here, but there. In Indonesia, shale gas might work for Chevron, because they have infrastructure and pipelines.

What are your hobbies?

Running for 30-40 minutes or around 5km in the morning near my home. Sometimes I cycle. I have no time for anything else. There are too many meetings and bureaucracy. And the meetings are all around Indonesia and need to be present in US once a while.

How aggressive are you? Would you be happy to take 100% of expired PSC's?

We will not take 100% and our goal is not to be operator in every block that we want to acquire. We are happy to be part of the consortium. We are not big. We just want to work and learn together. But if we need to Operate, we can because we have the people and the capability.

How can you get into deepwater exploration?

We want to bring exploration companies back to Indonesia, like Ophir and Tullow. We want a partnership where they do all the technical stuff, and we do the Indonesian stuff, and we get minority interest. That's the only way that can help Indonesia with exploration, otherwise nobody wants to do it.

Will Saka follow PGN and go public?

Yes, the objective is for Saka to go IPO as soon as possible, hopefully in 2016. Then we will be independent.

From left to right: Amin Hartoni, Peter Adam, Tumbur Parlindungan, Thomas Schievenbusch, Firman Yaman and Mega

MedcoEnergi: Decades of Growth

Donggi Senoro LNG plant, located in Central Sulawesi. Construction is completed, the plant is currently under a commissioning stage with target to produce LNG in mid 2015

About PT Medco Energi Internasional Tbk ("MedcoEnergi")

MedcoEnergi was founded on 9 June 1980 by Arifin Panigoro, one of the Indonesia's leading oil and gas businessmen, as the first private national oil and gas drilling company. MedcoEnergi is established under the laws of the Republic of Indonesia and became the public listed company in Indonesian Stock Exchange on 12 October 1994.

Within over three decades MedcoEnergi has significantly grown its business and built a solid fundamental of portfolios from all over the world, especially in Indonesia and Middle Eastern and North African countries. MedcoEnergi currently has over 30 oil and gas blocks and is operating in Indonesia as well as in overseas, including Libya, Oman, Papua New Guinea, Tunisia, United States of America and Yemen.

Focus of MedcoEnergi

Starting in 2011, MedcoEnergi has changed its business strategy, going back to the core business of oil-and-gas exploration and production. MedcoEnergi's business strategy has 4 folds, i.e. strengthening producing asset portfolio, increasing reserves life index, completing major projects and accelerating growth of other energy-related assets through strategic partnership. As an oil and gas company, MedcoEnergi continues to focus intensively on how to secure the Company's long term growth and sustainability.

In 2013, MedcoEnergi made a major change on the way it operated our fields. The operation organization has been moved from the headquarter-centric base to a full field-based station. This change will have bring two major improvements, namely increased agility and responsiveness of the operations team in responding to issues and challenges at the fields/sites, as well as a more streamlined headquarter structure, enabling better focus on planning and strategic pursuits.

Growth Plan

To support its growth agenda, MedcoEnergi has kicked off several major development projects. MedcoEnergi has been moving safely on track to sustain its operating profitability over the next few years, at which time MedcoEnergi will start to reap the benefits of our major oil and gas projects, including the Donggi Senoro Gas and LNG development, the largest upstream and downstream gas development project in Indonesia in recent memory. MedcoEnergi remains cautiously optimistic that the commencement of the Donggi Senoro Gas and LNG plant will be a turning point to establish itself as a major player in the gas and LNG business, both upstream and downstream. The commissioning of these major development projects, starting with the Donggi Senoro Gas and LNG projects in 2015, followed by the completion of Block A Gas project and Area 47 Libya oil project both in 2017 and Cosmos/Yasmin project in Tunisia which is slated for its completion in 2019, will assure the Company's near to medium-term growth prospects. In Area 47 Libya, MedcoEnergi has successfully discovered resources from 18 out of the 20 exploration wells drilled in four years, and achieved an exploration success ratio of 90%, well above the average global success rate. In 2008, the discovery of 352 MMBOE contingent resources in Area 47 was successfully made. MedcoEnergi became the operator of Area 47 in 2010 and since then increased gross contingent to 588 MMBOE (up by 67% from the level in 2008) through the drilling and testing of an additional three exploration wells. During 2013 - 2014, MedcoEnergi has successfully completed drilling of two more exploration and three appraisal wells and one well testing. Repeating another success story, a further oil and gas discovery was made. MedcoEnergi and its partners are

undertaking the development, operation and maintenance six out of 16 oil and gas fields that MedcoEnergi has found from the 18 discovered wells. MedcoEnergi aims to build a production facility for 50,000 BOPD of oil and 90 MMSCFD of gas which is slated for its first production by 2017 (Phase-1). The remaining ten oil and gas fields are currently being appraised and will be followed by Phase-2 development. In addition MedcoEnergi continues to seek for growth opportunities through the acquisition of producing oil and gas assets, especially in the regions of the Middle East, North Africa and Asia Pacific. In 2012 and 2014, MedcoEnergi has successfully added one producing block in Yemen and 8 blocks in Tunisia respectively. MedcoEnergi is set to double its current production rate to over 100,000 BOPD by 2019 by delivering successful major projects, growing its reserves organically through high-graded exploration activities and successful acquisition programs.

Oil Producing Facilities at Kaji Oil Field. Medco has successfully implemented a pilot project of EOR in this field

Success stories of MedcoEnergi ("the Company")

1992 The Company expanded its operations into oil and gas exploration and production by taking over a Technical Assistance Contract (TAC) now operated by PT Exspan Kalimantan and a Production Sharing Contract (PSC) now operated by PT Exspan Tarakan.

1994 The Company successfully conducted an Initial Public Offering. The first energy company to be listed on the Jakarta Stock Exchange.

1995 Acquired 100% shares of PT Stanvac Indonesia from Exxon and Mobil which held three oil and gas blocks in South Sumatra: South & Central Sumatra, Rimau and Pasemah.

1996 Discovered the giant oil field, Kaji and Semoga, Rimau Block, South Sumatra.

1997 Entered into the downstream business to operate Pertamina's methanol plant at Bunyu Island.

2000 Acquired three new working areas: Simenggaris, Western Madura and Senoro-Toili. Discovered oil field in Soka, South Sumatra.

2002 Acquired 25% working interest in Tuban block. Awarded a "B+" corporate credit rating with stable outlook by Standard & Poor's in February 2002, above Indonesia's sovereign credit rating.

2003 Signed Gas Supply Agreement with PLN (Indonesian state-owned electricity company) for gas supply from South & Central Sumatra PSC.

2004 Acquired 100% shares of Novus Petroleum Ltd, marking the Company's expansion into international oil and gas arena. Inaugurated the Company's first gas-fired power plant in Batam Island, Panaran I.

2005 Awarded Oil & Gas Exploration and Production Sharing Agreement of Area 47 from the Government of Libya. Acquired Langsa block and Sembakung block in Indonesia. Signed Operation & Maintenance Agreement with PLN for Tanjung Jati B coal power plant of 2 x 660 MW

2006 Won a tender and awarded for Service Contract for Karim Fields, Oman

2007 Drilled exploration wells in Area 47 in Libya and made six oil discoveries. Launched pilot project for Enhanced Oil Recovery (EOR) in Rimau Block. Commenced the development of Senoro Gas and LNG Projects through establishment of a joint venture of PT Donggi- Senoro LNG (DSLNG).

2008 Signed a Production Sharing Agreement with the Government of Yemen for Block 82 and 83. Completed the sale of the Company's drilling subsidiary, PT Apexindo Pratama Duta Tbk. Signed the first Coal Bed Methane (CBM) PSC in Indonesia to develop CBM in Musi Banyuasin Regency, South Sumatra. Completed drilling 20 exploration wells in Area 47, Libya. 18 out 20 wells were discovered oil and gas (exploration success rate of 90%).

2009 Entered into coal mining business by acquiring two mining concession rights in Nunukan, North Kalimantan.

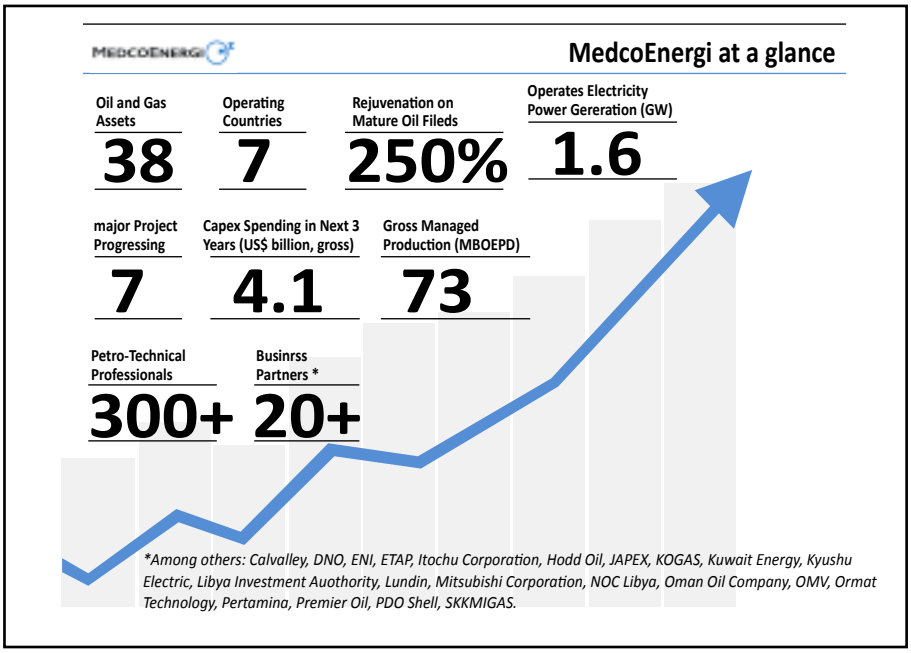
2010 Secured operatorship and successfully made three discoveries from three exploration wells in Area 47 in Libya. Obtained 20 – year extensions for three PSC working areas: South & Central Sumatra, Block A and Bawean.

2011 Completed the sale of Anaguid Block in Tunisia. Invited PT

Saratoga Power to become a shareholder of PT Medco Power Indonesia. Secured Commerciality declaration of Area 47, Libya.

2012 Acquired 25% of Block 9 Malik, Yemen. Inaugurated maiden shipment of 38,000 tons of coal to China. Earned PROPER Gold for Rimau Block for second year running (2011 and 2012). Signed a strategic partnership with Puma Energy LLC for PT Medco Sarana Kali Baru, fuel oil distribution & storage business unit.

2013 Secured project financing for Senoro for US$ 260 million. Received Gold PROPER Award for Rimau Block for third consecutive year (2011, 2012, and 2013). Completion asset swap with Salamander for Bangkanai with Simenggaris and Bengara. Establishment of a Joint Operating Company (JOC) of Nafusah Oil Operations B.V (Nafusah) with NOC Libya and Libyan Investment Authority. JOC Nafusah will develop and operate Area 47. Steadily increased the average gas sales price to reach over US$ 6/MMBTU for domestic markets.



2014 Acquired eight oil and gas working areas in Tunisia, through an acquisition of Storm Venture International (Barbados) Ltd. Secured the 2nd Commerciality declaration of Area 47 Libya for the additional three fields. Won a tender and acquired Block 56 in Oman.

PETROLEUM & MANAGEMENT PROGRAMS
FOR JANUARY - JUNE, 2015

• TNA and Evaluating The Results	Jamin Djuang, PE, M.Sc., MBA	Jan. 21 - 23*
• Effective Negotiation Skills	LDI Instructor	Feb. 16 - 18*
• Basic Petroleum Operations	Jamin Djuang, PE, M.Sc., MBA	Feb. 26 - 27*
• Public and Human Relations Skills	LDI Instructor	Mar. 4 - 6*
• Managing Conflict and Handling Difficult People	LDI Instructor	Mar. 4 - 6*
• Pedoman Tata Kerja (PTK 007)	Dr. Ir. Antarikso A., MBA, CPIM	Mar. 11 - 13*
• Report Writing in English	Jamin Djuang, PE, M.Sc., MBA	Mar. 11 - 13*
• Petroleum Economics, Risk and Fiscal Analysis	Guy Allinson	Mar. 16 - 20*
• Modern Office Management and Electronic Filing Systems	Ir. Rudianto Prabowo, MSIS	Mar. 18 - 20**
• Training of Trainers	Drs. Totok Krisdianto, MM	Mar. 25 - 27*
• Effective Presentation Skills	LDI Instructor	Mar. 25 - 27*
• Reliability Centered Maintenance	Dr. Ir. Rachmat K. Bachrun	Mar. 30 - Apr. 2*
• Understanding The PSC Concept	Dr. A. Rinto Pudyantoro & Team	Mar. 31 - Apr. 2*
• Planning and Scheduling Skills of Oil & Gas Projects	Ir. Pulung Susilo Rahardjo	Mar. 31 - Apr. 2*
• Managing The Human Capital	Johannes W. Karundeng, M.Sc.	April 8 - 10*
• Effective Supervisory Skills	LDI Instructor	April 8 - 10*
• Management and Teamwork Skills	LDI Instructor	April 8 - 10*
• Corrosion Control in The Oil and Gas Industry	Ir. Deden Supriyatman, MBA	April 13 - 17*
• Problem Solving and Decision Making	LDI Instructor	April 15 - 17*
• Fundamental of Coiled Tubing	Jerry L. Collin	April 20 - 24*
• Taxation, Legal and Financial Aspect of PSC	Dr. A. Rinto Pudyantoro & Team	April 22 - 24*
• Effective Communication and Interpersonal Skills	LDI Instructor	April 22 - 24*
• Oil and Gas Project Management	Ir. Pulung Susilo Rahardjo	April 27 - 30*
• Integrated Maintenance Management	Dr. I Wayan Suweca	April 27 - 30*
• Time Management and Personal Effectiveness	LDI Instructor	April 28 - 30*
• Plant Piping and Pipeline Systems	Dr. Maurice Stewart, PE, CSP	May 4 - 8*
• Coiled Tubing and Nitrogen	Diego Londono	May 4 - 8*
• AFE Budget Preparation Skills of Oil and Gas Project	Ir. Pulung Susilo Rahardjo	May 11 - 13*
• Maintenance Planning and Scheduling	LDI Instructor	May 11 - 13*
• Developing Your Potential For Success	Johannes W. Karundeng, M.Sc.	May 11 - 13*
• Well Completion and Workovers	Dennis Gaudet, PE	May 18 - 22*
• Production Safety Systems	Dr. Maurice Stewart, PE, CSP	May 18 - 22
• PSC Budgeting: WP&B, AFE and POD	Dr. A. Rinto Pudyantoro & Team	May 20 - 22*
• Uncertainty Analysis of Reservoir Models	Dr. Asnul Bahar	May 25 - 29**
• Oil and Gas Processing Plant	Dr. Maurice Stewart, PE, CSP	May 25 - 29
• Assertiveness and Influencing Skills	LDI Instructor	May 27 - 29**
• Cost Estimating and Project Control	Dr. Maurice Stewart, PE, CSP	June 3 - 5
• The Art and Science of Negotiation	Ir. Joko Margono, MM, MBA	June 3 - 5*

Note : Courses are in Jakarta except those marked with (*) are in Bandung, (**) in Yogyakarta and (***) in Bali

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E-mail : Lditrain@indo.net.id - Website : www.Lditraining.com

Utilization of Aerated Technique in Drilling Sub-Pressure Well

By Ashadi, Drilling Engineer

Education :
2001-2004 : B.Sc. Electrical Engineering, University of Indonesia (Cum Laude)
2010-2012 : M.Sc. Energy Management, University of Indonesia (Cum Laude)
Experience :
2005-2009 : Drilling & Measurement Engineer
2012- Now : Drilling Engineer

ABSTRACT

Obtaining drilling fluid and cutting returns while drilling in a subnormal pressure regime is still a big challenge in the drilling industry. Aerated drilling has been introduced as one of the solution. Aerated Drilling is a technique where compressed air in combination with the drilling fluid is used to reduce the effective density of the fluid column in the wellbore. The main objective is to enhance the chance of having circulation during drilling by reducing the Equivalent Circulating Density (ECD) in the wellbore.

One of the biggest challenges in drilling a subnormal pressure regime is loss circulation. This also mainly occurs when drilling a geothermal well. In geothermal field, the well targets typically are faults, fractures or fissures that have high permeability and are connected with the geothermal reservoir which has subnormal pressure. When these faults or fractures are intersected, losses will occur as the drilling fluid will enter the fracture zone rather than flowing to surface. Some of the cutting may enter the encountered fracture zone but some may stay in the annulus and accumulate. This cutting accumulation will result in torque increase that will limit the capability to drill deeper and it will also increase the risk of stuck pipe due to cutting pack off. The cutting entering formation also becomes a later problem as it may reduce the permeability of the fracture and thus the production of the well. Being able to manage circulation is very crucial as it will reduce the drilling risk, increase the drilling efficiency, enable better geological control & formation evaluation from cutting samples, and minimize formation damage.

Aerated drilling has been utilized to solve this problem. The intent is to manage the ECD that will allow a full or partial circulation despite subnormal pressure zone has been penetrated, without neglecting the well control aspect of the well. Understanding the ECD under various air/mud ratios and understanding the field formation pressure are essential for the successful application of the technology.

Despite the article will focus more on the aerated utilization in geothermal field, similar concept can be applied in Oil & Gas well on which subnormal pressure regime occurs.

AERATED DRILLING TECHNIQUE

Aerated Drilling is a technique where compressed air in combination with the drilling fluid is used to reduce the effective density of the fluid column in the wellbore. The main objective is to enhance the chance of having circulation during drilling by reducing the Equivalent Circulating Density (ECD) in the wellbore (Hole 2006).

Injecting compressed air into the mud circulating system to combat circulation losses while drilling for oil was first carried out by Phillips Petroleum in Utah, USA in 1941. During the early 1970's, air or 'Dust Drilling' was introduced at the Geysers geothermal field in California, USA. Aerated drilling of geothermal wells was initially developed by Geothermal Energy New Zealand Ltd. (GENZL) during the period 1978 to 1982 while involved in drilling projects at the Olkaria Geothermal field in Kenya, and at the Kakkonda field in Honshu, Japan; and during the latter part of this period GENZL developed its DOS based Air Drilling Simulation (Hole 2006).

PREDICTING AND CONTROLLING THE ECD

Estimating/calculating the ECD in an aerated environment require different formulation as if in a normal mud environment. The air will get compressed as it flows down through the drill pipe due to the hydro pressure from the mud above it. The volume of air at the bit will be different from the volume of air injected at surface due to this compression. Therefore the ECD at the bottom hole is very dynamic.

While there are some commercial software available to model this ECD, the author have instead been utilizing some scientific formula from two different group of scientist. They are formula developed by Guo-Ghalambor and formula developed by Al-Ajmi. The author has tried both formulas and both were giving quite similar result and trend. Once both formulas are considered valid to be used, one can use it for planning as well as review purpose.

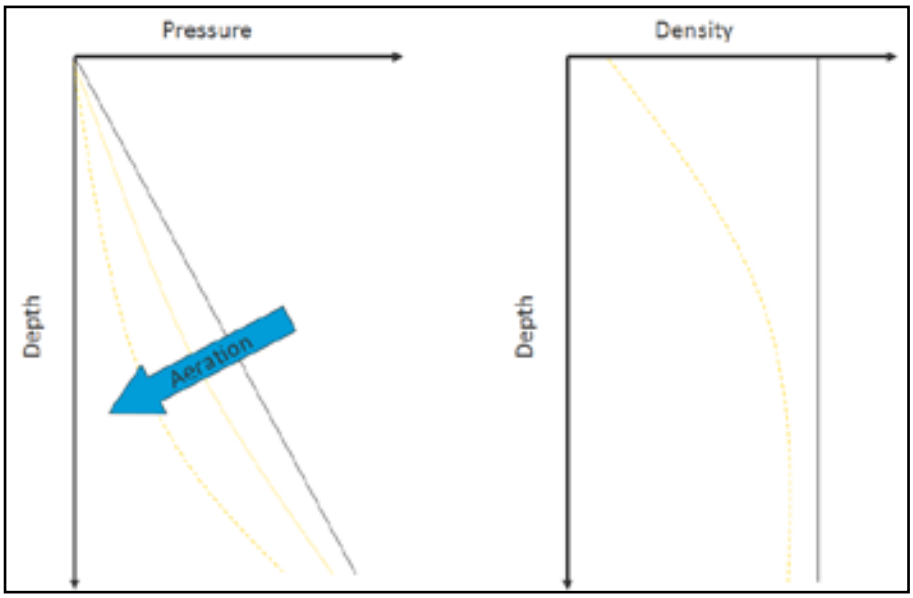

Fig 1. Aerated Process
(Figure taken from : Hole, H., 2006: Aerated Fluids For Drilling of Geothermal Wells. UNU-GTP, Iceland)

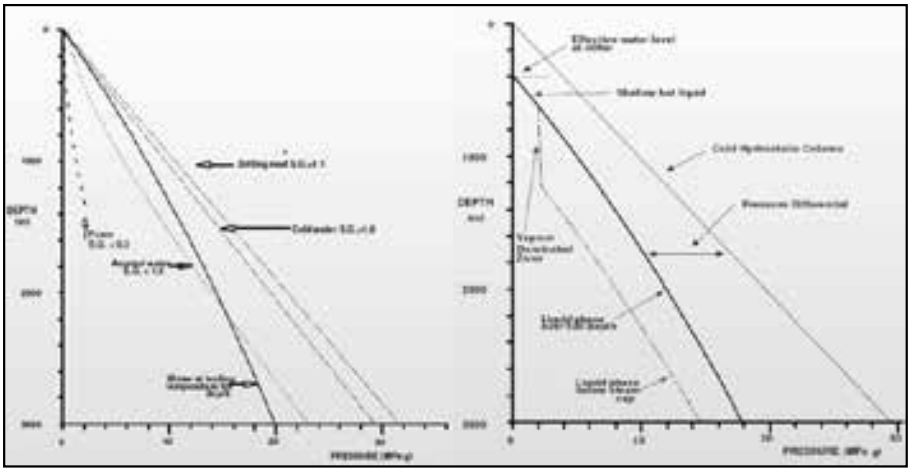

Fig 2. Various Type of Pressure Profile
(Figure taken from : Hole, H., 2006: Aerated Fluids For Drilling of Geothermal Wells. UNU-GTP, Iceland)

There are two main factors that contribute to drilling losses. They are the pressure difference (formation pressure versus ECD) and the formation permeability or injectivity index as for geothermal case. Having said that, there are certainly two ways to control the drilling losses i.e by controlling the pressure difference and/or controlling the permeability/II (for the rest of article, II will be used instead of permeability).

In a simple approach, rate of losses as a function of Injectivity Index and Delta Pressure can be formulated as:

Fluid Loss (psi) = **Injectivity Index** (kph/psi)x **Delta Pressure** (kph)

That means, the smaller the delta pressure, the lesser drilling fluid losses will be, at similar Injectivity Index. Since II is formation dependent and not to be reduced obviously, pressure difference is what the drilling team can control i.e. by controlling the ECD. Aerated drilling is utilized to control this ECD. The more air added into the system, the lesser the ECD is. Theoretically, if ECD was less over-balance to formation pressure then fluid can more likely be circulated to surface. This is the whole concept of utilizing aerated drilling to mitigate losses in drilling subnormal pressured well.

PREDICTING THE RATE OF LOSSES AND INJECTIVITY INDEX

There are several key information can be obtained by understanding all this pressure models during drilling, based on the simple physic formula as shown above . While the physic law has always remained the same; it is our understanding that is getting better and better.

If the II of the well is known, delta pressure can be predicted / modelled, then the rate of losses can be predicted too. In a mature field with many wells have been drilled (information is richly available), the II for any future nearby wells can be predicted with a higher degree of accuracy. Since formation pressure is well known, BHP during drilling with air/mud can be modelled and hence the delta pressure is known. This concept may be more difficult to apply in a new or even exploration field, but again in a developed field, this would be much more feasible to be done. By knowing in advance on what the drilling would expect (Return/PLC/TLC), the team can manage the plan in advance.

Secondly, especially for geothermal reservoir group, the team would be able to calculate the II prior to fluid damage (the original II). Still using the same formula, rate of losses at any delta pressure can tell us the II of wellbore. Reordering above formula:

Injectivity Index (kph/psi) =
Delta Pressure (kph) / **Fluid Loss** (psi)

Whenever any feed zone is encountered (in geothermal field) and TLC/PLC occurs, record the rate of losses and delta pressure at that particular moment. That will tell the II of that feed zone prior to any mud damage. The II obtained after well is completely drilled is a mud-damaged II. Knowing both II during and after drilling will tell how badly the feed zone is damaged and therefore it can give guidance if the well is good candidate for future work-over or not. Certainly further calculation/conversion need to be done since II is a function of fluid properties. II for drilling fluid is obviously different from II for geothermal production fluid, so further calculation/conversion still need to be done.

FUTURE STUDY

Addition of air into the drilling fluid system will certainly have an impact to other drilling aspect. While above discussion has focused mainly on the pressure aspect of the wellbore, other aspect has to be reviewed in order to generate a holistic approach. Impacts of aerated to the motor performance, bit performance, and drill cutting circulations are to name a few.

At the end, main goal of having a holistic hydraulic design is to fine tune the optimum drilling parameters. At any drilling situation, there will always be a trade-off for changing any drilling parameter. Therefore, the goal is not to achieve best parameter but rather optimum parameter at any particular situation to achieve a certain goal.

CONCLUSION

Being able to manage fluid circulation in drilling a subnormal pressure or geothermal well will bring significant benefit for the drilling, reservoir, and geologist group. Better hole cleaning for drilling, adequate formation evaluation for earth scientist, and better production for reservoir are the main benefits.

The main concept in managing circulation has always been the same i.e. rate of fluid loss is the product of Injectivity Index and Delta Pressure. Aerated Drilling has been utilized mainly to manage the delta pressure and hence controlling the rate of loss. By understanding the whole pressure profile (BHP, pore and fracture pressure) with the help of available resources (software, sensor, tools), the implementation of aerated drilling to mitigate this issue can get better and better.

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A New Platform for Offshore Exploration and Production

Peter Carragher
Rose & Associates, LLP
Houston, Texas, USA

Graham Hine
Liquid Robotics, Inc.
Sunnyvale, California, USA

Patrick Legh-Smith
Gatwick, England

Jeffrey Mayville
Rod Nelson
Houston, Texas

Sudhir Pai
Liquid Robotics Oil & Gas
Houston, Texas

Iain Parnum
Curtin University
Perth, Western Australia, Australia

Paul Shone
Chevron Energy Technology Company
London, England

Jonathan Smith
Shell Exploration and Production Company
Houston, Texas

Christian Tichatschke
Total E&P Uruguay BV
Montevideo, Uruguay

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Wave Glider is a registered trademark of Liquid Robotics, Inc.

Accurate data are essential for developing climate models and weather forecasts used in planning offshore E&P operations. A new remotely controlled, autonomous marine vehicle has been developed to carry a variety of sensors for conducting detailed meteorological and oceanographic surveys across vast distances and under extreme conditions. The role of this new sensor platform is expanding to support an even broader range of missions.

The oceans cover more than 70% of the Earth's surface and have played a dominant role in its geologic history. Although the oceans contain a substantial portion of our planet's natural resources, their depths remain largely unexplored. Long-term monitoring over vast expanses of ocean may lead to better understanding of processes that continue to shape the planet while helping scientists discover new resources and predict the impact of ocean forces that could disrupt commerce or alter the course of everyday life.

Forces of nature, such as hurricanes and typhoons, pose a recurring threat to thousands of communities along the coast; earthquakes and tsunamis occur less frequently but often cause more damage.[1] Sweeping events and weather patterns influenced by the ocean not only menace coastal dwellers but also impact industry and commerce around the world. The oil and gas industry feels the effects of weather in seasonal demand fluctuations. In the offshore environment, the effects of weather translate into concessions that operators must make: Is it prudent to mobilize a drilling rig, are the waves too high to offload equipment, or are the winds too strong for helicopter operations? Meteorological and oceanographic, or metocean, data—especially height of waves and period of swells, speed and direction of wind and surface or subsurface currents—provide crucial input for planning rig moves and placement. Geophysical survey crews must assess the effects of tides and currents on the feathering of seismic streamers as they are towed through the water.[2] Wave height is a key parameter used in designing production platforms, and pipelines must be installed to withstand subsea currents. Ocean monitoring plays an integral role in risk assessment and management by providing information that helps forecasters, planners and field personnel assess the degree to which they must accommodate forces of nature.

But monitoring is often a costly proposition. Conventional sensor platforms such as buoys, ships, aircraft and satellites are expensive and require extensive lead time for planning, procurement and construction. Personnel to support these platforms and their missions must also be trained and managed. Satellite-mounted sensors and storm-chaser aircraft evaluate the air column and ocean surface but are limited in their on-scene endurance, real-time sampling data rates and capability to measure conditions at or beneath the sea/air interface. Oceanographic ships can range over great distances while taking a variety of measurements, but vessel and crew are not meant to withstand extreme conditions and also must return to port for replenishment after a limited time. Ocean-observation buoys can also be outfitted with sensors but are anchored in place, so they measure conditions within only a relatively fixed location.[3] The cost to build, deploy or crew a metocean survey platform often starts in the millions of dollars and increases with the intricacies, risks or ambitions of the mission.

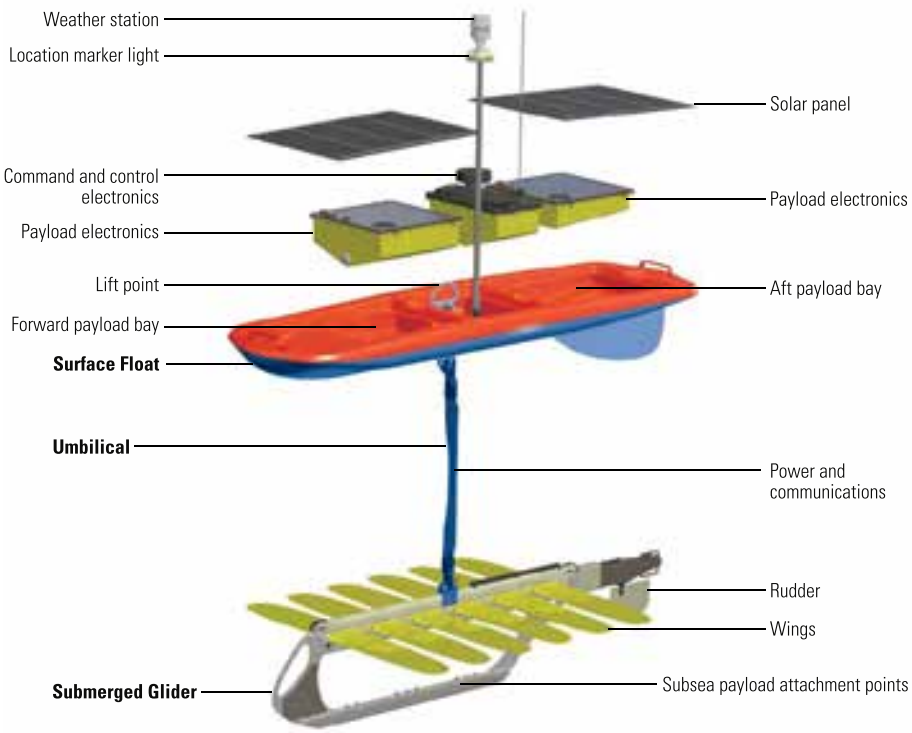
One complement, and in some cases alternative, to satellites, planes and ships is an unmanned mobile sensor platform for monitoring ocean conditions. This concept is part of a progression that led to development of remotely operated vehicles (ROVs), which have become essential inspection and intervention devices for deepwater oilfield operations.[4] With one or two skilled pilots at the surface, the ROV can wield the tools and power to carry out complex tasks in a forbiddingly dark, cold and high-pressure environment. Some ROVs eventually dropped their command and control umbilicals to take commands through subsea telemetry; now autonomous underwater vehicles (AUVs) are routinely used in subsea surveys. These unmanned vehicles have helped expand the envelope of deepwater operations and have been instrumental in increasing productivity and safety in one of the most hostile environments on Earth. These vehicles, however, require support from the surface.[5]

The Wave Glider autonomous marine vehicle (AMV), developed by Liquid Robotics, Inc., is a hybrid sea-surface and underwater vehicle that has taken the concept of autonomy beyond that of the AUV.[6] This wave-powered sensor platform enables collection and transmission of data gathered at sea on missions lasting up to a year. It is capable of crossing thousands of kilometers of ocean to gather oceanographic data, taking meteorological readings while maintaining a stationary position, or circling a rig at a preset distance to provide early warning of security or environmental threats.

Once deployed, it uses no crew, requires no fuel and produces no emissions, thus eliminating both risk to personnel and impact on the environment. For much less than the cost of a moored buoy or a vessel and crew, the Wave Glider vehicle provides mobility and long-range endurance for extended ocean monitoring missions. It has already carried out hundreds of missions ranging from the Arctic region to Australia and from the Canary Islands to Loch Ness in Scotland.

This article discusses the development of this multimission, autonomous sensor platform and describes its applications—from measuring metocean parameters to detecting oil seeps. Examples from the Gulf of Mexico and other areas demonstrate how persistent, unmanned mobile monitoring platforms have proved beneficial to offshore exploration and production efforts.

1. Bunting T, Chapman C, Christie P, Singh SC and Sledzik J: "The Science of Tsunamis," *Oilfield Review* 19, no. 3 (Autumn 2007): 4–19.
2. Feathering is the lateral deviation of a seismic streamer away from its intended towing direction as marine currents push the streamer off course.
3. The exact diameter of that fixed location is defined by the *watch circle* of the buoy's anchor system, which is a function of the length of chain attaching the anchor to the buoy. To withstand extremes in tides and wave height, the buoy is anchored with steel chain whose length is typically three to five times the water depth. Although this extra chain serves to reduce shock loading on the ground tackle used to anchor the buoy, it also means that the exact position of a buoy will vary with the tides, winds and currents.
4. For more on ROVs in deepwater applications: Downton G, Gomez S, Haci M, Maidla E and Royce C: "Robots to the Rescue," *Oilfield Review* 22, no. 3 (Autumn 2010): 16–27.
5. Manley JE and Hine G: "Persistent Unmanned Surface Vehicles for Subsea Support," paper OTC 21453, presented at the Offshore Technology Conference, Houston, May 2–5, 2011.
6. In 2012, Liquid Robotics, Inc. and Schlumberger created a joint venture known as Liquid Robotics Oil & Gas to extend autonomous marine vehicle services to the oil and gas industry.



^ Wave Glider system design. This autonomous marine vehicle is divided into three primary subsystems: surface float, umbilical and submerged glider. Each subsystem can be configured to meet client needs.

Vehicle Design

The Wave Glider AMV uses wave energy for thrust, while solar energy powers its rudder motor, navigation system and payload electronics. This AMV consists of a surface float and a submerged glider connected by an electromechanical umbilical (above). Each of these parts can support an array of sensors to create a custom payload for each mission. The float weighs about 68 kg [150 lbm] including a typical payload.

The float measures 208 by 60 cm [82 by 24 in.]. Its deck supports antennae for GPS, satellite communications and collision avoidance systems, as well as a mast to support a position marker light and flag for increased visibility. Its surface also holds two photovoltaic panels that continually replenish the lithium-ion batteries used to power the vehicle's navigation, communication systems and sensor payloads. Seven smart battery packs housed within the float are each electrically isolated with separate discharging and monitoring circuitry that permits only two batteries to be in use at a time.[7] Two payload bays support a total of 18 kg [40 lbm] of sensors and equipment.

Sea State	Wave Height, m	Ocean Surface Characteristics
0	0	Glassy calm
1	0 to 0.1	Rippled
2	0.1 to 0.5	Smooth or with wavelets
3	0.5 to 1.25	Slight
4	1.25 to 2.5	Moderate
5	2.5 to 4	Rough
6	4 to 6	Very rough
7	6 to 9	High
8	9 to 14	Very high
9	More than 14	Phenomenally high

^ Table of sea states. The World Meteorological Organization categorizes the force of progressively higher seas according to wave height. The Wave Glider AMV can operate in conditions up to sea state 6.

The umbilical, about 5.8 m [19 ft] long, provides a flexible connection between the surface float and submerged glider. This line also serves as a conduit for transmitting power and steering commands to the glider.

The submerged glider, or sub, is 2 m [6.5 ft] long. The sub glides on six pairs of underwater wings that propel the entire Wave Glider system forward. The sub frame supports a rudder and its control package. The frame weighs about 68 kg and can support a variety of sensors.

The low-profile surface float, high-strength umbilical and sturdy sub allow the vehicle to carry on through high winds and waves of the open ocean. The sub is sheltered from surface weather conditions and acts as a drift anchor to counter the effects of wind and wave on the surface float. The current model, the Wave Glider SV2 platform, has survived five hurricanes and three tropical cyclones and has logged more than 560,000 km [300,000 nautical mi] since 2009.

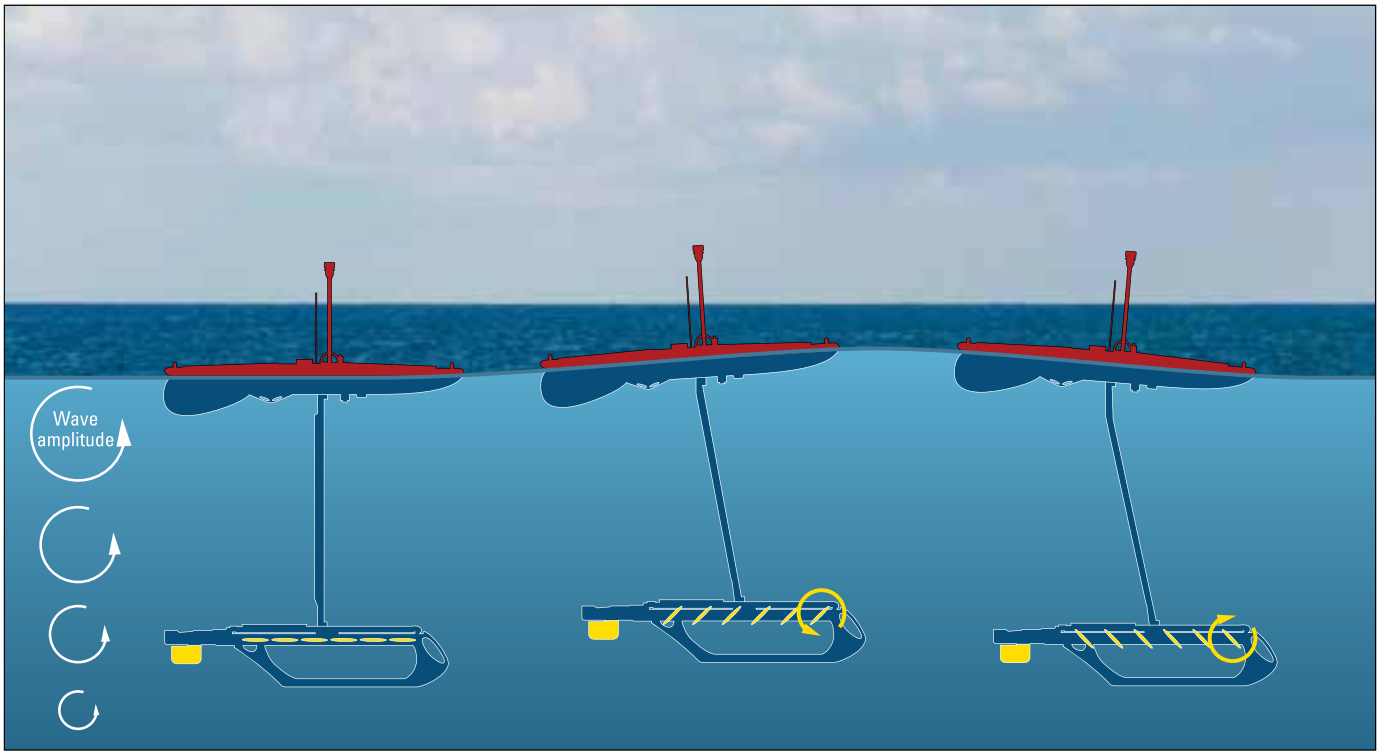
Ocean Locomotion

The Wave Glider propulsion system is passive and mechanical; it converts energy from wave motion into thrust.[8] This propulsion system exploits the natural difference in wave motion between the surface float and the submerged glider. Articulating fins, or wings, attached to the sub convert wave energy to generate more than 1.3 kN [300 lbf] of thrust as they pivot vertically. The vehicle produces forward thrust independent of wave direction as its float moves up and down with each wave and the sub tows the float forward (next page, top).

Forward speed is dependent on the overall buoyancy force provided by the float when tethered to the weight of the sub. The vehicle's mass and buoyancy vary with payload, so the float, umbilical and sub must be balanced and tuned to provide optimal propulsion performance. The AMV is designed to operate in variable conditions, ranging from sea state 0 to state 6 (left).

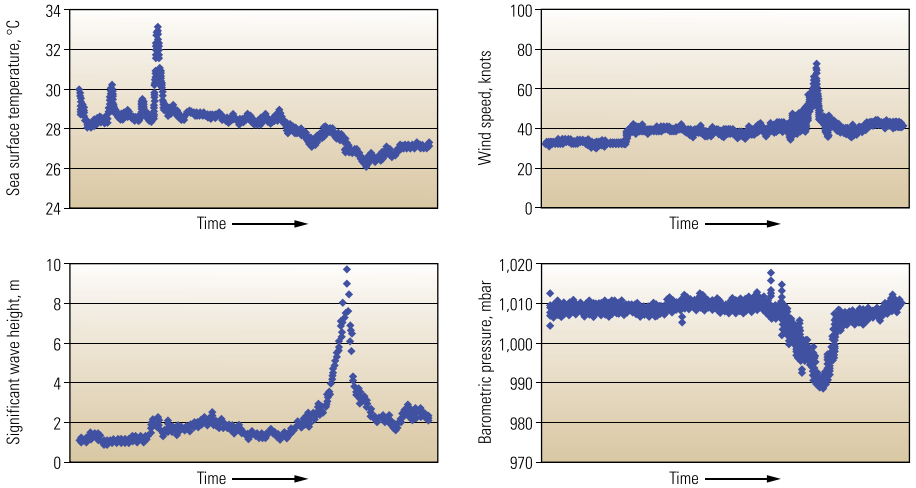
The vehicle can achieve speeds up to 1 m/s [2 knots] and in typical wave conditions of 0.3 to 1 m [1 to 3 ft] reaches 0.5 to 0.75 m/s [1 to 1.5 knots].[9] At this rate, it is able to travel about 1,000 km [620 mi, 540 nautical mi] in a month. It can also harvest energy from high-frequency, low-amplitude waves—such as wind ripples—so that even under calm conditions, its speed rarely drops below 0.25 m/s [0.5 knots].[10]

This AMV has demonstrated its capability to perform in extreme sea states. One Wave Glider vehicle, designated *G2*, experienced a close brush with Hurricane Isaac in August 2012. The storm



^ Wave propulsion. The Wave Glider system converts a portion of its vertical movement into forward thrust. As the surface float rises on the crest of a wave, it pulls the submerged glider upward by the umbilical. The glider's six pairs of articulated wings are pressed downward as the glider rises, translating the glider's upward rise into an upward and forward motion, which pulls the float forward (*middle*). As the float moves off the wave crest, the glider wings tilt upward, which again translates into forward motion (*right*). Wave motion is greatest at the water's surface and decreases with depth. The magnitude of forward propulsive force is proportional to the difference between the ocean wave amplitudes at the surface float and at the submerged glider wings.

passed within 100 km [60 mi] of *G2*'s location in the Gulf of Mexico. When the hurricane veered toward the vehicle, its pilot—who monitored the situation from the operations support center (OSC) in Sunnyvale, California, USA—issued a course change that took the vehicle out of danger. Outfitted with sensors to measure water speed, air and water temperature, wind speed and barometric pressure, *G2* transmitted data despite its proximity to the storm (right). More recently, in October 2012, a different Wave Glider AMV successfully piloted through 130-km/hr [70-knot] winds to transmit weather data in real time as Hurricane Sandy traveled northward along the US eastern seaboard.[11] In stormy conditions, the vehicle's performance is boosted by increased wave energy, which allows it to maintain its intended course.



^ Sensor readings from a storm. As Hurricane Isaac veered toward the Wave Glider *G2*, the AMV's sensors recorded a dramatic drop in water temperature with sustained winds of 40 knots [74 km/h], gusting to 74 knots [137 km/h] as barometric pressure fell to 988.3 mbar [14.3 psi].

7. Pai S: "Wave Glider—Introduction to an Innovative Autonomous Remotely Piloted Ocean Data Collection Platform," paper SPE 166626, presented at the SPE Offshore Europe Oil and Gas Conference and Exhibition, Aberdeen, September 3–6, 2013.
8. Leroy F and Hine G: "Persistent Unmanned Surface Vehicles for Well and Field Support," paper OTC 22545, presented at the Offshore Technology Conference Brazil, Rio de Janeiro, October 4–6, 2011.
9. A knot, or nautical mile per hour, is equivalent to 1.151 statute mile/h [1.852 km/h].
10. Dalgleish FR, Ouyang B, Vuorenkoski AK, Thomas JC and Carragher PD: "Towards Persistent Real-Time Autonomous Surveillance and Mapping of Surface Hydrocarbons," paper OTC 24241, presented at the Offshore Technology Conference, Houston, May 6–9, 2013.
11. Pai, reference 7.

^ Station keeping capability. An open ocean observation buoy (*right*) was moored next to a bottom pressure recorder (BPR) on the seafloor to relay data from the BPR to scientists on shore. Although it was moored beside the BPR, winds and currents tended to push the buoy to the southeast quadrant of its 3,400-m [11,000-ft] watch circle. A Wave Glider AMV (*left*) was tested for its feasibility as a relay station for the BPR data.

The Wave Glider propulsion system also allows it to hold station on one location, even in tidal or eddy currents. It simply steers to a designated waypoint—a programmed set of geographic coordinates. When it approaches the limits of a predefined watch circle, it turns around and heads back to the same point repeatedly. The AMV can maintain station for long durations with a watch circle diameter down to 50 m [164 ft], depending on currents and sea state. By contrast, the mooring systems of deep-ocean buoys employ ground tackle that produces a much wider watch circle (above).

The Sensor Platform

The Wave Glider AMV can accommodate a broad range of off-the-shelf or custom sensors to fit the needs of the mission. A GPS receiver not only determines vehicle position, it provides a precise time stamp for all data recorded on the mission. Photovoltaic panels keep lithium-ion batteries charged to support WiFi, cellular or satellite communications systems, onboard data processing and various payloads.

Additional sensor payloads can be configured according to client specifications:

- meteorological sensors to record barometric pressure, air temperature and wind direction, speed and gusts
- wave sensors to record wave height, period and direction
- acoustic modems to harvest data from sensors mounted on subsea structures or the seafloor
- bathymetry sensors to map water depth
- current sensors to record direction and speed
- water salinity and temperature sensors
- fluorometry systems to detect the presence of oil, turbidity and chlorophyll in the water
- magnetometers to measure the magnitude and direction of magnetic fields
- cameras to provide realtime imaging; also used to monitor ice proximity or to verify the presence of surface oil sheens
- passive acoustic recorders to detect and analyze marine mammal vocalizations.

Clients can monitor vehicle status and data in real time. An account-based credentialing scheme provides security for communicating with the vehicle using the Internet. Updates are generally carried out at client-specified intervals ranging from 1 to 15 min. An onboard hard drive records higher resolution sampling rates.

Piloting by Remote Control

The Wave Glider AMV can be programmed to travel directly from one location to another or to follow a specific route defined by multiple sets of geographic coordinates, or waypoints. The onboard GPS guides the vehicle from one waypoint to the next. The vehicle uses a 12-channel GPS receiver as its primary navigation sensor, along with a tilt-compensated compass with three-axis accelerometers and a water speed sensor. This system typically provides navigation accuracy of better than 3 m [10 ft].[12]

Alternatively, Wave Glider pilots can steer their charges remotely (next page, top). Command and control information is relayed via satellite link with a secure, web-based user interface for directing the units.[13] The Wave Glider Management System allows pilots to issue course commands using any Internet-enabled computer or cellular telephone that supports web browsing.[14]

Collision avoidance is crucial to the success of autonomous vehicle programs. A key strategy for the AMV is to see and be seen so that appropriate steering commands may be executed in time to avoid accidents. A mast, flag and light are typically installed to visually mark the AMV float position. More importantly, the float carries an integrated package of electronics to highlight its position. A radar enhancer produces a distinctive target on the radar screens of approaching vessels. A satellite communications system, azimuthal heading sensor and GPS are linked to an automatic identification system (AIS) for tracking vessel movement.

Commercial vessels are required to carry radar and AIS (next page, bottom). Automatic interrogation and exchange of position, course and speed data are provided by the AIS, whose data are displayed on the radar screen to help navigators on an approaching vessel track the course of the autonomous vehicle. Reciprocal AIS data are automatically relayed from the AMV to Wave Glider pilots onshore, who also monitor vessel traffic and issue AMV steering commands to prevent collisions.

E&P Applications

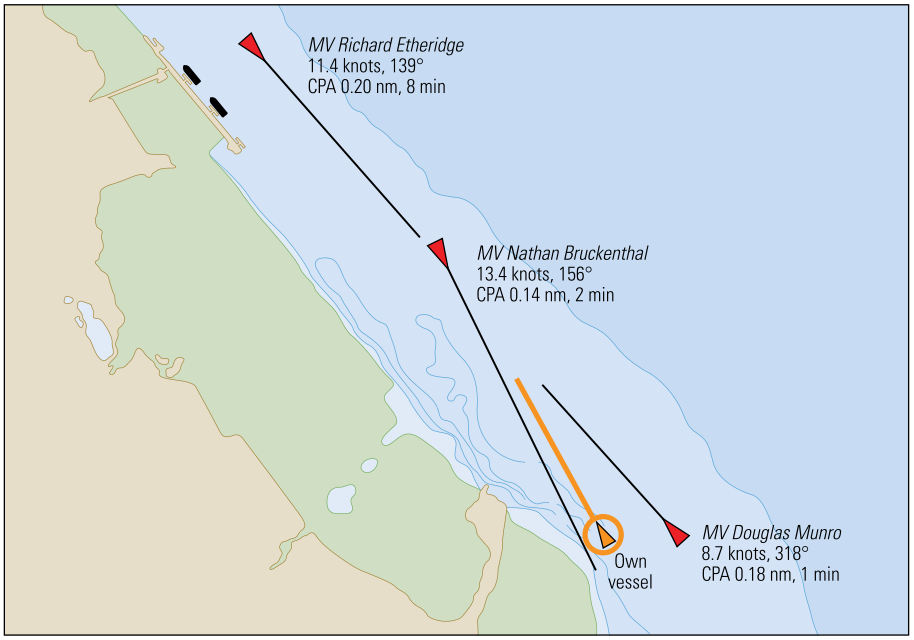
Wave Glider sensor platforms are suited to a variety of scientific missions and applications. Its persistence and range allow this AMV to gather time-series data across wide geographic areas, enabling scientific research that was not practical or economical using data gathered from buoys, ships or satellites.

Detection of naturally occurring hydrocarbon seeps is probably the oldest method of oilfield exploration. From a geologist's perspective, ocean surface oil is a good indicator of more reserves beneath the seabed. Ecologists and oceanographers are also interested in learning how organic carbon from these seeps might affect neighboring benthic and bentho-pelagic environments and the chemosynthetic communities they support.[15]

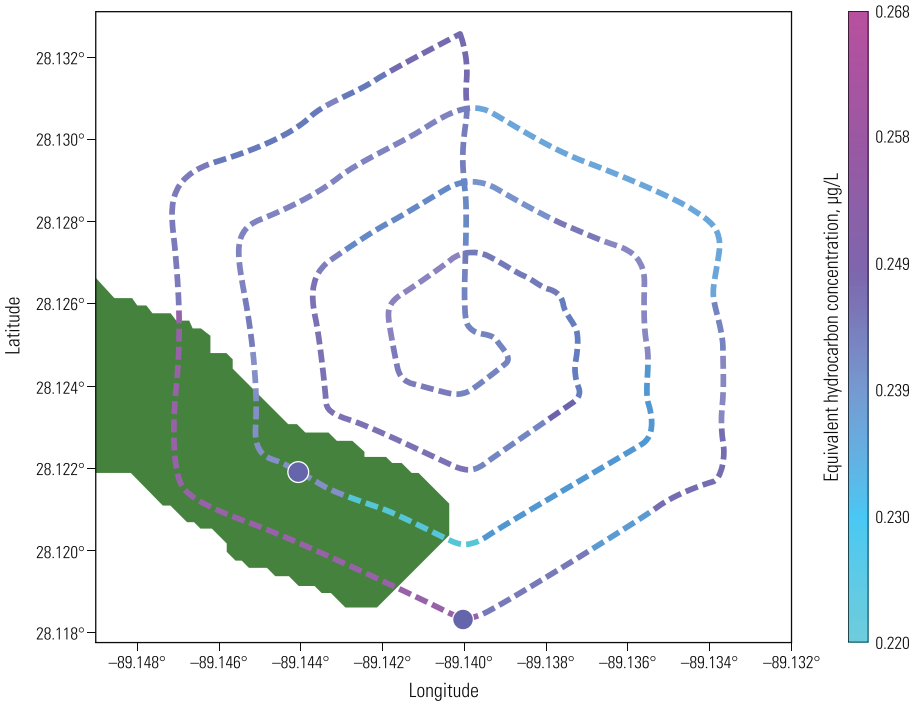
^ Pilot control station. At an onshore operations support center, pilots monitor vessel traffic, sea conditions and AMV operating parameters around the clock.

Biological interactions, mixing and dissolution consume or disperse a portion of the hydrocarbons as they rise through the water column, but some hydrocarbon bubbles or droplets eventually reach the surface. There, they spread out to form a thin oil patch, or sheen, whose depth and breadth depend on sea surface conditions—particularly wave agitation, temperature and evaporation, which affect the rate of dispersion. These patches occur regularly but are often short-lived. They can be observed visually or detected by satellite-mounted synthetic aperture radar (SAR). However, orbits of SAR satellites typically permit no more than two passes per day over a particular site. Unmanned sensor platforms that measure hydrocarbons and other environmental parameters and transmit the data to shore-based researchers are an effective alternative to satellites or ship-borne measurements.

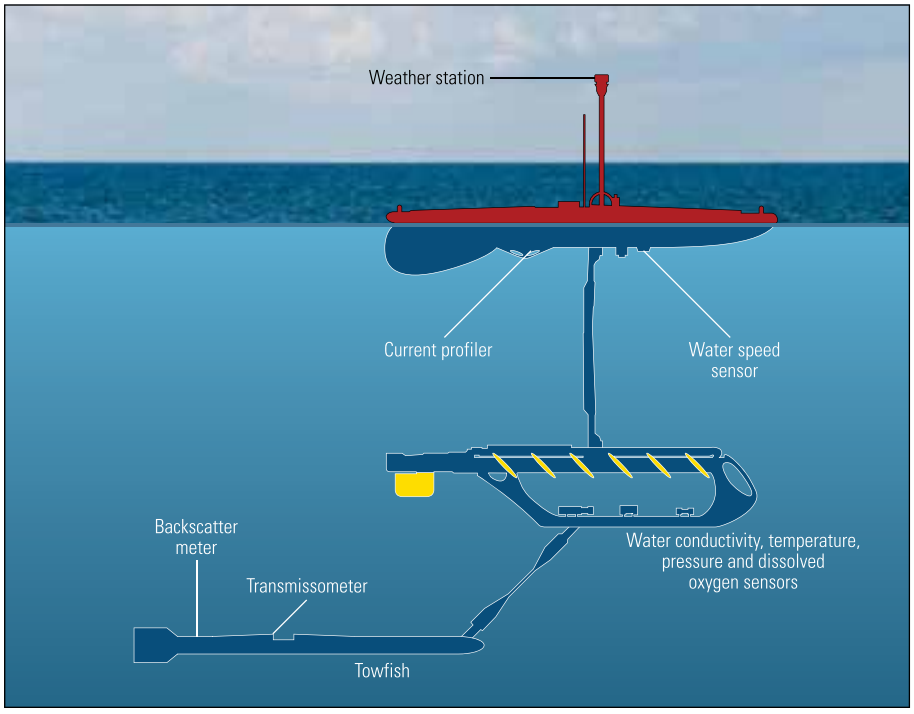
12. Pai, reference 7.
13. Anderson BS and Beatman L: "Autonomous Surface Vehicle Operations in the Arctic: Regional Baseline Data Acquisition," paper OTC 23737, presented at the Arctic Technology Conference, Houston, December 3–5, 2012.
14. Pai, reference 7.
15. Dalgleish et al, reference 10.



^ Typical AIS display. Vessel position, speed, heading, projected closest point of approach (CPA) in nautical miles (nm) and estimated time to CPA are displayed on an electronic chart overlay. The AIS updates this critical vessel information several times a minute. The vessel on which this display appears (orange, circled) will be passing close by three other vessels (red) if it maintains its present course and speed.



^ Hexagonal search pattern. Satellite-mounted synthetic aperture radar sensors detected a sheen (green) resulting from a seep in the Gulf of Mexico. During a Wave Glider sortie, the sensor vehicle encountered increased hydrocarbon concentrations. The Wave Glider trajectory is color coded to correspond to hydrocarbon concentration. Detected events, (large dots) in which spikes or sharp transitions are registered on multiple sensors, show where the AMV encountered higher concentrations of semivolatile hydrocarbons, thus indicating fresh accumulations.



^ AMV with towfish. This sensor platform obtained baseline measurements of particle suspension in the water column over a proposed pipeline dredging route. The AMV was configured to obtain surface weather measurements and current speed and direction, along with dissolved oxygen and water conductivity, temperature and pressure. Sensors on the towfish obtained turbidity measurements.

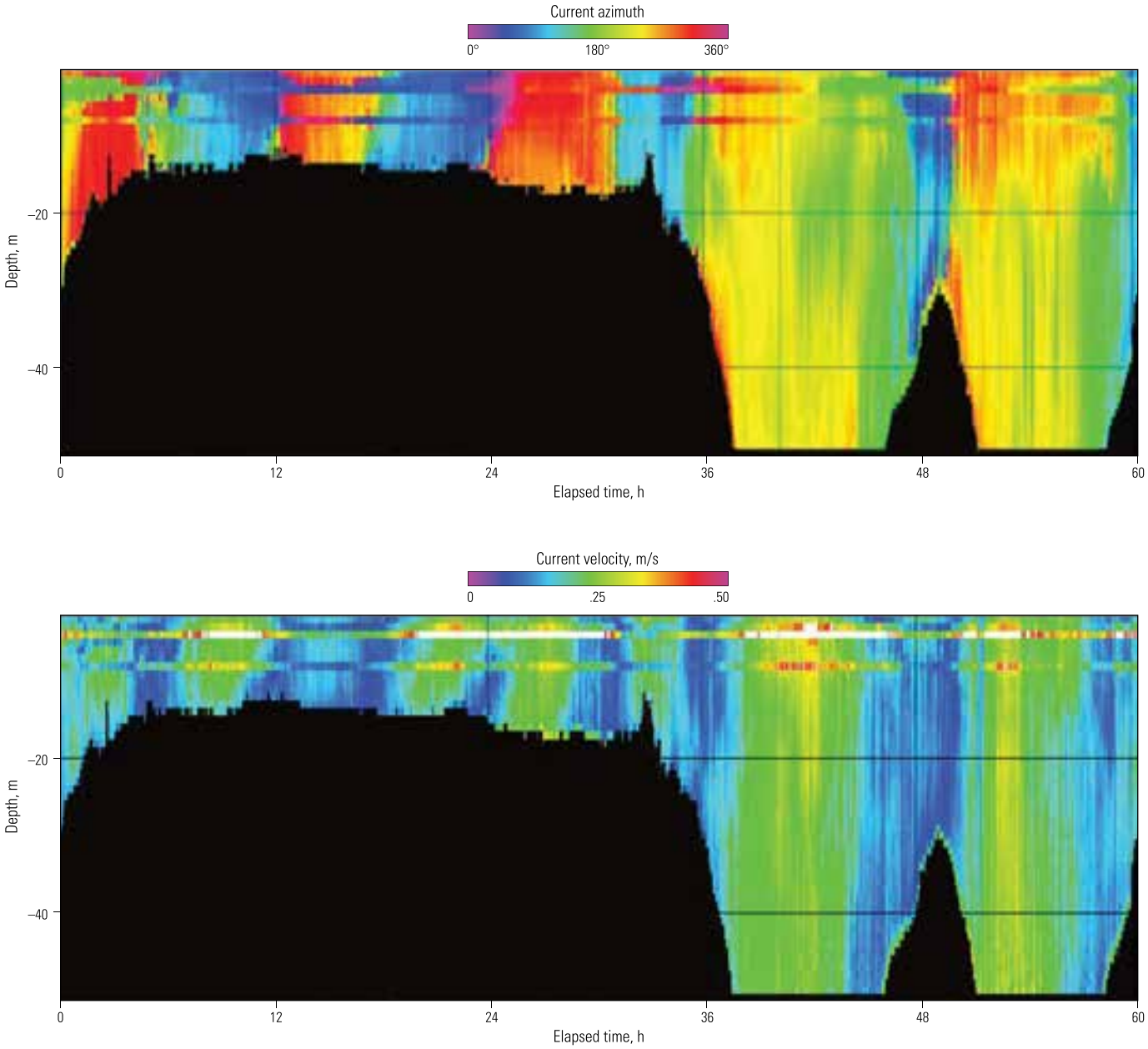
Wave Glider sensor platforms have been used during a two-month mission in the Mississippi Canyon area of the Gulf of Mexico to evaluate natural oil seeps in the vicinity of salt domes and mud volcanoes. The AMV science payload consisted of a float-mounted water speed sensor, a mast-mounted weather station, a fluorometer that measured low concentrations of semivolatile hydrocarbons and two optical sensors that measured concentrations of dissolved and suspended organic material via fluorescence.[16] Prior to the AMV deployment, optical sensor response was calibrated to known concentrations of crude oil at various stages of weathering in a wave tank testing facility. The resulting Wave Glider sensor data helped scientists map the location and extent of the natural oil sheens (left).

On the other side of the world, Chevron's Environmental Technology Unit, in collaboration with the Centre for Marine Science & Technology at Curtin University in Perth, Western Australia, deployed a unique sensor configuration on two Wave Glider sensor platforms.[17] The AMVs obtained baseline turbidity data prior to the initiation of dredging operations for a pipeline offshore Australia. Deployed in three sorties, the AMV sensor platforms carried out metocean surveys and obtained measurements to assess turbidity through areas affected by the dredging.

During the first sortie, the system obtained a variety of metocean measurements, including the direction and magnitude of ocean currents, air temperature, wind speed and direction, atmospheric pressure and water temperature and salinity. These data provided valuable environmental baseline information that helped scientists plan for subsequent sorties (next page).

The next sortie, conducted to obtain detailed particle suspension data, also demonstrated the towing capability of the Wave Glider sub. An AMV trailed a towfish sensor module behind the submerged glider to measure turbidity (left). The towfish measured optical transmission to determine light attenuation and measured backscatter at three wavelengths for calculating suspended sediment and mean particle size. Having established a predredge baseline, the AMVs were deployed again to measure suspended sediment during the dredging operation.

The third sortie allowed scientists to compare data obtained by towfish sensors during the second sortie with data obtained from a different optical sensor to track suspended sediment and particle size distribution. This comparison of results from state-of-the-art sensors helped the operator determine the best



^ Current and depth. Offshore Western Australia, a Wave Glider AMV recorded seafloor soundings down to 60 m [200 ft], along with current speed and direction. Tidal influence on current direction is pronounced over the shallower depths, with direction changing at about six-hour increments (red and blue, *top*). Currents showed irregular variations in speed along the survey path (*bottom*). All measurements are tied to GPS time and coordinates.

sensor system for future deployments. A final survey will be conducted after dredging is complete. These time-lapse surveys will enable scientists to compare profiles before, during and after dredging to evaluate any short- or long-term impacts on the environment.

The AMV has also helped geophysicists design seismic surveys. Seismic vessels employ several acoustic streamers, towed in parallel, to acquire geophysical data. These streamers, thousands of meters long, do not always follow directly in line behind the seismic vessel; instead, they drift laterally in response to the tides and currents they encounter. Although the streamers are steerable, this feathering can produce gaps in data coverage over an area and force the seismic vessel to steam back over that area to reacquire and infill missing data. To counter the effects of tide and current, survey planners often orient surveys in line with the direction of the predominant current.

Streamer feathering becomes a bigger problem when surveying close to fixed objects such as buoys, drilling rigs or production platforms. In support of a WesternGeco seismic vessel operating in the Gulf of Mexico, three Wave Glider sensor vehicles were deployed to report real-time weather and current data in the vicinity of rigs and platforms in the survey area. Each AMV used an acoustic Doppler

16. Dalgleish et al, reference 10.
17. Pai S and Shone P: "Remotely Piloted Ocean Vehicles to Conduct METOC and Turbidity Pre-Site Survey," paper presented at the 75th EAGE Conference and Exhibition, London, June 10–13, 2013.