A new project for Devon's coastal railway

Solving geological and geophysical tasks in the snow in Poland

Keechelus Reservoir to Kachess Reservoir Conveyance Project

ROBERTSON GEO®

Unlocking Your GeoData

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GLOBAL GEODATA NEWS

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IT'S HERE, THE ALL-NEW

RGeo-eye® VISUALIZER

Redefining borehole camera surveys by providing a full 360° unwrapped image of the borehole.

Unlike conventional camera systems, which rely on the operator spotting and recording a side view video of a potential problem in the borehole, **RGeo-eye® Visualizer** records the complete sidewall or casing, leaving nothing to chance.

FRACFLOW CONSULTANTS, INC. DARTMOUTH, CANADA
SUPERB CLARITY OF THE Hi-OPTV AT BREEDON ON THE HILL
THT INTERNATIONAL CO. LTD - EXCLUSIVE AGENT IN VIETNAM
NEW AGENT FOR NIGERIA - GEOSPACE SURVEY SERVICES LIMITED
DRUMCONRATH, IRELAND – AWN CONSULTING

INSIDE:
FOUR PAGE EDITORIAL INSERT

OFFSHORE WIND FARM DESIGN PROCESS
The Importance of Wireline Logging Data

The RGeo-eye® camera system is our market leading downhole camera system.

RGeo-eye® Downhole Camera

IT HAS A deep operating range for the acquisition of high-quality video feed for deep subsurface applications. The camera operates on industry-standard 4-core or coaxial wireline cable and offers pressure ratings to 5000 psi and a 90°C temperature rating.

90°C

3,000 METRES

30 FRAMES per sec

The camera comes with acquisition software that's easy to configure and work with, offering resolution control; lighting control; depth recording; text editing; recording video; screenshots; RGeo-eye® specification and depth & temperature warnings; Power meter and High res. frame capture mode with zoom-in function.

If viewing digitally click on downhole video image to view.

Download RGeo-eye® Downhole Camera literature here.

IT'S HERE, THE ALL-NEW RGeo-eye® VISUALIZER

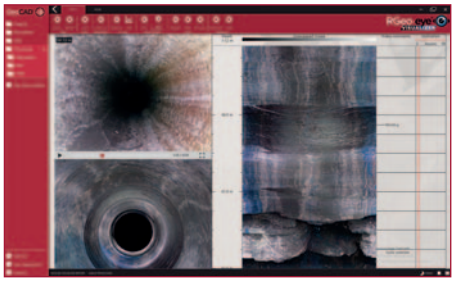
DEVELOPED BY LOGGING PROFESSIONALS with their reporting needs in mind, the software focuses on producing industry-standard video reports quickly and reliably.

With the emphasis on deliverables, the easy-to navigate module and pre-set templates reduce processing time without any compromise on quality. The RGeo-eye® Visualizer module within GeoCAD® is the software of choice for all logging users looking to reduce costs, improve workflows and enhance time management.

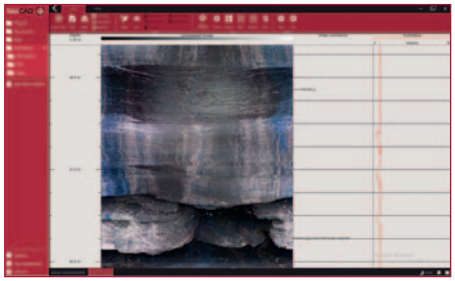
- 100% of the borehole or casing sidewall is recorded every time
- No longer dependent on the operator spotting and recording features
- No more disorientating videos to interpret
- RGeo-eye® delivers a down view video, a full 360° unwrapped image of the entire borehole and a 3D fly-through image of the borehole
- Quick and easy data collection - as the unwrapped image is produced after the down view video is obtained, the user just needs to make a record the down view video, as there is no longer any need to waste valuable time scanning the borehole walls looking for features
- One easy-to-use interface allows users to replay, review and comment on videos, take screenshots and produce standard reports; it couldn't be easier

VIDEO PROCESSING

Once the down view video is downloaded, the 360° unwrapped image is just a click away.



Standard Triple View Visualizer.

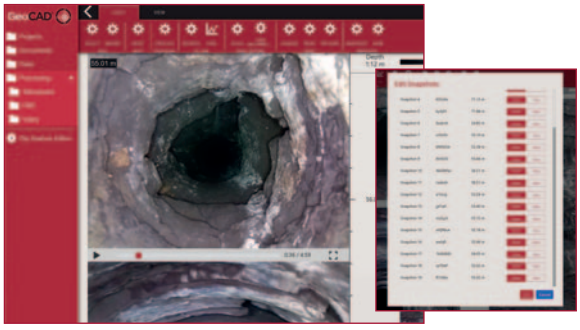


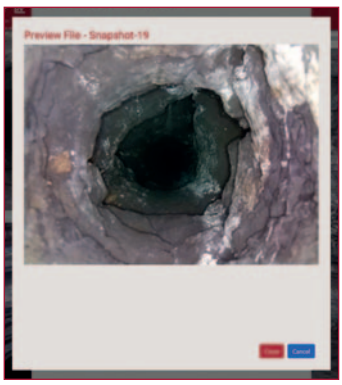
Detailed 'unwrapped' display.

The full-width display allows a more detailed analysis of the full borehole image. Unlike conventional side-view camera outputs, users know exactly where they are in the borehole. No more disoriented images and reliance on the operator to capture features.

SNAPSHOTS

Snapshots can be taken during replay, and can be viewed and edited before saving for inclusion in the final reports.





Example snapshot.

- *Snapshots can be viewed and edited at anytime*
- *Depth and video time is recorded on the snapshots for the final reports*

If viewing digitally click here to visit the GeoCAD® website for more information.

USER EXPERIENCE
Easy to navigate
Simple video import tools
No need to replay multiple side view video
Video, Unwrapped and 3D outputs all on one display
Video Comments/Snapshots
Quick and easy to use
Simple Report Wizard

STANDARD OUTPUTS
Standard down-view video
Full 360° unwrapped image
Spanshots with depth and time display
Industry-standard log header
PDF Reports
Comments against depth
Borehole inclination log

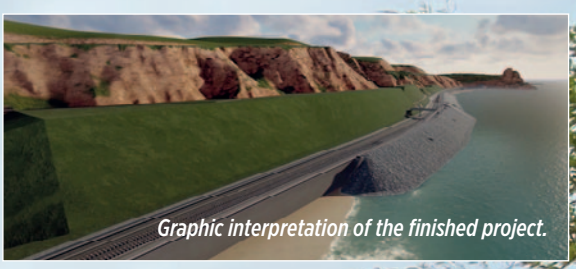
VISUALIZER FEATURES
Quick selection menu's
Triple view visualizer
Full control over image scaling and output
Flexible comment writing/editing tools
Image drag & rotate
3D Visualiser
Data import/export wizard

A new UK project for Devon's coastal railway

ROBERTSON GEO OPERATING SERVICES was contracted to conduct geologging on boreholes drilled as part of the geotechnical investigation for the re-alignment of the Parsons Tunnel to Teignmouth railway tracks in Devon.

The railway travels along a famously picturesque route along the south coast, with sheer sedimentary cliffs on one side, and the open ocean on the other. The project aims to improve this infrastructure by re-aligning the tracks and ultimately creating more space on the coastline. This space will allow for the installation of rockfall protection, will increase beach retention, and provide amenities to the public such as walking and cycling routes.

Robertson Geo Televiewers were deployed to increase their geological dataset where core sample recovery was impeded. Understanding groundwater conditions by running the NMR (nuclear magnetic resistivity) was also a priority, as with electrical measurements from the Focussed Electric and Electric Log probes. Other tools deployed included the 3-Arm Caliper, Triple Sonic, and the Temperature/Conductivity probe which provided important data on issues such as saltwater incursion into these coastal aquifers.



Graphic interpretation of the finished project.

Logging on site in Devon.

Superb clarity of the **HIGH RESOLUTION OPTICAL TELEVIEWER PROBE** at **Breedon on the Hill, UK** Quarry Extension

BREEDON IS A leading construction materials group in Great Britain and Ireland. Producing cement, aggregates, asphalt, ready-mixed concrete, Welsh slate and specialist concrete and clay products, and offering a range of contracting services.

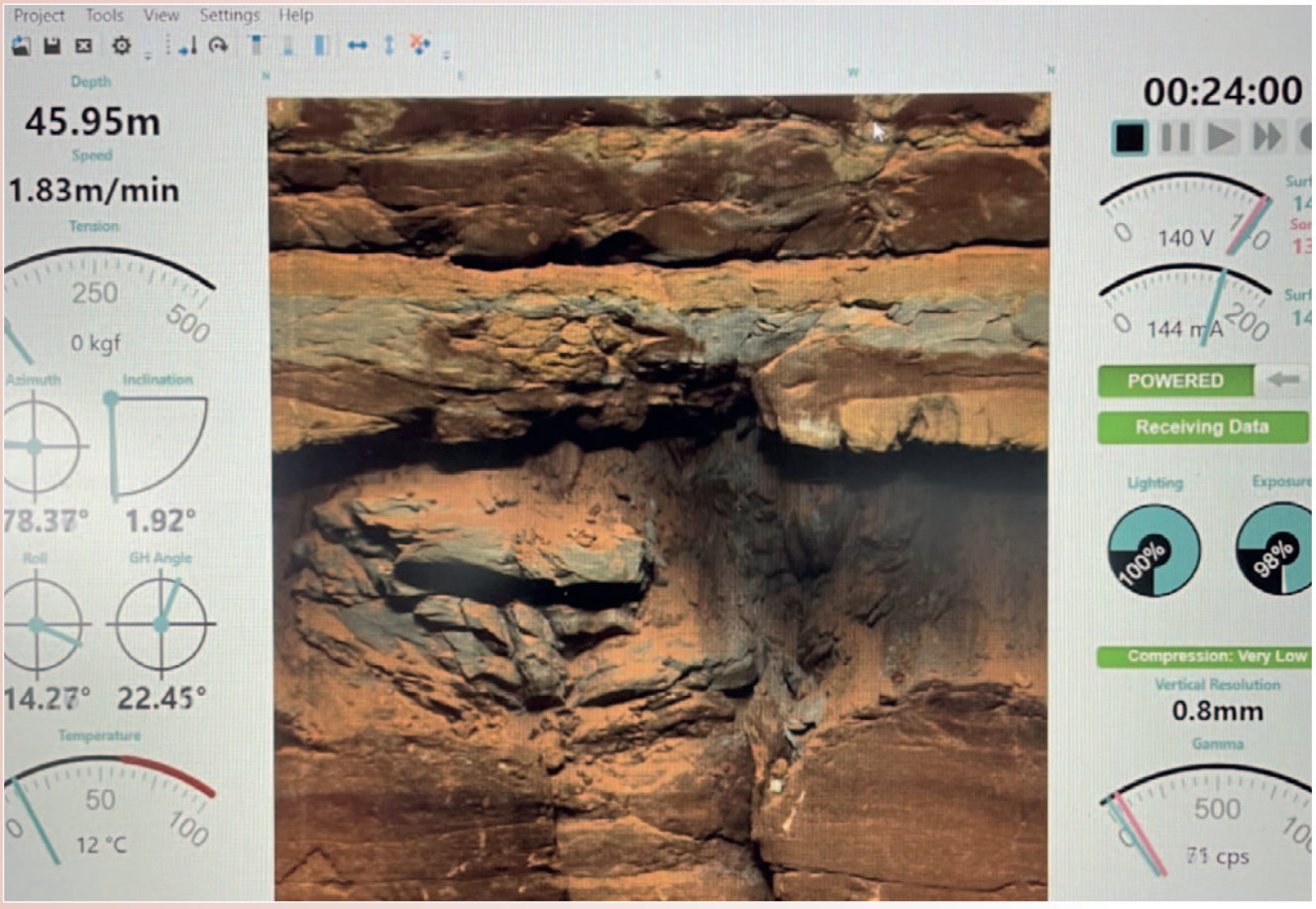
Robertson Geo Operational Services successfully completed a geotechnical inspection for Breedon on boreholes utilising a High Resolution Optical Televiewer (Hi-OPTV) and 3-Arm Caliper probes.

Following phase two of the quarry extension, the extraction of 6,375,000 tonnes of limestone and 1,455,000 tonnes of Golden Amber will begin. The duration of this stage is c.15.7 years, which will be determined by the time taken to work out the Golden Amber and thus release future tipping space for further stripping of the extension.

The Hi-OPTV provides a continuous very high resolution-oriented image of the borehole wall using a conventional light source. A unique optical system based on a fisheye lens allows the probe to survey 360 degrees simultaneously.

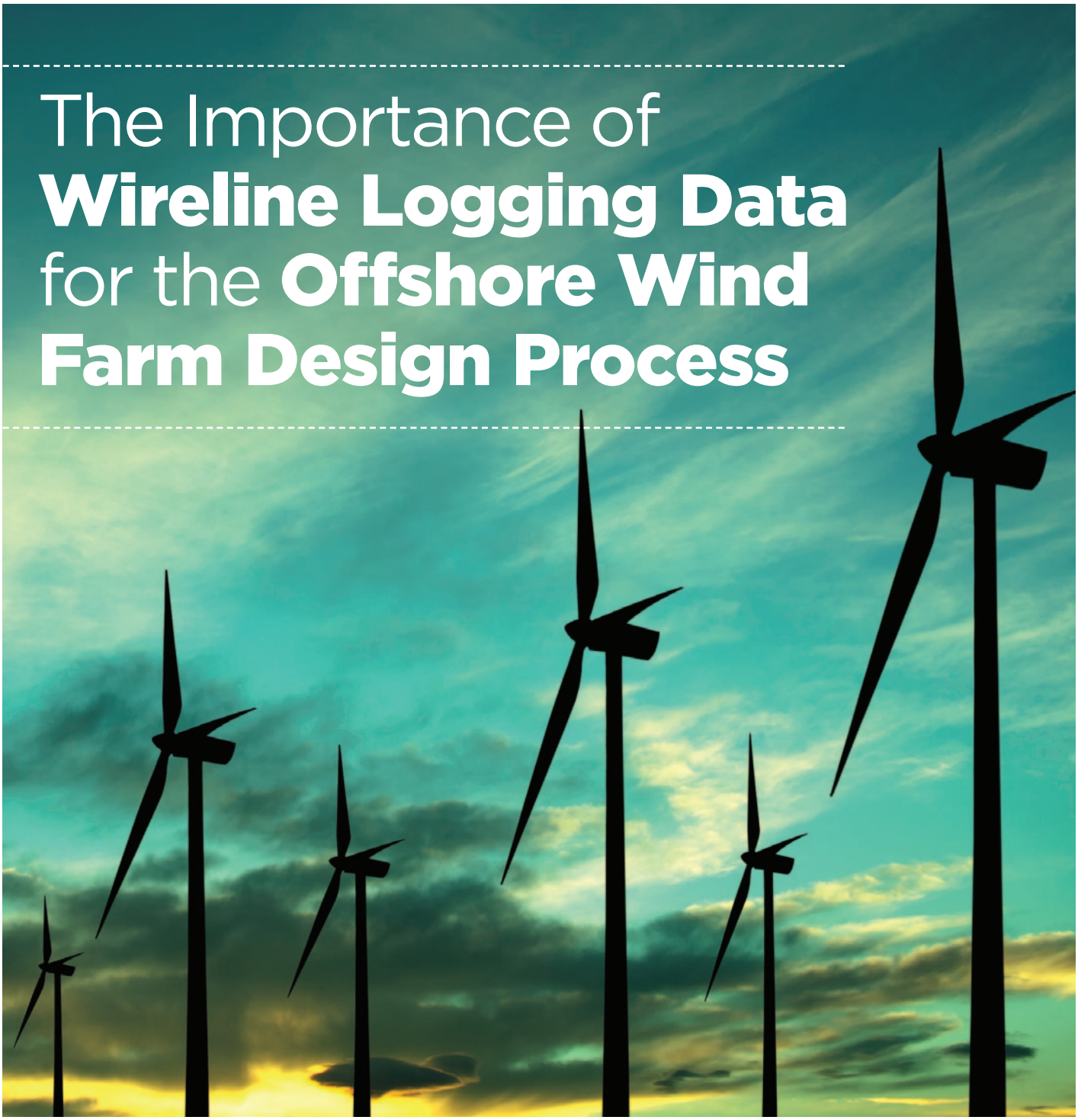
Fractures faults and voids can be detected using the Hi-OPTV to characterise features intersecting the borehole wall, including bedding, drilling-induced/natural fractures and faults. Integrated orientation measurements allow the inclination and direction of features to be understood relative to the borehole dip direction, or true or magnetic north.

The clarity of the Hi-OPTV was superb as illustrated in the below image making it easy to identify fractures, voids, bedding, and the changing geology at given depths below ground level. All vital information for a client in a geotechnical investigation such as this.



ROBERTSON GEO
Unlocking Your GeoData

The Importance of **Wireline Logging Data** for the **Offshore Wind Farm Design Process**



Introduction

Offshore Wind Farm (OWF) development is set on an unstoppable exponential growth curve as the world moves away from fossil fuel dependency toward zero-carbon targets. The scale of wind farms and the size of their individual turbines are increasing as is the distance from shorelines. Fixed bottom designs, predominantly monopiles, have dominated to date, but as suitable near shore locations are filled future trends will include various other designs including floating systems.

Wireline logging data has been routinely collected for OWF ground investigation on jack-up platforms and drill ships for over 15 years, feeding into the complex design processes necessary for these ever-larger structures.

Specifically, velocity data from the **Robertson Geo PS Logger**® has become a standard component of the geotechnical site investigation.

Offshore wind capacity is expected to grow by at least 235 GW over the next eight to 10 years (Courtesy: ABB).

Histories

The wireline logging technique dates to the 1920's whence the Schlumberger brothers demonstrated the first commercial electric log probe. Analog systems developed for the next 40 or 50 years notably being adopted for oil and gas exploration, with an increased diversity of probes. Robertson Geo entered the slim hole tool market in the 1980's developing digital systems for geotechnical, mineral and water applications. The advantage of this digital system being the plug compatibility of probes using a common winch/acquisition unit set-up.

Although wind power has been harnessed by man for millennia it was in 1978 that the Danish developed the world's first modern multi-megawatt wind turbine at Tvind. Capable of delivering 2MW, it had a nacelle, tubular tower, pitch-controlled wings and three blades and is still running today. All commercial wind turbines resemble this Danish model, a three-blade horizontal axis design, now all rotating clockwise. Denmark also developed the worlds first commercial OWF in shallow waters at Windby in 1991. OWF development has since accelerated through many pilot and small scale schemes to the giant OWF that are common today. UK, Germany and now China are currently leading the way in terms of installed OWF capacity.

OWF Site Investigation Techniques

For any OWF, investigation of the site is essential for all aspects of the development, from wind characterisation through geophysical and bathymetric surveys to sub-surface investigation. In addition to turbine locations there will be cable runs and infrastructure locations to be considered. For a large OWF it may take two seasons (years) to complete the geophysical and geotechnical investigations as they are best conducted separately to avoid interaction.

The collection of data to feed into the wind turbine design process is vital, due to the complex nature of the dynamic and cyclic loading of these structures, to characterise the soil-structure interactions. Regardless of which design approach is adopted, a marine geotechnical investigation (including in-situ and laboratory testing) is essential for a successful design. *See Figure 1.*

The geophysical survey phase of investigation will usually be conducted first and may include unexploded ordnance (UXO) detection from a magnetometer survey. Bottom profiling techniques such as Sonar and LiDAR will be used to map further sea bottom obstacles such as rock outcrops, boulders, and maritime wrecks. With the bottom profiling complete non-invasive investigation of the subsurface can begin using shallow reflection or refraction techniques. These usually require large slow moving vessels towing hydrophone arrays and consideration of the effect of the energy sources on marine mammals will have to be considered. For seismic reflection surveys the P wave velocity profiles from the PS Logger® probe can be used in the conversion of arrival times to depths (for stacking and migration velocities).

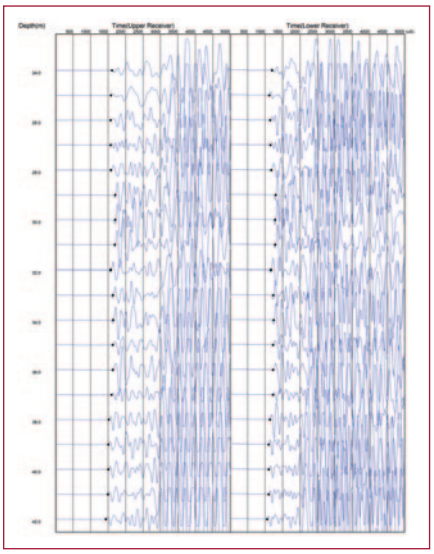
Geotechnical surveys employ invasive techniques and are usually conducted following the geophysical investigations. For shallow near-shore pilot or small-scale sites this was often carried out on small jack-up platforms where the crews were changed each shift. These arrangements also required a variety of support vessels such as tugs for platform movements, safety vessels on standby and crew transfer boats. As distances from shore increased it became impractical to change crews twice daily and larger more expensive accommodation platforms were then deployed, again with support vessels. The use of jack-ups is now mostly confined to areas where draughts are too shallow for drill ships or where tidal runs render their positioning difficult.

Heave-compensated, dynamically positioned drill ships now dominate the OWF geotechnical investigation market. These can operate, relatively economically, without assistance for long periods of time with the main constraint being the weather operating limits. These vessels employ sophisticated drilling systems which combine core sampling and CPT operations with the drilling process. Some testing of the cores may take place onboard, but the samples collected are subsequently sent for laboratory analysis where a plethora of tests may be conducted. The CPT testing provides data on tip resistance, sleeve friction and pore pressure from which many useful design parameters are derived. In addition, seismic CPT (SCPT) tests may also be conducted, involving the use of a separate seabed frame, as well as SPT or pressure meter tests.

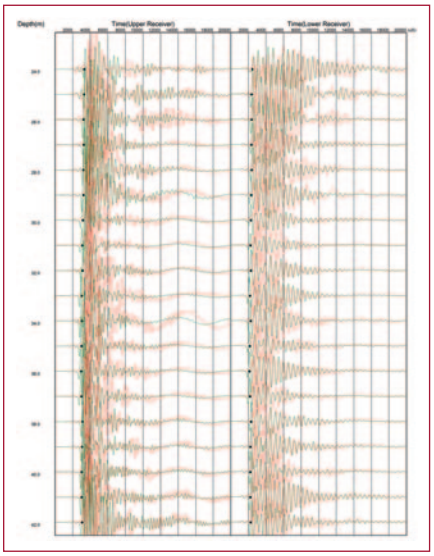
Once the borehole has reached target depth wireline logging is performed on the completed borehole, usually in stages to ensure maximum coverage. The PS Logger®, now a standard requirement for European and USA OWF, is run to provide P wave and S wave velocity profiles, often in conjunction with a caliper for QC purposes. The benefits of the PS Logger® are that it provides high quality data at the deeper sections of the borehole due to its integral energy source and provides information in rocks, pebbles, and gravels where CPT cannot penetrate. Where more competent

Type	Survey	Method	Deployment	Data Density Coverage
Non-invasive	UXO	Magnetometry	Shipborne / towed buoy	Areal
	Bathymetric	Sonar	Shipborne / towed buoy	Areal
	Bottom profiling	LiDAR	Shipborne / towed buoy	Areal
	Seismic	Shallow reflection/ refraction	Shipborne / towed array	Grid
Invasive	Sub-surface	Push CPT	Ship + seabed frame	Turbine/Infrastructure sites
	Borehole	Sampling, CPT, SCPT, PS Logger®	Jack-up / drill ship	Selected % of sites

Figure 1: Example OWF Site Investigation Programme



P waves logging example (Source: PS Logger®).



S waves logging example (Source: PS Logger®).

rocks are found an acoustic televiewer may also be deployed to provide borehole wall images showing bedding and fractures. This information is also used to provide core sample depth control and orientation for input into ground models.

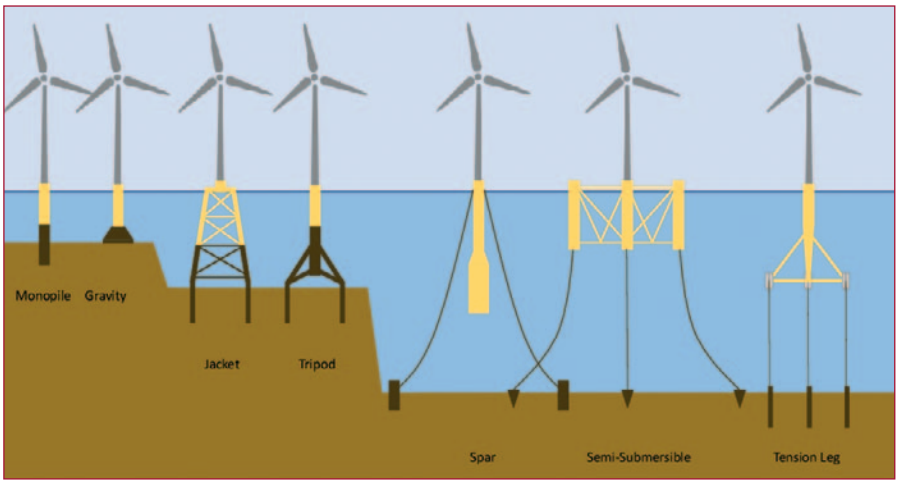
As drilling is often only conducted at a percentage of turbine locations it is vital that as much data as possible is extracted by wireline means from each borehole.

Foundation Designs

Practically all commercial scale OWF to date have been of the fixed bottom design, though the transition toward floating systems is underway, in terms of pilot programmes, small scale developments and aggressive future plans.

The fixed bottom designs come in a variety of types but are to date dominated by monopile systems. Monopiles are a well proven and relatively simple concept with low manufacturing costs and well-tried installation methods. They can be constructed in soft and stiff soils equally, but the local soil conditions need to be tested and understood. Monopiles with their high mass to stiffness ratio exhibit large modal deflections in the submerged zone, attract large wave forces and are prone to scour. Nonetheless, these issues, along with challenges in manufacturing, transport, installation and maintenance have largely been addressed leading to a fabulously successful design paradigm that is a leading light in the drive towards a zero-carbon future.

As water depths increase and turbine sizes grow the monopile design has had to scale up to ever larger diameters to support the ever-taller structures. As the limits of scalability are reached it becomes economic to consider other designs such as suction bucket foundations, tripods and jacket systems. These compound designs currently represent a small proportion of installed turbines when compared to monopiles but are increasing in popularity. With turbine outputs currently approaching 15MW and with plans already in place for up to 20MW turbines the sheer scale and impracticality of single monopiles to support these structures is already driving designs toward these more modular concepts. It should be noted that tripod and jacket structures place completely different loading characteristics on their multiple foundations when compared to monopiles. Whereas lateral forces on monopiles result in bending and overturning moments in subsurface structures, tripods and jackets convert much of the lateral forces into vertical push-pull effects on the foundations.



Types of support structure concepts (left to right): monopile, gravity based, jacket, tripod, spar, semi-submersible platform and tension-leg platform.

Whatever the design paradigm, data from wireline techniques is invaluable for designers to model the soil-structure interactions.

Unique Characteristics of Fixed Bottom Wind Turbine Design

Offshore wind turbine foundation design presents many unique challenges for designers, manufacturers and installers. Large offshore wind turbines (OWT) are tall, have high rotor nacelle masses (RNA mass), are relatively flexible and are subject to a variety of dynamic and cyclic loads. Issues of scalability are also important as loading characteristics change as diameters (and therefore stiffness) increase whereby the significance of flexural bending modes may be diminished relative to overturning moments. The main purpose of a foundation is to transfer loads safely without excessive deformation to the surrounding soil. The behaviour of saturated soil under cyclic and dynamic loading is very complex and therefore the design of the foundations for these structures is challenging.

The loading characteristics on OWT includes dynamic components from aerodynamics, waves and current and soil interaction as well as cyclic loads from the blade rotation. This loading profile results in lateral loads, bending moments, rotational moments/overturning moments and sway and rocking modes of vibration.

The design of the overall OWT must ensure that the natural frequency of the structure avoids the frequencies of the cyclic loading and therefore avoids resonance. Analysis of the spectra of the dynamic and cyclic loading shows wind having the lowest frequency range, waves next lowest, then rotor frequency (1P) and finally blade passing frequency (3P – for 3 blade turbines), *see Figure 2*. Bending modes of the tower together with the top RNA mass allow the sway-bending modes of the system to be determined. The foundation is very stiff axially when compared with the tower and effectively the tower vibrates, and the foundation provides stiffness and damping. The overall design frequency of the system should avoid the blade rotor frequencies and can be in the Soft-Soft, Soft-Stiff or Stiff-Stiff zones with many designs using the Soft-Stiff region.

The design of OWT foundations is based on many design tasks and analyses of design criterions in order to ensure that the relevant design limits are not exceeded, and the allowable turbine specific natural frequency ranges are maintained. Multibody Dynamics and the Finite Element Method are popular tools employed in the design process with data from the ground investigation

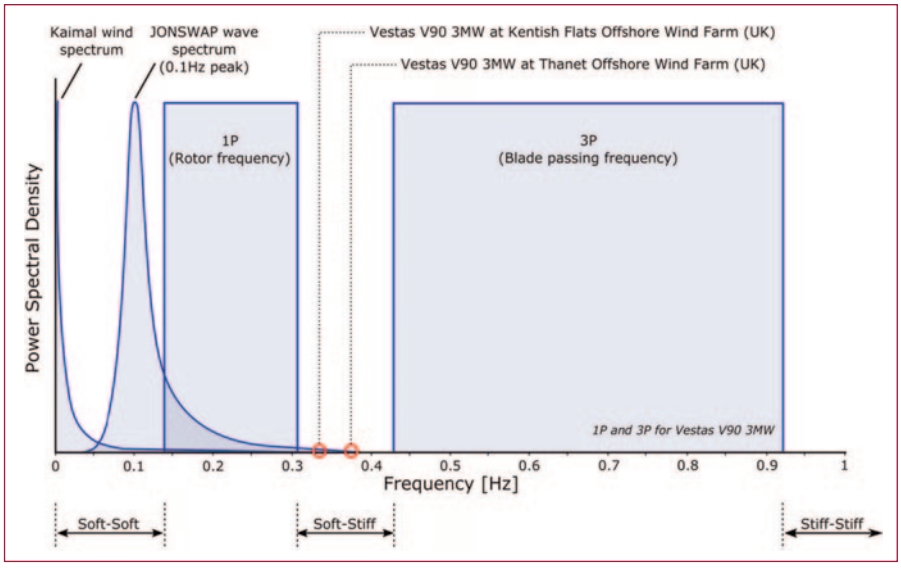
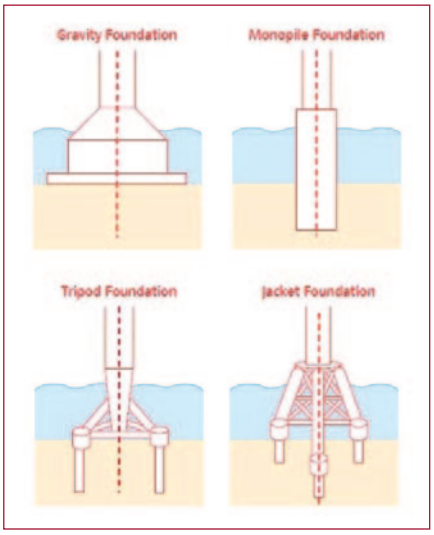


Figure 2: Example Power Spectra for OWT Design (Source: www.surrey.ac.uk).

being essential for analysing the soil-structure interactions. The modes of vibration will dictate the interaction of the foundations with the supporting soil. Furthermore, if the soil-structure interaction is understood, the long-term behaviour of the foundation can be predicted.

In European waters the PISA system has been adopted which provides a computational model for the analysis and design of laterally loaded monopile foundations for offshore wind turbines. The PISA system gives P-Y curves which simulate the soil resistance as predefined nonlinear springs. PISA provides a series of nonlinear P-Y curves that vary with depth and soil type giving pile deflection (Y) for a given soil pressure (P) per unit length of pile. For a monopile, the main interaction is lateral pile-soil interaction due to the overturning moment and the lateral load. Conversely, for a jacket, the main interaction is the axial load transfer. Therefore, the soil-structure interactions depend on the choice of foundation and how the soil surrounding the pile is loaded. The provision of sufficient damping is critical for offshore turbines to prevent excessive fatigue damage over the lifetime of the structure.

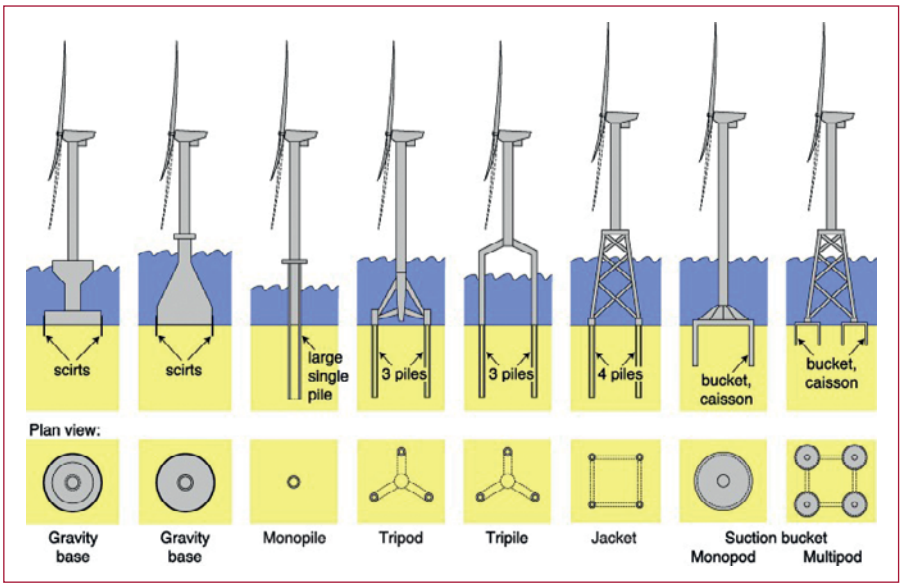
In addition to analysing stresses and determining natural frequencies there are many other factors that need to be considered for a successful design. These include turbine size, choice of foundation type, foundation installation methods, scour mitigation and supporting infrastructure, such as substations and cable runs, and environmental considerations.



Offshore wind turbines foundation types.

Wireline Data

The collection of wireline data now forms an integral part of the overall geotechnical investigation for OWF. The PS Logger® is now considered to be invaluable due to its ability to provide high quality velocity profiles for foundation design and has been adopted across UK, Europe, USA and Asia. Ease of deployment, reliability and the ability to collect data through formations that are impenetrable to CPT make it a go to technology for many OWF developers.



Fixed Bottom Designs.

Caliper logs are now commonplace to provide quality control for the PS Logger® when borehole conditions are less than ideal.

Where more competent formations are encountered the acoustic televiewer has been deployed to provide core orientation and depth control and for input into ground models. For the future, NMR technology is being considered as it gives detailed hydrogeological information, not easily obtained by other means, and raises the possibly for the derivation of in-situ density profiles. A notable benefit of the wireline system is that the same surface set-up can be used for a variety of probes, important for drill ship operation in the adverse environmental conditions encountered far from shore. *See Figure 3*.

The Future

With a proven track record for reliability and data quality in the OWF market, wireline systems will continue to provide data which is difficult or impossible to collect by other means. Robertson Geo Operational Services provide turnkey solutions for the hazardous environment of drill ship operations, all but eliminating attributable lost time. As offshore wind farms grow in size and move ever further out to sea, eventually embracing floating structures, wireline logging can continue to provide invaluable data for turbine locations, infrastructure sites and anchorage points.

Graham Comber
Geophysical Services Manager - Robertson Geo

Probe	Outputs	Example Usage	Comment
PS Logger®	P wave velocity	Conversion of reflection data times to depths	
	S wave velocity	(+ P) Calculation of Poisson's ratio	
	Poisson's ratio	Soil type classification	
		Elastic modelling	
	Shear modulus	Small strain moduli for elastic modelling	Requires density
	Young's modulus	Calculation of damping ratios	
	Bulk modulus	Calculation of settlement and rigidity	
Caliper	Borehole diameter	QC for PS Logger data	
		Identification of weak layers	
	Natural gamma	Bed delineation	
Acoustic Televiewer	Unwrapped image	Core orientation and depth control	Mainly for competent rocks
	Bedding and fracture Dips and azimuths	Ground modelling	
NMR	Porosity	Hydrogeological modelling	Proposed usage
	Pore size distribution		
	Mobile water content		
	Capillary water content		
	Clay based water content		
	Permeability		
	Transmissivity		

Figure 3: Example Wireline Data Outputs

Logging in the snow in Poland.

Logging in the snow in Poland

Geopartner logging vehicle at work in Lithuania.

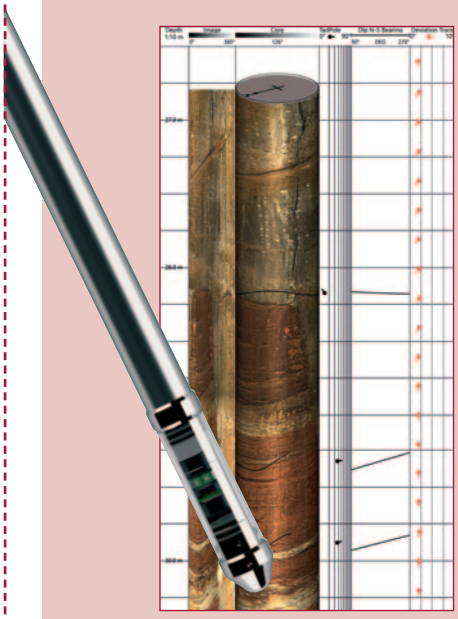
GEOPARTNER SP. WAS established over twenty years ago based on many years of experience of the founders.

From the beginning, the company has promoted the latest technologies and standards of solving geological and geophysical tasks. The basis of our activity is investing in people. Now we employ over forty engineers of many specialisations. They include specialists in geophysics, geology, engineering geology, hydrogeology, hydrology, and environmental protection.

Images of field work using Robertson Geo wireline tools and surface equipment are from a project in Lithuania near Kaunas. Vertical and directional boreholes 350m to 450m deep for identification of mineral resources (anchydrites), also from imaging geotechnical boreholes to identify the geological structure of a newly designed railway line approximately 60 km south-east of Krakow in Poland.

Przemysław Kiszka,
Project Manager/Senior Geologist

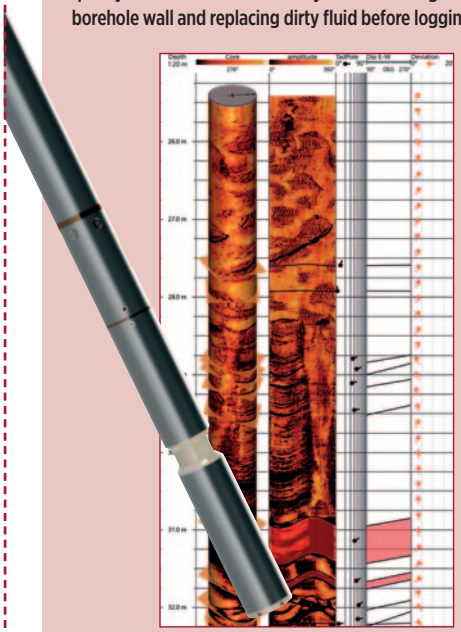
www.geopartner.pl



The High Resolution Optical Televiewer (Hi-OPTV) Probe, with logging data example.

How Televiewers work:

The acoustic televiewer logs the borehole wall in terms of hardness, measuring the amplitude of a high frequency reflected sonic pulse at very high resolution. It describes the borehole skin rather than the formation beyond. Hard rocks reflect high-amplitude signals and soft rocks, and fractures reflect low ones. The individual measurements of reflected amplitude are made continuously by a rotating transducer or, more often in slim tools, a rotating sonic mirror aligned with a stationary transducer. The result is a map of the borehole wall with an individual resolution of about 2mm in ideal conditions. The left edge of the High Resolution Acoustic Televiewer (HRAT) is aligned with magnetic north. Fractures and bedding planes appear as sinusoidal lines where the deepest point on the line is the direction of dip. The High Resolution Optical Televiewer (Hi-OPTV) provides an orientated photograph of the borehole wall at high resolution and without perspective. The system does not offer a travel time image, and log quality is dependent on clean borehole fluid if it is run below the water table. In slim holes, optical televiewer images can be of such high quality and value that it is usually worth cleaning the borehole wall and replacing dirty fluid before logging.



The High Resolution Acoustic Televiewer (HRAT) Probe with logging data example.

Fracflow Consultants, Inc.
Dartmouth, Canada

Robertson Geo Client, Fracflow Consultants Inc. is an environmental, hydrogeological, and geotechnical engineering company operating around the world from its main offices in Dartmouth, NS and St. John's, NL, and a satellite operation in Corner Brook (Gillams). Fracflow was incorporated in 1982 and provides consulting services for:

- *Hydrogeology, Ground Water and Surface Water Hydrology*
- *Environmental Engineering and Site Remediation*
- *Environmental Impact Assessments and Baseline Studies*
- *Geotechnical Engineering and Soil Mechanics*
- *Mine Dewatering and Minewater Management*
- *Geological Engineering and Rock Mechanics*
- *Foundation Design and Engineering*
- *Project Management*

Fracflow has successfully completed numerous small-scale and large-scale projects for federal, provincial, and municipal governments, research organizations, insurance companies, law firms, waste management companies, construction companies, petroleum producers, mining companies, small businesses, and private individuals.

Senior staff has over 30 years of experience in fracture orientation of boreholes.

Glen Bursey is a Principal, Vice President, and Manager of Fracflow's branch office in Dartmouth, Nova Scotia, and a Senior Hydrogeologist:

"The dedication, expertise, and innovative approach of our professionals, assisted by a cast of equally dedicated and competent support personnel and associated research consultants, has been the recipe for Fracflow's proven, and well-documented, track record of success and accomplishment.

One of the important advantages of our company is our size, which carries with it a commitment to our clients that the Senior staff are and will be involved in all aspects of a project, from its inception and planning to the final design, implementation, and reporting stages. The results of this commitment are reflected in the quality of our work and a long list of satisfied clients, which comes in part from a continued determination by our staff to find practical solutions to our client's problems in a timely fashion and at reasonable cost."

Recent Fracflow projects have included:

The inspection of the construction of a geothermal well field at a new build facility. Well bore conditions of 15cm in diameter borings, were carried out using Robertson Geo's HRAT logging system. Fracflow concluded that the drilling methods used by the drilling contractor imparted excessive energy to the rock/borehole wall and caused excessive rock breakage. The data from the HRAT proved essential for recommending the proper drilling tools and drilling methods to minimize borehole damage and borehole deviation with depth.

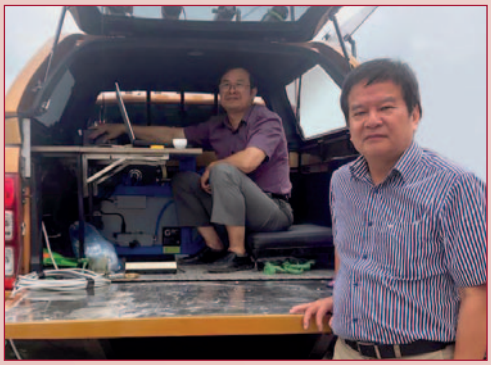
Fracflow conducted a phased water supply assessment of a proposed Country Club. It planned and executed a High Resolution Acoustic Televiewer (HRAT) survey in seven vertical exploratory, 15cm (6") diameter percussion, production wells and one exploratory, inclined, pilot production well and used the acquired data to determine fracture and bedding plane geometry as a function of depth and spatial location across the development site.

Three separate projects were completed as part of Pre-Feasibility Mine Study. Acoustic Televiewer services included logging approximately 24,385m of boreholes, data processing and interpretation. Fracflow compared the HRAT borehole azimuth and plunge data to the equivalent data collected by another contractor using a gyroscope. Both methods produced identical tilt and angles for inclined and vertical boreholes that extended 1,219m in length.

Fracflow Consultants, Inc. has conducted acoustic and optical televiewer logs in tens of thousands of meters of open boreholes in many different geologic environments. It deploys Robertson Geo Hi-OPTV and HRAT wireline probes using either Robertson Geo 500m or 2000m Winch system.

THT International Co. Ltd -
Robertson Geo's exclusive agent in Vietnam

THT International Co., Ltd is a manufacturing, service and trading company established in 1996. As well as supplying the domestic market, our products have been exported to Indonesia, India, Spain, Venezuela, Philippines, Malaysia, Iran, Iraq, Mexico, and many other countries.



Tuan Luong Si (front right) during the commissioning of a THT custom-built Robertson Geo 2000m logging unit.

I graduated from Bucharest University, Faculty of Geology and Geography. My major is Geophysics, and my graduation subject was Borehole Logging. It was way back in 1992 when I first experienced working with Robertson Geo for Diethelm Engineering Vietnam, this first project being the supply of a vehicle-mounted borehole logging station to the state Geology and Mining Company in 1996. After that, I established my company, THT International Co., Ltd and have had a lot of other business cooperation with Robertson Geo ever since.

Our main business with Robertson Geo is supplying equipment and service support to buyers. Probably the most complex and satisfying project of recent years was the sale and installation of a 2,000m logging system on a local vehicle for a large coal exploration client.

It gives me pleasure to use my knowledge of Geophysics to serve the right buyers in the field I studied at University and with Robertson Geo it gives me great confidence in working with a worldwide leading company in a unique technology sector. It pleases me to make friends and have good relationships with the companies who have bought our equipment. This is thanks to the high quality of equipment and service, which meet buyers' expectations and helps them do good business.

We have confidence in a company with good technical experts and support. Great trust in long-term friends from Robertson Geo who are helpful and sincere in all aspects. It assures you that it is always near you and sharing the difficult moments and problems to make the business successful.

Tuan Luong Si - Owner.

THT built custom logging truck.

Welcome to our New Agent for Nigeria

GEOSPACE SURVEY SERVICES

Opeyemi Oyewole, Managing Director for Geospace Survey Services Limited, is an expert in Geophysical and Offshore Survey and Data Analysis with over 20 years of experience from Project Manager Shallseis UK LTD for 3D T/Z OBC Seismic data acquisition at the Ibaka Location; Centrica Energy Nigeria for 2 years, also serving as the Senior Geophysicist and Project Manager with Brone Survey for 6 years. Opeyemi has additional experience as Senior Surveyor at Gardline Environmental LTD (UK) and Fugro Survey BV for 5 years and 1 year respectively.

Gavin Rowlands, our Global Business Development Manager, welcoming Opeyemi on his visit to Robertson Geo.

"Geospace Survey Services Limited is willing to participate in sales and service outlets for all Roberson Geo products and technology. We also have capacity in various partnerships for technical support with multinational oil and gas servicing companies as well as collaboration with local companies within Nigeria."

Back on the Exhibition road again after a difficult period

The last couple of years have been a difficult time for all businesses and we are pleased to say we are now supporting, participating, and exhibiting at International venues again. Meeting customers and new contacts face to face is important to us and over this year we have committed to events in the UK, USA, Canada, Europe and Asia.

Keep in touch with us at our events page on **www.robertson-geo.com** *- we are looking forward to seeing you.*

Keechelus Reservoir to Kachess Reservoir
Conveyance Project
Snoqualmie Pass, WA, USA

Global Geophysics, LLC. has wide experience of borehole data acquisition, but one of the challenges from working on a small barge is limited space.

THE BUREAU OF Reclamation and the Washington State Department of Ecology worked together to route water from the Yakima River to the Keechelus Dam. Water will then be moved through a tunnel to the Kachess Reservoir.

This project will diminish the strain on the Keechelus Dam and create the opportunity for the anticipated Kachess Drought Relief Pumping Plant, to deliver water for agriculture and domestic and municipal uses during a drought.

Before the construction of the tunnel that will ultimately move water from the Keechelus Reservoir to the Kachess Reservoir, structural studies needed to be conducted. With the aid of John Lui, PhD. and his company Global Geophysics, LLC., slope stability studies were underway to collect the true orientation and dip direction of the rock in several boreholes. The information was collected using Robertson Geo's High Resolution Optical Televiewer (Hi-OPTV) and High Resolution Acoustic Televiewer (HRAT) equipment. The equipment was deployed using Robertson Geo's Mini Winch. Global Geophysics, LLC collected information from many boreholes both on land and utilizing a barge on the lake.

Drumconrath, Ireland – AWN Consulting

ROBERTSON GEO WAS contracted by AWN Consulting Ireland to conduct a below surface investigation on a successful water well just outside the village of Nobber in North County Meath, Ireland.

The data collected from the investigation was used to help determine the optimal position of the next well to be drilled.

To make this decision, both the High Resolution Optical Televiewer (Hi-OPTV) and High Resolution Acoustic Televiewer (HRAT) were used - for maximum data recovery - to determine the orientation of the fractures in the well's geological formation. These tools were run in combination with a 3-Armed Caliper probe which provided the gamma profile of the well along with any change in diameter.

ROBERTSON GEO

Unlocking Your GeoData

SAFETY IS KEY ©

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