

For over 45 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.



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Unlocking Your GeoData

Geotechnical

Publication No: 001 RGO/25b

Borehole logging SUBSURFACE SITE INVESTIGATION AND DATA ACQUISITION

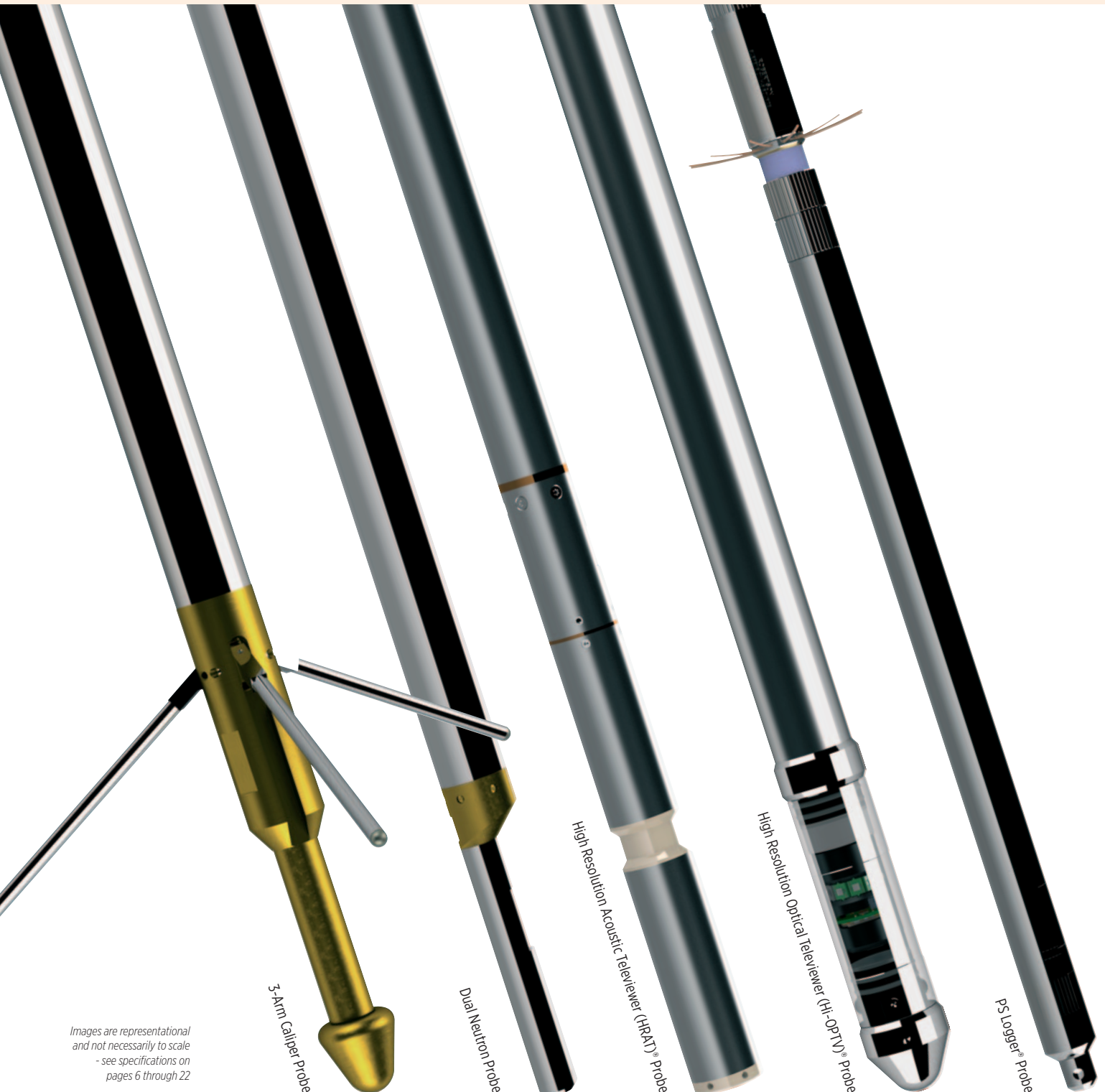


Foundation engineering
Slope stability studies
Fracture detection and analysis
Earthquake engineering
QA checking piles and diaphragm walls
Soil/rock in-situ testing
Voids and old mine workings location
Mine safety

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 Conwy, North Wales UK. Purchasers of equipment include geological surveyors, water authorities, mining houses, civil engineering consultants, aid organisations, drilling contractors and oil companies worldwide.



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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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

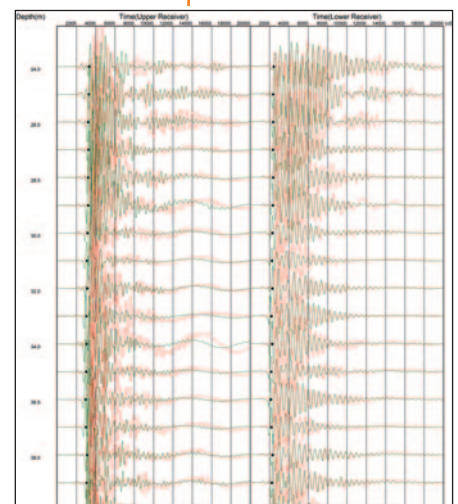
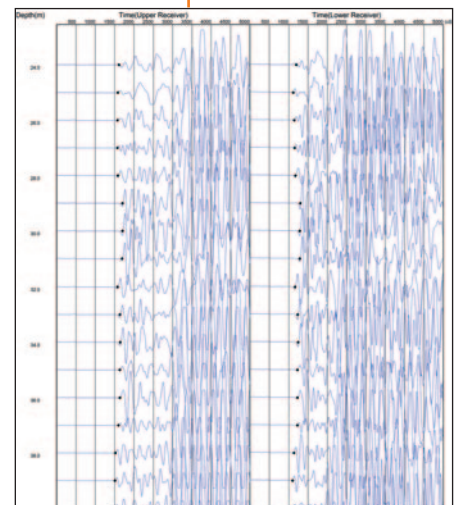
All Robertson Geo probes are fully tested and calibrated at the Conwy facility prior to dispatch, eliminating testing time on site and ensuring the probes are fully operational prior to downhole use.

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 22.

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 Conwy 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)®: provides a continuous high-resolution oriented ultrasound image of the borehole wall.

See page 6

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

4-Arm Caliper: can replace the 3-Arm Caliper with an advantage where the borehole cross-

section deviates from circular and provides a single continuous log of borehole diameter as recorded by two independent pairs of linked arms in contact with the borehole wall. The caliper is a useful first log to determine the borehole conditions before running more costly probes or those containing radioactive sources. *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 ore 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*

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 16*

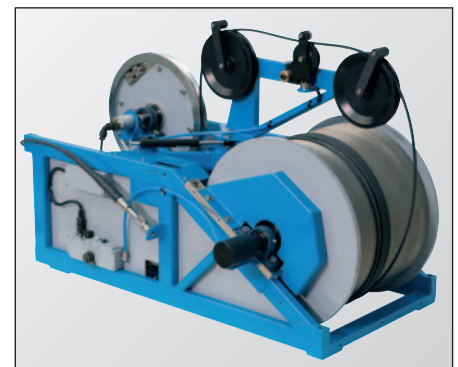
Elastmeter: a borehole lateral load tester designed to figure out deformation characteristics of the ground ranging from soft rock to hard rock. The deformation characteristics become useful information especially for the construction of large scale structures such as dams, bridges and high-rise buildings. *See page 17*

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 18*

Winlogger: MS Windows based operating system for the Micrologger2, provides field acquisition capability. In-house processing, interpretation and reporting is undertaken. *See page 18*



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

See pages 19-21

Sheaves: Wireline sheaves are designed for logging operations with all Robertson Geo winches. *See page 22*



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 Televiwer® Probe
and/or
- High Resolution Optical Televiwer® Probe
- 4-Arm Caliper Probe (recommended)
- 3-Arm Caliper Probe (optional)

Intermediate

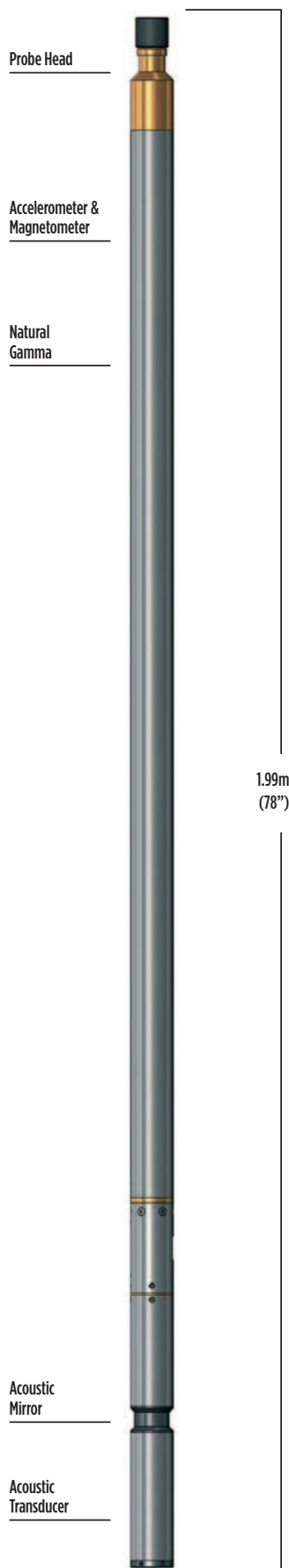
- Micrologger2
- Winch (Mini/500m/600m)
- High Resolution Acoustic Televiwer® Probe
- High Resolution Optical Televiwer® Probe
- 4-Arm Caliper Probe (recommended)
- 3-Arm Caliper Probe (optional)
- Formation Density Probe
- PS Logger® Probe
- Elastmeter
- Verticality

Advanced

- Micrologger2
- Winch (500m/2,000m)
- High Resolution Acoustic Televiwer® Probe
- High Resolution Optical Televiwer® Probe
- 4-Arm Caliper Probe (recommended)
- 3-Arm Caliper Probe (optional)
- 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 22

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.

GeoCAD[®] Televiewer Module: 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: Fluid filled
- Recommended Logging Speed: 2.5m/min

Specifications

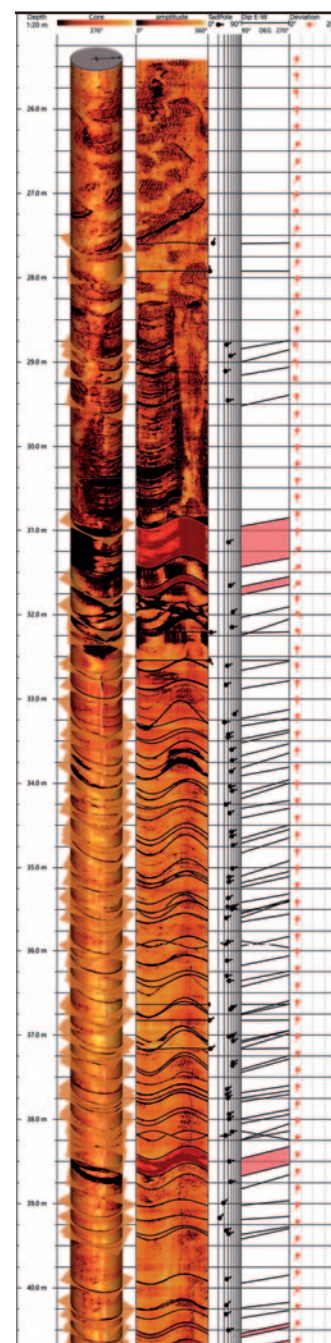
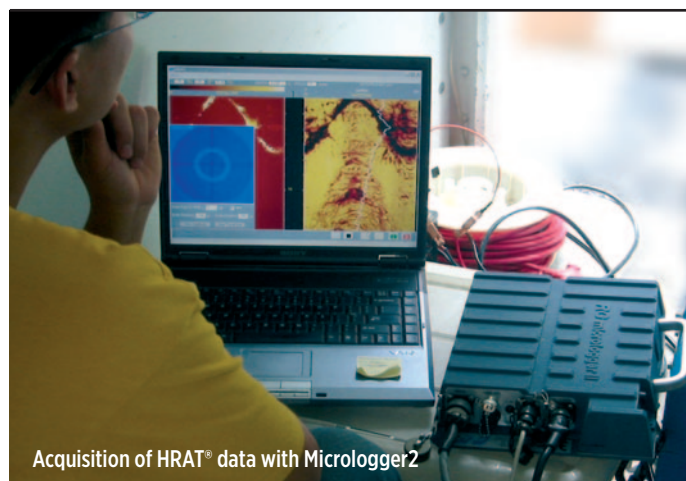
- Diameter: 42mm
- Length: 1.99m
- Weight: 5kg
- Temperature (max): 70°C
- Transducer type: 1.5MHz piezo-composite
- Rotation rate: 5 – 20rev/s
- Sample rate: up to 360/rev

Part Numbers

- I002184 HRAT[®] probe
- I002192 HRAT[®] including natural-gamma

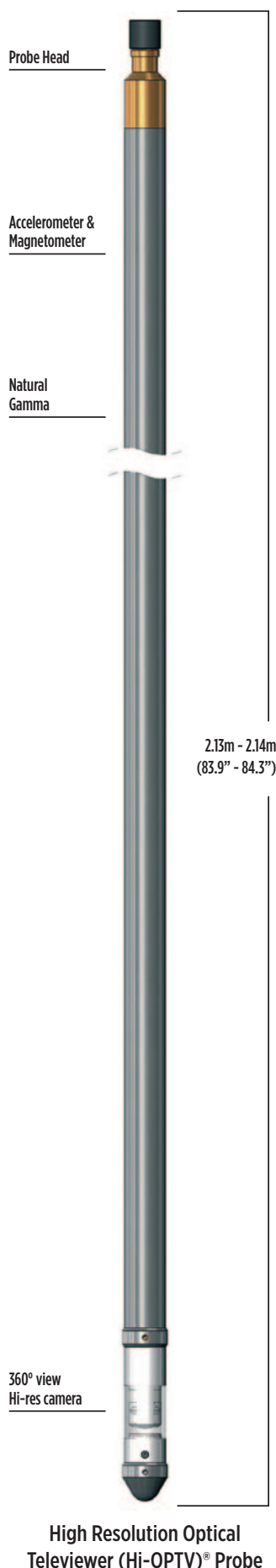
GeoCAD[®] Televiewer Module

- I020248 GeoCAD[®] Televiewer Module



Example of logging data

High Resolution Optical Televiewer (Hi-OPTV)[®]



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.

GeoCAD[®] Televiewer Module: 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

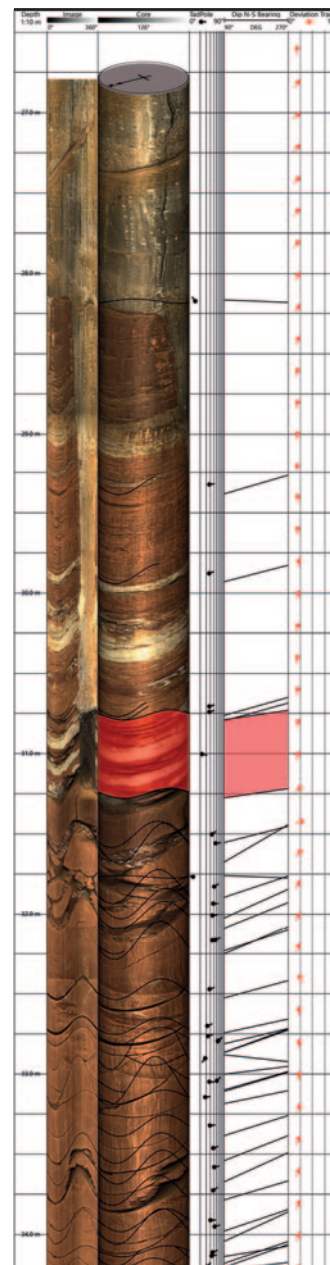
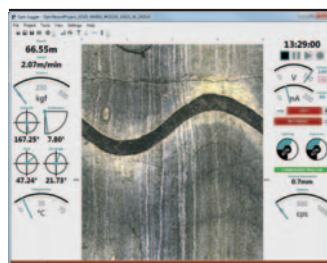
Length: 2.13m - 2.14m (10MPa/20MPa window)
Diameter: 46mm (10MPa) & 58mm (20MPa)
Weight: 6kg (10MPa) or 7.2kg (20MPa)
Temperature (max): 60°C
Circular resolution: user definable 360/540/720/900/1080/1260/1440 pixels
Sensor type: 1280 x 1024 pixels CMOS image sensor
Colour resolution: 24 bit RGB

Part Numbers

I017187 Hi-OPTV[®] probe (46mm)
I017188 Hi-OPTV[®] probe (46mm) with gamma
I017125 Hi-OPTV[®] probe (58mm)
I017216 Hi-OPTV[®] probe (58mm) with gamma
I015464 Gamma Test Blanket

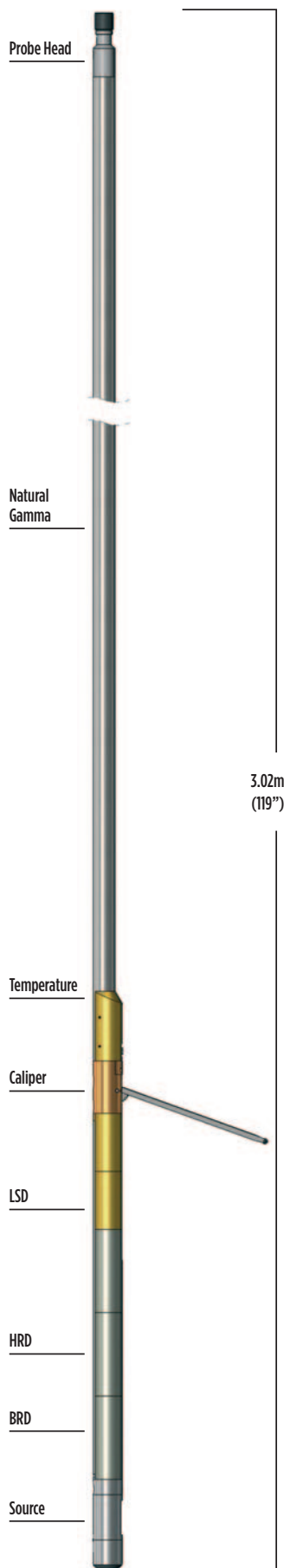
GeoCAD[®] Televiewer Module

I020248 GeoCAD[®] Televiewer Module



Examples of logging data

Formation Density



Formation Density Probe

The Formation Density probe provides a calibrated, borehole-compensated density measurement using a detachable ^{137}Cs gamma source and dual shielded detectors.

The far spaced detector (LSD) is calibrated, giving the best estimate of formation density as borehole wall effects are minimised. A shorter spaced detector (HRD) is also calibrated which provides improved vertical resolution. An optional shorter spaced third detector (BRD) provides a qualitative log with excellent vertical resolution for bed boundary delineation.

Principle of Measurement:

The source and detectors are held in contact with the borehole wall by a spring-loaded caliper arm measuring diameter for borehole compensation. Gamma radiation from the source is back-scattered (Compton effect) in the formation, reaching the detectors where the relative counts are measured using sodium iodide scintillation detectors. Calibration constants are determined using a water tank and an aluminium block which has previously undergone a primary calibration. The calibration constants are combined with the gamma counts and diameter readings in the supplied software to give a calibrated density in g/cc.

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
- Dual-calibrated density channels (LSD & HRD)
- Natural gamma
- Caliper
- Options:** Bed-resolution density (BRD) and 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

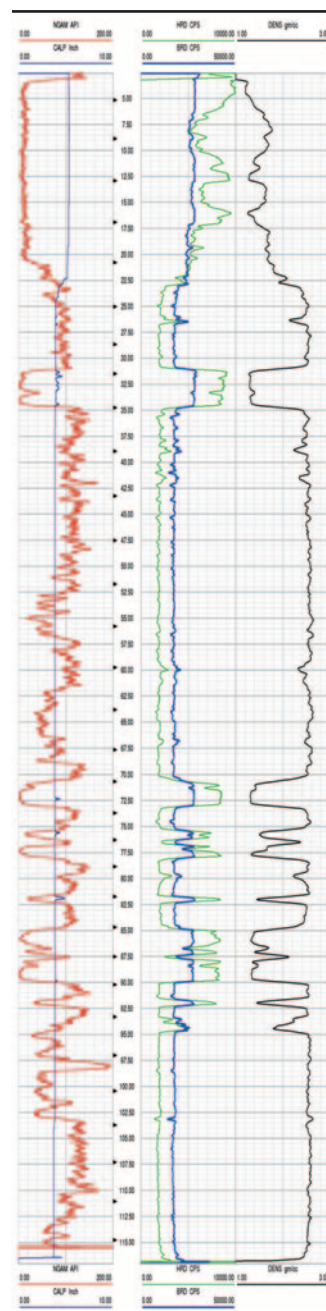
- Borehole type: All, including air filled (qualitative measurement only)
- Recommended Logging Speed: 3m/min

Specifications

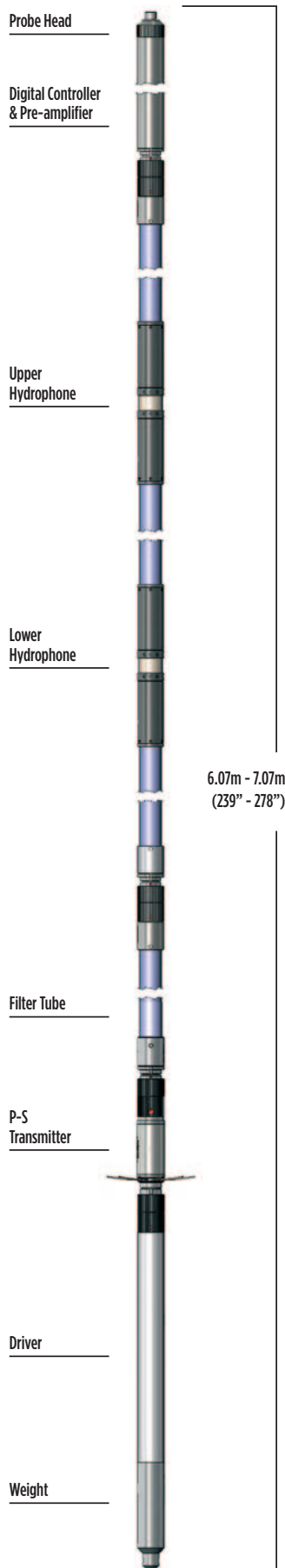
- Diameter: 51mm
- Length: 3.02m
- Weight: 24kg
- Temperature: 0-70°C (extended ranges available)
- Max. pressure: 20MPa
- Density range: 1.1 to 2.95g/cc
- Caliper range: 51mm to 300mm

Part Numbers

- 1002013 Formation Density probe
- 1002016 – includes BRD and temperature



Example of logging data



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 Poisson'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

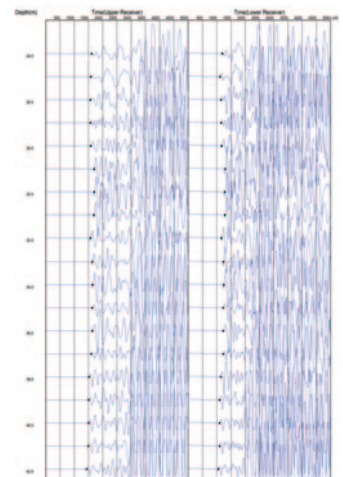
Specifications

- 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)

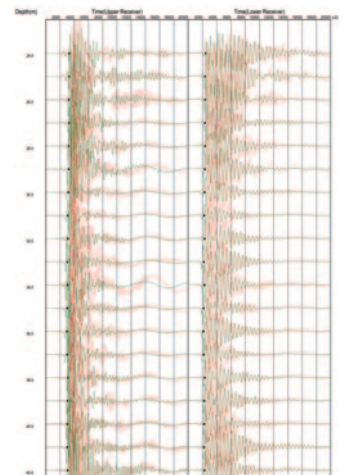
Part Numbers

- 1002244 PS Logger® probe in carrying case

P Waves

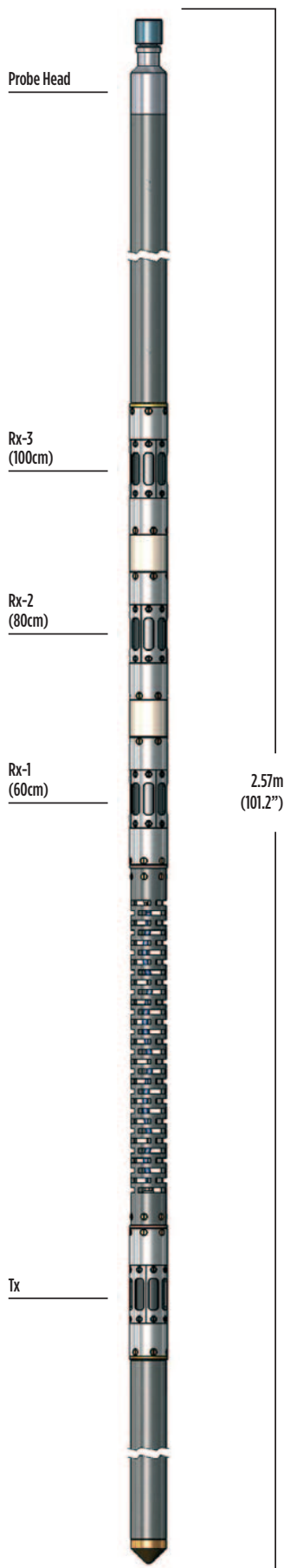


S Waves



Examples of logging data

Full Waveform Triple Sonic



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 ('wiggles') trace. The waveform data can be exported to be used in software packages, such as GeoCAD® for calculation of compressional (P), shear (S) and Stoneley velocities.

GeoCAD® Sonic Module: This optional package allows shear wave slowness processing from the full waveform data. These can be combined with additional density data to determine elastic moduli. First arrivals and waveform amplitudes can also be determined by the CBL function to provide cement bond quality reports.

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

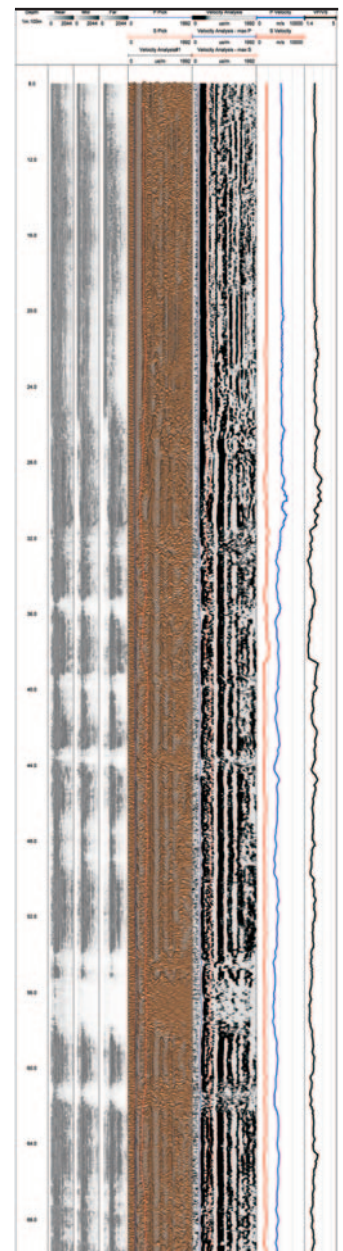
- Diameter: 45mm
- Length: 2.57m (2.96m with natural gamma)
- Weight: 11.5kg with natural gamma
- Temperature: 0-70°C (extended ranges available)
- Max. pressure: 20MPa

Part Numbers

- I013861 Full Waveform Triple Sonic probe with natural gamma

GeoCAD® Sonic Module

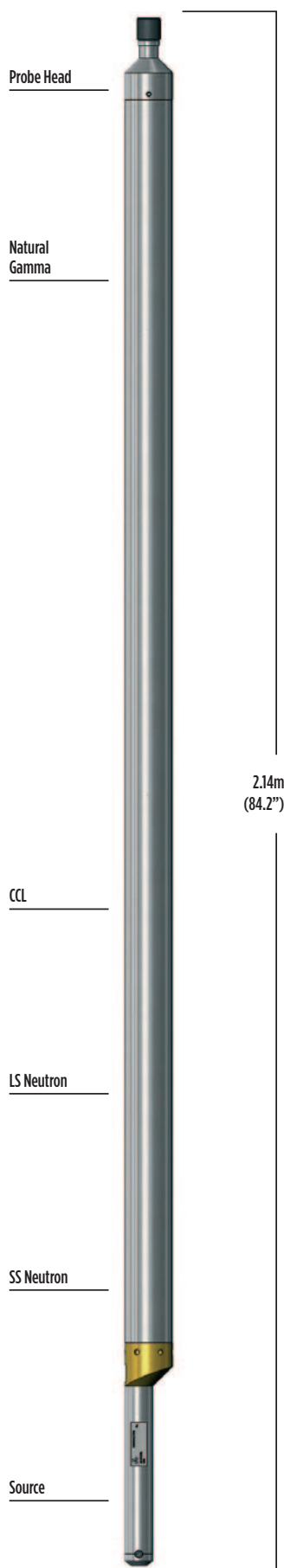
- I020983 GeoCAD® Sonic Module



Example of logging data

Full Waveform Triple Sonic Probe

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 ^3He proportional detectors and a detachable, sealed $^{241}\text{Am-Be}$ 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

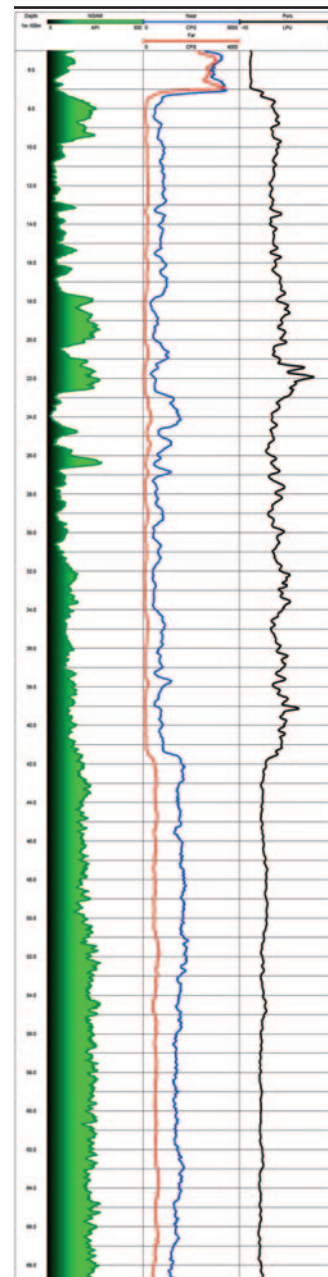
- Borehole type: open/cased, water-filled
- Centralisation: ex-centralised with bowspring
- Recommended Logging Speed: 4m/min

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)

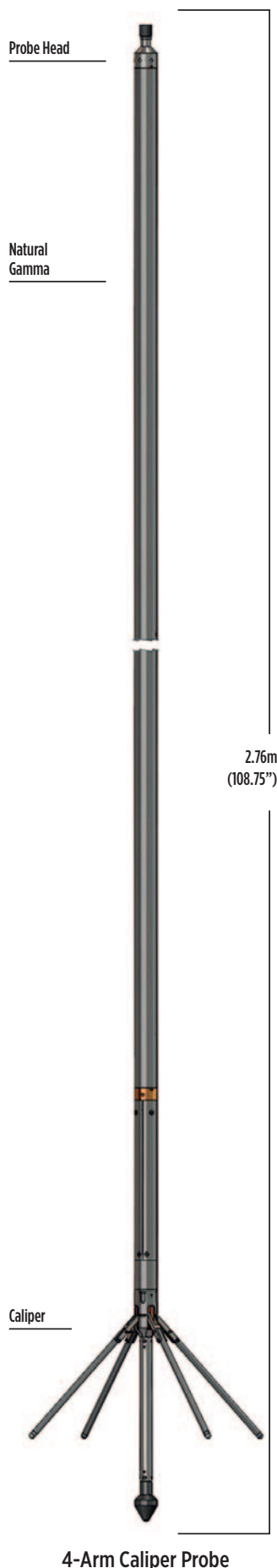
Part Numbers

- 1002029 Dual Neutron probe with natural gamma
- 1002030 - includes CCL



Example of logging data

4-Arm Caliper



The 4-Arm Caliper can replace the 3-Arm Caliper with an advantage where the borehole cross-section deviates from circular and provides a single continuous log of borehole diameter as recorded by two independent pairs of linked arms in contact with the borehole wall.

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. The long and short axis values are recorded.

SPECIFICATION:

Features

Sensitive X-Y caliper

Measurements

X and Y calipers
Borehole volume (derived)
Natural gamma

Applications

Water/minerals/engineering
Borehole diameter in two axes
Cracks, fissures and casing defects

Operating Conditions

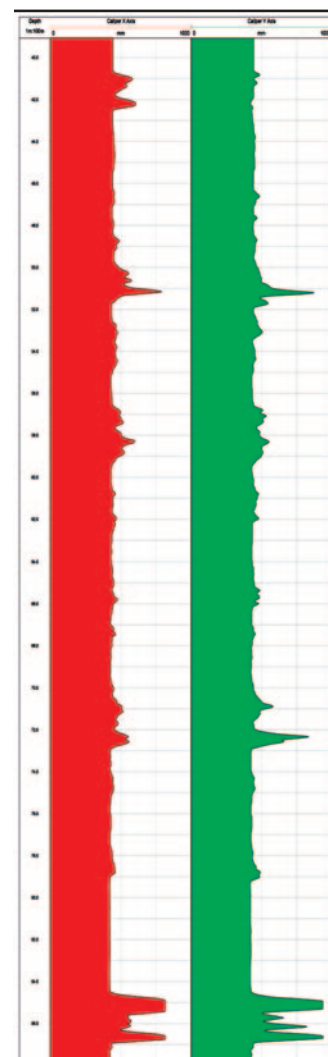
Borehole type: open/cased, water/air-filled
Centralisation: recommended
Recommended Logging Speed: 5m/min

Specifications

Diameter: 60mm
Length: 2.76m
Weight: 19kg
Temperature: 0-70°C (extended ranges available)
Max. pressure: 20MPa
Caliper range: 75mm to 700mm

Part Numbers

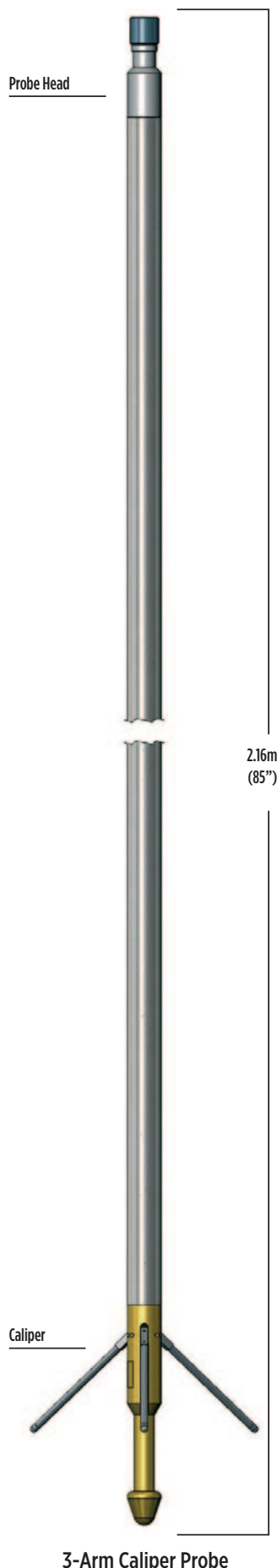
I018484 4-Arm Caliper



Example of logging data

3-Arm Caliper

710mm, 1000mm and 1500mm ranges



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)

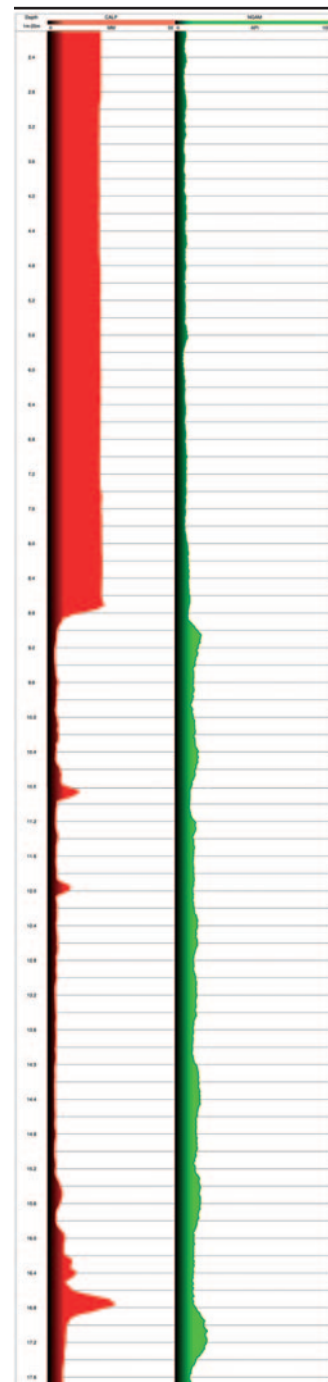
- Diameter: 60mm
- Length: 2.83m
- Weight: 15kg
- Range: 65-1000mm

3-Arm Caliper (1500mm range)

- Diameter: 80mm
- Length: 3.14m
- Weight: 17.5kg
- Range: 100 - 1600mm

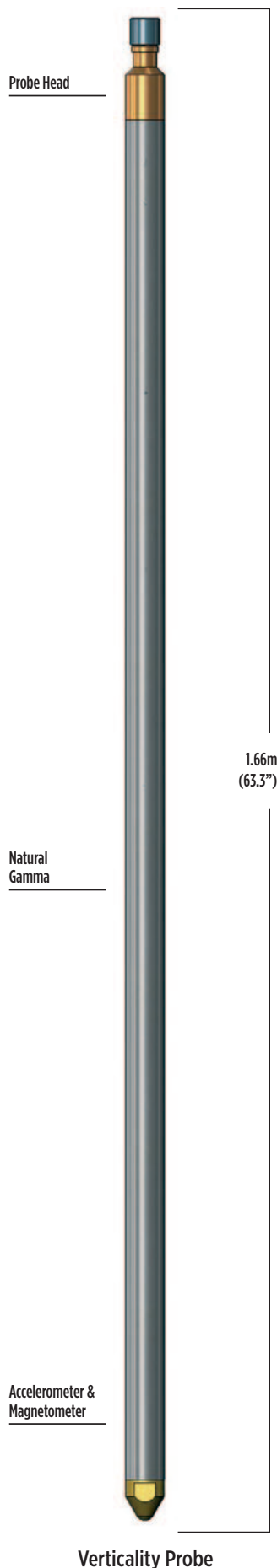
Part Numbers

- 1002035 3-Arm Caliper (710mm range) with arm extension kit and calibrator
- 1002037 – including natural gamma
- 1002041 3-Arm Caliper (1000mm range) with calibrator
- 1002052 3-Arm Caliper (1500mm range)



Example of logging data

Verticality



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

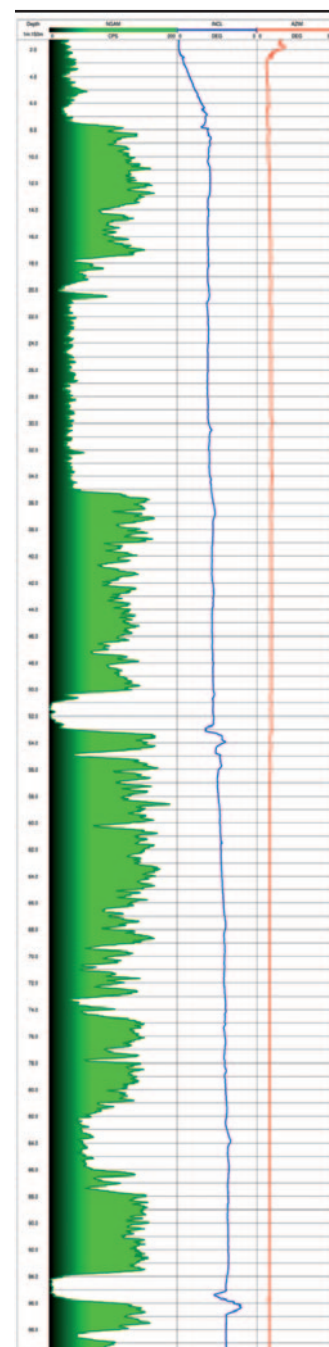
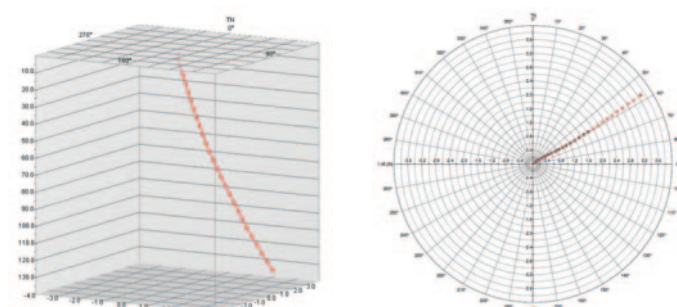
The operation of the probe is limited in steel casing or in the presence of magnetic minerals which affect the magnetometer. Under such conditions, only borehole inclination (without directional information) can be logged. The Gyro probe should be used in preference to the standard verticality probe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

Specifications

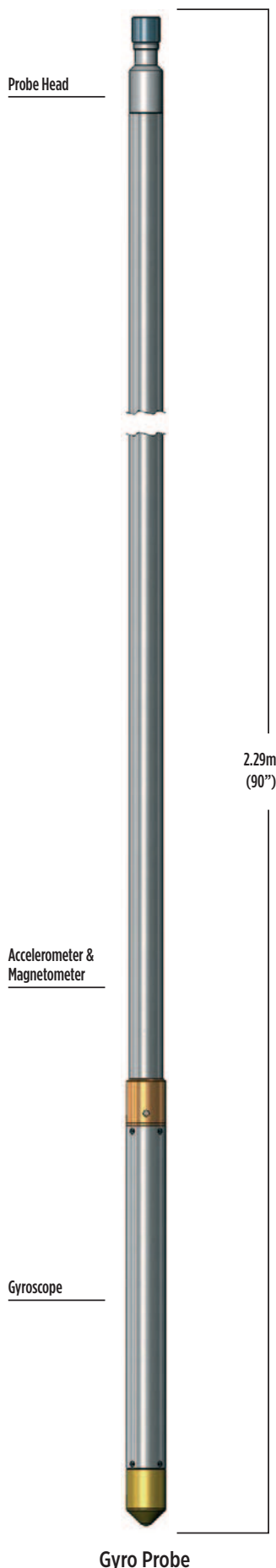
- Diameter: 42mm
- Length: 1.66m
- Weight: 5.5kg
- Temperature: 0-70°C (extended ranges available)
- Max. pressure: 20MPa
- Inclination range: Horizontal +/- 90°
- Azimuth range: 0 to 360°

Part Numbers

- I002141 Verticality probe with natural gamma



Examples of logging data



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

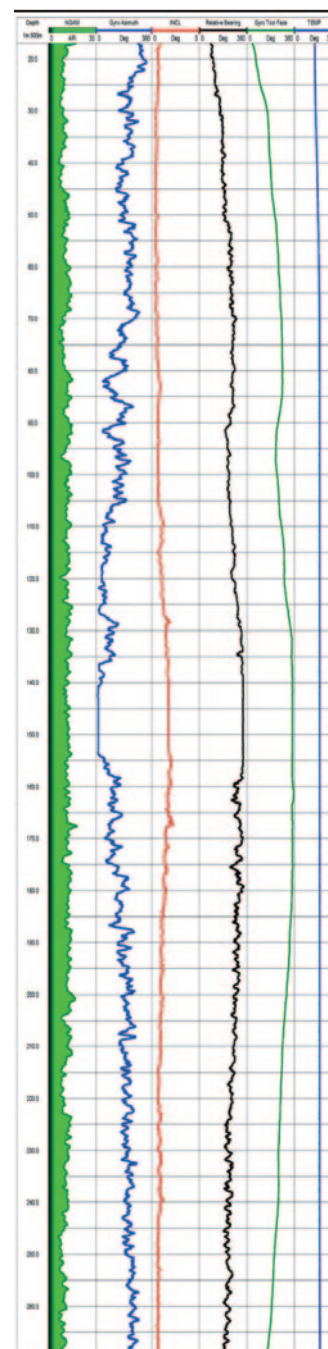
- Borehole type: open/cased hole; water/air-filled
- Centralisation: required
- Recommended Logging Speed: 3m/min

Specifications

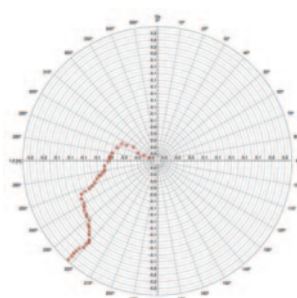
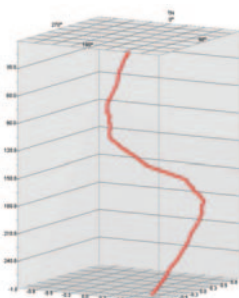
- Diameter: 45mm
- Length: 2.29m
- Weight: 12kg
- Temperature: 0-70°C (extended ranges available)
- Max. pressure: 20MPa
- Inclination range: 0 to 30°
- Azimuth range: 0 to 360°
- Magnetometer range: +/-100 μ T

Part Numbers

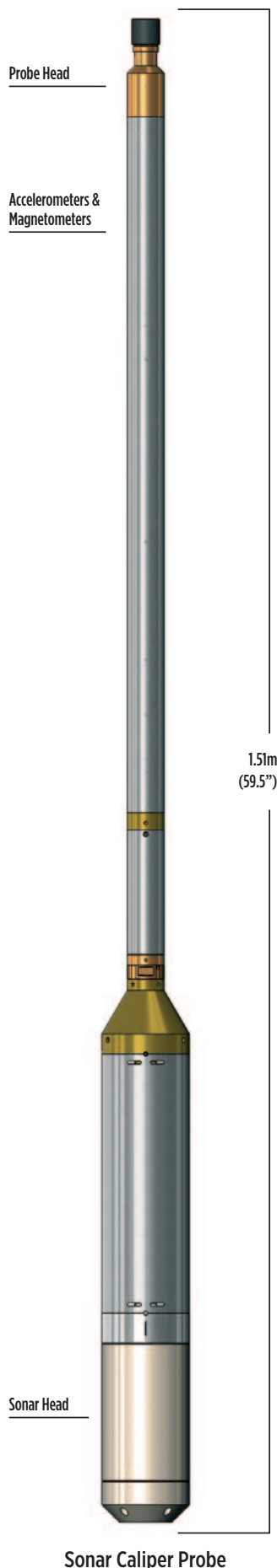
- I002150 Gyro probe with natural gamma
- I014559 Gyro Magnetometer probe with natural gamma



Examples of logging data



Sonar Caliper



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

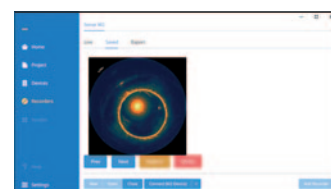
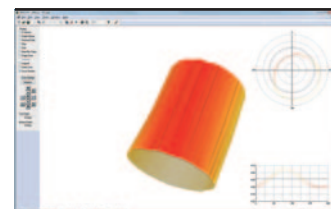
- Borehole type: Fluid filled
- Centralisation: Vertical borehole and central suspension point are advisable
- Recommended Logging Speed: Stationary at discreet points

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

- 1002193 Sonar Caliper Probe



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



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

1013754	Mini Winch includes power and data cables
1001117	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

1001019	500m winch including tripod, power and data cable
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600m Winch

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

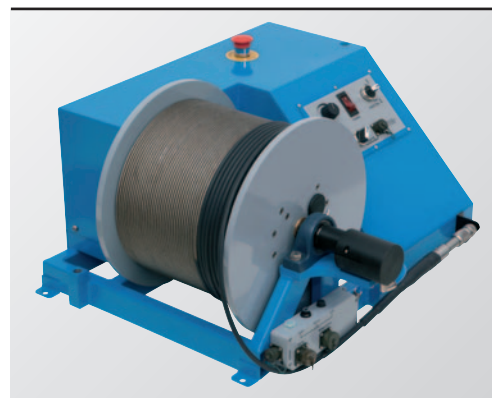
SPECIFICATION:

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

1001043	600m winch including tripod, power and data cable
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1000m/2000m Winch | 3000m 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.

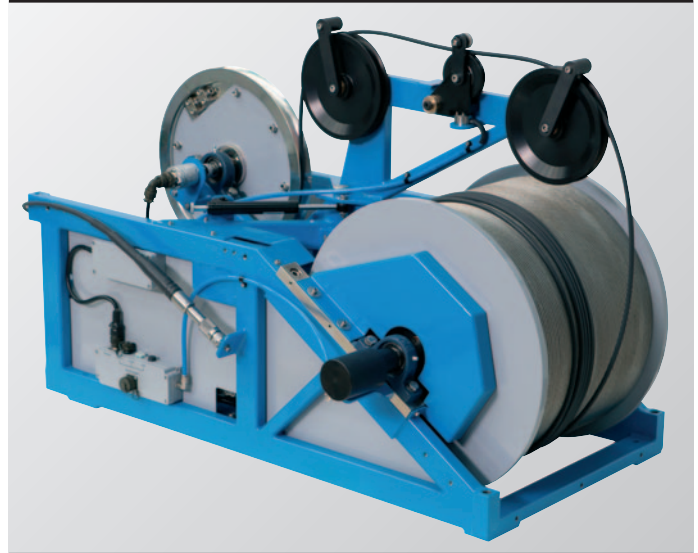
SPECIFICATION:

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

1018194	2000m winch for 3/16" 4-core cable includes tripod, power and data cable
1018193	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.*

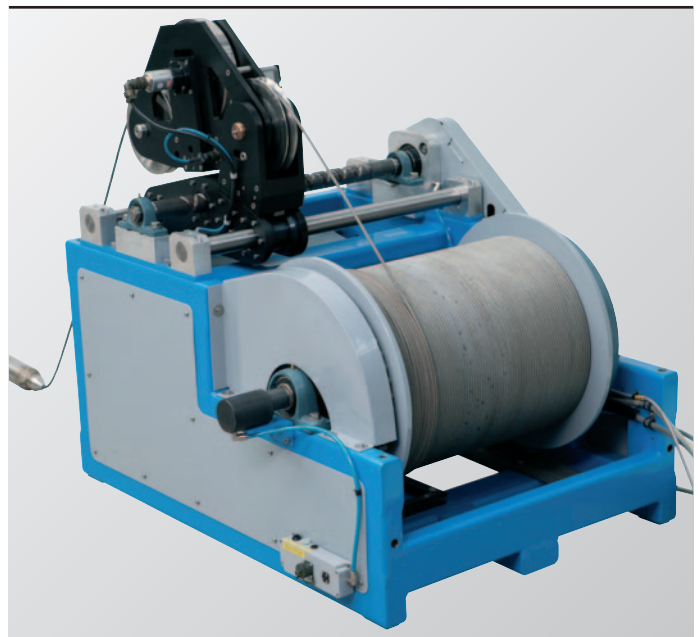
SPECIFICATION:

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

1013866	3000m winch for 3/16" four-core system includes tripod, power and data cable
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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.

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)

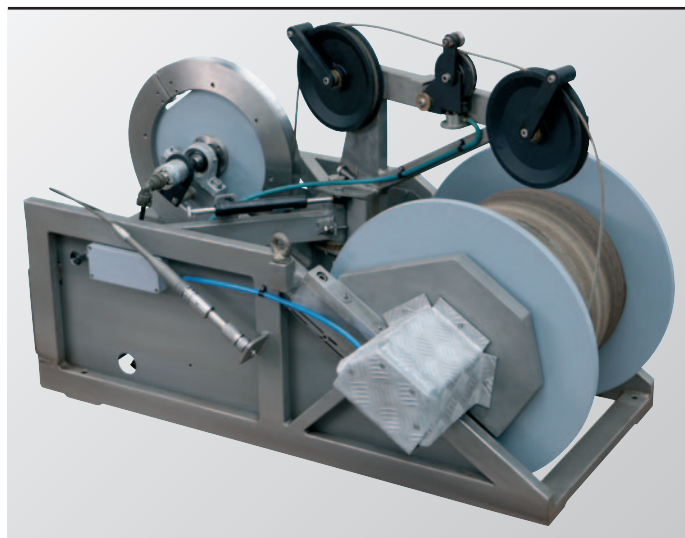
Motor: 2hp (1.5kW) at 110/220VAC

Size: 605(w) x 1060(l) x 735(h) mm

Weight: 142kg excluding cable

Part Numbers

1019167 2000m Marine Winch



2k Sheave | 3k Sheave

GEO Sheave wireline sheaves are designed for logging operations with all Robertson Geo winches.

The sheaves are constructed from stainless steel and marine resistant materials and come supplied in a custom transport case with an optional floor stand.

GEO Sheave 2k is suitable for all winches up to 2,000m capacity, with a maximum suspended load rating of 450kg.

For the 3,000m winch a larger version, GEO Sheave 3k, is available with a maximum suspended load rating of 1,250kg.

GEO sheave 2k



2k Sheave

Rated for 450kg maximum suspended load and suitable for all winches up to 2,000m capacity.

SPECIFICATION:

Specifications	
Type designation:	Wireline Sheave
Safe working load:	900kg
Maximum suspended load:	450kg
Sheave wheel root diameter:	200mm / 8"
Sheave wheel material:	Stainless Steel 316L
Cable types:	Request on sale (<i>Pulley groove design must be altered for different wirelines</i>)
Sheave mass:	9kg
Total mass (Sheave and case):	13.5kg
Transport case:	Included
Sheave overall dimensions:	330mm / 13" Diameter at largest point
Transport case dimensions:	502 x 415 x 246 mm / 19.76 x 16.34 x 9.69"
Operating temperatures:	-20°C to +50°C
Lifting equipment certificate:	Included
Extras:	Floor Stand (<i>for use with the bottom sheave</i>) Spare Guide Pins Spare Shackle

Part Numbers

I020820	GeoSheave 2k for 3/16" (set of two)
I020871	GeoSheave 2k floor stand

Pulley wheels are interchangeable for different cables.

EU REGULATIONS stipulate a new complete assembly must undergo proof load testing, and a new lifting equipment certificate issued. This should be done by Robertson Geo.

GEO sheave 3k



3k Sheave

Rated for 1,250kg maximum suspended load, for use with the Robertson Geo 3,000m winch.

SPECIFICATION:

Specifications	
Type designation:	Wireline Sheave
Safe working Load:	2,500kg
Maximum suspended load:	1,250kg
Sheave wheel root diameter:	360mm / 14.2"
Sheave wheel material:	Westlon M Plastic
Cable types:	Request on Sale (<i>Pulley groove design must be altered for different wirelines</i>)
Sheave mass:	13.5kg
Total mass (Sheave and case):	22kg
Transport case:	Included
Sheave overall dimensions:	360mm / 14.2" Diameter at largest point
Transport case dimensions:	687 x 528 x 276 mm / 27.04 x 20.78 x 10.86"
Operating temperatures:	-20°C to +50°C
Lifting equipment certificate:	Included
Extras:	Floor Stand (<i>for use with the bottom sheave</i>) Spare Guide Pins Spare Shackle

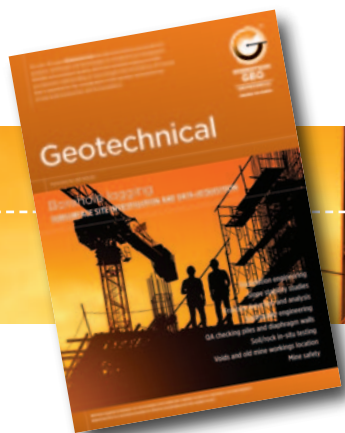
Part Numbers

I022744	GeoSheave 3k for 3/16" (set of two)
I022745	GeoSheave 3k floor stand

Pulley wheels are interchangeable for different cables.

EU REGULATIONS stipulate a new complete assembly must undergo proof load testing, and a new lifting equipment certificate issued. This should be done by Robertson Geo.

Our complete range of brochures:



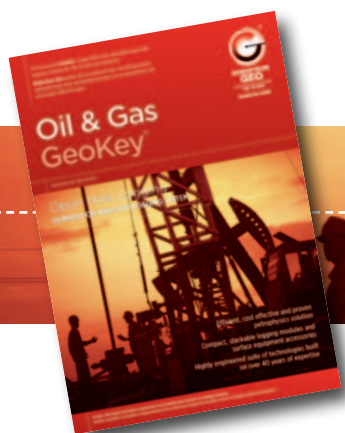
Geotechnical

SUBSURFACE SITE INVESTIGATION AND DATA ACQUISITION



Mining & Minerals

SUBSURFACE RESOURCE EXPLORATION AND MINE SAFETY PLANNING



Oil & Gas GeoKey®

SLIMHOLE OR THRU-PIPE OPEN HOLE LOGGING SYSTEM



Renewables

SUBSURFACE DATA ACQUISITION AND CHARACTERISATION



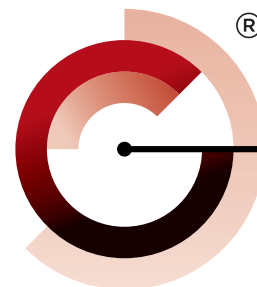
Water & Environmental

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