

BOREHOLE SEISMIC



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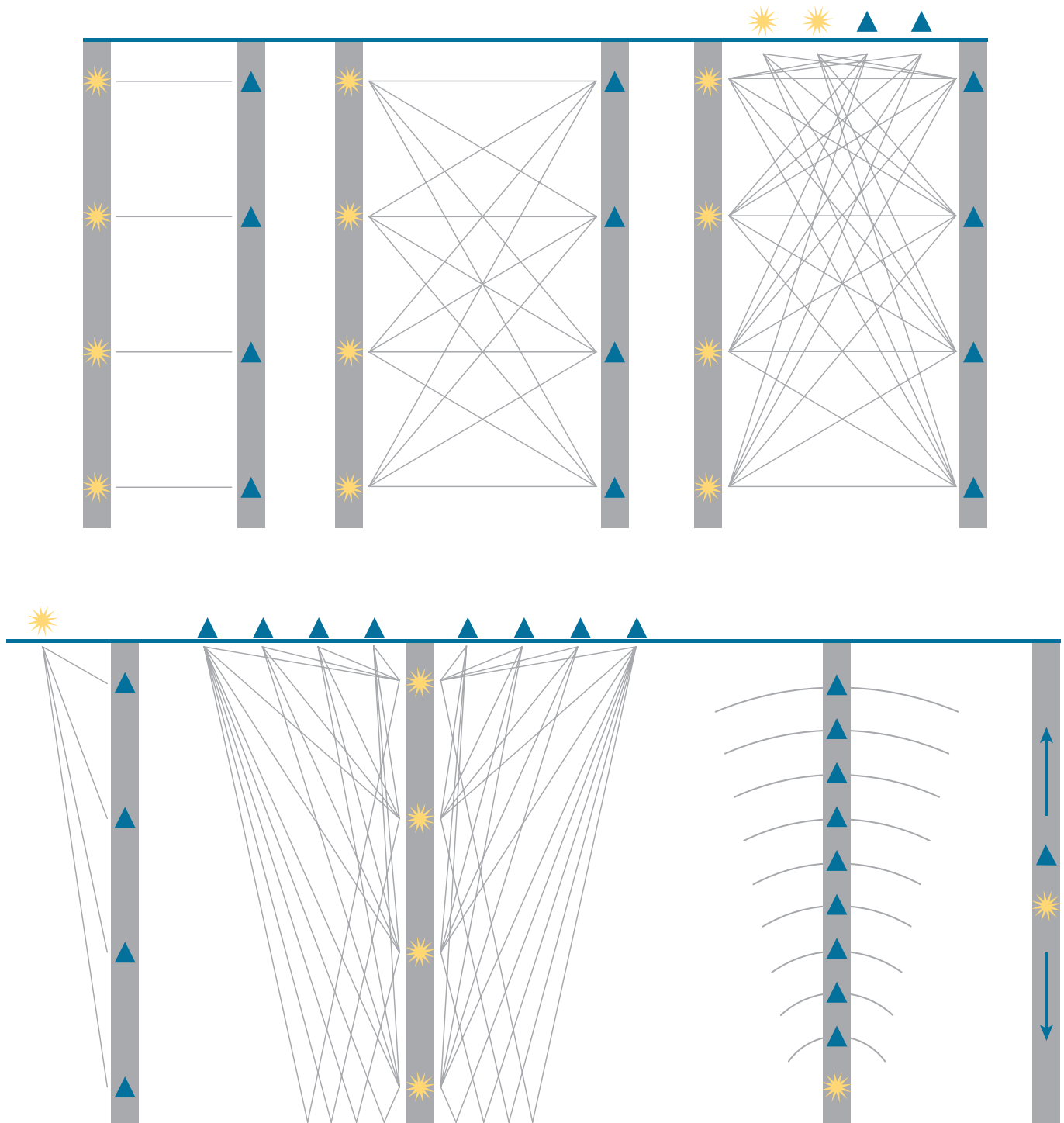
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Geodevice LLC has a vast experience in the development and production of equipment for performing all types of borehole seismic surveys. To date, we have a complete complex designed for solution of the most challenging tasks using the following borehole methods:

- Crosshole seismic testing (CST) is a method of a detailed study of rocks properties in the interwell space with localization of various anomalies associated with changes in the physical and mechanical properties of the rock mass.
- Different variations of the vertical seismic profiling method, such as zero-offset, offset and reversed VSP.
- Borehole acoustic studies - methods of lithological stratification and calculation of elastic properties of rocks near the wellbore in-situ.



Jack energy sources

MAIN features:

- High charging rate
- Capability to control power consumption
- Remote control unit
- Portability



Jack energy sources ensure the operation of sparker and electrodynamic sources used in geophysical surveys in boreholes by methods of crosshole seismic testing (CST), vertical seismic profiling (VSP), vertical seismoacoustic profiling (VSaP) and others.

Jack design deploys a reliable thyristor key, that enables obtaining a really short high-voltage electric pulse. The energy source is operated from the ac system with 110 / 220 V voltage.

Jack Version	500	1200	2500HP
Operating voltage	2-4 kV		
Discharger type	thyristor		
Trigger mode	external/repetitive/manual		
Operating energy	50-500 J	300-1200 J	300-2500 J
Charge rate	500 J/s	500 J/s	1500 J/s
Minimum period of operation at the minimum pulse energy	0.4 s	1.4 s	0.6 s
Minimum period of operation at the maximum pulse energy	1.2 s	2.7 s	1.9 s
Parameters of supplying electric line	110 or 220 V, 50 Hz		
Power consumption	1 kW	1 kW	1/2/3 kW
Overall dimensions	490×370×230 mm	540×410×270 mm	630×500×300 mm
Weight	18 kg	22 kg	34 kg

	JackPad
Function	remote control of Jack
Maximum length of communication line	100 m
Overall dimensions	210×165×90 mm
Weight	1 kg

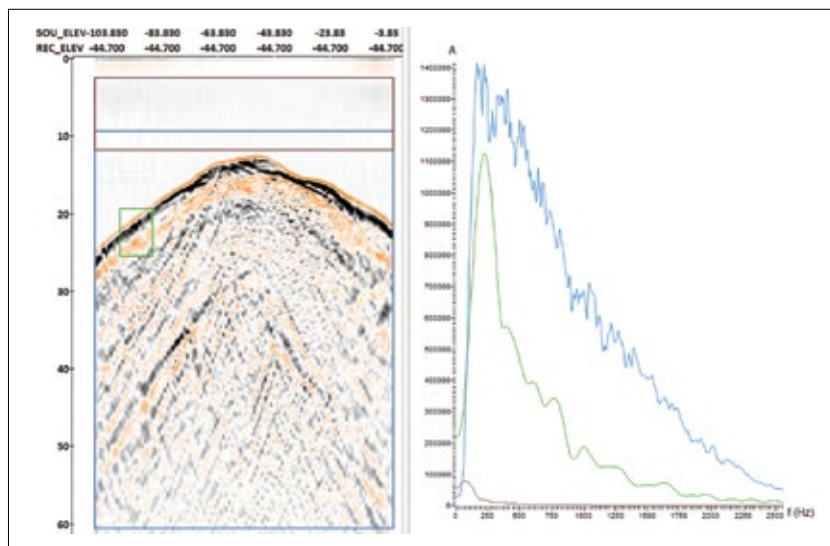
In Jack-500 and Jack-1200 models, pulse chargers provide an average charge rate of 500 J/s. Jack-2500HP version is equipped with a fast charger that is capable to regulate the charging speed (500 / 1000 / 1500 J/s). Thus, all Jack energy sources allow operation with compact portable generators (with power of 0.8 kW and more).

Jack energy sources allow one to operate with three triggering modes:

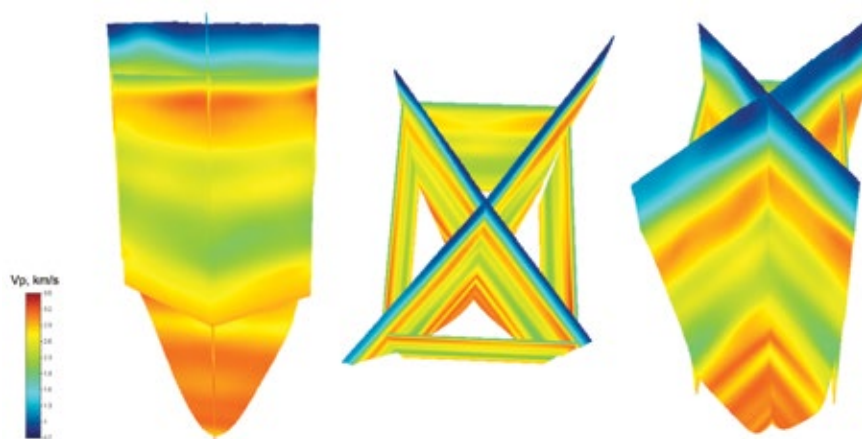
- triggering from an external device (seismic recording system, synchronization system, etc.)
- a series with a given number of pulses and a period of their repetition
- infinite series of pulses with a given period.

Jack energy sources can be equipped with a portable remote control unit JackPad.

Compact dimensions, impact-resistant leakproof casing, light weight, well-conceived and intuitive user interface, remote control unit, allow to consider Jack energy sources the most modern and truly mobile devices among all the alternatives available on the market.



Example of the crosshole seismic testing field data and its spectral composition (blue – for the entire wave pattern, green – for the first break, brown – for noise before the target waves arrival). Data obtained with borehole sparker Pulse, energy source Jack-2500HP and hydrophone array WellStreamer.



Crosshole seismic testing field data obtained with borehole sparker Pulse, energy source Jack-2500HP and hydrophone array WellStreamer. The distance between the central and lateral wells - 30 m.

Borehole sparker Pulse

MAIN features:

- Easily replaceable electrode group
- Can be used in wells with diameters starting from 40 mm
- Reel with high-voltage slip ring

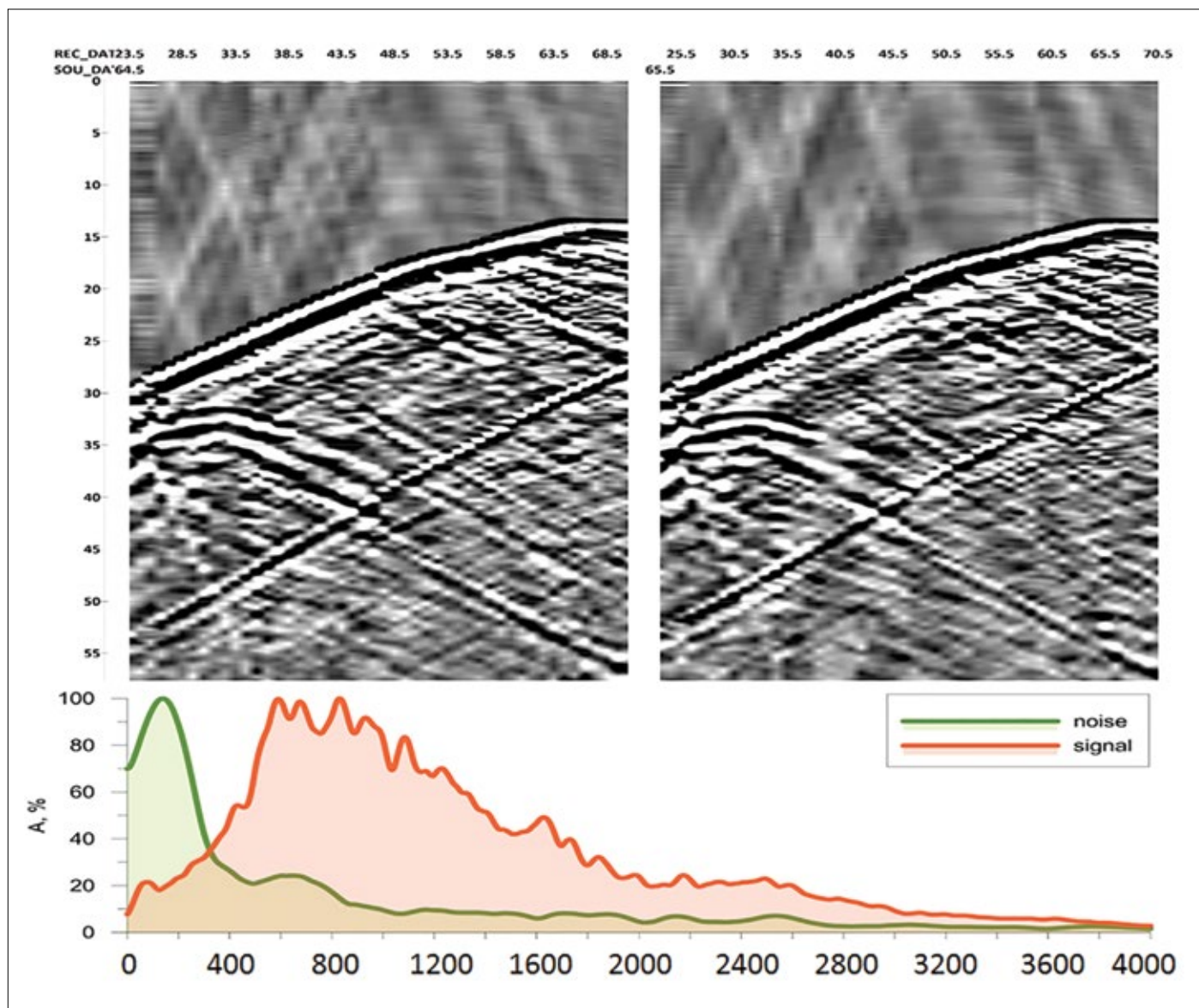


Borehole sparker Pulse is utilized to generate pressure waves in water-filled boreholes while performing the operations via crosshole seismic testing (CST) and vertical seismic profiling (VSP) methods. The operation of the Pulse source is provided by the Jack energy sources. The design of the source provides easy replacement of wear electrode groups, that also allows to control the signature of the source by installing a group with a different number of electrodes.

The standard diameters of the containers are 36 / 60 / 80 mm, thus allowing operations in wells with diameters starting from 40 mm. It is important to understand that in order to provide a stable pulse of high energy and a significant operational life of the source, a sufficient volume of the container and the number of electrodes greater than 25 are necessary.

Pulse sources are shipped on geophysical reels equipped with high-voltage slip ring. Thus, one does not need to disconnect the source from an energy source during operations of winding / unwinding the cable.





Crosshole seismic testing field data obtained with borehole sparker Pulse, energy source Jack-1200HP and hydrophone array WellStreamer.

Above – CSP seismograms for two shot points; below – amplitude spectra of signal and noise recorded before first arrivals.

Operating voltage	up to 6000 V
Operating energy	up to 1500 J (optionally: up to 500 J, up to 2500 J)
Well diameters	from 70 mm (optionally: from 40 mm)
Diameter	60 mm (optionally: 36 mm, 80 mm)
Length	500 mm
Dimensions on a reel	800 × 700 × 400 mm
Weight with a reel and a 100 m cable	appr. 75 kg

Borehole source of SH-waves SHock

MAIN features:

- Operating energies up to 1500 J
- Excites P- and SH- wave
- Can be used in dry wells

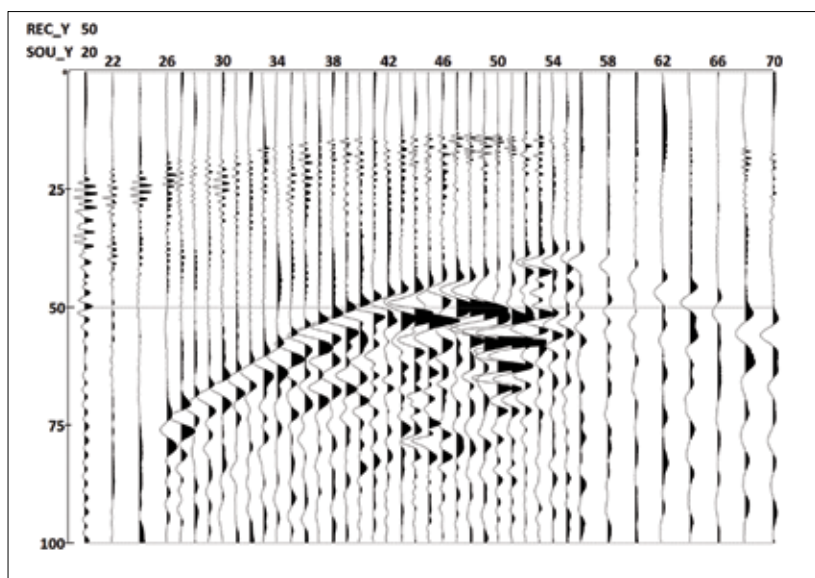


Operating voltage	up to 6000 V
Operating energy:	up to 1500 J
Well diameters	70 - 140 mm
Diameter	65 mm
Length	970 mm
Dimensions on a reel	570 × 550 × 650 mm
Weight with a reel and a 130 m pneumo-electric line	93 kg

The borehole source SHock is utilized to generate pressure (P-) and shear waves of horizontal polarization (SH-waves) in wells while performing the operations through crosshole seismic testing (CST) and reverse vertical seismic profiling (RVSP) methods. The operation of the SHock source is provided by the Jack energy sources.

The source generates a shear wave through an asymmetric blow delivered into wall of the well. A rigid pneumo-electric line makes it easy to rotate the source in the borehole, providing generation of “right” and “left” blows. The SHock source allows excitation of a seismic signal in both water-filled and dry wells, which is not feasible for borehole sparkers.

SHock is supplied on a reel equipped with a high-voltage slip ring. Thus, one does not need to disconnect the energy source during operations of winding / unwinding the cable.



Crosshole seismic testing field data after three-component record orientation. Data obtained with borehole source SHock, energy source Jack-1200HP and geophone array G-Streamer.

Borehole source of SV-waves GEOSv

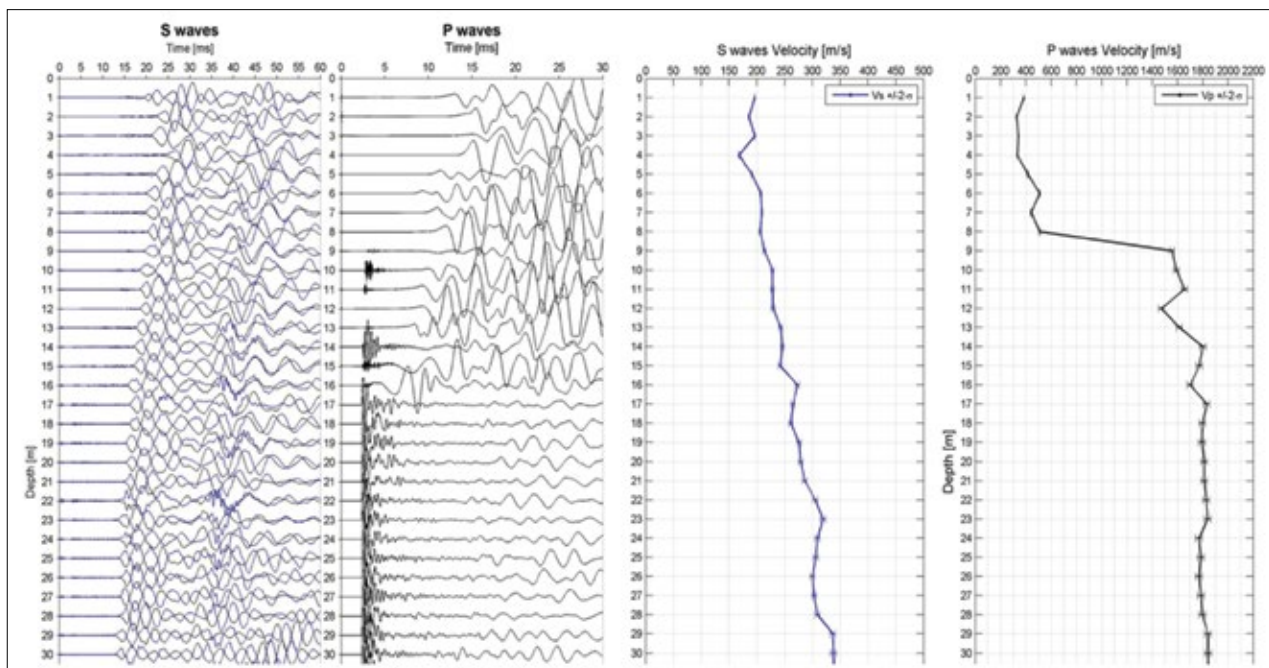


MAIN features:

- Light, powerful and easy-to-use
- Upward & downward vertical shear waves
- No need to orientate
- Pneumatic locking system

GEOSv is the unique borehole source specifically designed for crosshole seismic testing (CST). Provided with a fast-locking pneumatic system, it allows to generate polarized vertical shear waves. This device is fully in accordance with international standard ASTM D7400-08.

Diameter	65 mm
Length	654 mm
Waterproofing	200 m
Max air pressure	25 bar
Air pipe connection	6 mm
Max piston range	21.5 mm
Connector	high voltage 7 pins
Case	aluminium
Clamping pistons	2
Power supply	max 3000 V 300 J
Frequency bandwidth	100-600 Hz



Parallel crosshole seismic testing field data obtained with borehole source GEOSv (distance between wells - 4 m). From left to right: CST on S-wave data (Z-component); CST on P-wave data (H-component); The vertical velocity distribution of the S- and P- waves in the interwell space, respectively.

Geophone array GStreamer

Main features:

- Remote spring snapping
- Lowering the cable without load
- Compatibility with linear seismic recording systems



The borehole seismic array with three-component clamping geophone modules GStreamer is designed for multiwave crosshole seismic testing and VSP. The number of modules on the cable can vary from 1 to 8. The interval between modules is determined by the customer.

Three normally oriented geophones with a natural frequency of 12.5 Hz are deployed in each module. The module clamping is achieved by a semi-active spring system with the possibility of remote snapping in the well. The load for the lowering the cable into borehole is not required.

The use of array with clamping modules along with borehole source of SH-waves SHock and Jack energy source allows multiwave observations with registration of SH- and P- waves at distances between wells up to 30 m.

The geophone array can be supplied on a reel with slip ring, which allows to leave the equipment plugged into it while winding and unwinding the cable.

Number of modules in array	1 - 8
Number of channels in module	3
Compensation coupled geophones	+
Natural frequency of geophones	12.5 Hz
Maximum operating pressure	15 atm
Interval between modules in array	1 : 10 m
Maximum diameter of module	60 m
Borehole diameter range	70 - 150 mm
Clamping force range	1:7 - 1:11
Remote snapping of springs	+
Operation without load in a well	+
Compatible with linear seismic stations	+



Hydrophone array WellStreamer

Main features:

- Highly sensitive piezoceramic sensors
- Small diameter and light weight
- Compatibility with linear seismic recording systems



The borehole hydrophone array WellStreamer is designed for borehole seismic surveys at longitudinal (P-) waves. The hydrophone modules utilize highly sensitive piezoceramic sensors with preamplifiers. The default number of modules on the cable is 24, but it can vary from 1 to 48. The standard interval between pressure sensors is 1 m and the total length of the seismic array can reach 200 m or more.

The hydrophone array can be supplied on a reel with slip ring, which allows to leave the equipment plugged into it while winding and unwinding the cable.



Channels	1-24
Frequency range	1 - 10 000 Hz
Capacity of piezoelectric element	4 000 pF
Maximum pressure	60 atm
Breaking pressure	100 atm
Supply voltage	12-16 V
Current consumption per channel	10 mA
Output impedance of the preamplifier	395 Ohm
Maximum value of the output signal	±3.8 V
Operating temperature range	-10 ... +70 °C
Storage temperature range	-40 ... +70 °C
Diameter of the hydrophone module	42 mm
Length of the hydrophone module	200 mm
Weight of the hydrophone module	300 g
Interval between hydrophones	on request, but ≥ 0.25 m
Braiding of the cable	polyurethane
Longitudinal cable sealing	+
Screening of the cable and hydrophone module	+
Cable reinforcement	kevlar
Operating load	200 kg
Breaking force	400 kg
Cable diameter	13 mm
Minimum cable coiling radius	120 mm
Minimum coiling radius of active section	220 mm
Cable Weight	168 g/m
Weight with a 130 m cable on a reel	38 kg
Dimensions with reel	500×600×400 mm
Maximum cable system length	700 m
End connector	by agreement
End load	the lower end of the cable system is equipped with a weight-bearing loop; load can be supplied as agreed

Inclinometer probe INCLIS DH

MAIN features:

- allows to perform a 3D borehole deviation survey
- 3 magnetometric and 3 accelerometric sensors
- 360° orientation range



The new inclinometer probe INCLIS DH allows to perform a 3D borehole deviation survey. It is equipped with 3 magnetometric and 3 accelerometric sensors. In cases when the iron casing makes the correct operation of magnetometric sensors impossible, the system is provided with a set of aluminium rods that allows to drive the probe inside the borehole.




PROBE CHARACTERISTICS

Dimensions	100 cm x 40 mm in diameter
Weight	35 kg
Operating temperature range	-40÷125 C (-10 C÷125 C with recommended batteries)
Connectors	Souriau 200 bar IP69
Enclosure material	brass
Operating System	Windows XP, Vista, 7
Digital output	USB 2.0
Voltage	direct from USB

INTERNAL SENSORS

Orientation range	360° for all axes: inclination, azimuth, GTF, MTF, dip angle
Digital output rate/logging rate	up to 8 Hz
Output modes	acceleration and magnetic field vectors + temperature; orientation angles + temperature
Datalogging capacity	up to 32 768 data records
Digital output	RS-422 serial (four-wire full-duplex) standard
Supply voltage	+6.0 VDC min, +10.0 VDC max



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