For over 40 years **Robertson Geo** has been developing and producing products, techniques and technologies for Geotechnical investigations. Reliable and consistent quality data from borehole logging provides an important understanding of rock strength and the presence of fractures that is essential for the consideration of the location and positioning of new build construction and its foundations.

ROBERTSON GEO
GEOTECHNICAL
Unlocking Your GeoData

Geotechnical

Publication No: 001 RGO/20

Borehole logging

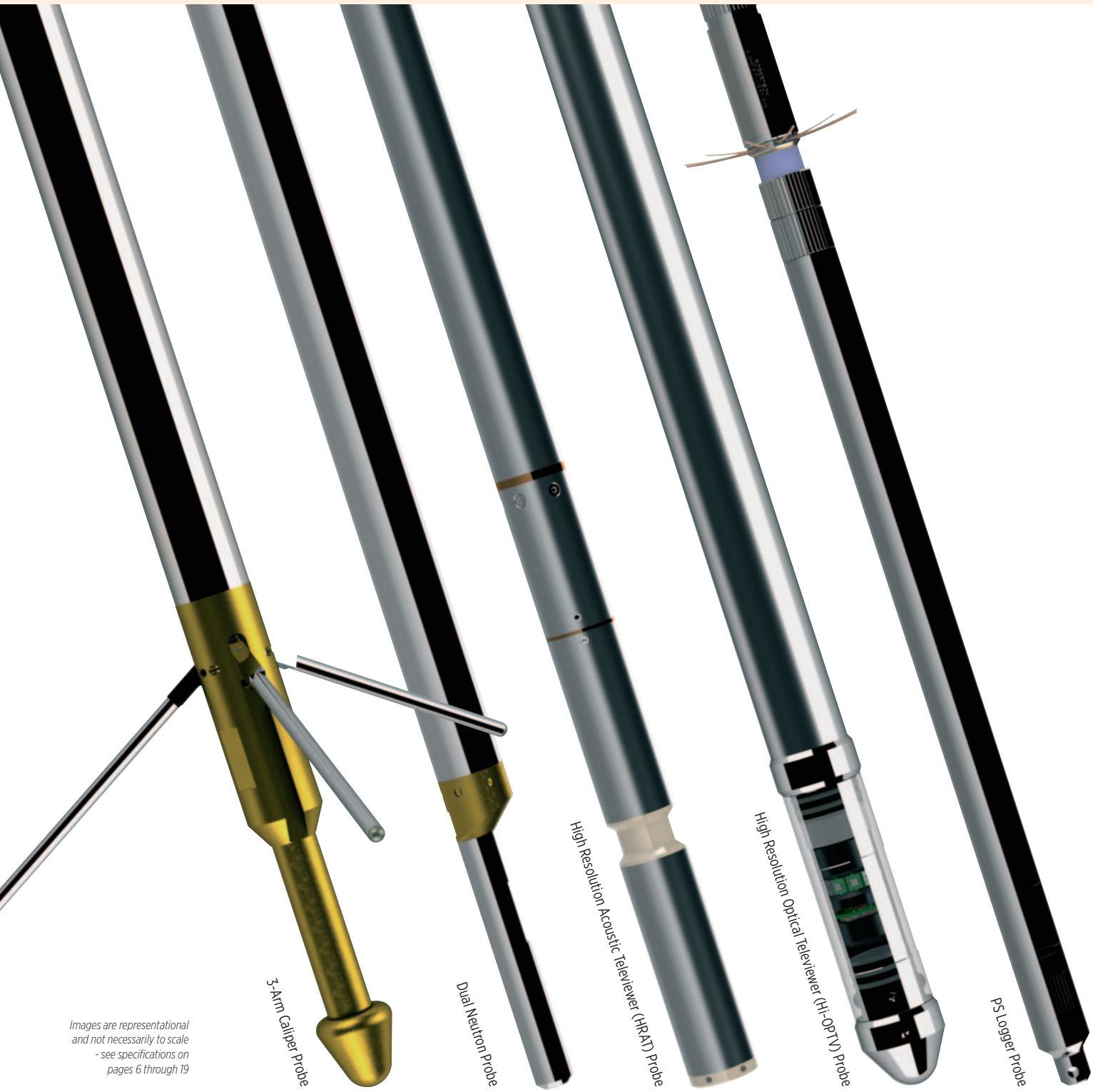
SUBSURFACE SITE INVESTIGATION AND DATA ACQUISITION

Foundation engineering
Slope stability studies
Fracture detection and analysis
Earthquake engineering
QA checking piles and diaphragm walls
Soil/rock in-situ testing
Voids and old mine workings location
Mine safety

Wireline logging techniques are increasingly used within the collation of data for subsurface site investigation. Robertson Geo is a specialist provider of services and products for this market sector.

Geotechnical

As the world's largest provider of slimhole logging instrumentation, Robertson Geo designs and builds its equipment and technologies at its manufacturing facility in Deganwy, North Wales UK. Purchasers of equipment include geological surveyors, water authorities, mining houses, civil engineering consultants, aid organisations, drilling contractors and oil companies worldwide.



Images are representational and not necessarily to scale - see specifications on pages 6 through 19

It is vital to understand the subsurface characteristics for geotechnical applications and construction projects. Robertson Geo is a specialist and very experienced international provider of wireline logging data acquisition and interpretation for these industries, with its technologies in worldwide everyday use.

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Unlocking Your GeoData

Geotechnical

Wireline data acquisition is a recognised, well established and cost and results effective methodology for site investigations, determining the subsurface properties of the formation and the presence of fractures, it is very important information for the location and design of new structures and foundations. Logging provides accurate and reliable data and is especially important in locations where collecting core samples is difficult and from poorly consolidated facies, weathered zones, soft formations and shallow boreholes as examples.

Rock strength can be estimated using measurements derived from Sonic and Density logs. One common technique uses the seismic compressional (P) velocity to estimate Unconfined Compressive Strength (UCS). The P-wave velocity can also be combined with the flexural (S) wave velocity and density to give stress/strain properties including Poisson's ratio, bulk modulus and Young's modulus. The Robertson Geo PS Logger probe includes a dipole source for measurement of P and S velocities in soft formations.

Fractures faults and voids can be detected using various imaging tools 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 and Sonar Caliper surveys are used to map underground voids and disused mine workings aiding risk assessment and remediation planning.

Robertson Geo uses its own designed and built instrumentation, proved to provide quality data acquisition over a broad range of international geotechnical applications including:

- *Foundation engineering*
- *Slope stability studies*
- *Fracture detection and analysis*
- *Earthquake engineering*
- *QA checking for piles and diaphragm walls*
- *In-situ testing of the soil/rock*
- *Location of voids and old mine workings*
- *Mine safety*

Logging services

Robertson Geo engineers are experienced, highly trained and fully certified for underground and surface mine working and can be deployed to any global location.

The complete catalogue of equipment is available on a service basis operated by these field crews. They are capable of prolonged logging services with minimum outside support and are expert in data processing and interpretation.

These are very cost effective contracting services in circumstances where projects do not justify purchasing equipment and the necessary back up facilities.

Equipment supply

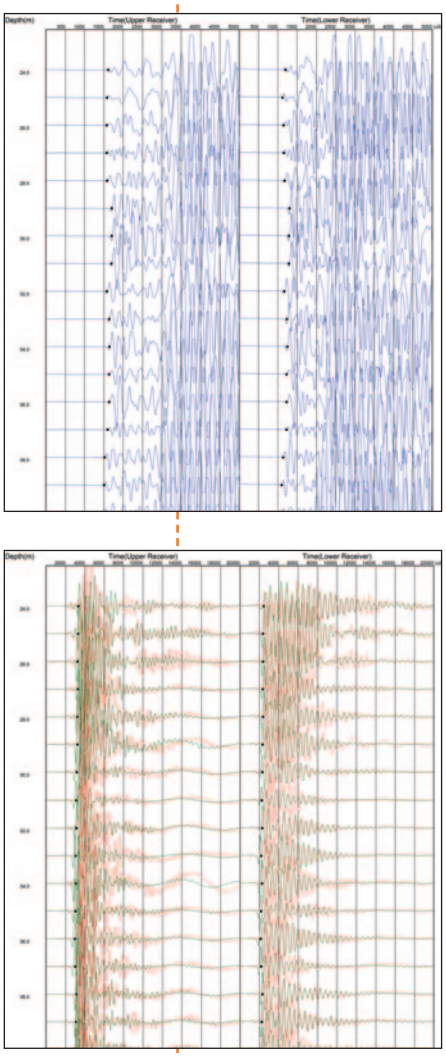
All Robertson Geo probes are fully tested and calibrated at the Deganwy facility prior to dispatch, eliminating testing time on site and ensuring the probes are fully operational prior to downhole use.

Depending on customer needs operational and customised training can be provided; this for winch use, probe deployment, logging techniques, data capture and equipment maintenance and troubleshooting.

Equipment rental

Robertson Geo equipment is available to rent with a minimum rental period of 3 days in the USA or 15 days elsewhere. Full systems (including winches) or individual probes can be rented as required with borehole and classroom based training made available for rental customers.

In-house data management and log processing services are available for rental equipment clients, at an additional cost.



Example of data created by the PS Logger Probe.

Further data examples are shown with each specification page for probes and where applicable surface equipment on pages 6 through 19.

Geotechnical

Robertson Geo is the only logging services provider with a QMS certified to ISO 9001, comprehensively calibrating all of its logging systems and uniquely using an on-site borehole for testing at its Deganwy test well and calibration facility.

In an industry where compliance and traceability are fundamental, all probes come with a certificate of conformity, and a probe maintenance service is available to verify functionality and calibration.

Probes

High Resolution Acoustic Televiewer (HRAT): used for borehole imaging in fluid and mud filled boreholes. The probe provides a 360° 'unwrapped' and orientated ultrasound image of the borehole walls. The probe is ideal for fracture identification and orientation (dip and direction), stratigraphic studies, local stress analysis (breakouts) and core orientation. *See page 6*

High Resolution Optical Televiewer (Hi-OPTV): provides a continuous very high-resolution oriented image of the borehole walls. The probe can be used in dry and water (clear fluid) filled boreholes. The probe offers a full colour image of the borehole, which can assist in mineral identification, it is ideal for fracture identification and orientation (dip and direction), stratigraphic studies, mineral identification and core orientation. *See page 7*

Formation Density: uses multiple detectors to provide an accurate borehole-compensated density measurement with excellent bed-boundary resolution. This can be used to determine lithology, density and porosity, rock strength and elasticity parameters when combined with the sonic probe and detection of weathered or fractured zones. *See page 8*

PS Logger: a low-frequency acoustic tool designed to measure compressional and shear-wave velocities in soils and soft rock formations. The probe is critical for earthquake engineering applications and also the tool for choice for offshore structures and windfarms. *See page 9*

Full Waveform Triple Sonic: is designed specifically for geotechnical and mining applications. It acquires transit-time and full wave data simultaneously from a single transmitter and three receivers. Formation velocity is calculated in triplicate independently of the borehole fluid path and the waveform data is used for the calculation of compressional (P), Shear (S) and Stoneley velocities. *See page 10*

Dual Neutron: provides an accurately calibrated borehole compensated neutron porosity measurement in mud-filled open holes. It is the probe of choice for quantitative formation-fluid studies. The measurement can help determine lithology identification, location of aquifer and aquitard. *See page 11*

Sonar Caliper: has been developed to provide a scaled and orientated cross-section of large bores, shafts, caverns and trench walls; combining accurate diameter measurement with a fully orientated 360° view of its surroundings. *See page 12*

3-Arm Caliper: measures the diameter of the borehole as a continuous record against depth. It is used as a check of borehole condition before casing operations or before running more expensive logging probes. It also provides a borehole volume for grout quantity design. *See page 13*

Verticality: the verticality of a borehole is key to determining the actual location and depth of a potential order body, as the vertical depth is often different to the drilled depth and is therefore critical for mine design. An alternative, the Gyro probe provides the same information in the presence of steel casing. *See page 14*

Gyro: acquires borehole inclination/azimuth logs in situations where metal casing or magnetic materials around the borehole prevent use of the standard verticality probe. The 3D-magnetometer version also acquires 3D-magnetic data for location of magnetic ore bodies. *See page 15*

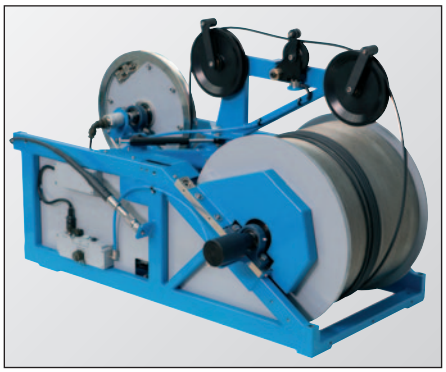
Elastmeter: a borehole lateral load tester designed to figure out deformation characteristics of the ground ranging from soft rock to hard rock. The deformation characteristics become useful information especially for the construction of large scale structures such as dams, bridges and high-rise buildings. *See page 16*

Surface equipment

Micrologger2: surface interface system for handling logging data acquisition, which supports all Robertson Geo probes, including acoustic and imaging tools.

Despite its small size, the Micrologger2 is equally at home as a portable system or with 2,000m of cable in a large truck. Its advanced features ensure long term reliability and freedom from drift or errors. *See page 17*

Winlogger: MS Windows based operating system for the Micrologger2, provides field acquisition capability. In-house processing, interpretation and reporting is undertaken. *See page 17*



Winches: Robertson Geo designs and builds its own range of winches of varying capacities for deploying subsurface probes on 4-core or co-axial cable.

- Mini Winch
- 500m Winch
- 600m Winch
- 1000m/2000m Winch
- 2000m Marine Winch
- 3000m Winch

From the battery-powered 175m Mini Winch to the heavy-duty 3,000m and Marine unit, each is precision engineered for reliable operation under arduous field conditions. Robertson Geo winches are feature-laden and include auto-level wind, tension measurement and integral depth encoder and are all compatible with the Micrologger2. *See pages 18-19*

Geotechnical Applications

Representative examples to show **Essential**, **Intermediate** and **Advanced** systems as a benchmark for identifying the level of data and interpretation required for individual locations and characteristics.

Robertson Geo support teams are always available for further information and discussion when considering system applications at *support@robertson-geo.com*

Essential

- Micrologger2
- Winch (Mini)
- High Resolution Acoustic Televiewer Probe
  and/or
  High Resolution Optical Televiewer Probe
- 3-Arm Caliper Probe

Intermediate

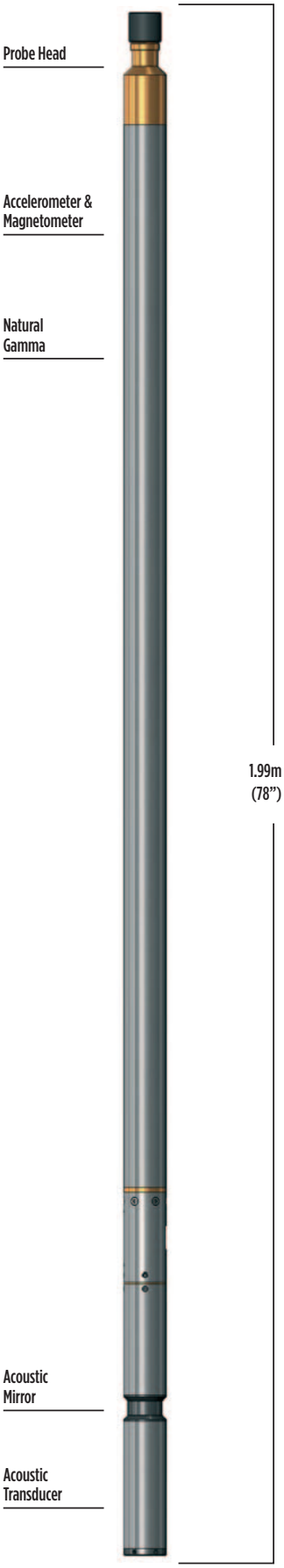
- Micrologger2
- Winch (Mini/500m/600m)
- High Resolution Acoustic Televiewer Probe
- High Resolution Optical Televiewer Probe
- 3-Arm Caliper Probe
- Formation Density Probe
- PS Logger Probe
- Elastmeter
- Verticality

Advanced

- Micrologger2
- Winch (500m/2,000m)
- High Resolution Acoustic Televiewer Probe
- High Resolution Optical Televiewer Probe
- 3-Arm Caliper Probe
- Formation Density Probe
- PS Logger Probe
- Full Waveform Triple Sonic Probe
- Dual Neutron Probe
- Sonar Caliper Probe
- Elastmeter
- Verticality
  and/or Gyro

See probe and surface equipment specifications pages 6 through 19

High Resolution Acoustic Televiewer (HRAT)



High Resolution Acoustic Televiewer (HRAT) Probe

The High Resolution Acoustic Televiewer (HRAT) provides a continuous high-resolution oriented ultrasound image of the borehole wall.

The probe uses a fixed acoustic transducer and a rotating acoustic mirror to scan the borehole walls with a focussed ultrasound beam. The amplitude and travel time of the reflected acoustic signal are recorded as separate image logs.

Features such as fractures reduce the reflected amplitude and appear as dark sinusoidal traces on the log. The travel-time log is equivalent to a 360-arm caliper and shows diameter changes within open fractures and 'break-outs'. Directional information is also recorded and used to orient the images in real time.

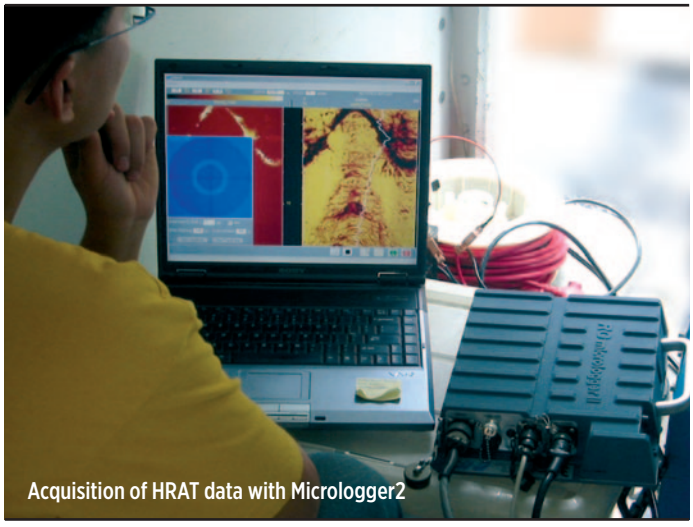
SPECIFICATION:

Applications
Fracture identification and orientation
Stratigraphic studies
Local stress studies (break-out)
Core orientation
Cased-hole studies

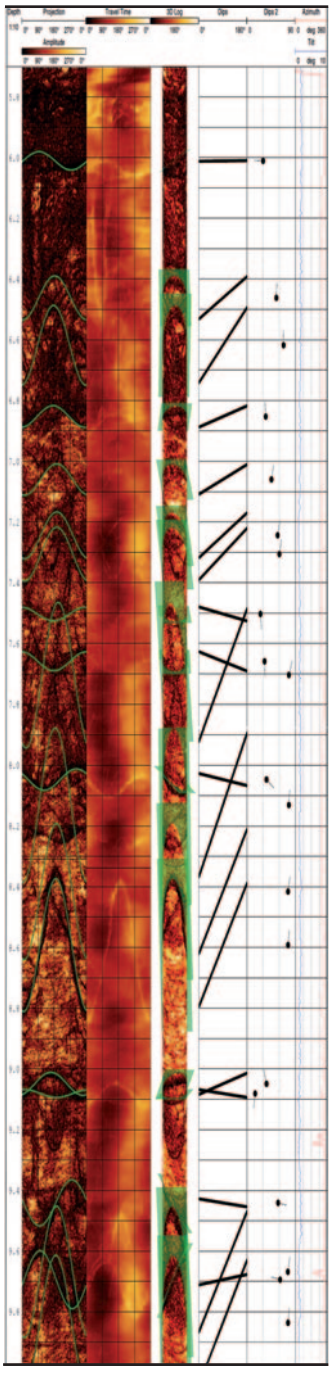
Operating Conditions	
Borehole Type:	Fluid filled
Recommended Logging Speed:	2.5m/min

Specifications	
Diameter:	42mm
Length:	1.99m
Weight:	5kg
Temperature (max):	70°C
Transducer type:	1.5MHz piezo-composite
Rotation rate:	5 – 20rev/s
Sample rate:	up to 360/rev

Part Numbers	
I002184	HRAT probe
I002192	HRAT including natural-gamma

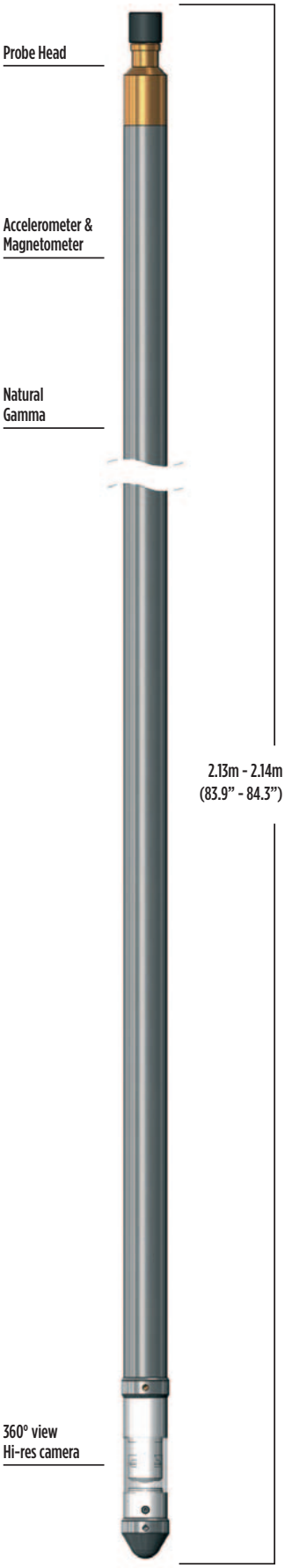


Acquisition of HRAT data with Micrologger2



Example of logging data

High Resolution Optical Televiewer (Hi-OPTV)



High Resolution Optical Televiewer (Hi-OPTV) Probe

The High Resolution Optical Televiewer (Hi-OPTV) provides a continuous very high resolution oriented image of the borehole walls using a conventional light source.

A unique optical system based on a fisheye lens allows the probe to survey 360 degrees simultaneously. This information is processed in real time to produce a complete 'unwrapped' image of the borehole oriented to magnetic north. The probe offers superior resolution to the High Resolution Acoustic Televiewer (HRAT) and produces images in real colour. While, unlike the HRAT, it can operate in air-filled boreholes, it is unsuitable for boreholes containing mud or cloudy fluids.

WellCad™ Image-processing software:

WellCad™ 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 convenient comparison of log and field data for orientation of fractured or incomplete core sections.

SPECIFICATION:

Applications

Fracture identification and orientation
Stratigraphic studies
Local stress studies (break-out)
Core orientation
Cased hole studies

Operating Conditions

Borehole Type:	Air filled or clear fluid
Recommended Logging Speed:	3m/min

Specifications

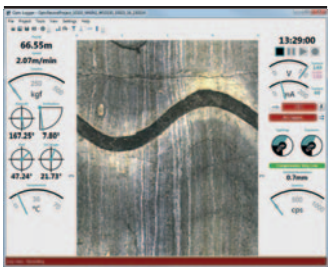
Length:	2.13m - 2.14m (10MPa/20MPa window)
Diameter:	46mm (10MPa) & 58mm (20MPa)
Weight:	6kg (10MPa) or 7.2kg (20MPa)
Temperature (max):	60°C
Circular resolution:	user definable 360/540/720 /900/1080/1260/1440 pixels
Sensor type:	1280 x 1024 pixels CMOS image sensor
Colour resolution:	24 bit RGB

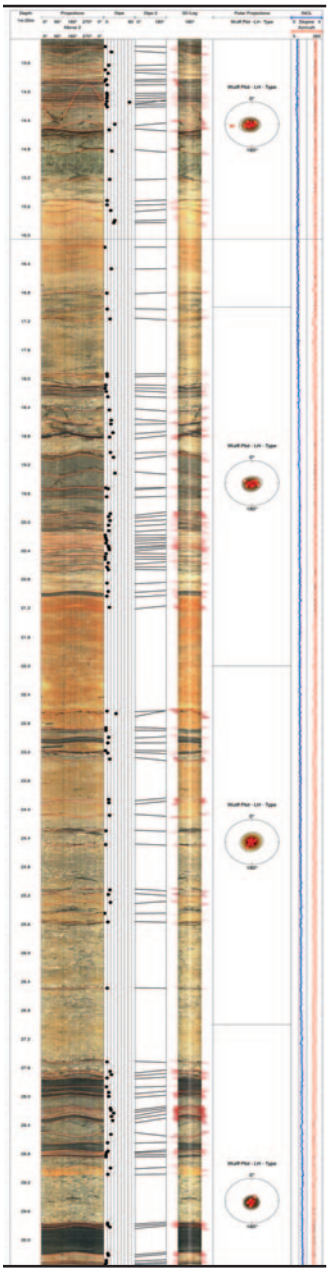
Part Numbers

I017187	Hi-OPTV probe (46mm)
I017188	Hi-OPTV probe (46mm) with gamma
I017215	Hi-OPTV probe (58mm)
I017216	Hi-OPTV probe (58mm) with gamma
I015464	Gamma Test Blanket

WellCAD™ Image-processing software

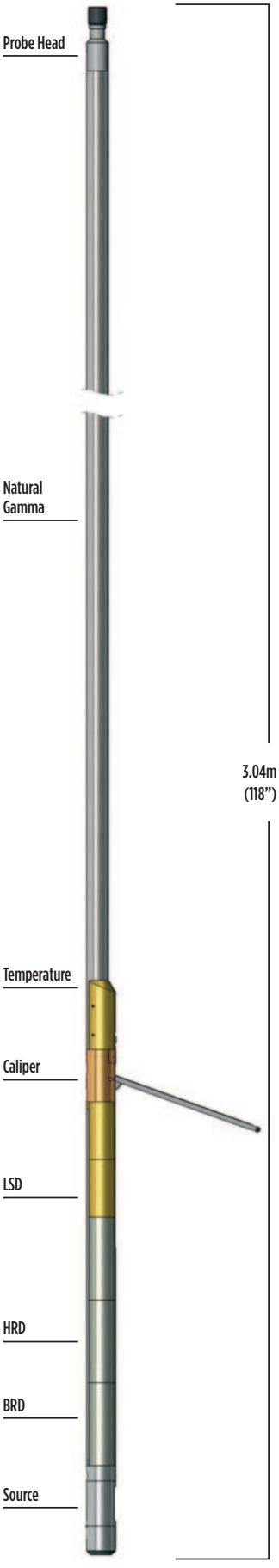
I000942	WellCAD™ Software
I000944	WellCAD™ Image Module





Examples of logging data

Formation Density, Density Guardlog & Iron Ore Density



Formation Density Probe

The Formation Density probe uses dual shielded detectors to provide a borehole-compensated density measurement with good bed-boundary resolution.

The Density Guardlog probe offers an additional LL3 focussed electrical measurement with good vertical resolution and depth of investigation. The Iron Ore Density probe includes extra collimation, different source-detector spacings and a higher activity source to extend the density range to 5g/cc for iron ore logging.

Principle of Measurement:

The probes contain a detachable 137Cs gamma source and two scintillation gamma detectors. The active windows of the source and detectors are maintained in contact with the borehole wall by a motorised caliper arm. Gamma radiation back-scattered by the formation (Compton effect) reaches the detectors where the relative count rates provide a measure of formation density.

SPECIFICATION:

Features

- Compensated density output in engineering units (g/cc)
- Short-spacing detector for high vertical resolution
- Tungsten shielding reduces borehole effects
- Standard calibration blocks for field or base use

Measurements

- Bulk density
- High-resolution density (HRD)
- Natural gamma
- Caliper
- Options: Guard resistivity, Bed-resolution density (BRD), Temperature
- Dual calibrated density channels
- Fluid Temperature

Applications

Minerals:
- Density and porosity
- Lithology
- Bed thickness and boundary location
- Coal ash and moisture content

Engineering:
- Rock strength and elasticity parameters (with sonic log)
- Detection of weathered or fractured zones

Water:
- Location of aquifer and aquitard
- Detection of cavities and missing cement

Operating Conditions

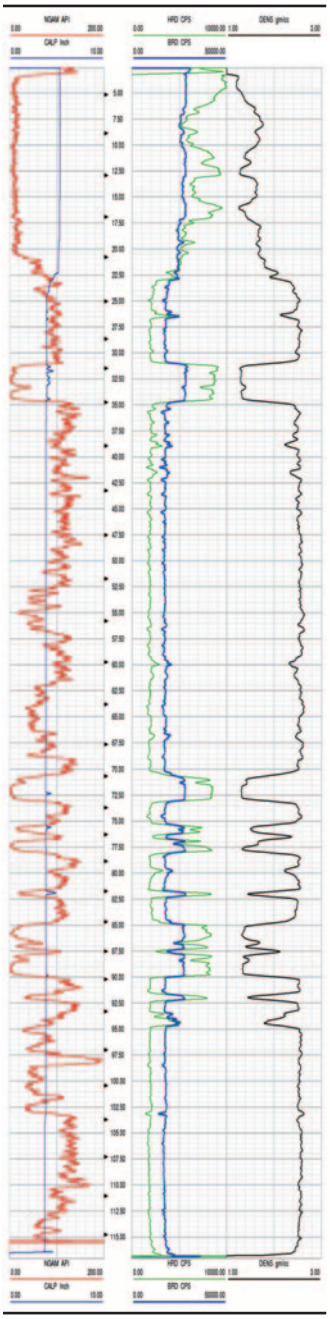
Borehole type:	All, including air filled (qualitative measurement only)
Recommended Logging Speed:	4m/min

Specifications

Diameter:	51mm
Length:	Formation Density 3.04m / Density Guardlog 2.89m
Weight:	21kg (Density Guardlog 28.5kg)
Temperature:	0-70°C (extended ranges available)
Max. pressure:	20MPa
Density range:	1.1 to 2.95g/cc (Formation Density and Density Guardlog probes) 1.5 to 5.0g/cc (Iron Ore Density probe)
Caliper range:	50mm to 300mm
Resistivity range:	1-10000 ohm-m

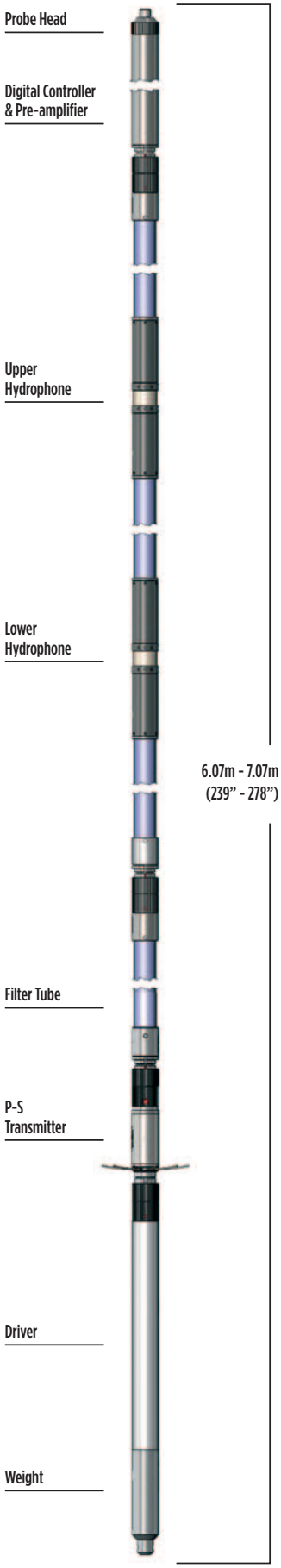
Part Numbers

I002013	Formation Density probe
I002016	– includes BRD and temperature
I014720	Density Guardlog probe with BRD
I018309	Iron Ore Density probe



Example of logging data

PS Logger



PS Logger Probe

The PS Logger probe is a low-frequency acoustic probe designed to measure compressional and shear-wave velocities in soils and soft rock formations.

It operates using indirect excitation rather than mode conversion as in a conventional sonic. It is capable of acquiring high resolution P and S wave data in borehole depths of up to 600m in water.

Principle of Measurement:

The PS Logger probe contains a unique design of powerful hammer source and two receivers, separated by acoustic damping tubes.

To acquire data, the probe is stopped at the required depth and the source is fired under surface command. Firing causes a solenoid-operated shuttle aligned across the borehole axis to strike plates on opposite sides of the probe in turn, setting up a pressure doublet in the surrounding fluid. The resultant fluid motion produces a tube wave at the borehole wall with velocity close to the shear velocity of the formation together with a compressional wave.

As the waves propagate parallel to the borehole axis, they set up corresponding fluid movements that are detected by the two neutral buoyancy 3D hydrophone receivers and geophones, allowing the wave velocity to be determined.

The facility to stack multiple shots and filter the data as in normal seismic data acquisition is included in the operating software.

SPECIFICATION:

Features

- High energy shear-wave source has typically 20x power of conventional sonic probes
- Low-frequency measurement, more representative of engineering situations
- Stacking of multiple shots
- Probe separates for shipping
- Real-time wavelet (wiggle) display
- Compatible with Robertson Geo Micrologger2

Measurements

- Formation compressional wave velocity
- Formation shear-wave velocity

Applications

- Site Investigation - foundation studies, windfarms, offshore structures, dam safety
- Physical properties of soil/rock - shear modulus, bulk modulus, compressibility and Poission's ratio
- Earthquake engineering - characterization of strong motion sites
- Velocity control for seismic reflection surveys
- Engineering

Operating Conditions

Borehole type:	open-hole, water-filled
Recommended Logging Speed:	Static measurements

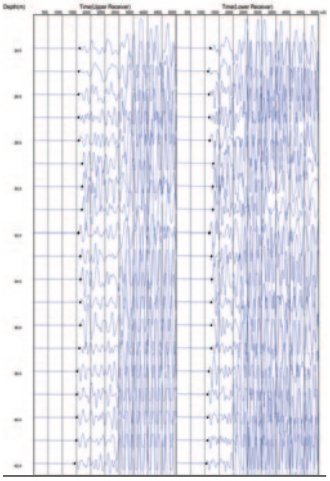
Specifications

Diameter:	50mm
Assembled length:	6.07m - 7.07m (1 or 2m filter)
Shipping case length:	1.45m (4.75ft) supplied in two transport cases
Assembled weight:	26.5kg - 28kg (1 or 2m filter)
Max. temperature:	70°C
Max. pressure:	6.5MPa
Transducer type:	solenoid and hammer
Receiver type:	3D hydrophones (p), geophones (s)
Receiver spacing:	1000mm (3.28ft)
Waveform acquisition period:	5.12mS to 409.6mS
Sampling:	2.5µs minimum
Down-hole gain:	0db to 42db (surface control)

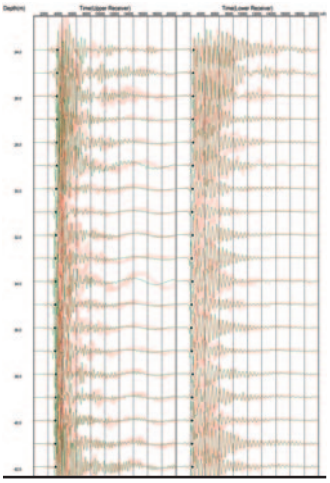
Part Numbers

I002244	PS Logger probe in carrying case

P Waves

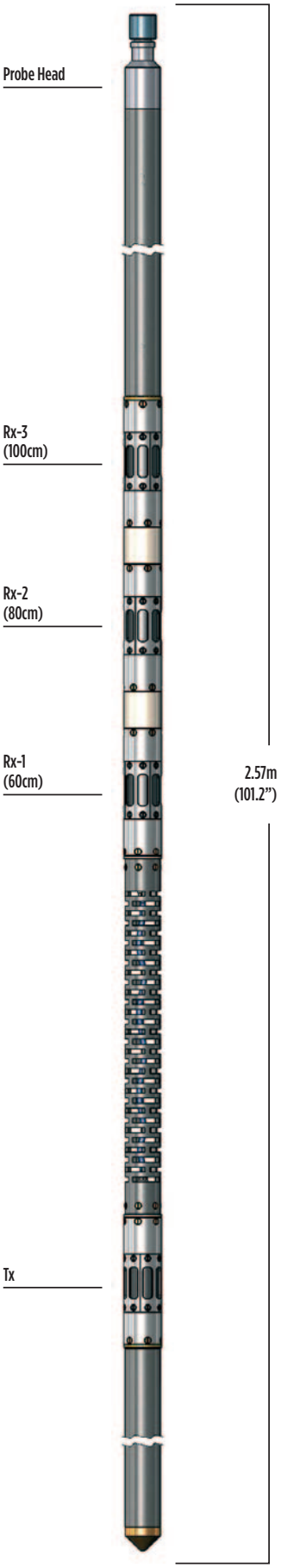


S Waves



Examples of logging data

Full Waveform Triple Sonic



Full Waveform Triple Sonic Probe

The Full Waveform Triple Sonic probe is a highly compact slimhole tool designed specifically for geotechnical and mining applications.

The probe acquires transit-time and full-waveform data simultaneously from a single transmitter and three receivers.

Principle of Measurement:

The piezoelectric transmitter is stimulated by a high-voltage pulse and radiates a high-frequency acoustic wave through the borehole fluid and formation to each receiver. An accurate quartz clock measures the first arrival transit time.

Formation Velocity: The probe measures the time of the first arrival at each receiver. The difference in arrival times between the three receiver pairings allows formation velocity to be calculated in triplicate, independent of the borehole fluid path.

Full Waveform Log: The probe records the full sonic wave-train at all receivers simultaneously. This can be displayed either as a variable-density log (VDL) or waveform ('wiggle') trace. The waveform data can be exported to be used in software packages, such as WellCAD™ for calculation of compressional (P), shear (S) and Stoneley velocities.

SPECIFICATION:

Features

- Short probe can be handled by single operator and easily transported
- Slim diameter for narrow boreholes
- Rigid construction for effective centralisation
- Down-hole digitisation of waveform data
- Detection gain and threshold under operator control
- Detection point and wavelet display shown in real-time

Measurements

- Formation velocity (slowness)
- Time of first arrival (delta-t)
- Integrated transit time
- Full-waveform data from 3 receivers
- Shear and Stoneley velocities (requires additional interpretation software)
- Natural Gamma

Applications

Geotechnical / Mining / Water

- Fracture and permeability indication in hard rock
- Rock strength and elasticity
- Lithology identification
- Porosity
- Correction of seismic velocity

Operating Conditions

Borehole type:

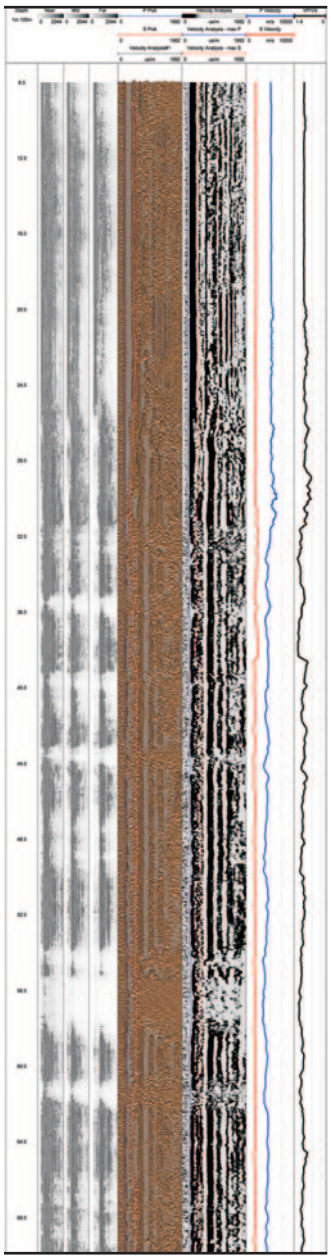
Sonic:	open-hole, water-filled
Centralisation:	required
Recommended Logging Speed:	3m/min

Specifications

Diameter:	45mm
Length:	2.57m (2.96m with natural gamma)
Weight:	11.5kg with natural gamma
Temperature:	0-70°C (extended ranges available)
Max. pressure:	20MPa

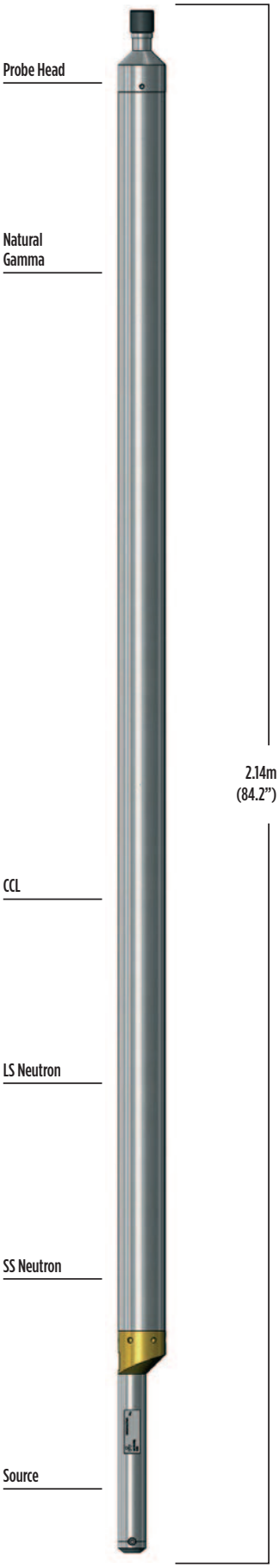
Part Numbers

1013861	Full Waveform Triple Sonic probe with natural gamma



Example of logging data

Dual Neutron



Dual Neutron Probe

The Dual Neutron probe provides a calibrated borehole-compensated neutron porosity measurement in mud-filled open holes.

It is the probe of choice for quantitative formation-fluid studies.

A single-detector neutron probe is also available for qualitative porosity logging under most borehole conditions including through steel or plastic casing and drill-pipe.

Principle of Measurement:

The Dual Neutron measurement uses two ^{3}He proportional detectors and a detachable, sealed ^{241}Am-Be neutron source. Fast neutrons emitted by the source are scattered and slowed to thermal levels, principally by hydrogen in the formation. The ratio of the neutron flux reaching the near and far detectors depends on the hydrogen index and porosity. Use of dual detectors and a ratio method provides a porosity measurement compensated for borehole diameter but not independent of it.

SPECIFICATION:

Features

- Real-time porosity measurement
- Compensation for borehole diameter

Measurements

- Compensated porosity
- Neutron (raw counts)
- Natural gamma
- Option: Casing-collar locator (CCL)

Applications

Minerals / Water / Engineering

- Lithology identification
- Location of aquifer and aquitard
- Fracture analysis in coals
- Correlation between open and cased-hole logs
- Strata correlation between wells

Operating Conditions

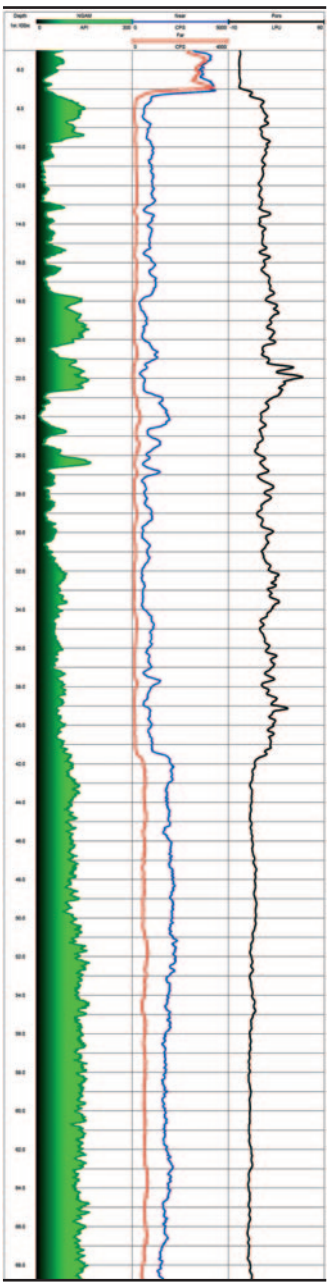
Borehole type:	open/cased, water-filled
Centralisation:	ex-centralised with bowspring
Recommended Logging Speed:	4m/min

Specifications

Diameter:	65mm
Length:	2.14m
Weight:	19.5kg
Temperature:	0-70°C (0-125°C optional)
Max. pressure:	20MPa
Range:	15 to 45% Limestone Porosity Units (LPU)

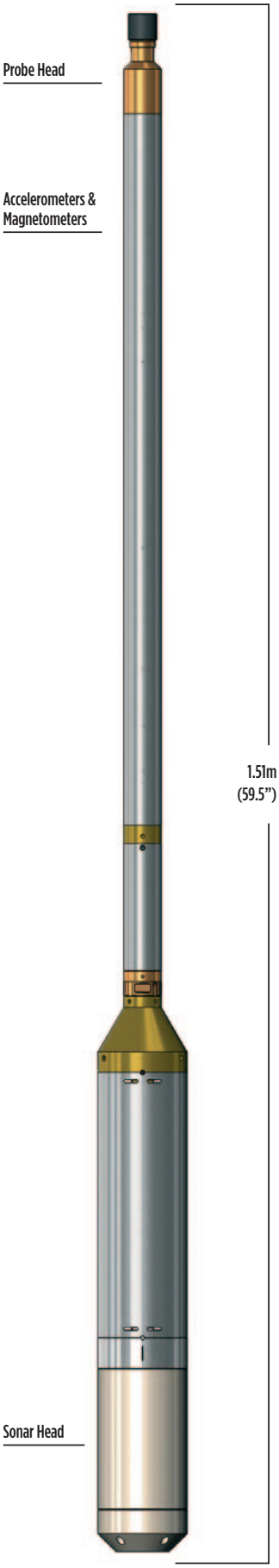
Part Numbers

I002029	Dual Neutron probe with natural gamma
I002030	- includes CCL



Example of logging data

Sonar Caliper



Sonar Caliper Probe

The Sonar Caliper Probe has been developed to provide a scaled and orientated cross-section of large bores, shafts, caverns and trench walls; combining accurate diameter measurement with a fully orientated 360° view of its surroundings.

700kHz and 200kHz models are available to suit varying in-situ fluid conditions.

Principle of Measurement:

Sonar operates by emitting a pulse of sound that is reflected by a solid object; timing the delay between emission and the arrival of the reflected sound wave back at the probe allows for a calculation of distance. The Sonar Caliper Probe makes 400 individual radius measurements in a 360° arc around the probe and then orientates them to magnetic north.

SPECIFICATION:

Features

- Real time large diameter measurement
- Layout orientation/mapping

Measurements

- Spatial diameter
- Orientation
- Spatial volume – derived value

Applications

- Large diameter boreholes (> 1500mm)
- Trench walls
- Shafts, caverns and voids

Operating Conditions

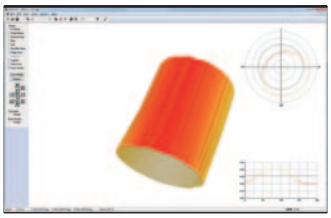
Borehole type:	Fluid filled
Centralisation:	Vertical borehole and central suspension point are advisable
Recommended Logging Speed:	Stationary at discreet points

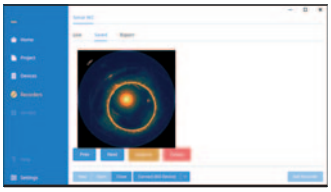
Specifications

Max Diameter:	700kHz - 75mm 200kHz - 100mm
Length:	1.51m
Weight:	16kg
Temperature:	70°C
Pressure:	10MPa
Range:	700kHz - 50m in clear water and brines 200kHz - TBA

Part Numbers

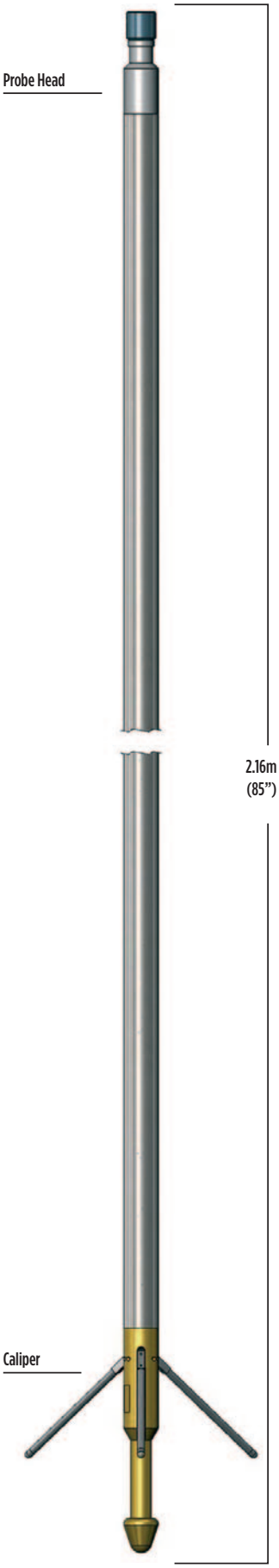
I002193	Sonar Caliper Probe





Examples of logging data

3-Arm Caliper
710mm, 1000mm and 1500mm ranges



3-Arm Caliper Probe

The 3-Arm Caliper probe provides a single continuous log of borehole diameter as recorded by three mechanically coupled arms in contact with the borehole wall.

710mm, 1000mm and 1500mm range calipers are available to suit a range of well diameters. The caliper is a useful first log to determine the borehole conditions before running more costly probes or those containing radioactive sources.

Principle of Measurement:

Opening and closing of the motor-driver caliper arms is by surface command, allowing the probe to run into the borehole with the arms retracted. Once opened, the spring-loaded arms respond to borehole diameter variations as the probe is raised up the borehole.

SPECIFICATION:

Features

- Small diameter for slim-hole operation
- Extension arms supplied as standard for 38mm version
- Optional natural-gamma measurement
- Optional casing collar locator

Measurements

- CCL (optional)
- Borehole volume (derived)
- Natural Gamma (optional)
- Borehole volume

Applications

- Minerals/Water/Engineering
- Location of borehole collapse or obstructions
- Cement volume calculations for grouting
- Identification of hard and soft lithology
- Location of cracks, fissures, caving, faulting, casing breaks
- Correction of other logs affected by borehole diameter

Operating Conditions

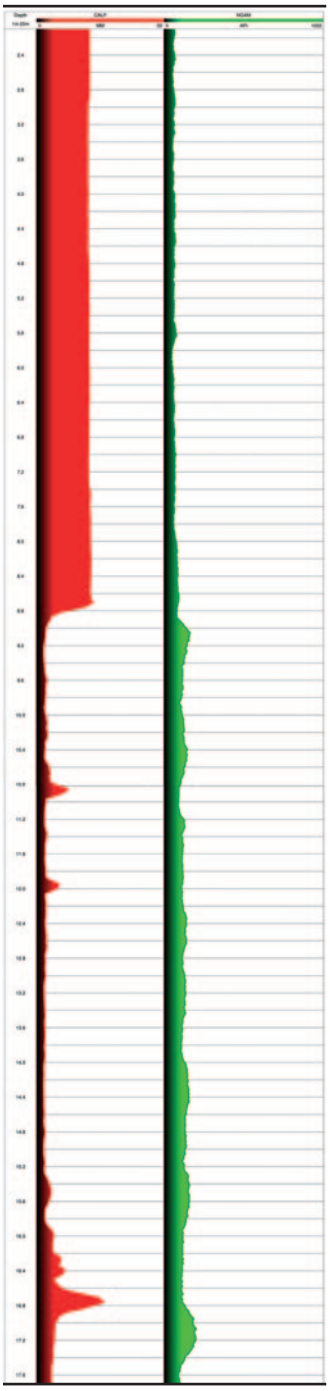
Borehole type:	open/cased; water/air-filled
Centralisation:	recommended in large holes
Centralisation:	recommended in inclined holes
Recommended Logging Speed:	5m/min

Specifications

Temperature:	0-70°C (extended ranges available)
Max. pressure:	20MPa
3-Arm Caliper (710mm range)	
Diameter:	38mm
Length:	2.18m-2.68m (depending on CCL and extended arms)
Weight:	7.5kg
Range:	40-300mm and 40-710mm
3-Arm Caliper (1000mm range)	
Diameter:	60mm
Length:	2.83m
Weight:	15kg
Range:	65-1000mm
3-Arm Caliper (1500mm range)	
Diameter:	80mm
Length:	3.14m
Weight:	17.5kg
Range:	100 - 1600mm

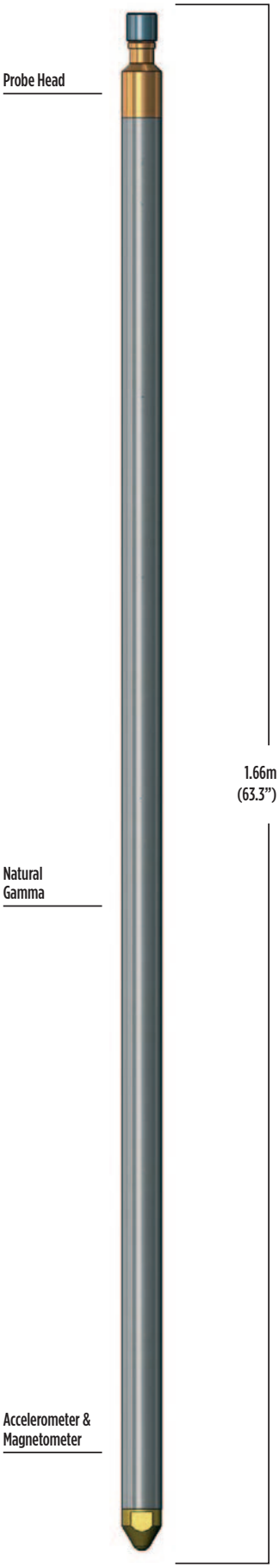
Part Numbers

I002035	3-Arm Caliper (710mm range) with arm extension kit and calibrator
I002037	– including natural gamma
I002041	3-Arm Caliper (1000mm range) with calibrator
I002052	3-Arm Caliper (1500mm range)



Example of logging data

Verticality



Verticality Probe

The Verticality probe provides accurate, continuous measurements of borehole inclination and direction.

These are output directly as log traces or may be processed further to produce tabular and graphical outputs of borehole position, borehole drift and true vertical depth.

Principle of Measurement:

The probe includes a triaxial magnetometer to determine the bearing of a reference in the probe relative to magnetic North and three accelerometers to measure inclination. The outputs from the transducers are processed by a downhole microprocessor to give final borehole inclination and azimuth data in real time.

SPECIFICATION:

Features

- Small diameter for slimhole operations
- Continuous borehole orientation log
- Suitable for all borehole inclinations and directions

Measurements

- Borehole inclination
- Borehole direction
- Borehole drift
- True vertical depth
- Natural Gamma

Applications

Minerals / Water / Engineering

- Bed-thickness estimation
- Surveying and deviation checks
- True seam depth

Operating Conditions

Borehole type:	open/plastic-cased, water/air-filled
Centralisation:	non-magnetic centralisers required
Recommended Logging Speed:	4m/min

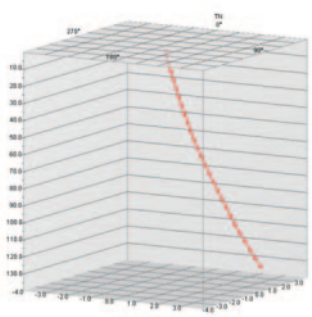
The operation of the probe is limited in steel casing or in the presence of magnetic minerals which affect the magnetometer. Under such conditions, only borehole inclination (without directional information) can be logged. The Gyro probe should be used in preference to the standard verticality probe in such cases.

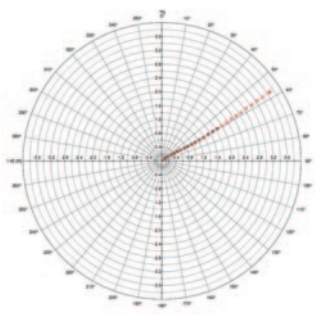
Specifications

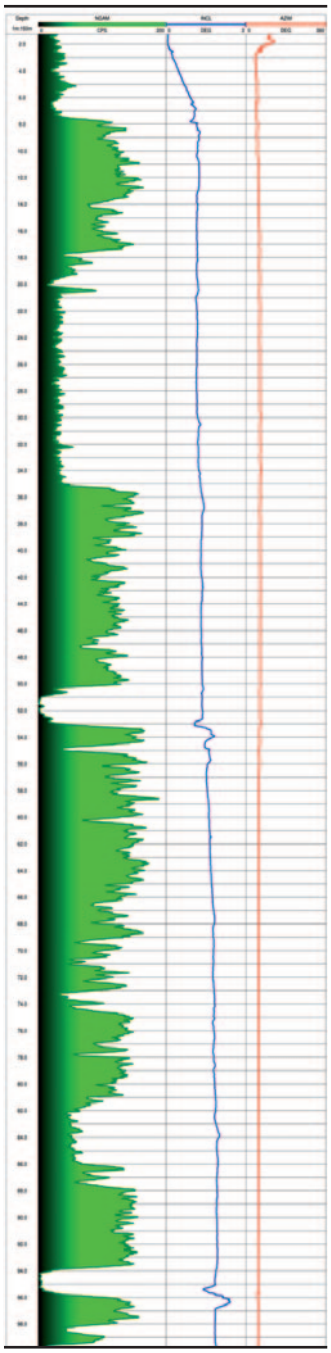
Diameter:	42mm
Length:	1.66m
Weight:	5.5kg
Temperature:	0-70°C (extended ranges available)
Max. pressure:	20MPa
Inclination range:	Horizontal +/- 90°
Azimuth range:	0 to 360°

Part Numbers

I002141	Verticality probe with natural gamma

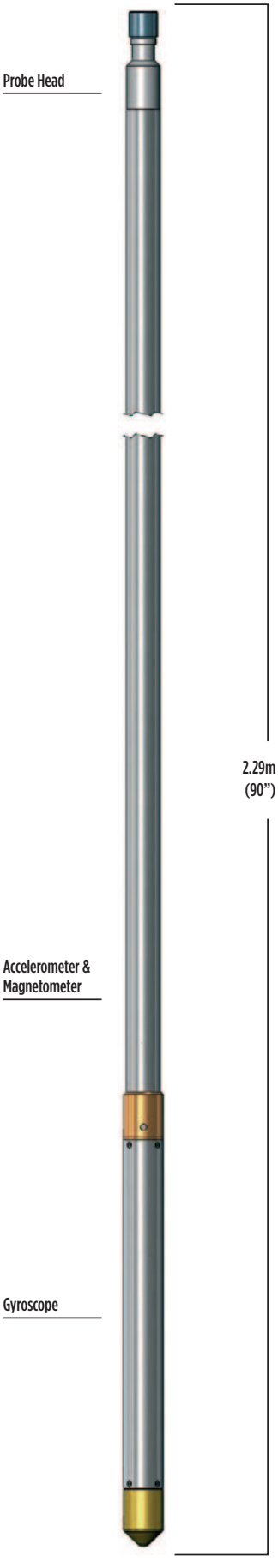






Examples of logging data

Gyro



Gyro Probe

The Gyro probe acquires borehole inclination/azimuth logs in situations where metal casing or magnetic materials around the borehole prevent use of the standard verticality probe.

The Gyro Magnetometer version also acquires 3D-magnetic data for location of magnetic ore bodies.

Principle of Measurement:

The standard probe includes a gimbal-mounted directional gyroscope for orientational measurement and three accelerometers for inclination. In the Gyro Magnetometer probe, an additional triaxial fluxgate magnetometer continuously measures X, Y and Z magnetic components. These are used to compute the magnitude and direction of the magnetic field around the probe.

SPECIFICATION:

Features

- Continuous log of borehole inclination/azimuth
- Not influenced by metal casing or magnetic materials
- Low drift compared to 'rate' gyroscopes
- Natural-gamma measurement
- Magnitude and direction of surrounding magnetic field

Measurements

- Borehole inclination
- Borehole drift
- True vertical depth
- Natural Gamma
- Magnitude and direction of surrounding magnetic field

Applications

Water / Minerals / Engineering

- Verticality measurements in steel casing or in the presence of magnetic ores
- Detection of nearby magnetic ore bodies (Gyro Magnetometer probe)

Operating Conditions

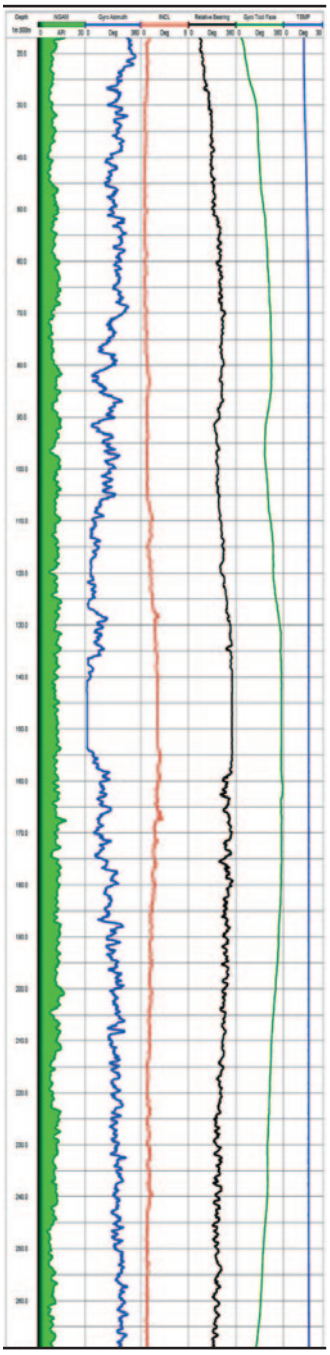
Borehole type:	open/cased hole; water/air-filled
Centralisation:	required
Recommended Logging Speed:	3m/min

Specifications

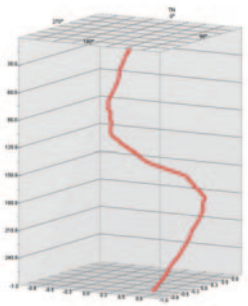
Diameter:	45mm
Length:	2.29m
Weight:	12kg
Temperature:	0-70°C (extended ranges available)
Max. pressure:	20MPa
Inclination range:	0 to 30°
Azimuth range:	0 to 360°
Magnetometer range:	+/-100 µT

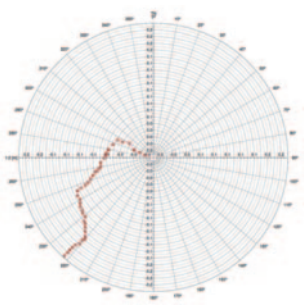
Part Numbers

I002150	Gyro probe with natural gamma
I014559	Gyro Magnetometer probe with natural gamma



Examples of logging data





Elastmeter

The Elastmeter is a borehole lateral load tester designed to figure out deformation characteristics of the ground ranging from soft rock to hard rock. The deformation characteristics become useful information especially for the construction of large scale structures such as dams, bridges and high-rise buildings.

The Elastmeter has a range of probes to provide pressuremeter tests of rock in BQ (60 mm), NQ (76 mm) and HQ (98 mm) boreholes. Both pressure and displacement are measured directly in the probe using electrical transducers. A mechanical arm is used for the measurement of displacement making maintenance easier. Applied pressure is measured by a precise semi-conductor transducer in the probe.

Pressuremeter and data recorder:

The system comes complete with data recorder, probe and cables for up to 200m use.

SPECIFICATION:

Specifications	
Probe Types:	BQ (60 mm), NQ (76 mm) and HQ (98 mm)
Max Pressure:	20MPa
Deformation range:	BQ Probe 66-80mm NQ Probe 76-90mm HQ Probe 100-115mm
Probe Diameter:	BQ Probe 62mm NQ Probe 72mm HQ Probe 96mm
Weight:	BQ Probe 20kg NQ Probe 20kg HQ Probe 30kg

Part Numbers	
Model 4023	Elast Recorder
Model BQ	Elastmeter Probe BQ
Model NQ	Elastmeter Probe NQ
Model HQ	Elastmeter Probe HQ
Model 4185	High Pressure Pump
04181-2001	Control Cable 100m
Model 4153	High Pressure Cable
04181-4024	Carrying case for probe - wooden
04149-6005	Tool Kit
04154-4005	Calibration pipe 76mm I.D for NX
04154-4007	Calibration pipe 82mm I.D for NX
15491-2010	Packer tube for NX - hard
01167-0501	Battery pack with carrying bag
12539-2015	Battery charger - 100 or 220V AC
12539-9001	Step-down transformer

Micrologger2 | Winlogger Software

Micrologger2

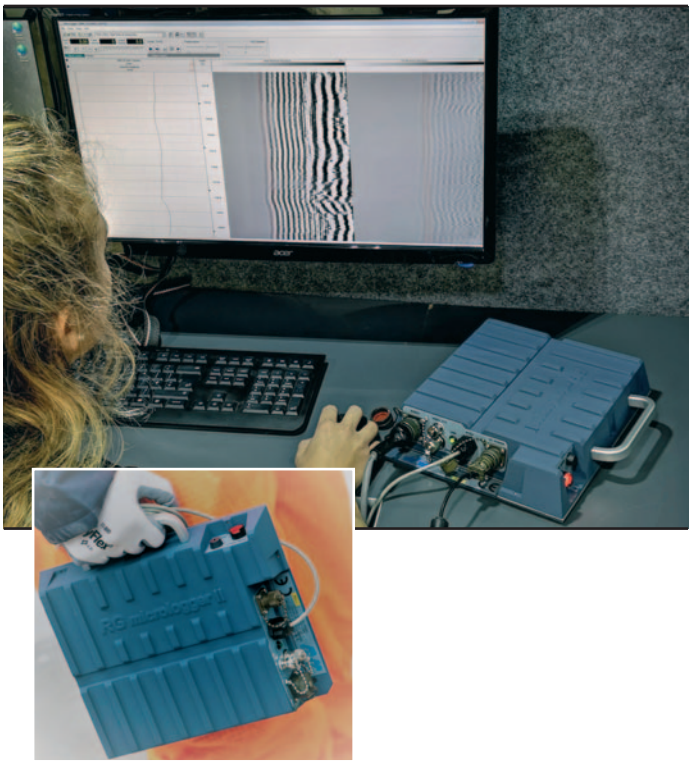
Micrologger2 is the surface interface system for handling logging data acquisition. It supports all Robertson Geo probes including acoustic and imaging tools.

Compact and lightweight Micrologger2 is probably the most powerful portable logging system around and with over 600 units used around the globe it has a proven record for its reliability and technology.

SPECIFICATION:

Features
Logging
Supports Robertson Geo and many third-party probes
USB high-speed link to PC Compatible with most winches/cables
Real-time data display and printing
Supports Windows™ printers
Data output in LAS and Robertson Geo formats
Modular construction for easy field maintenance

Part Numbers	
I000184	Robertson Geo USB Micrologger2
I000204	110/220VAC power supply for ML2 and winch (up to 500m)
I000197	Canvas bag for Micrologger2
I013689	Robertson Geo Micrologger2 (video capability installed)
I000192	Micrologger2 12V PSU (Black Box)
I000211	Notebook PC using latest Windows software
I000213	Semi-Ruggedised notebook PC using latest Windows software
I014942	Fast Thermal Printer for continuous plots (Desk Top)
I014946	Fast Thermal Printer for continuous plots (Rack Mounted)



Winlogger Software

Winlogger is the MS Windows based operating system for the Micrologger2, providing field acquisition capability, processing and reporting for the full range of Robertson Geo probes.

It is easy to operate, retaining a standard Windows™ look using familiar tool bars and drop-down menus for all frequently needed functions.

The package incorporates powerful features including a built-in compiler to allow the more advanced user to construct custom 'User Functions' to process multichannel data in real time during logging.

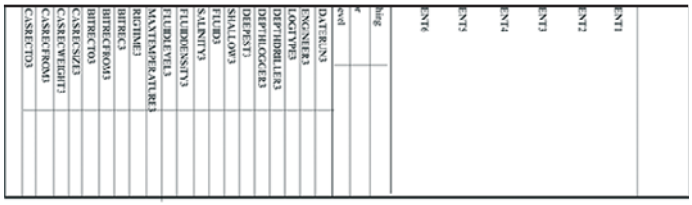
Robertson Geo Winlogger is supplied with a multi-user licence allowing free distribution of the software to any user of Robertson Geo log data.

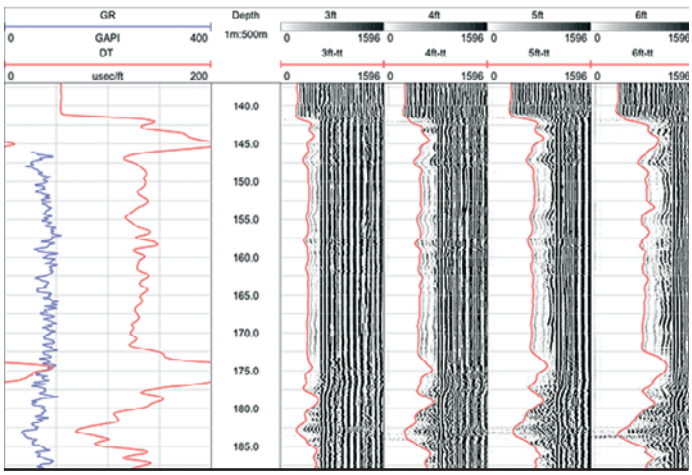
This policy has proved popular with wireline service companies who may provide Winlogger to clients to allow them to replay or reprocess data in-house without resorting to 3rd-party packages.

SPECIFICATION:

Features
Support for all Robertson Geo digital slim-hole probes
Screen/printer log display in calibrated engineering units
Selectable depth sample interval (1, 2, 5, 10 cms etc)
Metric and imperial logs in API format
Custom logos and headers Data export in ASCII (LAS) format
Compatible with Windows 10 and earlier OS

Part Numbers	
I000466	Winlogger software





Mini Winch | 500m Winch | 600m Winch

Robertson Geo designs and builds its own range of winches of varying capacities for deploying subsurface probes on 4-core or co-axial cable.

Each winch is precision engineered for reliable use in the most challenging field applications. The winches are fully compatible with the Micrologger2 surface system and the full range of Robertson Geo probes, for depths of up to 3,000m.

Mini Winch

The Robertson Geo Mini Winch is portable, compact and robust. Its basic 'no-frills' design is aimed at long-term reliability under arduous conditions.

SPECIFICATION:

Specifications	
Capacity:	175m (575') 4.72, (3/16") cable
Speed:	0 – 17.5m/min (0 – 57ft/min) on full drum (12VDC operation)
Motor:	550W (12 – 24VDC)
Size:	340(w) x 400(l) x 320(h) mm
Weight:	19kg excluding cable

Part Numbers	
I013754	Mini Winch includes power and data cables
I001117	Mini Winch Tripod with Encoder

500m Winch

A robust heavy-duty unit, the 500m Winch can be operated from a vehicle battery and is ideal for heavier probes in shallow boreholes.

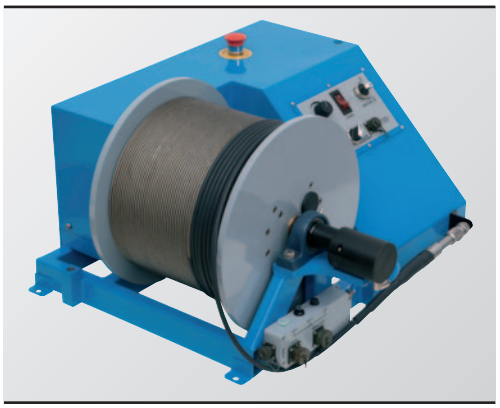
SPECIFICATION:

Specifications	
Capacity:	530m (1738') 3/16" 4-core cable
Speed:	0 – 13m/min (0 – 43ft/min)
Motor:	180W at 12VDC
Size:	582(w) x 482(l) x 414(h) mm
Weight:	52kg excluding cable

Part Numbers	
I001019	500m winch including tripod, power and data cable

600m Winch

Of similar basic construction to the 500m winch, the 600m is mains/generator powered.



SPECIFICATION:

Specifications	
Capacity:	630m (2066') 3/16" 4-core cable
Speed:	0 – 15m/min (0 – 49ft/min)
Motor:	540W at 110/220VAC
Size:	622(w) x 696(l) x 370(h) mm
Weight:	80kg excluding cable

Part Numbers	
I001043	600m winch including tripod, power and data cable

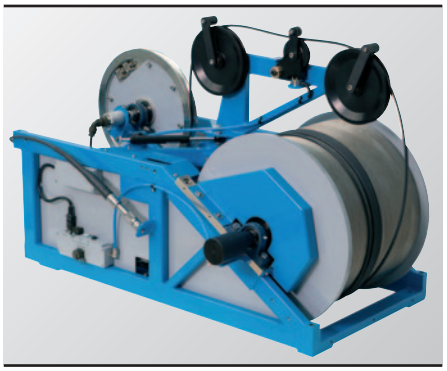
1000m/2000m Winch | 3000m Winch
2000m Marine Winch

Robertson Geo designs and builds its own range of winches of varying capacities for deploying subsurface probes on 4-core or co-axial cable.

Each winch is precision engineered for reliable use in the most challenging field applications. The winches are fully compatible with the Micrologger2 surface system and the full range of Robertson Geo probes, for depths of up to 3,000m.

1000m/2000m Winch

The standard unit for truck-mounted operations in deep boreholes, the 2000m winch includes an integral depth wheel and an automatic level wind.



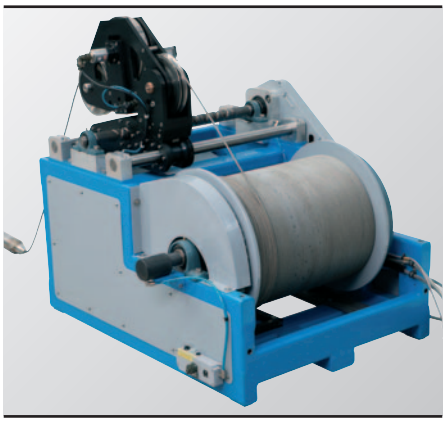
SPECIFICATION:

Specifications	
Capacity:	2030m (6658') 3/16" 4-core cable 1030m (3378') 1/4" coaxial cable
Speed:	0 – 30m/min (0 – 99ft/min)
Motor:	2hp (1.5kW) at 110/220VAC
Size:	605(w) x 1060(l) x 735(h) mm
Weight:	142kg excluding cable

Part Numbers	
I001021	2000m winch for 3/16" 4-core cable includes tripod, power and data cable
I001034	1000m winch for 1/4" coaxial cable includes tripod, power and data cable

3000m Winch

A heavy-duty electric draw-works designed for deeper hole and oil/gas investigations. *Please note the pressure limits of standard Robertson Geo slimhole tools.*



SPECIFICATION:

Specifications	
Capacity:	3000m (9840') 3/16" cable
Speed:	0.2 – 34m/min rim: 0.5 – 100m/min
Pull:	1,350kgF Rim: 460kgF
Motor:	440VAC 3-Phase 4kVA
Dimensions:	1000(w) x 1100(l) x 900(h) mm
Weight:	415kg excluding cable

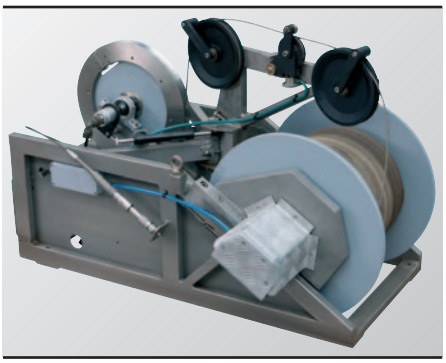
Part Numbers	
I013866	3000m winch for 3/16" four-core system includes tripod, power and data cable

2000m Marine Winch

Working experience by Robertson Geo offshore logging crews has led to the modification of the 2000m Winch and the introduction of a Marine variation to resist corrosive, saline conditions.

The communications box is waterproofed and filled with silicon to protect the electronics.

Grade 316 stainless steel has been introduced to replace standard steel components. 316 contains the alloy molybdenum, significantly enhancing corrosion resistance, especially for more saline or chloride exposed environments. 316 components include structural frames, depth wheel, panels, spacers, shafts and gears, sprockets and chains.



SPECIFICATION:

Specifications	
Capacity:	2030m (6658') 3/16" 4-core cable 1030m (3378') 1/4" coaxial cable
Speed:	0 – 30m/min (0 – 99ft/min)
Motor:	2hp (1.5kW) at 110/220VAC
Size:	605(w) x 1060(l) x 735(h) mm
Weight:	142kg excluding cable

Part Numbers	
I019167	2000m Marine Winch

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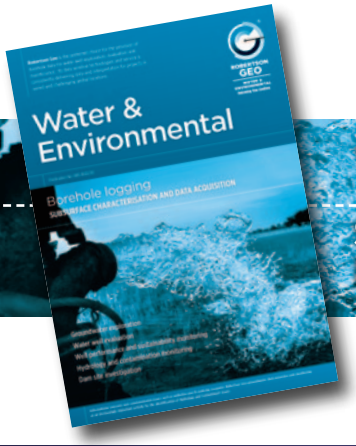

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