Eye on Design: Underwater Measurement Systems

SARbot for Rapid Subsea Rescue Ops

MARINE TECHNOLOGY REPORTER

September 2010
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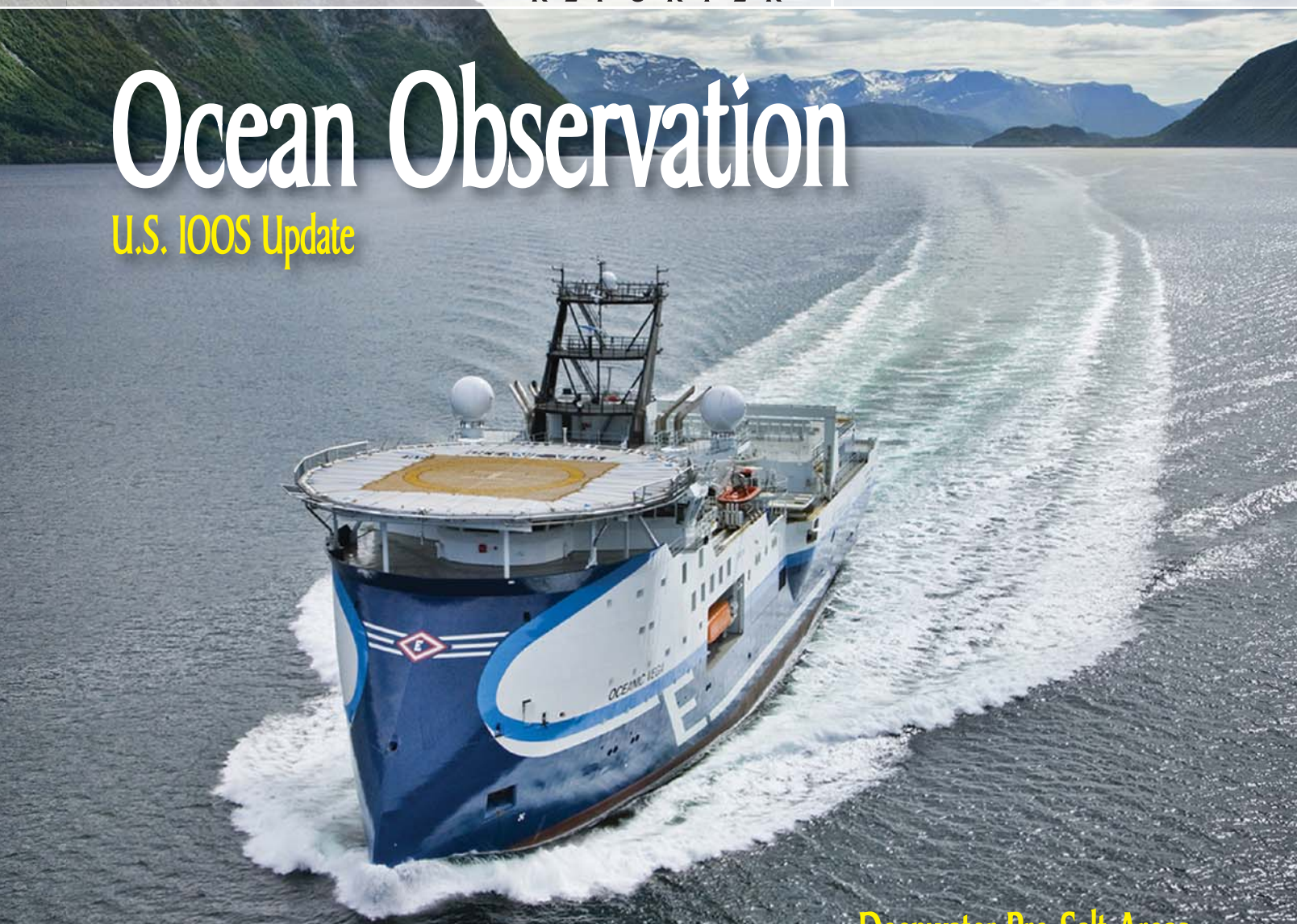
Ocean Observation

U.S. IOOS Update



Deepwater Pre-Salt Areas
Brazil v. W. Africa

CEO Interview
Bob Black, Seebyte

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(Photo courtesy Tony Hall)

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See Story on page 18

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Claudio Paschoa *is a contributor for Marine Technology Reporter based in Rio de Janeiro.*

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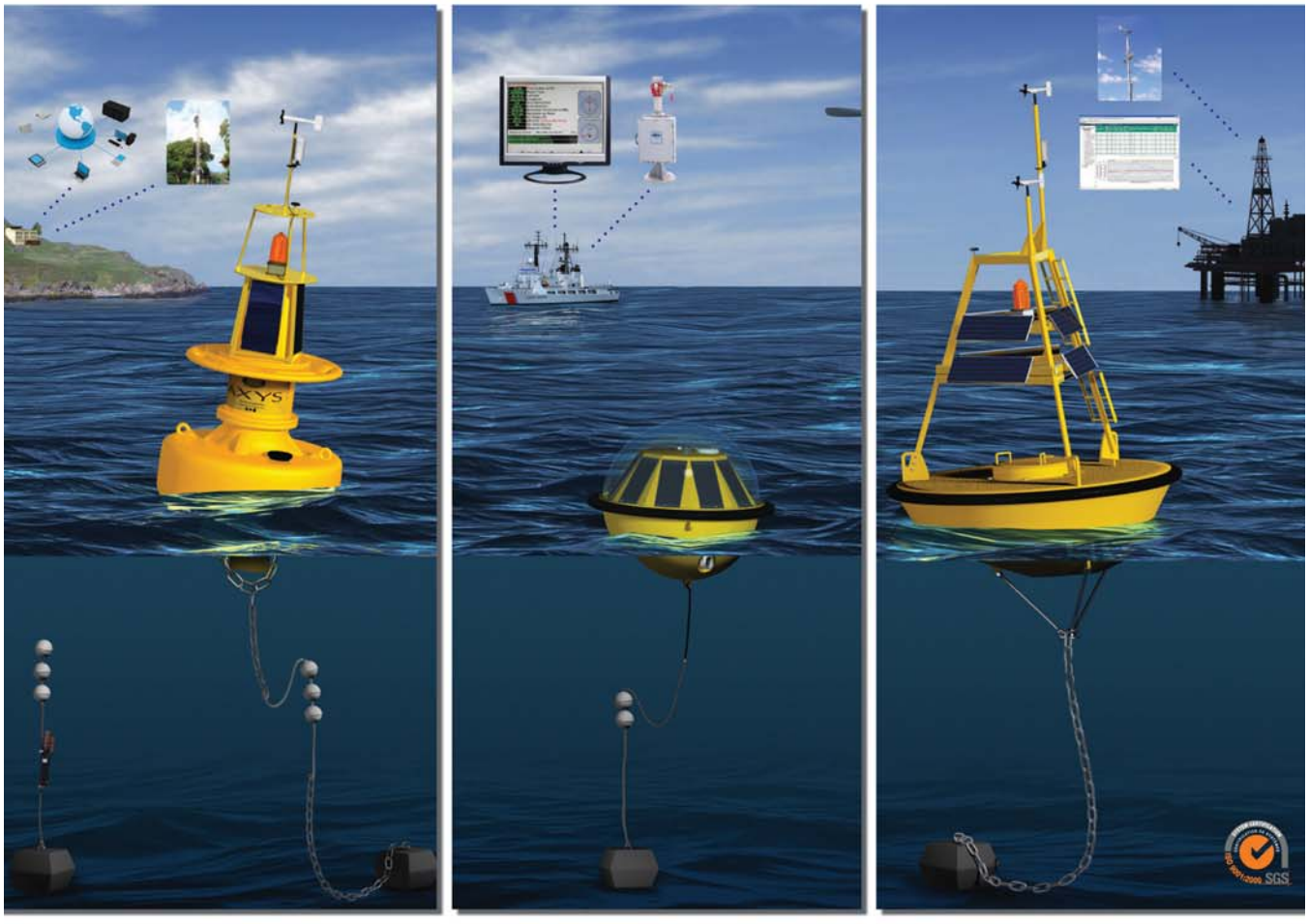

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Ocean observation is all-encompassing, and the push to discover, recover and analyze increasingly large quantities of information from two-thirds of our planet continues to grow by leaps and bounds. Whether it is monitoring plumes of oil from an errant offshore oil well; tracking stocks and development of subsea species; or keeping tabs on underwater activity for maritime security and military purposes, ocean observation can mean vastly different things to different people.

This month we are honored that **Zdenka Willis**, Director of the U.S. Integrated Ocean Observing System (IOOS) Program, NOAA, took the time from her schedule to share with your an insightful update of the U.S. IOOS program. While the article is highly informative to the current and future direction of U.S. IOOS, it is the opening paragraphs that caught my eye, as she reports — while on vacation no less — on how the U.S. ocean observation initiative is much more than business, it is in fact dearly personal. Her story starts on page 26.

This month I am pleased to introduce a new section to the publication, our "interview" section starting on page 14 which profiles Bob Black, the new CEO of Edinburgh-based Seebyte. Mr. Black was an excellent choice for this inaugural slot, as he and his company embody many of the characteristics — small, fast-growing, innovative, global — which are hallmarks for this business as a whole. While this spot generally fills up rather quickly, I invite you to drop me a note to nominate your company's CEO for inclusion in this quick-hit interview format.

Gregory R. Trauthwein • trauthwein@marinelink.com • tel: 212-477-6700

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Order for New Deep Water Vessel

Heerema Marine Contractors (HMC) announced the signing of a letter of intent with Daewoo Shipbuilding and Marine Engineering Co., Ltd., Korea (DSME), for the building of a new Deep Water Construction Vessel, for approximately $600 to $700m. HMC selected to build a monohull vessel with the capability to execute complex deep water infrastructure and pipeline projects in ultra deep water, and also with sufficient lifting capacity to execute installation of fixed platforms in relatively shallow water. A key attribute of the vessel will be its fast transit speed. HMC believes this will complement its existing fleet providing a unique fleet composition, which will allow HMC to continue to offer unrivalled services to the offshore oil and gas industry on a world-wide basis.

DSME won the design, engineering, procurement, construction, installation, commissioning and testing of the vessel. Huisman will be responsible for the cranes, tower and reels. The vessel is scheduled for completion of all tests & trials by mid-2013.

"With this new Deep Water Construction Vessel, HMC will reinforce its unique position in the deep water pipelay market. We are confident that with DSME and Huisman we found reliable partners who can build a key asset that will assist us in expanding further into more ultradeep and complex SURF projects globally," said Jan Pieter Klaver, CEO, HMC.

Ulstein Delivers Seismic RV

Oceanic Vega was named and delivered on July 2. The vessel is owned through a joint venture between shipowner, Eidesvik, and the geophysical company, CGGVeritas. "We are proud to deliver one of the most modern and advanced seismic research vessels in the world," said managing director at Ulstein Verft, Karsten Sævik. "Oceanic Vega meets strict environmental standards," said Jan Fredrik Meling, CEO at Eidesvik Offshore. "Equipped with state-of-the-art technology, the ship reduces harmful atmospheric emissions and prevents oil discharge through its double hull construction. We are very satisfied with the X-BOW vessel Viking Poseidon delivered by Ulstein in January. The ship operates smoothly with minimal vibrations and movements. This grants optimal vessel comfort, which is very important for the working conditions of our seafarers."

The Oceanic Vega is the first of two vessels of the SX120 type, designed by Ulstein Design & Solutions. It is a powerful seismic research vessel with a towing force of 140 tons during seismic operations. The vessel is suited to the acquisition of large 3D, 4D or high-resolution projects, utilizing a current streamer configuration of up 16 streamers separated by 100 m or more. The vessel´s 20 streamer winches are each capable of spooling 9 km of streamers.

Carrying an ICE-C classification, the Oceanic Vega is able to operate in cold waters. The vessel is designed to stay permanently at sea, with five years´ docking intervals, and complies with the redundant propulsion notation from DNV. Oceanic Vega complies with the Clean Design demands from DNV, and with the SPS requirements for up to 60 persons. There are 52 single cabins and only nine double cabins. The mess room, galley and the four dayrooms have large windows facing the sea to add comfort for the crew. The vessel is equipped with a helideck to facilitate an efficient crew change. The X-BOW results in lower added resistance and smoother bow immergence. This leads to reduced operational disturbances or involuntary speed reduction.

(Photo courtesy Tony Hall)

Bluefin To Expand

Bluefin Robotics has begun work on building a 54,000-sq. ft. facility in the Quincy Shipyard, with a plan to relocate there in the fall, focusing on AUV development, production and testing. Bluefin's move to Quincy doubles the high-tech company's space, and for the first time, merges operations under one roof. The new location provides the Cambridge-based firm with direct access to the ocean for marine operations, which is currently conducted in East Boston. The move will co-locate engineering, production and marine operations functions, streamlining testing and demonstration phases of the business. The landlord is Quincy Shipyard, LLC, an affiliate of Jay Cashman, Inc.

Sub-Atlantic Wins ROV Contract

Singapore diving contractor Seatrax Singapore Pte Ltd. contracted with Sub-Atlantic Asia Pacific to strengthen its subsea services capability with their first electric work class ROV - the Comanche.

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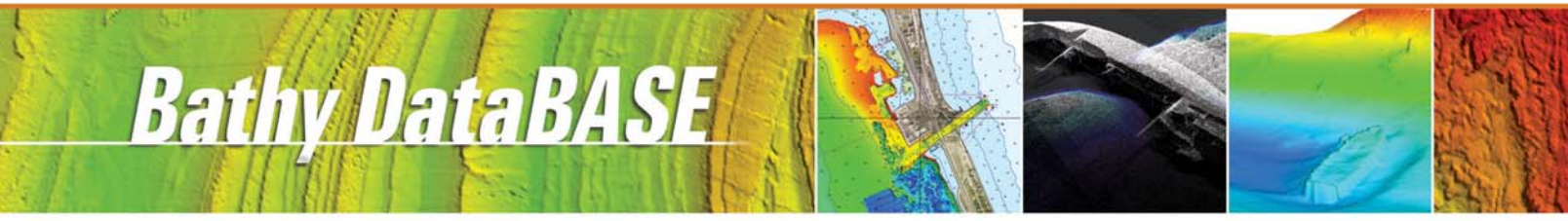

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WHOI Breaks Ground Equipped with an $8.1m federal Recovery Act grant and a shovel, the Woods Hole Oceanographic Institution (WHOI) celebrated the groundbreaking of its new Laboratory for Ocean Sensors and Observing Systems (LOSOS) on, August 4, at the Clark Laboratory on the Institution's Quissett Campus.
"The Laboratory for Ocean Sensors and Observing Systems will provide essential space for several ongoing large projects, enabling new approaches to ocean observations well into the 21st century," said Dr. Susan Avery, president and director of WHOI. The funding comes from NIST.

MREC Comes to Boston The 2nd Annual New England Marine Renewable Energy Center Technical Conference is scheduled to take place on Tuesday Nov. 2, 2010 at the Microsoft NERD Ctr., located at 1 Memorial Dr. in Cambridge. The 3rd Annual MREC Stakeholder Conference has joined with the 6th Conference on Clean Energy, which takes place at the Hynes Convention center in Boston on November 3-4, 2010.
www.mrec.umassd.edu

SARbot

For Rapid Subsea Rescue Operations

SeaBotix, in cooperation with Tritech International and Marine Simulation, has developed the a specially designed, rapid response underwater rescue system. Until now remote operated technology has been used to recover drowning victims, not rescue. Improved medical studies have shown that a person experiencing near drowning in water up to 21ºC has the potential for rescue. If the victim can be rescued from the water within approximately 90 minutes there is a good chance that the residual oxygen in their body will keep them alive without permanent damage to their vital organs.

The problem has been locating and rescuing the victim in difficult conditions without furthering human risk. SeaBotix Inc. was approached by Derbyshire Fire & Rescue in the U.K. to develop a solution to the more than 700 drownings per year. The UK Fire & Rescue has the ability to be on location in response to an emergency in under 10 minutes, however, they are unable to work below the water.

SeaBotix worked with the Derbyshire Fire & Rescue to develop a new ROV rescue system that would operate in near zero visibility, in poor weather and strong currents, while being simple enough to operate by rescue personnel. The result is a modified LBV system with high definition Tritech Gemini 720i imaging sonar, limb grasping manipulator, video enhancement and a small diameter, low drag tether with a 100kg working load. In addition, the advanced SARbotM rescue system includes a new high resolution StarFish 990F side scan sonar from Tritech International and a purpose built LBV training simulator by Marine Simulation.

The total package offers rescue teams with large-area search capability and built-in training in a rapid-response rescue ROV.

Field trials with the Derbyshire Fire & Rescue proved the ROV system can be setup and deployed in less than 3 minutes providing rescue personnel with time to locate the victim. The system was simplified to reduce technical aspects found in ROV systems requiring care or attention. This allows for rescue personnel to focus on rescue and not setup. A typical scenario is one where a person has consumed alcohol late at night and decides the nearby water looks inviting. Upon entering the water the person is shocked by the coldness and inhales water. This process leads to filling of the lungs and drowning. Upon receiving a call, rescue personnel can set up and deploy at the last seen location of the drowning victim. Utilizing the Gemini 720i imaging sonar, the drowning victim is located and the rLBV is navigated to within grasping range. For conditions where visibility is near zero, external ultra bright LED lights and video enhancement are utilized. Upon locating the victim, the specially designed grasping jaws attach to an arm or leg and the rLBV can be pulled back to the shore using it's ultra strong tether. Once the rescued victim is to shore, the medical technicians can prepare for transport to a local hospital and ultimate revival.

For more information,
Email: Marketing@SeaBotix.com

USCG, ORPC
Partner on Tidal Energy Demo

U.S. Coast Guard Sector Northern New England (SNNE) crews partnered with Ocean Renewable Power Company (ORPC) members to demonstrate the a robust tidal energy program on, Aug. 24, 2010. Gov. John Baldacci, Congressman Mike Michaud and Capt. James McPherson, SNNE's commander, united at Coast Guard Station Eastport to celebrate the first-ever successful implementation of tidal energy at a federal facility. Massive tidal ranges in the ocean waters surrounding Eastport represent some of the largest in the country, rising and falling over 20 feet. The Coast Guard's Research and Development Center (RDC), located in New London, Conn., and SNNE collaborated with Ocean Renewable Power Company to commission the first ever use of a tidal energy generator.

The 60 kW tidal turbine was launched in March for testing and is the largest ocean tidal energy generator in the United States. The turbine generator unit (TGU) is set in a steel-composite frame and is deployed from one of ORPC's research vessels, the Energy Tide 2, in Cobscook Bay. The unit utilizes advanced design cross-flow turbines to drive the generator and the electricity produced will charge a set of battery modules housed in the Energy Tide 2.

The generator was recently re-deployed following several upgrades and began providing clean, grid-compatible electricity to Coast Guard Station Eastport's 41-foot Utility Boat on Aug. 18, 2010. The TGU will also be involved in a concurrent project to test an active acoustic monitoring system that identifies marine life and debris in the vicinity of the turbine.

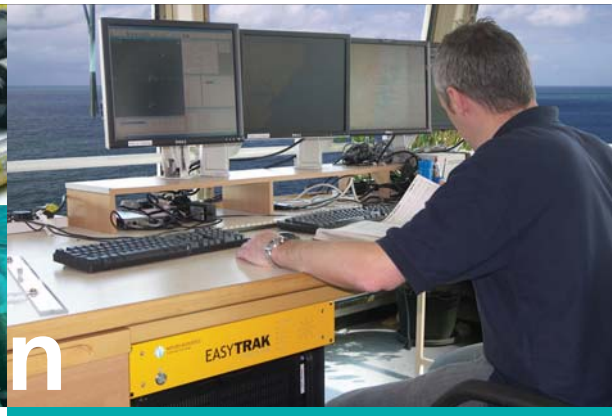
"The tidal generator is a pioneering concept in the field of renewable energy," said McPherson. "The fact that this prototype is successfully producing power gives us the sense that this project has unlimited potential for not only Coast Guard facilities, but for the United States."

Iver2: In Search of Earhart

OceanServer Technology recently loaned an Iver2 AUV outfitted with Side Scan Sonar to the The International Group for Historic Aircraft Recovery (acronym TIGHAR, pronounced "tiger"), the world's leading aviation archaeological foundation. The TIGHAR foundation has organized several trips to Gardner Island, now Nikumaroro in the

Republic of Kiribati based on the hypothesis that Amelia Earhart and Fred Noonan landed and eventually died on this remote Pacific island. The Iver2 vehicle was operated by Seabotix, a worldwide leader in small ROVs, to sweep large areas of the Nikumaroro Lagoon and collect Side Scan Sonar images. The AUV sonar data was used to identify geo-referenced targets of interest that could then be further investigated by an ROV. For further information on the "The Earhart Project" visit the TIGHAR website: http://tighar.org.

At home in the ocean



Easytrak Nexus is the second generation USBL tracking system from Applied Acoustics.

With Broadband Spread Spectrum technology at its heart, Nexus has the ability to transfer digital data from subsea to surface, all the while continuing to provide secure and stable positioning information in challenging environments. Versatile, flexible and simple to install and operate, Easytrak Nexus is tracking, made easy.

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A simple yet effective setup. We think it's pretty neat.

RESON

Image of the wreck of the SS Breda courtesy of ADUS

Five Minutes with

Bob Black, CEO, Seebyte

SeeByte, the Edinburgh-based developer of the software for managing unmanned and remote assets, recently appointed Bob Black as its new CEO. Black, who joins Seebyte from Capgemini, where he headed its Oil & Gas division in Aberdeen, will be tasked with the mission to take SeeByte deeper into global Energy and Defense markets, where its customers already number 11 of the world's leading Navies, several major oil companies and global offshore contractors. Black recently took the time to share with Marine Technology Reporter and its readers his insights on the company, his new position, and the subsea market in general. ***– by Greg Trauthwein, Editor***

How did you initially take an interest in the maritime/subsea industry?

I've spent the last 20 years building technology and consulting businesses in the Defense & Security and Oil & Gas sectors, but never both sectors at the same time. SeeByte has great traction in the Military sector, and is perfectly poised for stronger growth in the Oil & Gas sector. The opportunity to join SeeByte as CEO was a great opportunity for me to deploy market knowledge from both sectors to drive the growth of a company.

How would you describe your management style?

The principal job of any manager is to create an environment where teams can be successful. Managers achieve very little on their own. SeeByte has a remarkable team of creative and talented people assembled from around the globe. My principal objective is to ensure that our culture and environment removes any blockers to their success.

Briefly describe SeeByte and its position in the subsea marketplace?

At its very core, SeeByte creates advanced software that's used for managing unmanned and remote assets. We assist our customers in transforming their raw data into information that can be used for asset management and the operation of underwater vehicles. SeeByte aims to eliminate the difficulties faced by operators and to make their work safer, quicker and more accurate. We operate in the military and energy sectors, with a vision to become the premier smart-ware provider for owners and operators of remote vehicles and platforms.

What attracted you to accept the top spot at SeeByte?

I've always believed that if you get enough smart people together then anything is possible. SeeByte has retained a technology lead thanks to the quality of our people, and has a great track record of debt-free profitable growth. With the quality of our team and the opportunities before us, the potential was too attractive to ignore.

Taking the helm as CEO of SeeByte, what do you count as your biggest challenges relating to the company?

As I mentioned, SeeByte has a reputation as a quality provider of smart software solutions. What people don't realize is that we also have a great record of de-risking and fielding novel technologies from concept through to production. It is this aspect of the company that intrigues me as it has not been as well promoted in the past as it should have been. I feel it's an area where we can offer significant experience to our cus-

tomers, so it's something I am keen to drive in the future. At SeeByte we aim to help our clients adopt new and better operating practices through the deployment of our technologies.

What do you count as the most significant subsea technologies that have helped us to work underwater more efficiently and safely?

I would have to say that the advent of robotics has been instrumental in making the shift from shallow waters to deep waters, efficiently and safely. **In both the military and offshore industries, UUV's are helping operators reduce the risk to humans and the environment.** However, most of the systems in use today are fairly basic when it comes to their software capabilities; I think that SeeByte can make a real difference in the future of safety and efficiency with our SMART software offering. At the moment, our focus on autonomy is, in my opinion, key in enforcing efficiency and safety in underwater scenarios, by allowing ROV's to reason and make decisions to assist the human operators.

How is SeeByte investing today to ensure its viability tomorrow?

Well, clearly my appointment is a statement of intent that we are looking to strengthen our management and skills as we improve and grow our global footprint. Already 75% of our revenues come from exports, despite our team remaining predominantly based in the UK; it's a firm view that through investing in our staff today we will be set to progress globally in the future. In relation to our product-base, SeeByte prides itself on being at the forefront of SMART technology, and by remaining firmly invested in state-of-the-art technology and solutions I think we will ensure our future viability and success.

Share with us your outlook on business for the coming few years?

I think there is a great opportunity for SeeByte to penetrate the Asian region, and this is actually something that we are currently progressing at this moment, so geographically this is a focal point for the future. In terms of advancements in technology, the military and oil & gas space has been

investing in autonomous underwater vehicle technology and I feel we are in an ideal position to help progress with this, having invested a significant resources in the future of autonomy.

What do you consider to be the biggest challenges to your company in terms of:

Legislation?

More than half of our revenues come from export, with the U.S Military as one of our main customers. The legislation involved in legally exporting software with potential military application remains a challenge for us.

Technical Matters?

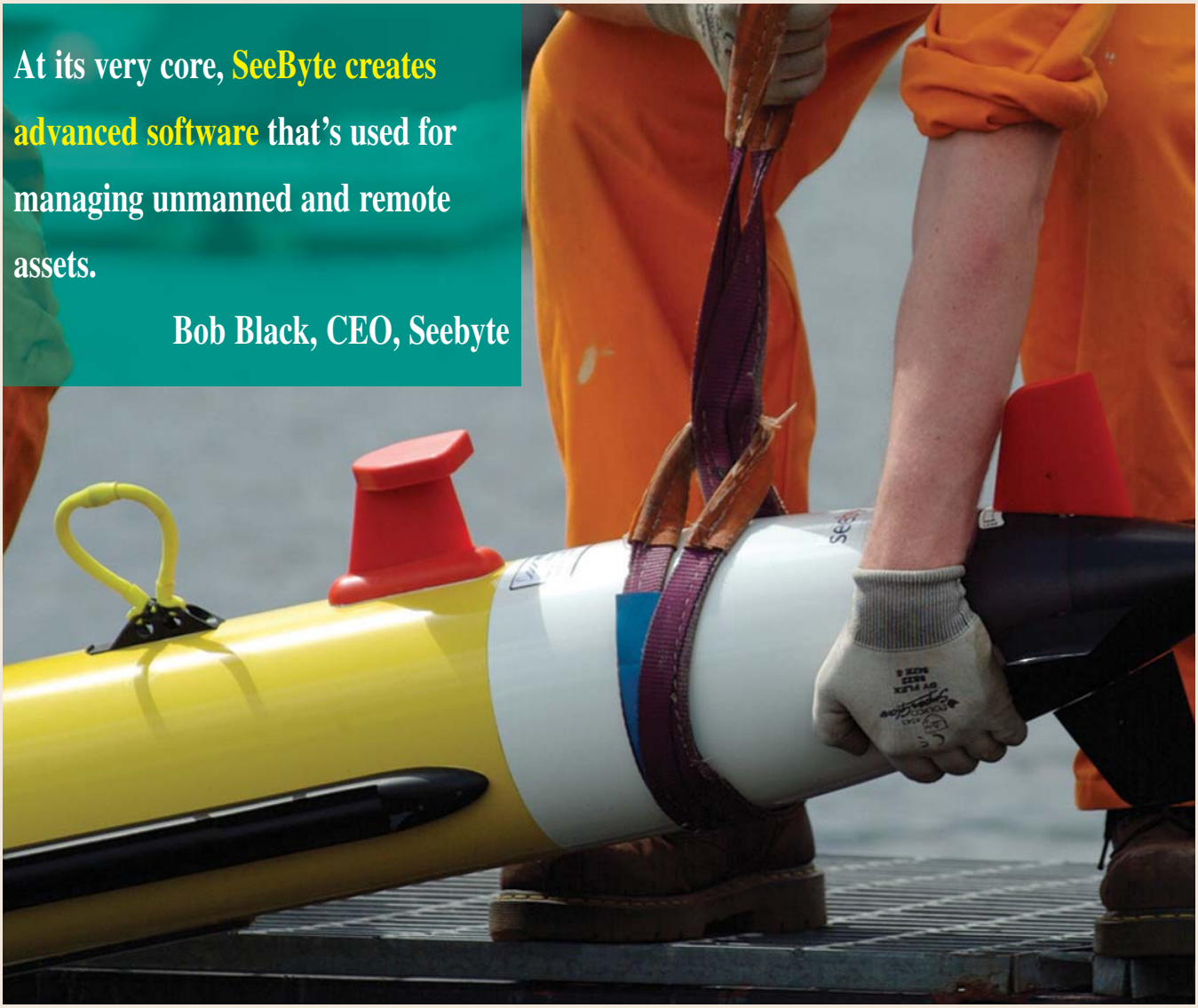
I'd have to say that the global lack of standardization in data formats and the differing exchange of data between systems can at times prove a difficulty – especially since one of our main focuses is on the plug-and-play, simple to use concept of technology.

Competition?

In the past our biggest competitor has actually been the status-quo. It is hugely challenging to persuade large organizations like the military and oil companies to adapt to the latest advancements in software technology, even when doing so would be to their benefit. Perhaps surprisingly, in our experience government clients have been quicker on the uptake than large commercial organisations. As a small company, it can be difficult for our value propositions to gain sufficient traction and momentum to cut through established ways of doing things.

At its very core, SeeByte creates advanced software that's used for managing unmanned and remote assets.

Bob Black, CEO, Seebyte



Underwater Motion Measurement System

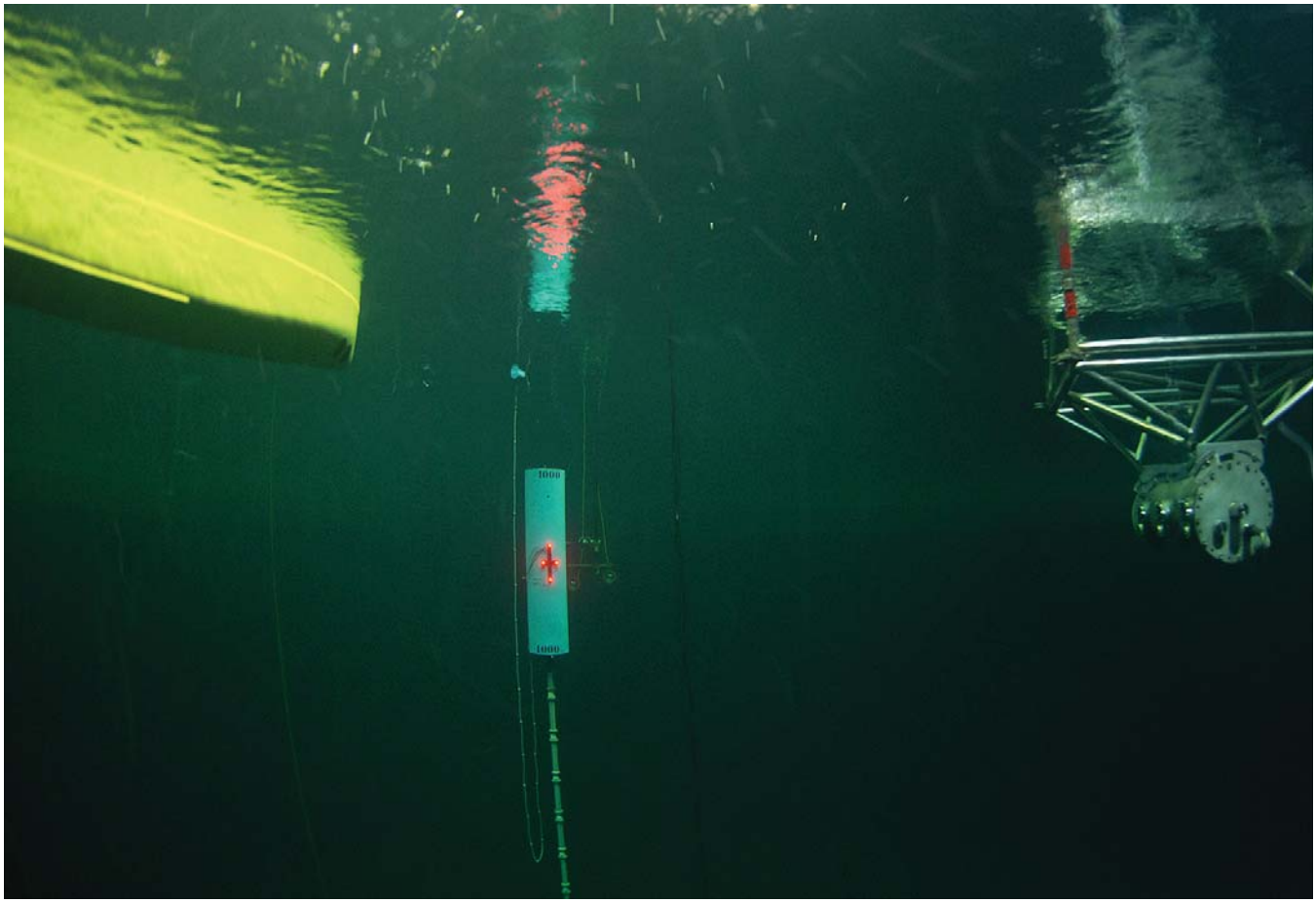
by Reinier Bergevoet, MARIN

MARIN decided to tackle the problems associated with measuring underwater motions by developing a new Underwater Motion Measurement System.

For years, MARIN has been able to measure 6 Degree of Freedom (DoF) motions for floating structures using Krypton (now Nikon), Rodymm DMM optical measurement systems. This system uses three cameras mounted on a beam which track synchronised active markers on the model. These systems can measure motions of structures with the active markers above the water surface.

Traditionally, motions of submerged structures were determined using accelerometers or video recordings. Determining low-frequency motions from accelerometers is very inaccurate. Using video recordings to determine the motions is very time-consuming and this technique can only be used to determine motions in the camera plane. Due to an increasing number of projects containing subsea structures, such as disconnectable turret mooring systems and mid-water riser support arches, and the industry's questions about their underwater behaviour, in

UMS camera and ultra bright red LEDs



2004 MARIN decided to develop a 6 DoF, contactless Underwater Motion Measurement System (UMS), comparable to the above-water system. In close cooperation with the Krypton Corporation a modified version of its K600 optical measurement system was developed.

K600 Adapted for Underwater

Several changes had to be made to the original K600 system to be able to use it underwater. First, the infrared Light Emitting Diodes (LEDs) used for structures above water had to be replaced by different colour LEDs because the absorption of infrared light underwater is very large. After some research ultra bright red LEDs were chosen for the new UMS. Secondly, a watertight housing for the camera beam, including a stiff connection frame to the basin carriage, had to be manufactured. Using MARIN`s diffraction software, DIFFRAC, the wave loads on the connection frame and camera housing were determined and taken into account in the design. The frame has to be very stiff in order to minimise the motions of the camera beam because that has a big impact on measurement accuracy.

Improved Measurement Quality

Furthermore, a system of tracks was developed to be able to mount the camera on the basin floor, allowing camera positions below the object to be tracked. This track-mounting

About the Author

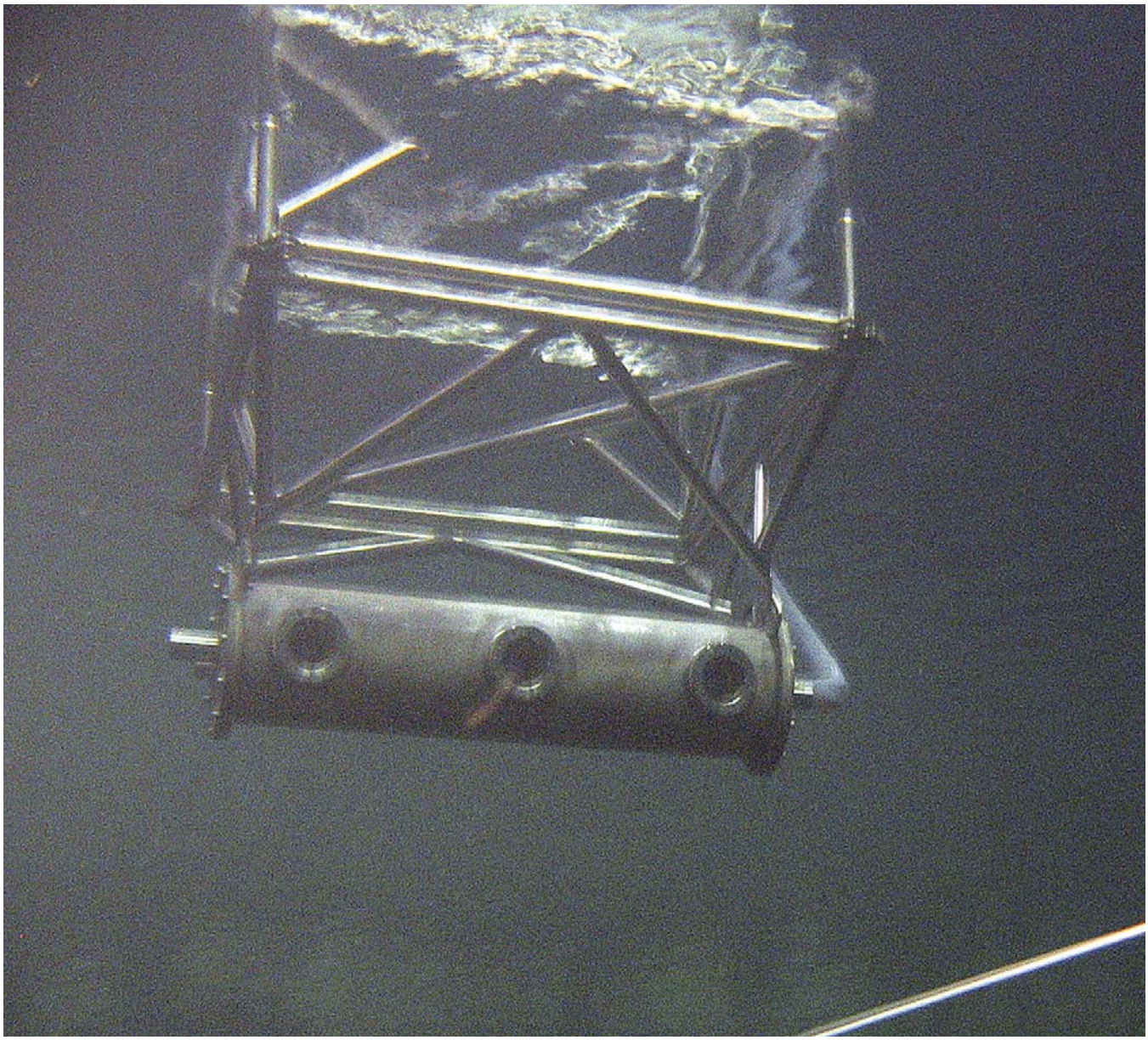
Reinier Bergevoet is project engineer at the Offshore department of MARIN.

option reduces the chance of reflections of the LEDs on the water surface, thus improving measurement quality and accuracy. The engineering of the camera control software comprised the last stage of the development. An important requirement in the specifications was that the UMS should be able to measure in the same coordinate system as the above-water system. This is essential for disconnectable turret systems for instance, to be able to determine buoy positions with respect to the floater. A special calibration device was developed to be able to convert the UMS coordinate system to the MARIN standard coordinate system.

This new measurement system is able to measure 3 DoF of up to 30 individual LEDs (e.g. for riser shape measurement), or 6 DoF of up to 3 bodies, (e.g. for underwater buoys). The system can measure in a large area (maximum of 3 * 3 metres at a distance of 6 metres from the camera), with a typical specified measurement resolution of 0.02 mm and a specified measurement uncertainty of 0.3mm (U95).

In recent years the UMS system has been applied for numerous complex measurements. It enabled the study of disconnectable turret systems in survival conditions, hybrid riser towers and other subsea systems in current and waves. The accurate measurements made it possible to study motion behaviour but also possible interactions between different structures that could otherwise not have been quantified.

UMS: MARIN's special eye for underwater behavior.



Liability Risk Management

Below the Water Line

Using sonar to mitigate liability risk for ships, divers & ports

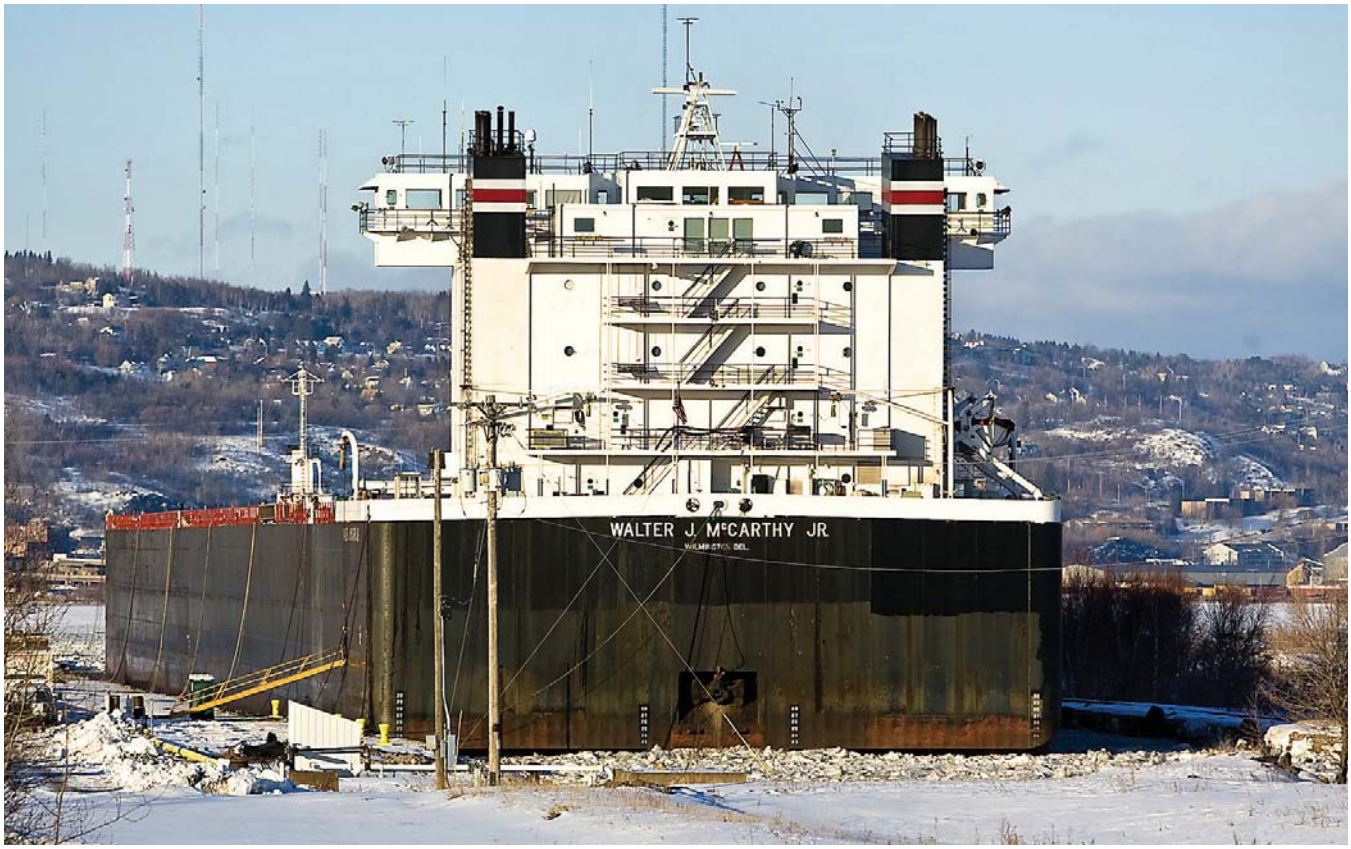
by Steve Campbell

On January 15, 2008, the Walter J. McCarthy Jr. was a typical Great Lakes coal ship in the process of shutting down operations as the winter shipping season on Lake Superior was coming to a close. A few hours later its engine room flooded at dockside in the Duluth-Superior harbor in Minnesota, and a $5 million lawsuit was in the works, a victim of an underwater threat lying hidden on the harbor floor.

Was it sabotage? No; it later came to light that in -40°F weather and lake ice six feet thick — frigid but not unusual winter weather — the 1,000-foot lake freighter had struck a submerged object right beside the dock. This object pierced the hull and began flooding the vessel's engine room. The crew shut off the engines and all hands evacuated the ship as it took on twenty feet of water in the engine room next to the Hallett Company dock.

What exactly caused the sinking was a mystery at first. More important than finding out what happened, however, was to quickly assess the damage and determine how to fix and refloat the boat before the severe winter weather froze the flooded ship's engine room. Otherwise, refloating the ship would be delayed months into the spring, as the freighter's owner would have to wait until the ice inside melted in the spring thaw, and then have the water pumped out and the engines overhauled. Speed was imperative because costs were rising every day.

Commercial divers were brought in to survey the extent of the damage. Brian Abbott of Nautilus Marine Group of



(Photo Credit: Duluth News Tribune, January 15, 2008)

Haslett, Michigan found environmental conditions extreme. "We've been in all sorts of rough diving situations, but this was something else. It was forty below, and our divers were dealing with ice six feet thick that was already closing in on the ship. In these conditions and with poor visibility, we had our hands full."

His task: assess the damage and find out what had caused the sinking — and do it quickly.

Sonar Discovers an Expensive Underwater Surprise

In these conditions, his dive team didn't just jump in and feel around; any diving would have to be "get in and get out," so Abbott first went into action using an advanced, portable electronic sonar scanner made by Kongsberg Mesotech. Kongsberg's sonar was lowered into the water to deliver real-time sonar viewing, electronic images and records showing the extent of the damage inflicted on the ship. Then he used the same technology to check around the ship on the sea floor to determine what might have been the cause of the damage. The findings were surprising, to say the least.

"We imaged a concrete block about 10x10 feet and six or seven feet tall sitting right on the harbor floor," said Abbott, whose team is called in to perform commercial diving and survey projects in ports all across the U.S. "The lawyers will determine if this was the cause [responsibility for the estimated $5 million in damage costs caused by the incident is still before the courts], but one thing is certain from my experience diving in ports: it's scary that no one really knows what's under those ships."

What is Really Underwater?

The Walter J. McCarthy incident highlights a key issue in port maintenance: what underwater hazards are lurking out there for ships and what is the true condition of the port's underwater infrastructure? Unknown hazards such as sunken barges, lost containers, shopping carts, lost suitcases present a costly liability and downtime risk to ship owners, and to the harbour owners they might end up suing.

But aside from the risk to ships, many port piers and walls are many decades old, some dating from the early part of the last century. How have these stood the test of time? What crumbling infrastructure is close to collapse?

Unfortunately, out of sight usually means out of mind, and, given tight maintenance budgets, it's likely difficult for port managers to keep on top of potential underwater trouble until something like a ship sinking goes badly wrong. Current practices involve sending divers out on an ad hoc basis once a year to physically sample the state

of various pilings, piers and walls. However, in murky or low-visibility water, this amounts to hunting and feeling around in the dark, like the proverbial blind man describing an elephant.

Today there is a better way. For the first time, port authorities can now gain detailed visual documentation of underwater infrastructure conditions to analyze and archive. This is something that was not even possible until more advanced scanning sonar technologies began to be applied to map out harbour floors, piers and docks. Prior to this advance, in most cases port authorities relied on descriptions of a pier's sub-surface state from divers feeling around blindly in zero-visibility conditions. Clearly, sonar represents a significant addition to the port manager's insurance risk management toolbox.

Managing the Port's Insurance Risk

How can sonar be used? According to Abbott, in a proactive maintenance campaign, sonar is used first to map out and image the various targeted infrastructure items to develop a baseline foundation of the port's current condition. The harbor floor bottom around docks and slips, and out into the harbor, should be included, and a composite map drawn up that shows all the unusual items on the sea floor. (These can range from vehicles, dropped containers, lost suitcases and shopping carts to mishandled cargo and enormous concrete blocks.)

In addition, side-scan sonar enables the real-time viewing of underwater pier walls buckling either in or out, any damage or deterioration, and the state of support pilings and their bases; in addition, the sea floor underneath docks can be imaged. Electronic pictures of all of this information, once created and saved, can then be assembled into a mosaic for easy viewing and analysis by port management at their desks, and subsequently printed and archived electronically as a baseline study for future maintenance budget planning.

In Portland, Oregon, for example, city engineering officials charged with maintaining the sea wall along the Willamette River had underwater surveying expert Brian Abbott of Nautilus Marine Group use sonar to develop a composite underwater image of the entire wall. They were able to use this to establish a visual baseline record of possible weak spots and develop a program of maintenance work. "What's valuable is that you can go back down in a couple of years and take similar images," notes Abbott. "Then compare over time to see the changes when you need to prioritize your always-tight maintenance and capital budgets."

"With advances in sonar computing technology, the resolution and quality of underwater images is now quite high. It's very eye-opening for port managers," notes Kongsberg's senior projects' manager Mark Atherton, also the author of the upcoming textbook Visualization of Underwater Structures Using Scanning Sonar, and an expert in the field. "Sonar is the port manager's portal for viewing and monitoring the state of the port's substantial underwater infrastructure assets."

Most ports have regular survey programs involving divers going down to check out underwater structures, pilings, bridge supports and pier walls. The problem is that, in murky conditions, visibility is poor and divers are forced to feel around blindly, raising quality-control and safety issues.

At the Port of Montreal, one of the largest port authorities on North America's eastern coast, geomatics engineers have already used sonar to conduct a survey of the port's underwater infrastructure. The goal was to establish a baseline not only for maintenance plans, but also for future infrastructure expansion.

The current economic situation, where global trade and

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Brian Abbott,
Nautilus Marine Group
Haslett, Michigan

port activity has slowed considerably, provides breathing room for ports to take stock and prepare the foundations for future expansion as the upgraded Panama Canal and other developments impact trade flows and create new port opportunities. Federal stimulus funding is now available, at least for the next few years to upgrade and enhance vital public port infrastructure. Ports can use sonar to uncover problems to allow maintenance departments to prioritize five- and ten-year work programs. The sonar images can also be used as confirming visual evidence when requesting capital funding for repair and expansion. And, of course, identify significant liability risks.

Ultimately, sonar shows port managers what's really going on with port underwater infrastructure and helps them make better decisions — probably the best benefit of all.

Ocean Observation

U.S. IOOS Program Update

by Zdenka Willis, Director, U.S. IOOS Program, NOAA

As I write this, I am taking some personal ocean observing at my beach house in South Carolina where I spend my days with my family walking the lovely beaches and enjoying the surf. So, for me, the U.S. Integrated Ocean Observing System (IOOS) is personal, which is something I share with everyone involved in IOOS. The passion runs high as we all strive to set up this national effort. As I reflect on the accomplishments since we last reported two years ago, there has been good progress, but additional resources remains elusive.

On March 30, 2009, President Obama signed the Integrated Coastal and Ocean Observation System Act of 2009 ("the Act") into law, authorizing U.S. IOOS and designating NOAA as the lead federal agency. This was followed, on July 19, 2010, by the Administration releasing the Final Recommendations of the Interagency Ocean Policy Task Force, which has as one of its priorities to strength and integrate Federal and non-Federal ocean observing systems into a national system, and integrate that system into international observation efforts.

At the National Level

Data Management and Communications (DMAC) is the primary mechanism to integrate collected data. The Data Integration Framework (DIF) will finish in September with having integrated seven variables (i.e. ocean currents, temperature, salinity, water level, waves, chlorophyll, and surface winds) at three NOAA data centers and all eleven of the IOOS Regional Coastal Ocean Observing Systems (RCOOS) and will transition to the baseline capability of the IOOS DMAC subsystem. IOOS data integration was used to improve NOAA's operational storm surge model. NOAA's National Weather Service (NWS) forecasters and emergency managers can now call up time series graphs of water levels and winds and display them along with surge information from the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) program. It was first used during the 2009 hurricane season to improve communications to the public on expected inundated areas in advance of a hurricane. In June 2010, IOOS launched the first version of the IOOS Data Catalog to allow users to find the data they want, for the location and time period of interest, from all available IOOS partners without having to know in advance which partners actually operate the observing systems and data servers.

We made progress on implementing the Act. The Integrated Ocean Observing Committee (IOOC) was chartered. Initial steps included hosting a town hall session focused on public-private partnerships at the Oceans '09 conference sponsored by the Marine Technology Society, drafting a public-private use process, beginning to develop certification standards for IOOS' non-federal assets, releasing yet another competitive Federal Funding Opportunity for regional participation in FY11, continuing to focus on the development of a data management and communications system, and pursuing a path forward for establishing a System Advisory Committee.

Advances in Observing

High Frequency Radars (HFR) operate in 9 of 11 IOOS Regions. A national HFR data delivery system was established at NOAA's National Data Buoy Center (NDBC), The Scripps Institution of Oceanography, and Rutgers University. The United States Coast Guard ingests surface data currents from HFR sites into its SAR operations center for the mid-Atlantic coast which results in decreasing the area of search by up to two thirds over a four-day period. In 2009 the National Surface Current Monitoring Plan was published.

The U.S. Army Corps of Engineers (USACE) and NDBC have long led the nation in wave observation programs, but the observation locations were based on local project or user requirements resulting in a useful but ad hoc network with limited integration. The National Operational Wave Observation Plan addresses this situation by defining a comprehensive wave-observing network for the United States. The plan defines a standard level of wave measurement accuracy, assesses existing measurement locations, adds additional observations in critical

"gap" locations, implements a continuous testing and evaluation program, supports the quality assurance/quality control and data integration and promotes the development of new sensors and measurement techniques.

"New Technology's Historic Underwater Flight Advances Climate Understanding, Education" is how we describe the Atlantic crossing of Scarlet Knight, from April 27, 2009 to December 9, 2009. Scarlet Knight is a Slocum Glider developed in partnership with Teledyne Webb Research Inc. **This effort emulates the partnerships of IOOS bringing together Rutgers University, NOAA, the Office of Naval Research, the National Science Foundation, Puertos Del Estado (Spanish Port Authority), and Teledyne Webb Research Inc.** This mission opens up new frontiers in the ocean, with the ability to accomplish for deep water oceanography what it has already done in continental shelf oceanography. The data collected through this mission was used to benchmark remotely sensed information and the HYCOM model output. As part of an undergraduate class, this mission also provided practical applications for oceanography, computer science, and engineering students. Additional glider operations include efforts in the mid-Atlantic by MACOORA and SECOORA, by SCCOOS to evaluate El Niño conditions, by PacIOOS for integration and model verification, by GLOS to test applicability in freshwater, by NANOOS with the incorporation of acoustic modems to track fish.

Partners of IOOS recently deployed various types of ocean data collection sensors. PacIOOS deployed water quality systems in Guam, Palau, the Marshall Islands, and the Federated States of Micronesia. Two additional buoys will be deployed in Hawaii and the insular Pacific. NANOOS, with the Murdock Foundation, deployed a buoy system off the coast of Newport, OR, which measures meteorological quantities, chlorophyll, turbidity, dissolved oxygen, temperature, salinity, pCO2 and pH. MACOORA deployed the historic Francis Scott Key buoy in the Patapsco River. CaRA worked closely with NWS San Juan Weather Forecast Office (WFO) and deployed a mesonet consisting of eight coastal weather stations (in collaboration with WeatherFlow, Inc.) and two coastal data buoys off the southern and northern coasts of Puerto Rico.

An important component of observing is ensuring that the sensors we use are validated and verified. The Alliance for Coastal Technologies (ACT) is a partnership of research institutions, resource managers, and private sector companies dedicated to fostering the development

and adoption of effective and reliable sensors and sensor platforms for environmental monitoring and the long-term stewardship of coastal ocean resources. In total, ACT has conducted 226 instrument performance tests in the laboratory under a wide range of environmental conditions and different deployment applications. The focus in 2009 was performing validation tests on in situ pCO2 sensors and this will continue in 2010.

IOOS Model Testbed to Improve Marine Forecasts along Atlantic and Gulf

In 2010, IOOS kicked off a project under the Southeastern Universities Research Association (SURA) to evaluate the readiness of marine forecasts along the Atlantic and Gulf of Mexico coasts and improve them for operational use. This project creates an objective environment to compare the latest models for improved forecasting of chronic issues of high relevance in the Atlantic and Gulf regions such as flooding from storm surge and seasonal depletion of oxygen in shallow waters. They will also explore methods for effectively delivering model results to regional centers, scientists, and managers relying on IOOS. Congress kick-started the grant opportunity with the inclusion of funding to support such a project in last year's Consolidated Appropriations Act.

Products and Services

Across the IOOS regions, there a number of new products and services and space limitation only allows me to highlight a small sample that support the IOOS themes of Marine Operations, Climate Variability and Change, Ecosystems, Fisheries, and Water Quality, Coastal Hazards, and Coastal and Marine Spatial Planning.

During the Deepwater Horizon crisis, the U.S. IOOS community provided highly valued support to the Federal response and showed that the concept of U.S. IOOS was one that was sound. Highlights of this support include:

- Six HFR, along the Northern Gulf of Mexico and Florida coasts, were used by NOAA to support trajectory modeling.

"New Technology's Historic Underwater Flight Advances Climate Understanding, Education" is how we describe the Atlantic crossing of Scarlet Knight, from April 27, 2009 to December 9, 2009. Scarlet Knight is a Slocum Glider developed in partnership with Teledyne Webb Research Inc.

- Gliders from MACOORA, SECOORA, GCOOS, and SCCOOS partners and industry partners IRobot and Teledyne Webb Research Inc were flown to collect three-dimensional information of the water column.
- Models from SECOORA and GCOOS partners were used by NOAA for trajectory forecasts.
- Imagery from SECOORA and GCOOS partners were integrated with HFR surface currents and were used USGS, NGA, and NOAA.

An emerging U.S. IOOS partnership centers on the threat of ocean acidification. U.S. IOOS is working with NOAA's Pacific Marine Environmental Laboratory to deploy their MapCO2 sensor on coastal

buoys. Additionally, the U.S. IOOS is teaming up with shellfish growers as they are already experiencing the effects of ocean acidification. A workshop was held in July 2010 and brought together constituents from west coast fisheries industries, scientists, and governmental representatives to address concerns related to the impacts of ocean acidification on the west coast shellfish growers and other fisheries industries.

The Alaska Ocean Observing System (AOOS) and the Oil Spill Recovery Institute (OSRI) conducted an ocean observing system field experiment in Prince William Sound (PWS) in the summer of 2009 to evaluate the utility of the sensor arrays and the accuracy of model forecasts.

During the field experiment, drifting buoys, CTD casts and AUV and glider transects were made to collect water column profiles. An HFR array was deployed to map surface currents in the central basin. All of the data collected was made available through the AOOS data management system to develop numerical models for forecasting weather, waves, and ocean conditions.

GLOS developed models that display real-time and forecasted waterway data in the corridors between Lake Huron and Lake Erie in southeast Michigan. These models have the potential to protect water quality and drinking water supplies for millions of people by directly supporting decision-making related to drinking water intakes and pollution/spill response.

The models also improve the responsiveness of search and rescue operations. MACOORA is developing "ecosystem-based fishery management" and "spatial marine planning" by producing two new real-time datasets for assimilation by the three dynamic models and established a pair of regional glider lines that zigzag north to south across the mid-Atlantic Byte.

Within SECOORA, they are working within the state of South Carolina to improve beach swimming advisories and shellfish bed closure forecasts due to elevated levels of bacterial contamination.

Standard sampling protocols require the 24-hour incubation of water samples before results are available therefore better predictive capabilities will enhance the utility of an existing monitoring program and to reduce the impact of unneeded closures (false positives) and failures to close when needed (false negatives). Collaboration between the University of South Carolina, the University of Maryland, the South Carolina Department of Health and Environmental Control (SCDHEC), and the Raytheon Corporation developed a decision support tool to address this need.

In California, SCCOOS and CeNCOOS work with the local WFO to provide accurate "bar" forecasts. SCCOOS, in conjunction with its sister program, Coastal Data Information Program (CDIP), operates a number of wave buoys along the coast as well as a wave model. Data from the wave buoys are being used for weather forecasts. For example, a wave buoy placed on the San Francisco Bar at the entrance of San Francisco Bay provides wave data for the NWS forecasts, thereby resulting in a 75% decrease of rescue incidents as reported by the USCG. By incorporating three-day waves forecasts, the IOOS regions are able to send automated messages to the NWS offices and city officials when the model predicts that the threshold levels are to be exceeded.

PacIOOS publishes beach safety conditions for ten beaches in the Hawaii Islands. This website was established through cooperation amongst the Hawaii Lifeguard Association, City & County of Honolulu, County of Maui, Hawaii Department of Health, Hawaii Tourism Authority, and the University of Hawaii School of Ocean and Earth Science and Technology as a non-profit venture. The website provides wave and beach hazard information that is updated every ten minutes based on forecasts by the NWS. Additionally, other factors such as beach closures, road closures, stinging jellyfish, shark sightings, and other events are posted on the site when available.

NERACOOS released a new Model Forecast / Observation Viewer to permit comparing model forecasts against actual observation for both wave height and water levels. The models include both Wave Watch Three and FVCOM. FVCOM has both a Northeast Atlantic domain and a smaller Massachusetts Bay domain. The NERACOOS Map and Model Viewer was designed to permit rapid browsing of the output of several models running in the Northeast region.

This tool was developed using a product called Mapserver and integrates model output layers made available by the provider via a standard webservice know as Web Mapping Service (WMS).

Conclusion

U.S. IOOS is a team sport where contributions come from all seventeen federal agencies. Further, there are a number of other programs that are also working to provide information on the coastal environment as both contributors to IOOS and users of IOOS. The Integrated Ocean Observing System (IOOS) is working with other

federal initiatives such as the National Science Foundation's Ocean Observatories Initiative (OOI) and the National Water Quality Monitoring Network (NWQMN) for U.S. coastal waters and their tributaries, to enable the United States to make more effective use of existing resources, new knowledge, and advances in technology.

The challenge facing all of us in the ocean observing business is the ability to sustain these observations and continue coordinating each of these efforts.

The recent release of the National Ocean Policy and structure to support the holistic focus on ocean observing along our Oceans, Coasts and Great Lakes, gives me hope that we will be able to realize the potential of a fully functioning US IOOS.

About the Author

Zdenka Willis, Director US IOOS Program, NOAA.

Similarities in Pre-Salt Areas

Brazil vs. West Africa

by Claudio Paschoa, contributing editor

Although the pre-salt reservoirs on both margins of the South Atlantic have many similarities, they also show differences in structural style, source rock depositional setting and reservoir characteristics. There are however, enough similarities that permit O&G geologists to compare seismic data from locations such as the huge Tupi pre-salt field in Brazil to new seismic data acquired in West African plays, and through these comparisons determine the probability of encountering pre-salt hydrocarbon depositions and optimizing the use of exploratory drill ships.

Continental Drift and Pre-salt History

Drifting continental fragments formed the pre-historic supercontinent of Pangaea around 250 million years ago, Pangaea split to form the supercontinents of Gondwana in the south and Eurasia in the north about 180 million years ago. Eurasia eventually split to form North America and Europe, as these landmasses are known today.

Many of the major petroleum provinces of the world are associated with rift basins, such as the North Sea basins, the Brazilian rift basins and the West African rift basins.

The Brazilian and West African continental margins are characterized by the regional distribution of syn-rift and post-rift sediment assemblages. Syn-rift includes a sequence deposited during active rifting, typically showing facies and thickness changes across the active faults, unconformities on the fault footwalls may pass laterally into continuous conformable sequences in the hanging walls. Some of these early sediment assemblages can now be found deep underwater, sometimes in shallow water. To get to the different layers containing the original syn-rift depositions it is still necessary to drill sometimes more than 4,000m (13,123 feet) under the seabed.

The Brazilian and West African pre-salt reservoirs began to be formed when sedimentary rocks were deposited around 130 million years ago, in the Early Cretaceous period of the Mesozoic era.

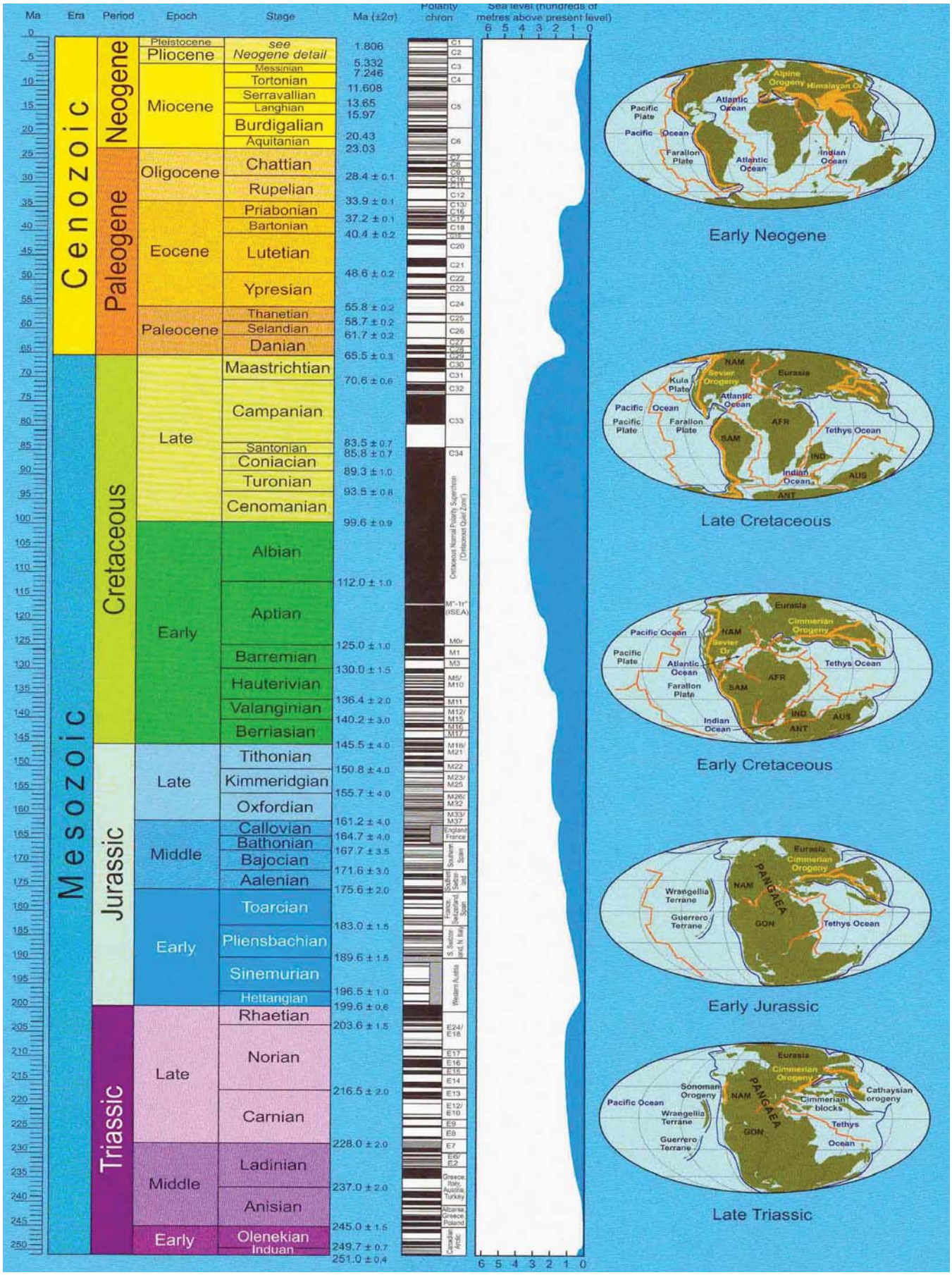
This is when the southern portion of Gondwana violently split causing a rift as two landmasses, that would be known as South America and Africa started drifting apart. The margins of the South Atlantic were formed as result of three rift propagation episodes, the first during the Berriasian — Hauterivian phase of the Early Cretaceous period, between 145.5 and 136.4 million years ago. Another rift propagation episode occurred during the Hauterivian – Middle Barremian phase, between 136.4 and 127.5 million years ago.

The last rift propagation episode was during the Barremian-Early Aptian phase between 127.5 and 120 million years ago. Each of these rift formation episodes formed a series of basins. The last of these rifting episodes also resulted in the emplacement of the oceanic crust in the South Atlantic Ocean.

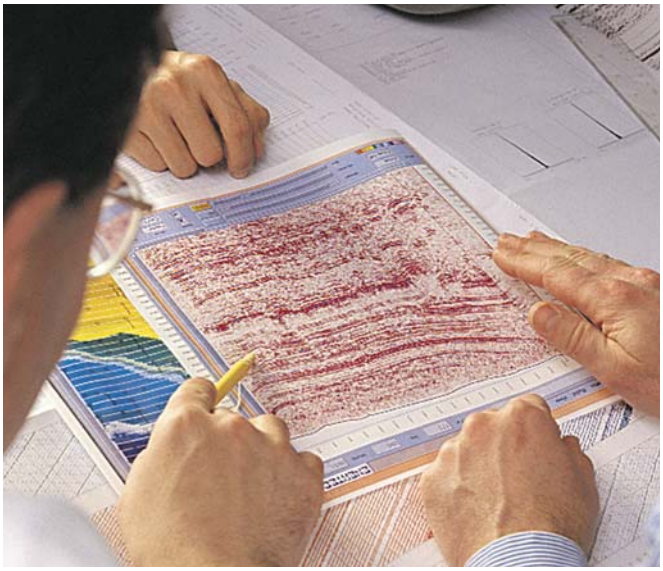
The first syn-rift propagation episode caused a shallow rift to form at the southern tip of the supercontinent, causing massive landslides as the landmasses physically split, this in turn caused massive deposition of stones, organic matter and sediments in fan shaped patterns on both sides of the rift. Seawater from the surrounding seas, along with fresh water from rivers located on both sides of the rift also seeped into the rift, depositing more organic matter and sediments that helped form the source rock that would be the generators of the pre-salt oil.

Along the second rift propagation episode, the rift grew wider forming a lake and began to fill with more water from rivers and saltwater seeping from the sea to the north and south as the landmasses continued slowly drifting apart. The organic matter present in the water also began to be deposited on the bottom.

As the rift slowly but steadily expanded, a larger salt lake began to form between the two landmasses. Sediments that were deposited on the bottom of this salt lake during the violent separation of the landmasses accumulated on the bottom and grew in thickness as even more sediments and organic matter where deposited by rivers flowing from the landmasses and subsequent landslides around the lake.



(Credit International Commission on Stratigraphy and Geological Museum Oslo University)



(Photo credit CGGVeritas)

CGGVeritas geologists at work.

Rivers flowing into the salt lake continued depositing sediments and organic matter over the sediments already present at the lakebed, forming various layers of sediments composed of stones of various sizes, sediments and organic matter, such as plankton. The lake slowly grew as the land masses continued drifting apart and as more sea water began seeping in, the high salt content of the lake began to form layers of salt deposits on the bottom over the deposited sediments, steadily growing in thickness.

As sea water continued seeping into the lake and the landmasses continued drifting apart the salt lake between the landmasses grew larger. This sea water deposited even more salt over the organic matter, much of which was made up of planktons, which over time turned into a viscous mass and after tens of millions of years turned into hydrocarbons. As the landmasses steadily drifted apart, the salt lake first took on the dimensions of a sea and along many millions of years of drifting it turned into what is now known as the Atlantic Ocean.

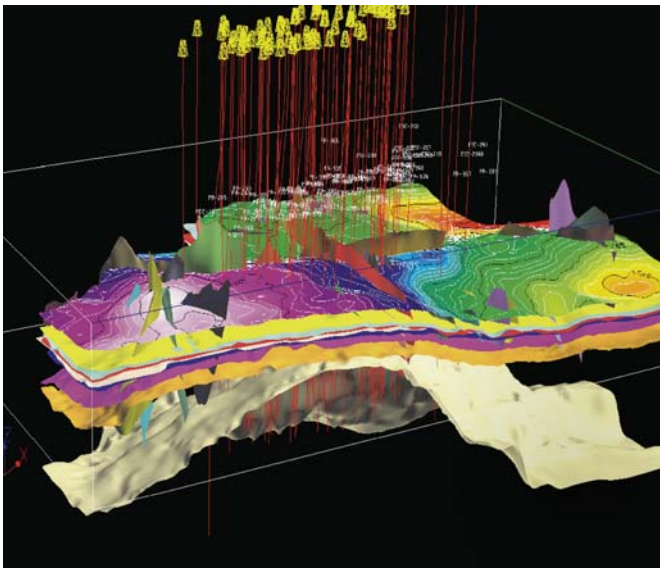
The formation of the pre-salt structure the Gulf of Mexico is quite different from the structures in Brazil and WA since the pre-salt reserves in the Gulf of Mexico are from a younger reservoir that initially formed over the salt, in time the salt moved and eventually settled over the hydrocarbon reservoirs, which have a different source rock composition than found in Brazil and WA. The source rocks found in the South Atlantic pre-salt reservoirs are carbonate rocks.

Along these tens of millions of years the salt deposits at the bottom on both sides of the drifting landmasses grew in thickness and now in some parts this salt crust is over 2,000 meters (6,561 feet) thick, while in other parts it may be only around 200 meters (656 feet) thick.

The salt crusts effectively work as a seal over the pre-salt reservoirs, forming a barrier for the reservoirs underneath them, in such a way that the hydrocarbons contained in the reservoirs cannot seep to the surface. The pre-salt plays in Brazil were not explored earlier mainly due to high E&P costs. Efforts were concentrated on the post-salt plays, which do not involve drilling through salt crusts, therefore being more easily accessible and involving less capital investment.

In Brazil, the pre-salt reservoirs are known to be present up to and beyond 300 km from the coast, however many geologists believe that hydrocarbons may be found under salt layers even further away from shore than that. Exactly how far from shore these pre-salt reservoirs can be found is unknown and it may take decades for the full extent of these reservoirs to be mapped. The same is true on the West African side of the Atlantic Ocean, where exploration has not reached the more advanced stage it has in Brazil. In WA, onshore and deepwater offshore pre-salt reservoirs have been discovered and some geologists believe that onshore reservoirs may eventually also be discovered in Brazil.

The pre-salt regions in Brazil are officially recognized as being present in an area roughly 800km (497 miles) long and 200km (124 miles) wide, ranging from the north of State of Santa Catarina to the State of Espirito Santo, with some of the most important plays being found off the States of Rio de Janeiro and São Paulo, where the Tupi, Iara, Franco, Libra and Guara fields are located. This area



(Photo credit CGGVeritas)

Geovation software CGGVeritas.

(Credit Falkland Islands Department of Mineral Resources)

Gondwana circa 400 milllion years ago.

is known by insiders as the "Picanha Azul" (Blue rump steak area).

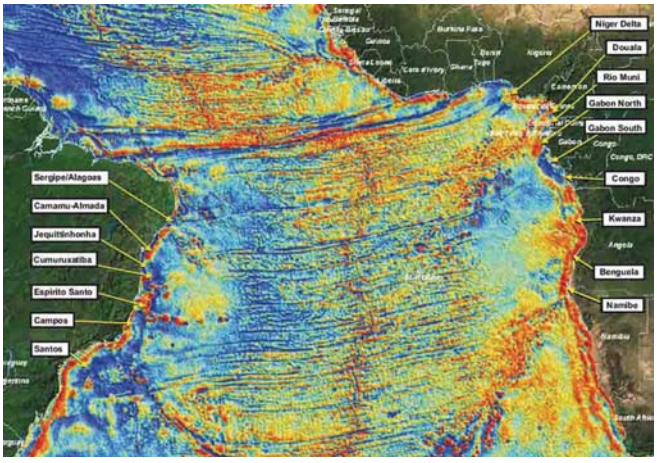
Marcio Rocha Mello, president of the Brazilian Association of Petroleum Geologists, the national branch of AAPG (US), and head of HRT O&G, estimates reserves of up to 100 billion barrels in the Brazilian pre-salt region. Using a $60 per barrel calculation, that would add up to roughly $6 trillion. ANP (The Brazilian national petroleum agency) has disclosed it estimates at least 50 billion barrels, but unofficially admits there may be more, whereas Petrobras prefers not to speculate publicly on this, and only considers the amount of proven pre-salt reserves, which is at around 20 billion barrels, counting the latest discoveries.

The discovery of pre-salt reservoirs in Brazil and West Africa caught many people by surprise, but certainly not geologists involved in O&G exploration. When the massive Tupi field in the Campos Basin was discovered in 2007, Petrobras geologists already expected pre-salt discoveries would also be made in West Africa, due to the geophysical similarities found through seismic analysis on both sides of the South Atlantic Ocean. Petrobras has been doing seismic studies along the WA coast for many years and the area is considered so strategic that Petrobras usually declines to comment on its WA explorations due to these strategic considerations.

Parts of southeast Brazil used to be attached to what is now Angola. Considering the recent large oil finds off Brazil, there could potentially be something similar in Angola. There have been many exciting discoveries in the Santos Basin, offshore Brazil, including Tupi, Guara, Iara, Franco, Libra and Parque das Baleias, this last one located on the north tip of the Campos Basin, off the State of Espirito Santo. Even more recently pre-salt reservoirs have been found under some post-salt reservoirs in the Campos Basin, whose post-salt reservoirs are presently the main oil producing areas in Brazil. Geologists agree that the post-salt oil found at the Campos Basin originated in the pre-salt reservoirs below them and seeped over the salt crust through fractures caused by movement of the salt crust, which are not solid, they are more like highly viscous plastic or metal fluids. It is important to note that Petrobras has obtained a success rate of a staggering 87% in pre-salt exploration in the Picanha Azul area of the Santos Basin, where most of the major discoveries are located.

Considering that the land which is now Southern Angola and Namibia used to be attached to Southeast Brazil, you might expect the geological characteristics, and pre-salt potential, in both regions to be similar, that can be considered true, but only to a certain extent as there are important differences in the structure of the salt layer and of the rocks and sediments underneath it. It is known that both regions have good potential and some similarities in their geological structure, but the differences need to be taken into account. One of these differences is the fact that seismic studies undertaken in West Africa up to now have in most cases shown that the salt layers present there are not as homogeneous as the ones that have been found in offshore Brazil, which in turn may have caused more oil seepage from the pre-salt reservoirs located in WA, as the salt seal is not as consistent as it is in Brazil.

Along the coast of Brazil and West Africa the characteristics of geometry and distribution of sediments differ from basin to basin. In Brazil the thickness of the drift sequence is much greater in the southern basins than in the northern basins. In WA rift and pre-rift sedimentary rocks are exposed in outcrops close to Precambrian rocks at the Kwanza, Cabinda and Gabon Basins, whereas this



(Credit Republique Gabonaise)

Related Basins in Brazil and West Africa.

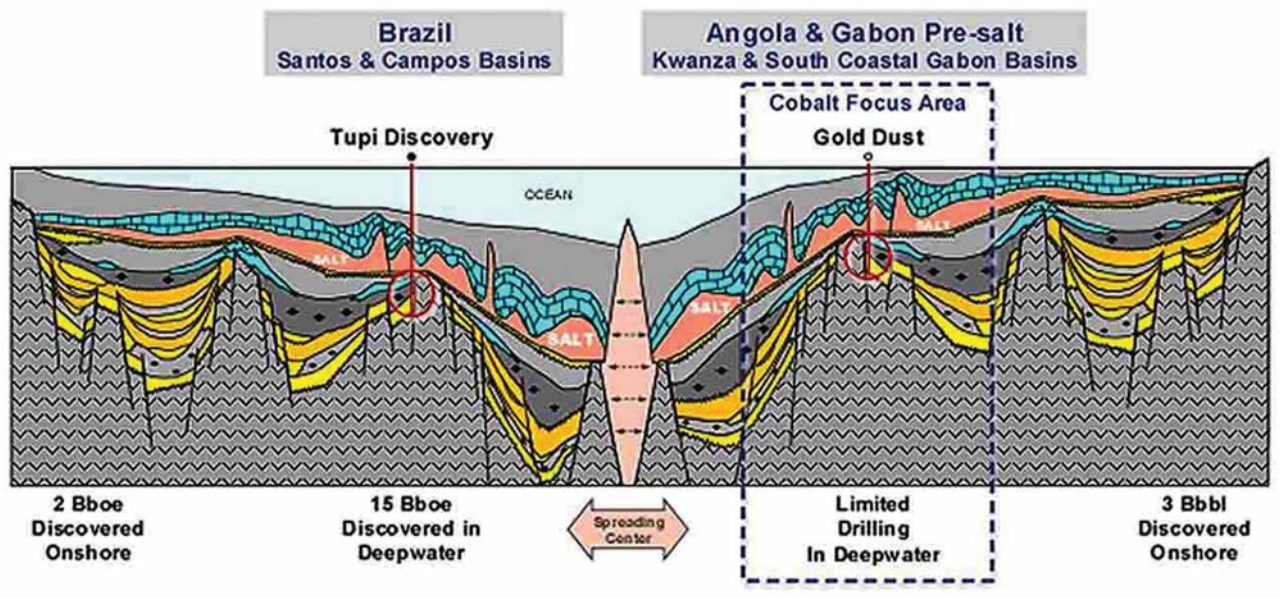
(Photo credit Western Geophysical)

Seismic ship shooting a 3D marine survey.

type of exposure only occurs in the northern Sergipe-Alagoas and Recôncavo Basins in Brazil. These rift and pre-rift exposures do not occur in the southern Brazilian Basins, such as Santos and Campos. According to Marcio Rochas Mello in his book 'Petroleum Systems of the South Atlantic Margins', these differences partially reflect a asymmetrical rifting pattern along the two continental margins.

Northeast Brazil was attached to what is now known as the countries of Ivory Coast, Ghana, Togo, Benin, Nigeria, Cameroon and Gabon. Although Petrobras has not been actively pursuing pre-salt exploration in Northeast Brazil, Marco Rocha Mello from HRT Oil & Gas, who as a geologist for Petrobras at the time, participated in the early seismographic studies undertaken along the Brazilian coast in the late seventies and early eighties, claims that there is seismic data that indicates the presence of potential pre-salt hydrocarbon reservoirs all the way up to Recife in the Northeast state of Ceará and that the drilling was not undertaken due to high costs and not having the necessary technology at the time. If we take into consideration the new pre-salt discoveries in Gabon, the likelihood of pre-salt structures and their hydrocarbon reservoirs being present in Northeast Brazil must be considered high.

One of the reasons for the large discoveries on the Brazilian side of the South Atlantic Ocean is the very thick continuous layer of salt, which has served to keep much of the hydrocarbon accumulations in place. This means that the potential for large volume reservoirs on the Brazilian side could be higher. This is not the case on the Angolan side, where the salt structures are not as homogeneous and neither are the source rocks underneath them. In Gabon, it appears that the geological systems hold much more similarity to the systems found at the Santos Basin, so the possibility of finding large reservoirs there is higher. There is still much more drilling to be done on both sides of the Atlantic Ocean, in order to reach the full potential and a



Credit Cobalt International Energy.

South Atlantic Basins cross section.

better understanding of the hydrocarbon deposits that can be explored. All of these areas are relatively unexplored. In truth, even today very little is known about pre-salt in the South Atlantic.

Companies exploring these plays are not very keen about sharing whatever knowledge they have. Petrobras, for example, rarely comments on E&P in West Africa, as it is considered strategic and thus confidential, information. The same is true for some players drilling off the West African coast. However much more information is available about the pre-salt plays in Brazil. This undoubtedly is due to the fact that these Brazilian pre-salt plays have received much more exposure than the West African plays, due mainly to some of them having very high proven recovery potential.

Based on publicly available data, the potential for new pre-salt discoveries in Brazil is very good, if not excellent. The three main basins (Santos, Campos and Espirito Santo) have proven pre-salt plays that are believed to be quite extensive, although most geologists who have had access to seismic data from these areas, tend to agree that it is improbable that any new discoveries will be greater than the Tupi play, although the possibility of huge new pre-salt discoveries in Brazil, cannot be totally discarded.

New pre-salt plays have very recently been discovered in areas beyond the officially recognized Brazilian pre-salt area boundaries, which may force a Petrobras and ANP (The Brazilian National Petroleum Agency) to review these pre-salt area boundaries.

Looking at Angola across the South Atlantic, the geology is a slightly different. The salt seal is not usually as thick as on the Brazilian side. Players have tried to look for oil by drilling around the salt, but there have not been many attempts to drill through the salt and see what is underneath it. Petrobras has been buying a lot of offshore acreage in Angola, possibly because they think they can apply their experience and technology developed at the pre-salt E&P in Brazil to offshore Angola, where they definitely have a vast amount of seismic data to work with.

Petrobras is known to have a wealthy database of proprietary knowledge related to pre-salt E&P which it does not share. This includes a massive quantity of seismic data related to pre-salt exploration, from both sides of the Atlantic. The main pre-salt potential is believed to be in Southern Angola and further south towards Namibia, although recent discoveries in Gabon to the north are forcing these views to be reconsidered.

On the Brazilian side, the geology is characterized by a very large, thick salt layer, which has stopped the majority of the oil from seeping away. The theory is that the large salt lake which existed for a period after the South American and African land masses separated extended from what is now known as the Santos to the Espirito Santo Basins on the Brazilian coast, this means that much of the geological structure along this part of the Brazilian coast is reasonably homogenous and has experienced few structural changes.

This has been confirmed by the carbonate reservoirs found during drilling, which are very homogeneous over most of the area. The reservoir rock is mainly composed of stromatolites for hundreds of kilometers. Most of the wells drilled so far in the Brazilian pre-salt expose this unique carbonate reservoir rock. There are not many areas like this around the world. There are a number of faults in the reservoir rock structure, which affects the current location of the hydrocarbon accumulations. Many of the rock structures found under the salt crust also have a secondary porosity figure due to this fracturing.

Brazilian state-owned Petrobras is definitely interested in developing Angola's ultra-deepwater oil exploration, known as pre-salt, Brazil's Trade and Development Minister Miguel Jorge said last year. "A director of Petrobras had a meeting with Angola's economy minister and told him Petrobras, which is present there, has a big interest in drilling and working in an area we call pre-salt deep and ultra deep waters," said Miguel Jorge. Norwegian oil and gas operator Statoil said in July 2009 that it was also looking at pre-salt exploration in Angola, which rivals Nigeria as Africa's biggest oil producer. Super-majors such as Exxon, Shell, BP and Chevron are also present, operating large acreage plots in WA.

"The Usan development project adds to Chevron's deep queue of projects that are expected to generate significant new production from West Africa's deep water," said Ali Moshiri, president, Chevron Africa and Latin America E&P.

In Gabon pre-salt plays have been drilled and discoveries made, both onshore and offshore, proving that pre-salt reservoirs are present there. In late February 2010 ARKeX completed a BlueQube Marine gravity gradiometry survey on behalf of CGGVeritas over 9,000km² (3,474 mi²) of the Zone Sud area offshore Gabon. The survey was performed as part of a comprehensive work program undertaken by CGGVeritas in partnership with the Ministere des Mines, du Petrole et des Hydrocarbures with technical support from the Direction Generale des Hydrocarbures to improve understanding of untapped potential in the pre-salt province of Gabon to coincide with the recently

Credit Petrobras

Illustration of exploratory blocks in Brazil.

announced 10th Gabonese Licensing Round. Jim Martin, Chief Geophysicist, EAME Data Library, CGGVeritas, commented, 'We expect the ARKeX gravity gradiometry data to be extremely useful on this survey. Imaging the pre-salt is complex and the key is to accurately constrain the geometry of the salt bodies for accurate Earth Modeling and prestack depth migration. Gravity gradiometry data will provide a higher resolution model of the shallow section which will also improve the estimate of depth-to-base salt and therefore improve the estimate of the syn-rift sediment thickness to identify potential targets in the pre-salt section'. There is considerable untapped potential in the salt province of Gabon, especially in the pre-salt section which is currently poorly resolved on seismic. Petroleum systems have been identified in all the coastal basins and rich source rocks are present, the Melinia shale, for example, averaging 5-6% TOC (Total Organic Content). Sand-rich sediment supply along with both pre- and post-salt deposition provides excellent reservoir potential while an active tectonic history, together with salt movement, are ideal for generating large structural traps with potentially very significant reserves.

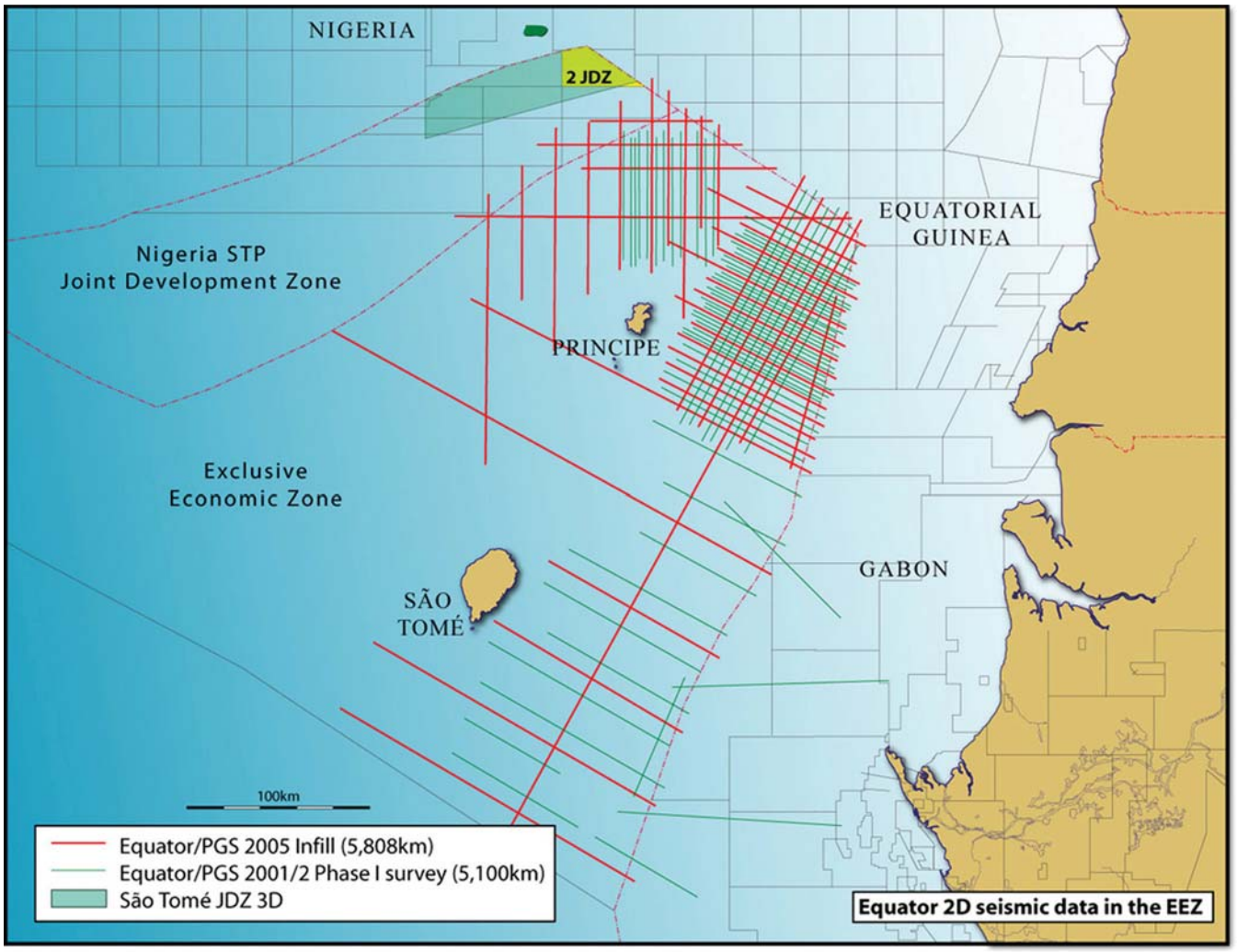
According to the president of Petrobras, Mr. José Sergio Gabrielli, there are important similarities between the pre-salt geological systems in Brazil and West Africa, and Petrobras in highly interested in participating in the development of the West African pre-salt potential, especially in countries such as Nigeria, Angola and Namibia where Petrobras has many assets in place and is expected to acquire new E&P blocks during the 10th Gabonese licensing round this year.

The importance of the pre-salt to local economies

For O&G producers and exporters, higher oil prices are expected to be a blessing rather than a curse. Yet evidence shows that in many of the net oil exporting countries (such as Africa, Mexico and Venezuela), it has been a major source of economic, social, political and environmental problems, rather than only as a treasure. The co-existence of significant oil wealth and large-scale poverty remains a "paradox of plenty," if not an outright resource curse in itself, for nations experiencing these problems. It can be said that Brazil managed to escape this curse, but only just, as this is due mostly to the government, institutional and reasonable economic stability the country has enjoyed along the last two decades. It is also important for Brazil that other national production markets have remained reasonably stable and sometimes even growing. Agriculture, mining, general industrial manufacture, O&G refining capabilities, industrial equipment manufacture, recently shipbuilding and even tourism, are all thriving industries in Brazil. This has helped to avoid the economic and social symptoms associated to the oil curse. Brazil is not totally dependent on O & G, although the pre-salt combined with new post-salt discoveries will be a major economic help to a country which is still far from eradicating poverty and unemployment.

The essential issue is that to create and sustain long-term wealth—rather than a short-term O&G boom—mineral resources have to be converted into other forms of capital (human, financial, and infrastructure) and more sustainable livelihood opportunities.

The West African pre-salt potential does exist and quite a few O&G geologists in Brazil believe that new pre-salt discoveries in WA are imminent. The greatest problems WA countries will face is related the lack of proprietary technology to explore and produce in these regions, reduced industrial bases, reduced refining capabilities, regional conflicts and institutional instability. In terms of



West Africa seismic.

technology to develop E&P in WA, the countries with pre-salt reserves will need to work with major oil companies who have or are developing the necessary technology. The other problems they face are much more complicated and may take generations to resolve.

In Brazil, Petrobras has the necessary proprietary technology for pre-salt E&P, and the Brazilian pre-salt is still open to foreign oil companies. A consolidated and diverse industrial base is present, as is a large consumer market. Most importantly there is institutional and judiciary stability which helps to attract foreign investors and also helps control and fight corruption.

In conclusion the similarities between the Brazilian and WA pre-salt must be considered a blessing on both sides of the Atlantic. The challenges that need to be faced in order to recover this light pre-salt oil are massive, but definitely not impossible. The fact that important pre-salt finds have been made in southeast Brazil is a definite boost to continued exploration of the WA offshore, as recent pre-salt discoveries in the northwest Gulf of Guinea are good indicators of potential pre-salt acreage in northeast Brazil. These facts should make finding seismic similarities that much easier. The deepwater pre-salt discoveries and eventual production on both margins of the South Atlantic can also be considered of worldwide importance due to the increasing world oil consumption, decreasing reserves in mature shallow water oil fields and decrease in new shallow water finds. Global oil demand in 2010 is pegged at 86.6 million barrels per day and global oil demand in 2030 is estimated to be at around 106 million barrels per day. New discoveries in new O&G frontiers such as deepwater post-salt, deepwater pre-salt, arctic shallow and deepwater exploration will all be vital in reaching a position to fulfill this estimated future demand.

Lester New MCT Chair

Paul Lester, previously the Chief Executive of VT Group plc before it was acquired by Babcock International Group plc, has been appointed Chairman of UK tidal energy company, Marine Current Turbines Ltd. He succeeds Tony Davies who has been non-executive chairman of Marine Current Turbines for the past two years.

Axon Appoints Adame

Axon Energy Products announced the appointment of Donna Adame as President of Axon Rig Concept and Design, Inc. (RCD). RCD is a wholly owned subsidiary of Axon Energy Products, AS. RCD is a concept designer and provider of innovative solutions for offshore drilling facilities on an engineering, EP and EPC basis. Adame assumes the role after serving as Vice President of Sales & Marketing for Axon Pressure Products. Her previous experience includes four years in the offshore marine oil & gas markets, and nine years in power products and power generation of the construction, industrial and oil & gas markets. She holds a Masters degree in Business Administration, and is a doctorial candidate for a PhD in Business Administration.

RBR Announces New President, Board Chair

RBR announced that Greg Johnson, who for two years has led the engineering developments of the company, takes over as President on September 1, 2010. Kara-Lee Golota will continues as Vice-President and Frank Johnson assumes the role of Chair of the Board with a particular interest in fostering new activities allied to the work of RBR and instrumentation.

Fugro Chance Promotes Thibodeaux, Prewitt

Prewitt

Thibodeaux

Fugro Chance announced two top management promotions. Blaine Thibodeaux has been appointed as Vice President of the Marine Group. Thibodeaux is responsible for Chance Lafayette's Gulf of Mexico offshore operations. Thibodeaux replaces Jim O'Neal who recently retired after completion of 47 years of continuous service to the company. Larry Prewitt has been promoted to General Manager of the Marine Group and as Thibodeaux's deputy will oversee innovative services such as STARFIX.Moor and major marine projects. Prewitt has also been appointed to Fugro's technical innovation team for the positioning business line within Fugro.

Ferguson Joins Global

Global Diving & Salvage welcomed John Ferguson, Business Development Manager, to its Offshore Support Division. Ferguson has more than 17 years of experience in the offshore and international O&G industry, tapping this experience to prepare for opening a Houston office as the General Manager. His current responsibilities include expanding Global's commercial diving, ROV, and environmental services within the Gulf of Mexico region and evaluating international market potential.

New Name, Familiar Face in Offshore Wind

Tony Trapp announced the creation of a new business, called O-Power Limited. O-Power (OP) will develop new technology in offshore engineering and hopes to make a significant contribution to the rapidly growing offshore wind market. OP offers concept development and analysis, right through to the supply and installation of product. It will use the human, physical and business resources of NE England to provide attractive and competitive engineering solutions - always aimed at improving technology. O-Power is an independent company founded and staffed by a team of engineers. It is based in Northumberland. The creation of OP is supported by IHC Merwede, a leader in the construction of specialist dredging equipment and a major supplier of specialist offshore technology and vessels.

CodaOctopus Adds Hinett

CodaOctopus Products has expanded its sales team with the appointment of Ben Hinett. His experience in the subsea industry began when he joined Thales GeoSolutions (formerly Racal) in 1999.

Subsea 7, CRC-Evans Enter Partnership

Subsea 7 entered into a global technology partnership agreement with CRC-Evans Pipeline International (CRC-Evans) that is intended to lead to both companies providing a range of enhanced pipeline fabrication services to the global offshore subsea engineering and construction market.

C & C Opens West Coast Division

C & C Technologies opened its West Coast Division and appointed Richard McGee as its West Coast Division Manager. The office will provide geoscience services and special projects along the west coast of North America, in Alaska, and worldwide. The C & C West Coast Division can be contacted at 1-425-408-9190 or at: 17706 Brickyard Road, Bothell, WA 98011

www.cctech.us

L-3 Klein Announcs SSS Seminar

L-3 Klein Associates announced plans for a Side Scan Sonar (SSS) Operations and Maintenance Training Seminar from October 5-7, 2010. The three day seminar will be conducted at L-3 Klein's Facility in Salem, NH. The training will include two days of classroom instruction and one day of on-the-water training. The seminar is geared to the operator, as well as to the manager, who wants a better understanding of Side Scan Sonar techniques. The instructor for the course will be Garry Kozak. For the past 27 years, Garry has been employed by L-3 Klein Associates as a sales engineer. He is a recognized expert in undersea search operations and travels the world providing consulting and training expertise to Navies and companies who have a critical underwater search need. To register for the class, please contact Carol Morrissey at 603-893-6131 or via email at Carol.Morrissey@L-3com.com.

Tritech Sale to NCS

Tritech International provided sonars to independent offshore survey company NCS Survey. NCS Survey has purchased a suite of Tritech sonars to assist in its survey operations, adding to its growing portfolio of specialist survey and positioning solution services.

www.tritech.co.uk

Teledyne Impulse Wins ISO Certification

Teledyne Impulse achieved the ISO (International Organization for Standardization) 9001:2008 certification from Intertek Testing Services NA, Inc. Teledyne Impulse is one of a select number of companies to meet the stringent ISO 9001:2008 certification requirements.

www.teledyneimpluse.com

UGA: Grants to Assess Enviro Impacts of Gulf Spill

Two University of Georgia marine sciences researchers, Samantha Joye and Patricia Medeiros, have received rapid response grants from the National Science Foundation to further assess the environmental impacts of the Deepwater Horizon oil spill.

Joye, Medeiros and colleagues from UGA and other universities left last week on an expedition in the Gulf of Mexico to locate, map and further characterize the deepwater plumes discovered in May in the Gulf of Mexico. Joye, a professor in UGA's department of marine sciences, part of the Franklin College of Arts and Sciences, received $192,528 to purchase three cavity ring-down spectroscopy systems. The instruments will allow Joye to quantify the composition and concentration of methane, dissolved inorganic carbon and the dissolved organic carbon in seawater samples by identifying chemicals based on their interactions with light.

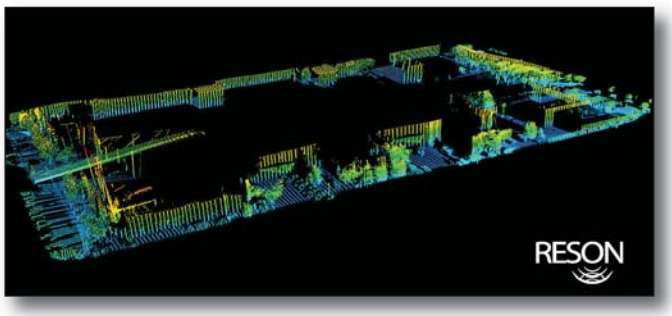
Medeiros, an assistant research scientist in marine sciences, also received an NSF rapid response grant, this one for $100,900, to purchase a gas chromatograph coupled to a mass spectrometer detector. She will use the instrument to characterize the organic composition of sediment and particulate carbon in samples collected in the Gulf.

TRIAXYS with Currents Buoy Available with Teledyne RDI ADCP

AXYS Technologies, Inc. (AXYS) said the TRIAXYS Directional Wave Buoy can now be ordered with a Monitor 600 KHz Teledyne RD Instruments Acoustic Doppler Current Profiler (ADCP). Teledyne RDI engineers are currently finalizing the unique ADCP design and expect to ship the first unit to AXYS in mid-September 2010. AXYS engineers will then perform integration and test activities to ensure compliance with all quality assurance requirements. This first integrated buoy will be delivered to Eiva in Denmark for use in the company's offshore and marine survey projects. Teledyne RDI's engineers have modified its off-the-shelf ADCP product by re-orienting its electronics package, allowing the ADCP to fit and operate within the TRIAXYS buoy hull.

Reson Integrates Scanning Laser

Fusing data sets from multiple sensors is a demanding requirements being seen more and more frequently in client specifications, typically combining photogrammetry or laser data with multibeam sonar data to create a seamless image of structures above and below the waterline. Reson has prepared the PDS2000 software package to combine data under the waterline with data above the waterline to show breakwaters and arbor walls.



Reson completed integration of scanning laser systems into its hydrographic software package PDS2000, supporting multiple sensor types. Data from the laser scanners are shown real in time, and are fully corrected for heave, roll, pitch, heading and position. Together with the multibeam data, crisp laser images are presented to the operator providing a clear, real-time view of structures both above and below the waterline in a single survey line.

Data from the laser scanner can be collected simultaneously with the SeaBat multibeam sonar. All data is collected and combined by PDS2000. PDS2000 also applies real-time processing to the laser scanning data in order to collect good quality data. Data from the laserscanner can be processed, edited and validated in one of the 3D editors available in PDS2000.

LinkQuest Rolls Out FlowScout 600

LinkQuest recently introduced the FlowScout 600 acoustic flow meter based on innovative acoustic Doppler technology. The single-beam FlowScout 600 acoustic flow meter is capable of reaching up to 110m in range with an accuracy of up to 0.5% +/- 2.0 mm/s. The operating frequency of the FlowScout 600 system is 600 kHz. The standard depth rating of the system is 100m. The FlowQuest system is typically used to precisely measure water velocities in water channels and rivers. It can be easily installed on an irrigation channel bank, a bridge abutment, or a river bank.

Email: sales@link-quest.com

RBR Delivers to Australia

RBR delivered a MS-310 micro-salinometer to the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Hobart, Australia via its agent Metocean Services International www.metoceanservices.com. The MS-310 joins the other equipment at the extensive calibration facility at CSIRO, where they not only calibrate their own oceanographic instrumentation, but offer the service for a range of clients including state research agencies, water authorities and the Australian Antarctic Division. More details of CSIROs

New Underwater Positioning System

Kongsberg Maritime has a new range of acoustic underwater positioning systems and transponders, designed to harness the power of 'Cymbal', Kongsberg Maritime's new signal processing protocol while also being backwards compatible with the HPR 400 protocol and analog transponders. In addition to a new family of transponders called cNODE, new systems include HiPAP 501/451/351/351P, which are the second generation of Kongsberg Maritime's acoustic underwater positioning system and are designed to offer improved position accuracy, longer range capability and faster data telemetry. The new cNODE series of transponders consists of three models: **Maxi** - a full size transponder with large battery capacity, floating collar and release mechanism, and long life operation, designed primarily for seabed deployment. **Midi** - a short transponder with good battery capacity perfectly suited for subsea construction work and **Mini** - a small transponder for ROV/AUV mounting and subsea construction work. cPAP, a new compact subsea transceiver, designed for ROV positioning is also part of the new transponder family.

www.kongsberg.com

calibration facility can be found at http://www.csiro.au/services/OceanographicCalibrationService.html. The MS-310 is designed for an accuracy of ±0.002 PSU and uses sample volumes of less than 20 ml. The consumption of expensive standard seawater is greatly reduced through a standardization technique which allows the standard sample to be reused for many measurements. The dual cell approach removes the need for highly stable bath temperatures since both cells are surrounded by a well stirred oil bath to ensure thermal uniformity. This ensures that sample properties needn't be changed by warming to match the salinometer, making it ideally suited to CSIRO's requirement to calibrate over a range of temperature.

Email: info@rbr-global.com

Schilling HD ROV Targets IMR, Drill Support Markets

Schilling Robotics launched the HD Remotely Operated Vehicle (ROV). Schilling's 125shp HD system is currently completing deepwater sea trials and two HD systems have been ordered for delivery this year. The HD employs Schilling Robotics' technology to bring a high performance work-class ROV system to the market that has a compact deck footprint, while providing design features and performance normally reserved for larger systems.

The HD is designed for accommodating the specific

needs of the Inspection, Maintenance, and Repair (IMR), drill support, and medium-duty construction markets. The HD features Schilling's power management system, remote diagnostics, and advanced automatic piloting modes that deliver superior operational stability and prec6utise control. Based on integrated sub-systems, the HD is designed to reduce complexity, increase efficiency, and lower the cost of owning and operating an ROV. The HD includes dedicated interfaces for integrating intervention or survey tooling. Ergonomic and modular system design provides users with spacious access to the system for rapid maintenance, and a large onboard capacity for installing additional intervention tools. Combined with Schilling's electric TMS system, the HD is capable of excursions up to 425m.

www.Schilling.com

SureGrip Casing Running Tool

Mooring connector company First Subsea was awarded a contract by Canrig Drilling Technology Ltd to supply ball and taper connectors for the new SureGrip automated casing running tool used during drilling operations. The ball and taper technology provides both the gripping / handling function and rotational torque for the threaded pipe sections, specifically casing, during rig operations. First Subsea's Ballgrab ball and taper works on the simple principle of a ball engaged in a taper. As the SureGrip is lowered on to the pipe end, the balls roll down tapers and grip the outer wall of the pipe in direct proportion to the load applied.

Email: info@firstsubsea.com

Cyclops-7 Submersible Fluorometer

Turner Designs offers a corrosion-resistant plastic housing for its C-7 Submersible Fluorometer. The plastic housing is designed as ideal for long term deployments or environments that may degrade or corrode stainless steel sensors. The new plastic body offers the best option in corrosion-resistant material without incurring the higher costs of titanium housings. The plastic C-7 is available with either standard connectors or, for greater corrosion resistance, titanium connectors. The plastic C-7 is available in all the same optical configurations – Chlorophyll, Rhodamine WT dye, Fluorescein dye, Phycocyanin, Phycoerythrin, CDOM, Optical Brighteners, Crude Oil, Refined Fuels, and even Turbidity.

E-Mail: sales@turnerdesigns.com

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Qualifications: Strong technical background, capability to work independently in the field and directly with the customer. Degree in engineering, GIS, or marine science and/or technology or equivalent work experience is strongly desired. Experience in the geophysical and/or hydrographic survey industries, preferably with knowledge of the Gulf of Mexico offshore marketplace.
Head office is located in Lynnwood, Washington. Position is located in Houston, Texas.
Darlene Burt
Kongsberg Underwater Technology, Inc.
19210 33rd Avenue West, Suite A
Lynnwood, WA 98036
USA
Email: darlene.burt@kongsberg.com

PACKAGE ENGINEER - ONSHORE

Job Location: France,
Our client is seeking an onshore based Package Engineer to work in their offices in France.
They are looking for someone to start asap, the contract is expected to last 14 months.
The project mainly involves handlign equipment including sheave blocks, cranes, wire ropes, winches, and hydraulic jackign systems. There may also be involvement in a handlign study of a new module to install large subsea pumps on an FPSO
Sam Cheesman
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Heath Road
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United Kingdom
Email: sam.cheesman@yukpsoffshore.com

MARINE ENGINEER

Job Location: USA, Juneau
Marine Engineer
Saltwater Inc. is looking for a Marine Engineer to work on the State of Alaska's Ocean Ranger Program, as part of our management team. The right individual for the job will have a flexible attitude and the ability to work well with a variety of different people. The position, which is comparable to that of a port engineer, will be based in Juneau, Alaska and will require some travel. Job duties include:
• Training Ocean Rangers
• Reviewing/Approving the training course syllabus
• Supervising Ocean Rangers
• Reviewing Ocean Ranger reports
• Liaising with the Department of Environmental Conservation Project Manager and Saltwater staff
Applicants must have a minimum of two years of maritime/marine experience, at the level of U.S. Coast Guard licensed 2nd engineer or higher. A background in environmental compliance is ideal. Applicants with experience of marine sanitation systems, staff supervision and training adults are preferred.
Salary: DOE
Start date: October 2010
To apply please send a resume and copies of all relevant certifications to:
Saltwater Inc.
Attn: Kathy Robinson
Phone: (907) 276-3241
Fax: (907) 258-5999
Email: Kathy@saltwaterinc.com
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- Ocean Renewable Energy
- Wreck Oil Removal Program (WORP)
- Federal Technology Overview
- Undersea Robotics

We invite you to be a part of OTE 2011, back on the water in beautiful Newport R.I.

May 24-26, 2011

Contact Rob Howard to be a part OTE 2011 - (561)732-4368 or howard@marinelink.com

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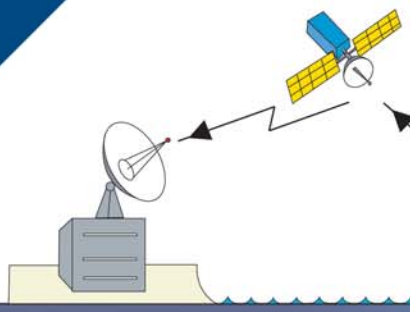
More than 3,000 Sea-Bird IM instruments deployed worldwide since 1997

Real-Time Data Moorings using *Field-Proven* Sea-Bird Inductive Modem (IM) Telemetry

Using a standard plastic-jacketed, galvanized-steel-wire mooring cable as the communication link, up to 100 instruments are easily positioned at any depth up to 6000 meters without cable connectors



IMM

Inductive Modem Module

SBE 37-IMP-IDO

CT(D)-DO Recorder with Integral Pump

ICC

Inductive Cable Coupler

SBE 39-IM

T(D) Recorder

SBE 37-IMP

CT(D) Recorder with Integral Pump

SBE 16*plus*-IM V2

CT(D) Recorder with Auxiliary Sensors (DO, Fluorometer, Turbidity, PAR, etc.)

Third Party Examples

TRDI DVS with integrated IMM

Nortek Aquadopp IM400

UIMM

Underwater Inductive Modem Module (make any RS-232 instrument compatible with Sea-Bird IM telemetry)

CTD-DO

CT-DO

CTD

CT

CTD

T

CT

TD

Third party instrument with integrated IMM

CT

CTD & Auxiliary Sensors

Underwater Inductive Modem

ADCP or other serial instrument

Maximum 6000 meters

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, Washington 98005 USA
www.seabird.com

E-mail: seabird@seabird.com
Telephone: (425) 643-9866
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TRITON® XLR
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The Triton® XLR is designed to provide a "medium-duty, work-class solution" for applications in the 100HP to 125HP range.

TXLR features:

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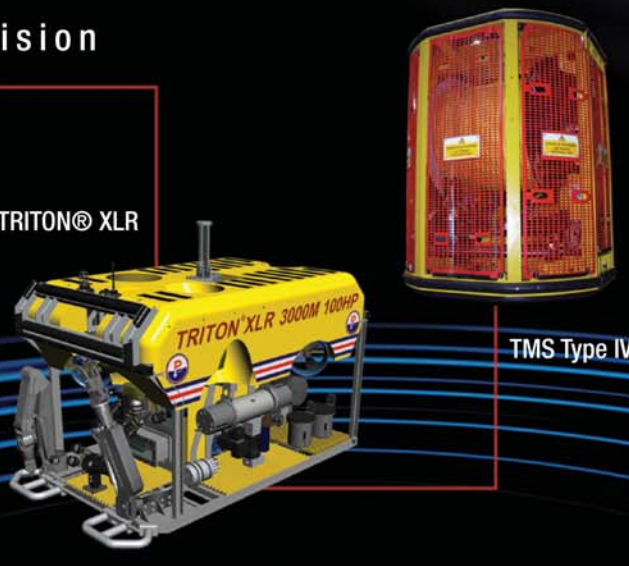
- Tooling manifold
- Survey system
- Fully integrated with the next-generation Type IV TMS
- Graphical diagnostics within the ICE control system

The Triton® XLR is available in 2,000 to 4,000-metre versions, both having a 150kg payload, depending on configuration and the capacity for up to 2,000kg work package interface.

Experience, Dedication, Vision



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