Hi-OPTV Survey for over 700 boreholes

Offshore does not always mean the ocean

Temperature log and geothermal gradient in Colombia

ROBERTSON GEO

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ATLANTIC SHORES OFFSHORE WIND

HIGH IN THE SWISS MOUNTAINS

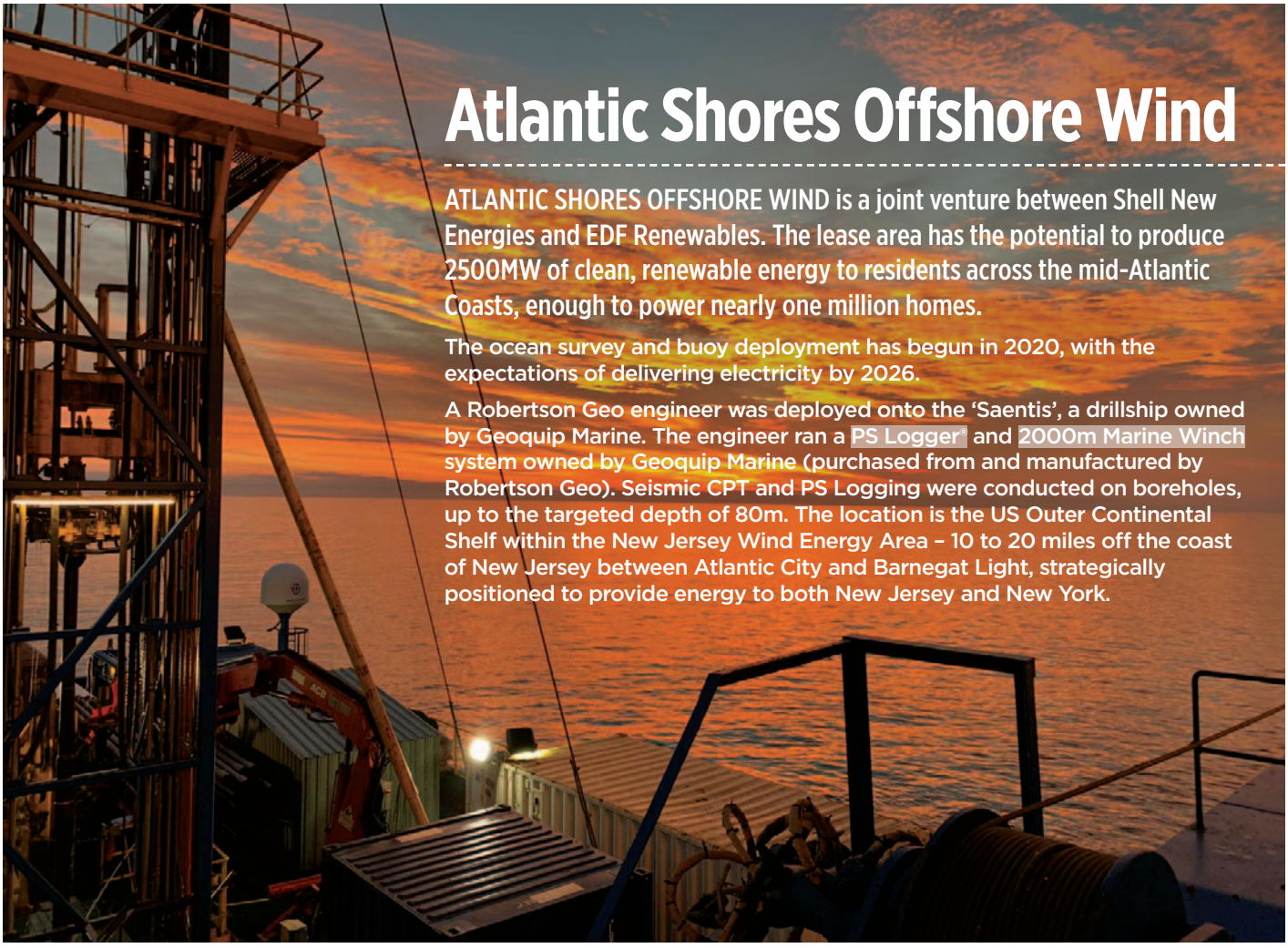
ALL IN A DAY'S WORK ON THE ISLE OF MAN

DEEP WELL DRILLING IN CHIHUAHUA, MEXICO

NEW TUNNEL IN THE NORDHAVN AREA OF COPENHAGEN

LANDSLIDE RISK REDUCTION SANGER, CALIFORNIA

CHECK OUT THE 4-PAGE GEOCAD® INSERT INSIDE



Atlantic Shores Offshore Wind

ATLANTIC SHORES OFFSHORE WIND is a joint venture between Shell New Energies and EDF Renewables. The lease area has the potential to produce 2500MW of clean, renewable energy to residents across the mid-Atlantic Coasts, enough to power nearly one million homes.

The ocean survey and buoy deployment has begun in 2020, with the expectations of delivering electricity by 2026.

A Robertson Geo engineer was deployed onto the 'Saentis', a drillship owned by Geoquip Marine. The engineer ran a PS Logger® and 2000m Marine Winch system owned by Geoquip Marine (purchased from and manufactured by Robertson Geo). Seismic CPT and PS Logging were conducted on boreholes, up to the targeted depth of 80m. The location is the US Outer Continental Shelf within the New Jersey Wind Energy Area – 10 to 20 miles off the coast of New Jersey between Atlantic City and Barnegat Light, strategically positioned to provide energy to both New Jersey and New York.

Pine Flat Landslide Risk Reduction and Monitoring project

Sanger, California USA

THE DAM WAS built by the U.S. Army Corps of Engineers (USACE) and completed in 1954. As the site was close to Robertson Geo's US base in Fresno, a Technical Service Engineer joined us at the job site.

It was an extremely challenging site as we were working on a steep slope at the side of the dam. We deployed a highly portable system for the project, which comprised a Robertson Geo Micrologger2, Mini Winch, and Verticality Tool. The project aimed to secure the slope from a potential landslide to the power plant at the base of the dam, as the soils on one side of the dam are sliding slowly. We were contracted to install rockfall fences and movement and moisture monitoring devices underground in the slide area.

Boreholes were drilled perpendicular to the ground surface. Being on a slope meant the anchors varied from horizontal at every location and around 50 degrees on average. The probe was used to verify the azimuth of the hole for the build records, and to also verify the hole was completely vertical in whatever orientation needed. Meaning, we could have no more than one degree of deviation from the top to the bottom of the borehole. This showed the drill didn't wander on its way down, and the finished borehole was within specification. The probe also verified hole depth. The instrumentation holes were up to 105 feet deep, and the fence anchors 28 feet.

Soil conditions led to the holes collapsing more than anticipated. It was also noted that the original dam plans in certain areas didn't depict reality, leading to a very custom dam design.

APEX Rockfall Mitigation, LLC
- Robertson Geo customer

Offshore
does not always mean the ocean

CONTRACTED BY STRUCTURAL SOILS, Robertson Geo carried out work on a borehole located within a lake. The borehole was positioned over water at the potential foundations of a HS2 railway viaduct.

To complete the drilling and logging of these boreholes a pontoon was constructed to carry the drill rig, allowing it to be positioned at multiple target locations across the lake. Rib boats were used to maneuver a smaller platform, containing supplies over to and from the larger drill rig pontoon.

Portable Robertson Geo equipment was used for easy transportation to and from the pontoon. The kit included a 120m Mini Winch and surface unit, High Resolution Optical Televiewer (Hi-OPTV), High Resolution Acoustic Televiewer (HRAT), 3-Arm Caliper and PS Logger®.

Our Engineers are specially trained and equipped to work in this environment as they have undergone several specialised training courses such as Basic Offshore Safety Induction and Emergency Training, First Aid and Boat Transfer training amongst others.

All in a day's work on the ISLE OF MAN

STRATA RENEWABLES CONTRACTED Robertson Geo to conduct televiewer surveys of boreholes located just outside of Douglas, Isle of Man.

Due to the strict Covid-19 regulations at the time of logging, once off the ferry the Engineers were exclusively restricted to their vehicle, hotel, and logging site.

The project was for the potential expansion of a sewer works site with the boreholes situated on a steep hill adjacent to the current works. Access to the boreholes was difficult due to the steep gradients and therefore the portable Mini Winch system was utilized.

30m boreholes were logged with both the High Resolution Optical Televiewer (Hi-OPTV) and High Resolution Acoustic Televiewer (HRAT) for maximum data recovery.

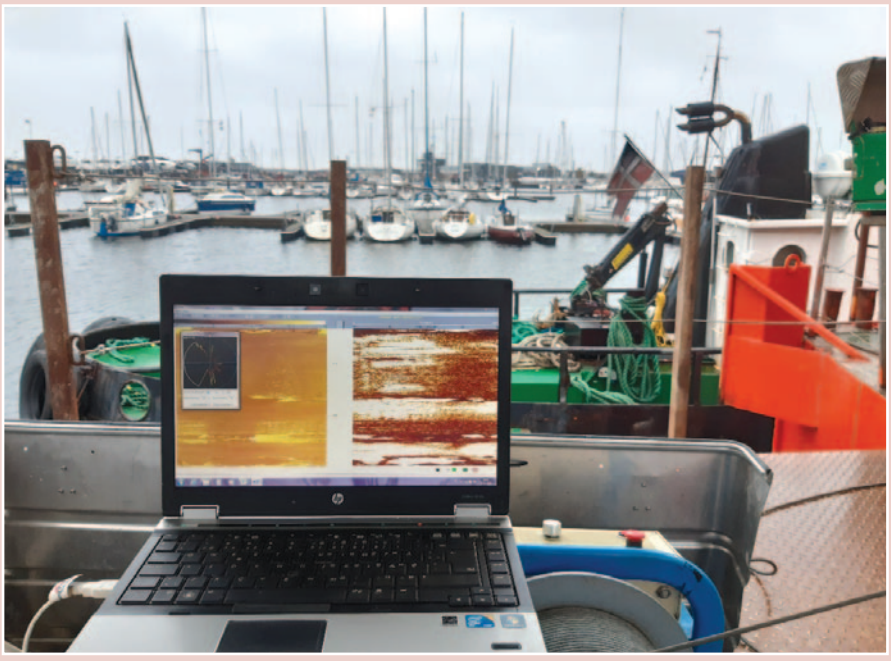
New tunnel in the Nordhavn area of COPENHAGEN

AS PART OF the pre-investigations for the construction of a new tunnel in the Nordhavn area of Copenhagen, Robertson Geo carried out geophysical borehole logging of 11 boreholes.

The objective of the Nordhavn tunnel is to create more direct access to the urban development areas in the outer and inner Nordhavn, as access to the port activities in the area is improved. A large part of the heavy traffic will be moved away from the rest of the road network in the center of Copenhagen.

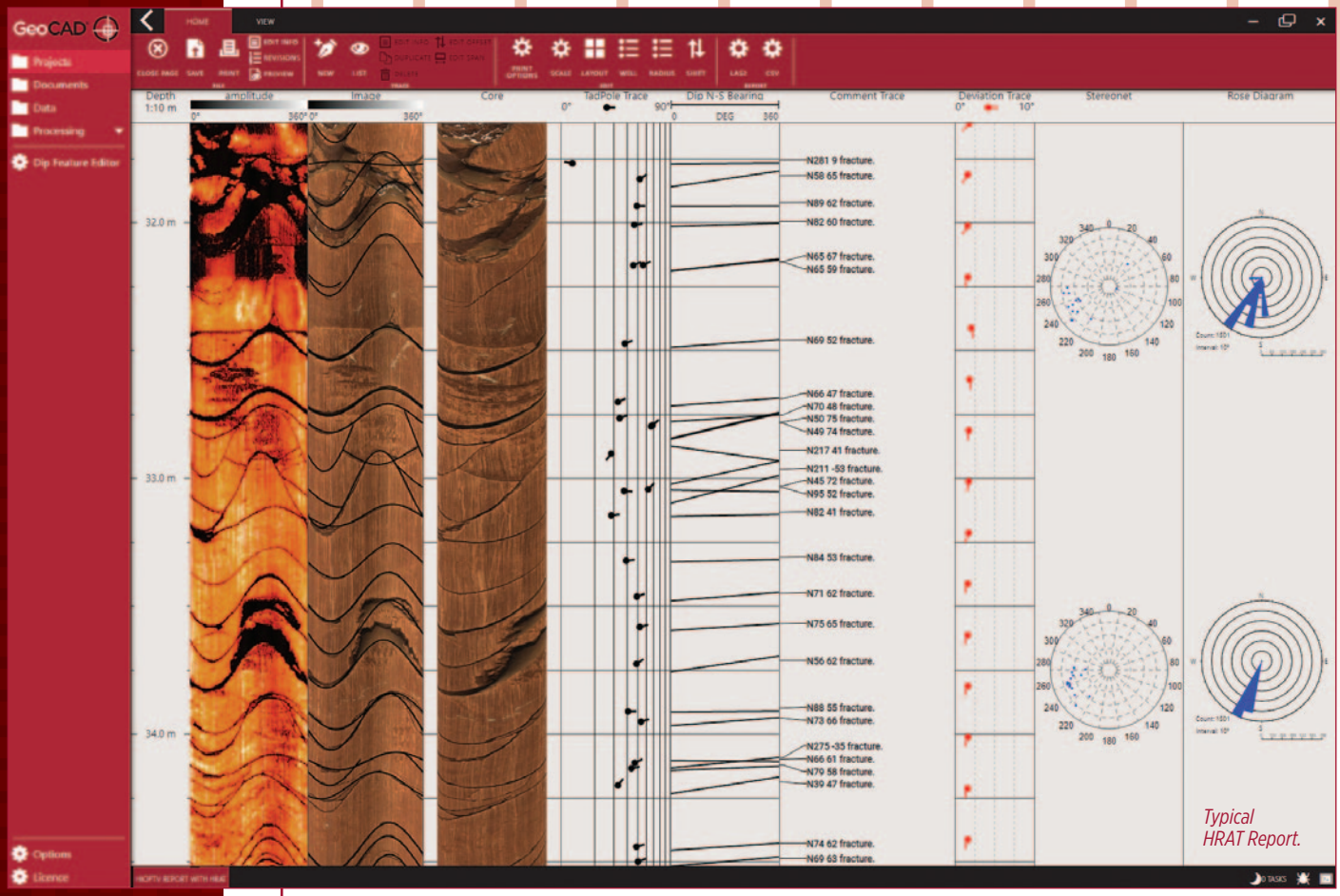
Facts about the tunnel

- *Length: 1.4 km*
- *Cross section: 9m - the same as the Nordhavnsvej tunnel*
- *Design speed: 80 km/h*
- *Tunnel height: approx. 5.5 m above the roadway (with that height there is room for signs and ventilation)*
- *Tunnels and ramps are adapted to EMS vehicles and 15m buses*
- *Boreholes were logged using the Robertson Geo High Resolution Acoustic Televiewer (HRAT)*



No gimmicks, no extra costs – **GeoCAD®** is developed by logging professionals, uniquely combining decades of knowhow to deliver streamlined workflows with an efficient, easy-to-use windows-based package, producing industry-standard televiewer reports so you can unlock the true value of your data.

GeoCAD® for Televiewers



Typical HRAT Report.

GeoCAD® is a windows-based package for processing, interpreting, and displaying acoustic and optical televiewer image logs. Standard log presentations include tadpole and stick plots, stereographic projections of poles to planes and azimuth frequency diagrams. The synthetic core display allows the convenient comparison of log and field data for the orientation of fractured or incomplete core sections.

GeoCAD® for Televiewers

Developed by logging professionals with their reporting needs in mind, the software focuses on producing industry-standard televiewer reports quickly and reliably - all you need to create quality reports without any gimmicks and unnecessary and costly extras.

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

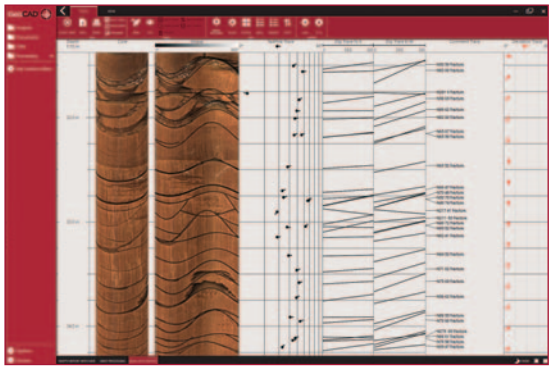
Standard reporting made easy is an important element of **GeoCAD®** and helps users to produce consistent, high-quality results no matter who processes the data.

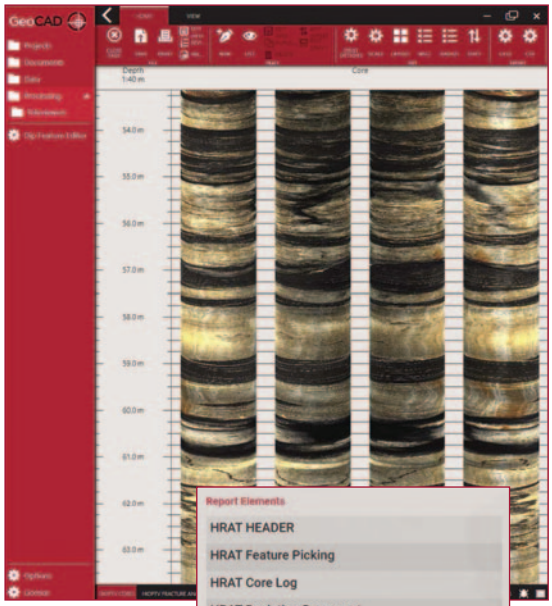
User Experience
Easy to navigate
Pre-set industry standard templates
'Drag & drop' data import
Quick and easy feature picking tools
Simple and effective 'final report' wizard
Standardised reporting
Flexible printing option

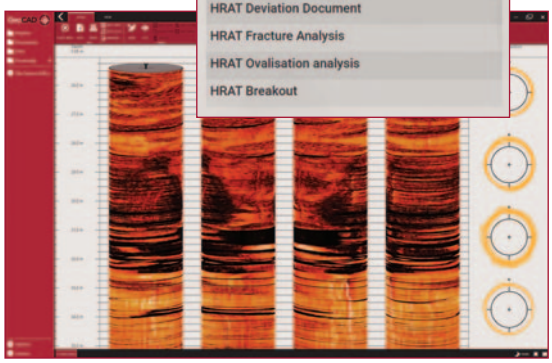
Standard Outputs
Detailed Reports
Feature Picking Log
Core Log
Deviation Log
Fracture Analysis
Ovalisation Analysis
Breakout Log
3D Core Log
Image Log
Tabulated Data

GeoCAD® Features
Quick selection menu's
Drag & drop layout configurator
Powerful feature picking tools
Dip style editor
Real-time data logs
Easy-to-use document creator
Data generator/ export wizard
Revision log

Televiewer Interpretation and Processing







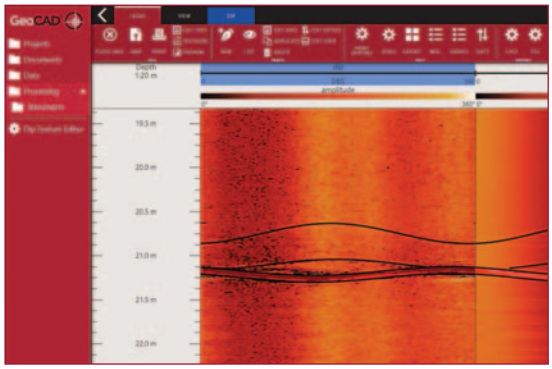
GeoCAD® provides structure picking tools, feature classification, correction, classic reporting and visualisation of Robertson Geo image logs. **The seamless log acquisition to processing workflow offered by the GeoCAD® platform provides the customer with a unique and unrivalled experience.**

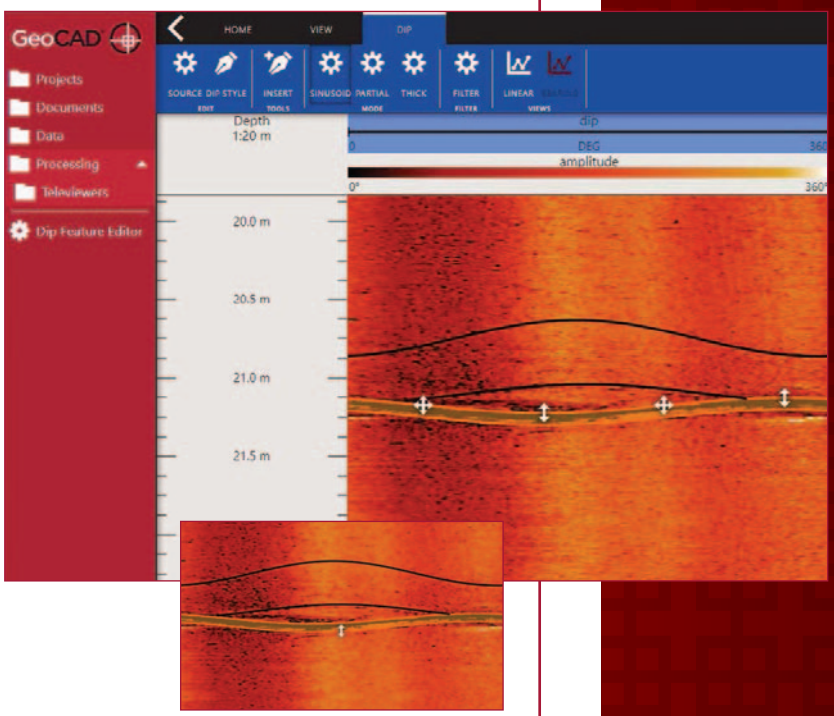
The GeoCAD® processing and interpretation toolbox provides:

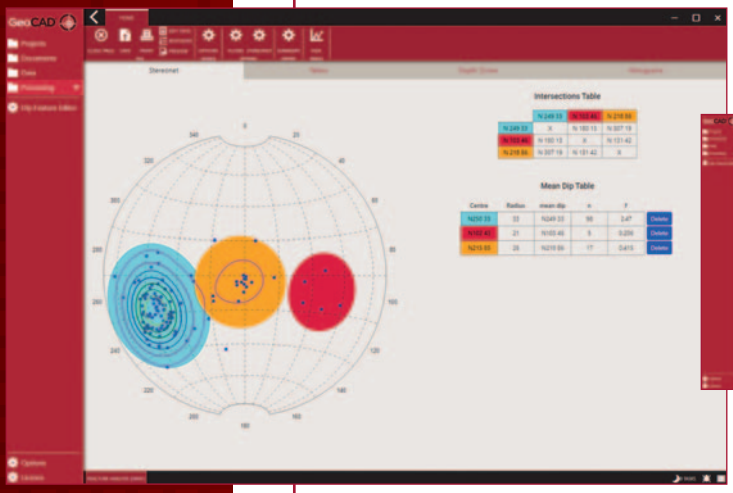
- Unlimited recording of picked bedding and fracture features with azimuth, dip and thickness or aperture reported
- Features can be categorised (classed) using a fully customised menu
- The picked features can be complete or partial
- The recording of linear features such a breakout and tensile fractures
- Feature thickness
- Features are displayed as a sinusoid, partial sinusoid, tadpole and stick plots
- Dips can be presented as stereonet, histogram or rose diagram
- The original core images can also be imported and presented with the process logs

GeoCAD® for Televiewers fast and easy to use 'feature picking' interface saves time and is an ideal platform for professional and first-time users alike.

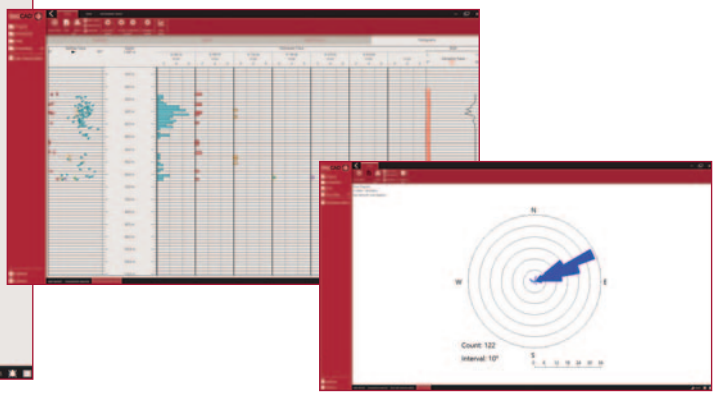
Users can create individual 'classifications' using the feature editor and set defaults for commonly selected features. The dip menu allows the selection of feature type by sinusoid, partial and thick. The 'thick' function will measure the thickness of the bedding or fracture picked as shown in the example below.

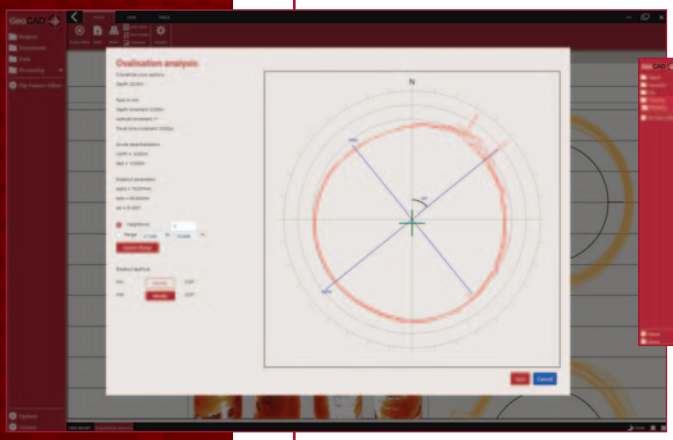


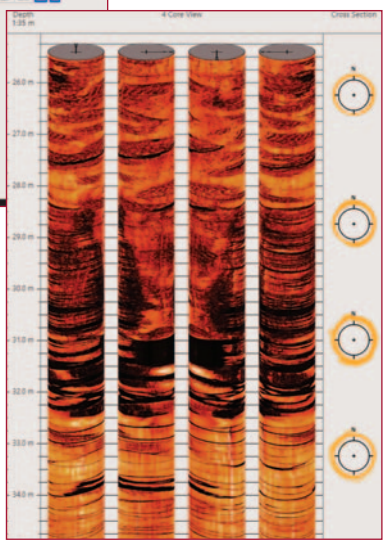




Other typical outputs as part of the fracture analysis module include the generation of stereonet, histogram and rose diagrams.

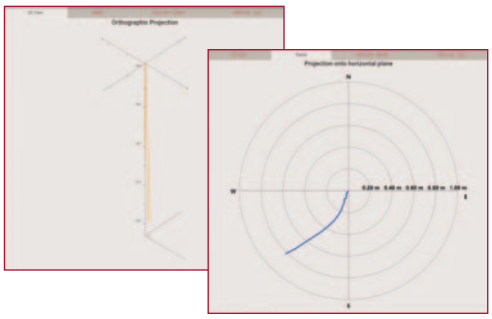






Ovalisation and breakout plots can also be produced.

'Drag & drop' function speeds up the file importation and processing procedure.



Standard deviation plots and data sets are available as part of the reports.

Flexible print wizard makes reporting quick and easy.

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The Rock Grouting project at McCook Reservoir,
Robertson Geo client Nicholson Construction, Canonsburg, PA, USA

Hi-OPTV Survey for over 700 boreholes

MCCOOK RESERVOIR IS a 26.5 million cubic meter (7 billion gallon) storage reservoir as part of the combined sewer overflow system for the Chicago area. The excavation will extend 76m (250ft) into limestone.

To decrease permeability in the rock up to two orders of magnitude to less than 0.5 Lugeons, two rows of grout curtain (one on each side of the cutoff wall staggered 15 degrees from vertical in opposite directions) are drilled through the overburden then 99m (325ft) into the limestone.

To obtain the reservoir storage, the basin was constructed by excavating and shaping an average of 19m (65ft) of overburden soil then blasting/excavating 76m (250ft) further into limestone bedrock. To decrease permeability around the perimeter of the reservoir, a cement bentonite cutoff wall was constructed through the overburden soils.

Beneath the cutoff wall will be two rows of grout curtain drilled through the overburden then into the limestone to depths of 107m (350ft) to provide the necessary ground treatment to decrease permeability in the rock zones. One row is outside and one row inside the overburden cutoff wall. The grout holes are inclined at 15 degrees from vertical and with each row in opposite directions.

Robertson Geo's High Resolution Optical Televiewer (Hi-OPTV), along with the Micrologger2 was used to verify the inclination, alignment and to identify the fracture direction and orientations in a total of 752 boreholes of depths varying from 5ft to 40ft.

Drilling of a deep well for drinking water supply in the town of Escalón, Municipality of Jiménez

Chihuahua, Mexico

INGENIEROS E HIDROGEOLOGOS CONSULTORES is a long standing client of Robertson Geo and has since 1999 been completing geophysical projects using Robertson Geo equipment.

The town of Escalón is located in the south of the state of Chihuahua, bordering the state of Durango, in northern Mexico. The town is located in an arid and dry area, where groundwater extraction flows are low and even water has a high content of SDT.

According to the results of the electrical and gamma ray logging, the areas with the greatest hydrogeological potential were identified, determining the final design of the well.

HIGH IN THE Swiss Mountains

Robertson Geo customer Terradata has recently tackled difficult access (quite the norm in Switzerland) logging projects.

Viamala:

Investigation of the foundation of the old bridge in the gorge of Viamala, borehole loggings were carried out to collect information on the condition of the foundations and the surrounding rock strata for fractures and stability.

Near Brienz:

To investigate a slope instability, several boreholes were logged. The soil was very fractured and the access to the boreholes very difficult or only possible with the helicopter.

We will be expanding Terradata information re these projects in our next issue of GeoUnlocked®.

Temperature log and geothermal gradient using a Robertson Geo high temperature tool in COLOMBIA South America

A BOREHOLE LOGGING with an electrical probe obtains the values of temperature under the surface. One of the objectives is determinate the geothermal gradient. The geothermal gradient is the amount that the Earth's temperature increases with depth. It indicates heat flowing from the Earth's warm interior to its surface. On average, the temperature increases between 25°C or 30°C for every kilometer of depth.

The objective was to take the temperature measurement every 100 meters of drilling advance into the inclined (-48°) borehole and then take the continuous log of temperature from collar to total depth drilled.

Logging of temperature every 100m:

Expected with this scenario is that behavior of temperature measurement at splice depth does show increase or decrease in the values depending on the logging operation (because of different date of logging, conditions of drilling fluids, groundwater) could show a change at the merge sections showing an offset that could induce a noise in the analysis.

Continuous logging:

This option consists of obtaining the borehole temperature when the drilling operation is finalised. A continuous record of temperature will be taken from the surface to the total depth (downward direction) of the borehole because the probe has the sensor at the bottom and will find with more detail any anomaly presents in the borehole (commonly associated to entry of fluids into the borehole or fluid exit into the formation).

On the out-run operations is possible to take the temperature and have a balanced temperature record to analyze better the behavior of the temperature in the borehole.

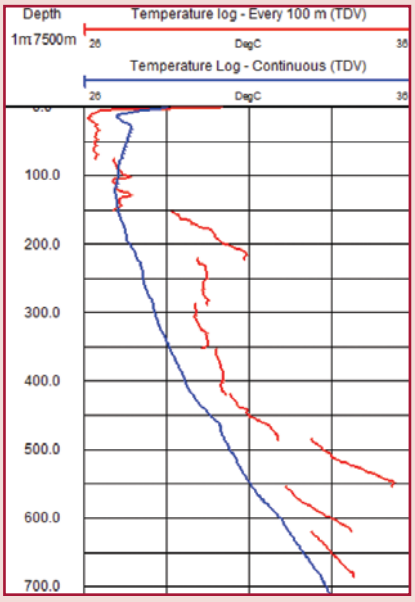
GeoBC Servicios Integrados S.A.S - Robertson Geo Customer

Following the summary (refer to true vertical depth TDV) results:

The temperature logs carried out every 100m of drilling in the borehole showed differences in magnitude in the splicing depth. This change of temperature measurement could be associated with chemical composition of the drilling mud/additives and mixture with groundwater (there is not sufficient evidence as data does not show changes of temperature along the specific section logged).

All conditions mentioned above affect the variability of the ΔT when the data was obtained every 100m. These conditions in the continuous log are constant and the temperature measurement has a better behavior (as an increasing trend that is proportional to the increased depth).

Using a linear regression method the gradient was estimated at 9.5°C/KM for continuous log and 11°C/KM for every 100m logs.



Life of a Logging Engineer

Joanne van Aardt

Offshore... Double it and add a few weeks for good measure

EVERY ROBERTSON GEO engineer is familiar with the uncertainty and unpredictability of the offshore world, and we have all learnt (most of us the hard way) that the only constant out there is the inevitable change.

This can be due to several factors such as project scope amendments, poor weather conditions, crew and personnel requirements, mobs/demobs as well as the occasional unfortunate breaking of crucial equipment. Over the past year or so the Covid-19 pandemic has also proven to be a main driver of this change.

In the midst of the pandemic, I was lucky enough to have the opportunity to head over to the United States to work on the ground investigations for an offshore windfarm. The usual Covid-19 protocols were followed which involved social distancing, hotel isolation and several Covid tests. The initial scope of the project was approximately three weeks, so like any experienced engineer would, I doubled that timeframe just to be safe.

Three weeks later, the project had gone very smoothly, and it looked like we were due to make the sought-after home date. However, little did I know looming in the background was another project States-side. A couple days before the project was due to finish, I was asked to move to another vessel and embark on another offshore wind project further up the coast. At this stage with all the Covid restrictions I had been informed that there was a very small chance of crew change, but that the second project was a smaller scope and should take about the same length of time.

Well to cut a long story short (unlike my trip), 13 weeks later and nearly at the 100 days abroad mark I finally managed to see the vessel grow smaller and smaller in the rear-view mirror as we drove away towards the airport. I have learnt my lesson which is not only to double the project timeframe, but to add a couple weeks for good measure.

A big highlight of the job was getting to make a port call in New York and even though none of the ship personnel were allowed onto land because of the pandemic, we were lucky enough to see several New York landmarks from our bay. These included the Statue of Liberty, Brooklyn Bridge, and the World Trade Centre, as well as witnessing the lights from ground zero as we were alongside on the eve of the 9/11 remembrance.

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