Multi-Component Borehole Geophone BGK3

Geotomographie GmbH, Am Tonnenberg 18, 56567 Neuwied (Germany)
Tel.: +49 2631 778135 email: info@geotomographie.de

Content

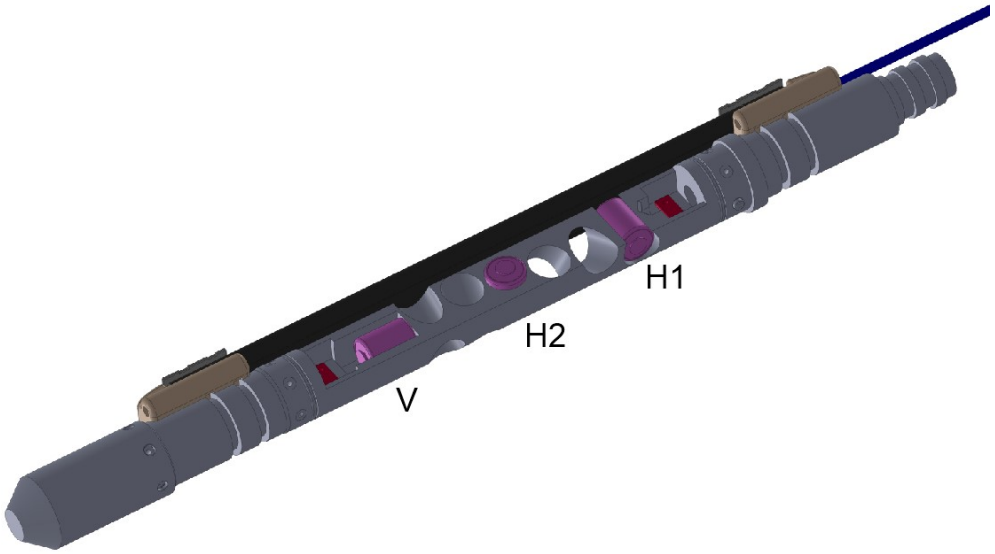
1. Description

The borehole geophone BGK3 is used to receive P- and S-waves in dry or water-filled boreholes. The borehole geophone BGK3 contains of a tri-axial sensor. The geophone is coupled to the borehole wall by a pneumatic clamping system (inflatable bladder). Air is supplied to the BGK3 through an electro-pneumatic hybrid cable with a Kevlar tension string. A magnetic compass shows azimuthal deviation to the North and can be used to get the orientation of the geophone in the borehole. The cable is terminated by a connector to the seismograph. It is a robust tool with a body diameter of 50 mm, which can be used for seismic measurements in boreholes of a diameter of 75mm (or larger if spacers are used) to a depth of a maximum of 200 m. The receiver weigths about 5 kg and the 100 m cable approx. 18.3 kg (in air).

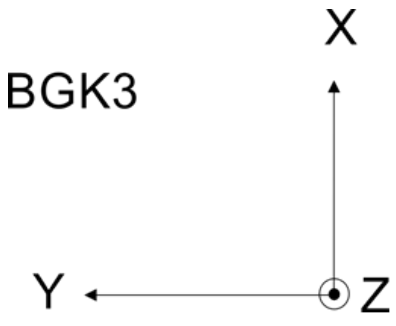
It consists of three main parts, the geophone unit, which is connected directly moulded to the borehole cable, the pneumatic clamping unit, and the magnetic compass unit for measuring the angle between the magnetic North and the axis of the H1-geophone axis (reference direction).

1.1 Geophone Unit BGK3

The tri-axial sensor is placed inside a stainless steel tube, acting as a multi-component seismic receiver. Horizontal components are placed in 90° steps in a clockwise order.



- **H1:** X (North)
- **H2:** Y
- **H3**: Z



The reference direction of the geophone unit is the axis of the H1 element. Two markings (N) in a line on the outside of the geophone housing indicate the reference direction.

The sensors will give a positive rising signal in the direction of the sensor array (see Figure 1, a seismic impulse in the direction of the marker line will provide a positive rising signal). All other H components can be tested in the same way. To supply the pneumatic clamping device, a small pressure tube is routed inside the geophone unit from the quick connector on the probe head to the clamping unit.

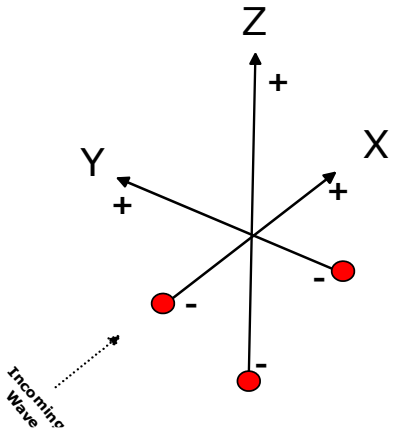


Figure 1: Sensor orientation and signal polarity

1.2 Geophone wiring

The following three channels are active:

Channel 1	Geophone H1 (X)	Pin A Signal +
		Pin B Signal -
Channel 2	Geophone H2 (Y)	Pin C Signal +
		Pin D Signal -
Channel 3	Geophone V	Pin E Signal +
		Pin F Signal –

1.3 Pneumatic clamping unit

The pneumatic clamping unit is used to anchor the geophone inside the borehole for seismic recording. If air is injected into the clamping unit, the rubber housing expands in the direction opposite to the reference direction. After reaching the borehole wall, the geophone probe is pressed against the wall. By further increasing the pressure, the probe can be anchored in the borehole for seismic recording. If the rubber hose is damaged, the clamping unit can be replaced as described in chapter 3 Maintenance.

1.4 Compass unit

The magnetic compass is located at the lowest part of the geophone. It's a 3C magnetic sensor in a non-magnetic housing.

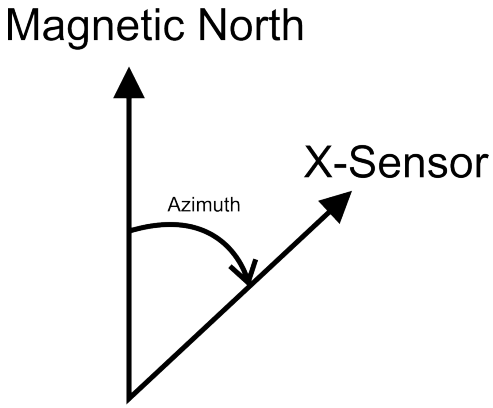


Figure 2: Schematic sketch showing angle measure

The angle between the magnetic North and the direction of the H1 (X) component can be correctly measured and is displayed on the surface unit. The resolution and accuracy of the compass readings is better +/-1°. A display at the drum shows the measured magnetic azimuth of the downhole sensor.

1.5 Drum Instrumentation

The air pressure can be checked using the pressure gauge (see Figure 3).

Figure 3: Connectors on orange drum

- The OPEN valve (turn counter-clockwise) allows air to be supplied.
- The CLOSE valve (clockwise) allows the air to be released and the pressure to be maintained for Clamping.
- **RELEASE allows the air to be released while the pump is connected.**

The air pump connection is supplied with a special adapter. The outer ring must be pulled back to release the pump from the "AIR IN" socket. The pump can be permanently connected and does not need to be disconnected to release the air.

There are several other connectors mounted on the black plastic disk (see Figure 3)

Figure 4: Connectors on black plastic disc

USB:

- USB Interface to read magnetic azimuth using PC

ON/OFF:

- Switch on/off display

CHARGER:

- Adapter to charge internal batteries for compass

LIGHT:

- Press shortly once the display and it will be illuminated (30sec)
- Press longer; illumination is forever (press again illumination stops)

RESET/CAL

- Press shortly compass is reset (resets basic values)
- Press longer (~ 2 sec) hard iron calibration is made. Hold BGK vertical and turn twice within the calibration time (20sec) for calibration.

2. Operation

2.1 Preparation

2.1.1 Clamping Steps

The maximum diameter of the borehole for anchoring the geophone is approximately 90 mm (without extension).

Please follow these steps to clamp the borehole geophone to the borehole wall:

Air in for Clamping	• Lower the geophone to the desired depth • Connect the air pump to the valve • Apply pressure while lifting the cable slightly up and down • Stop applying pressure if BGK clamps (lifting up and down is no longer possible) • Gently close the valve (turn to the right) • The geophone is now fixed. Lower the cable by 5-10 cm and clamp it with the clamping device. This will release the tension in the cable.
Air out for release	• Disconnect the air pump from the valve • Open the valve (turn to the left) and release the pressure until the geophone is released. • Move the geophone to the next position

Apply gentle pressure to the system. Stop if the system clamps. Check pressure frequently to see if the BGK still clamps.

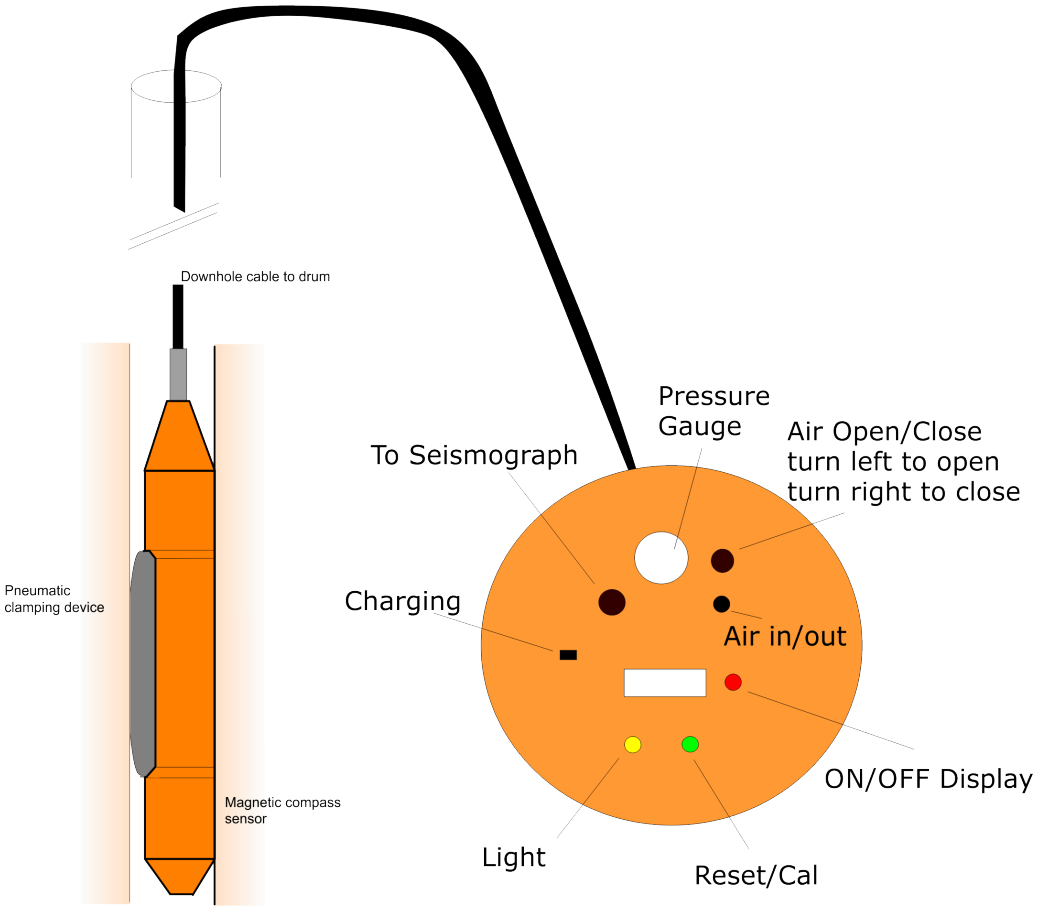


Figure 5: Clamping and Release of the borehole geophone

2.1.2 Cable handling

To ensure a quality measurement, please note the following when handling the cable

- Please unwind the cable before starting the measurement.
- Place the cable in loops and avoid kinking the cable.

2.2 Measurement

2.2.1 Magnetic Compass

Read compass values once the BGK has been clamped. You may write down values for later processing (sensor rotation).

2.2.2 Moving the Borehole Geophone

- The cable is clamped in place!
- Disconnect the air pump from the valve
- Open the valve (turn to the left) and release the pressure until the geophone is released.
- Move the geophone to the next position

3. Maintenance

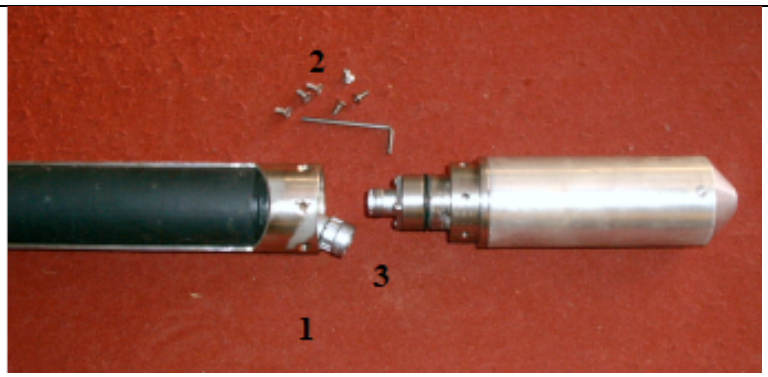
3.1 Exchange of the clamping unit for older type of BGK

If the rubber hose is damaged, the clamping unit can be replaced as follows:

- Unscrew the screw connection of the housing tube of the clamping unit on the compass side and open the cable connection. Remove the compass unit.
- Unscrew the housing tube on the geophone unit side and unscrew the clamping unit.
- Place a new rubber hose on the plastic tube and secure (or take a new clamp) and reassemble all parts in reverse order as described above.

New clamping units can be supplied as spares on request. Please get in touch with us!

To dismantle the rubber clamping part, please do the following:

1		• Remove all 6 screws from the lower part of the 3C geophone (1,2) • Pull out carefully the lower part of the compass (attention Short Compass Line) • Disconnect the compass part carefully
2		• Remove the upper 6 screws (4) • Remove stainless steel clamping window (5) • Remove carefully rubber tube by counter-clock wise turnings (6) • Clean windings (7) and pour new HYLOMAR on winding • Screw the new rubber tube clockwise • Attach stainless steel clamping window (Keeo NORTH direction marked with “N” • Connect the compass cable and grease O-Ring at the lower compass part • Attach the lower compass part by keeping “N” marking in the correct position

3.2 Exchange of the clamping unit for new type of BGK

1. Open the hose connection (push in outer ring to pull out the PUR hose)

2. Cut the four cable ties and remove damaged packer

3. Put new cable ties on

4. Fix cables ties and cut close to cable lock

5. Connect air hose