Multi-Component Borehole Geophone BGK7

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

Content

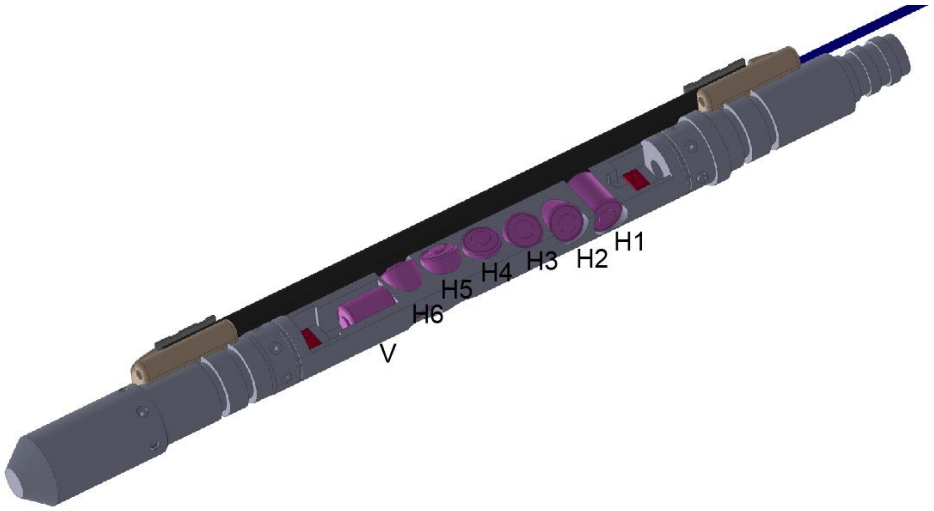
1. Description

The borehole geophone BGK7 is used to receive P- and S-waves in dry or water-filled boreholes. The borehole geophone BGK7 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 BGK7 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 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).

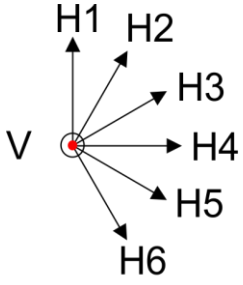
1.1 Geophone Unit BGK7

Seven BGK7 horizontal geophone sensors (H1, H2, H3, H4, H5, H6) and a single vertical geophone (V) are placed inside a stainless steel tube, acting as a multi-component seismic receiver.



Horizontal components are placed clockwise in 30° steps (see Figure 1)

- **H1:** X (North)
- **H2:** X+30°
- **H3**: X+60°
- **H4:** X+90°
- **H5:** X+120°
- **H6:** X+150°
- **H5:** Z



H1 = Ch1
H2 = Ch2
H3 = Ch3
H4 = Ch4
H5 = Ch5
H6 = Ch6
V = Ch7

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. A small pressure tube is routed inside the geophone unit from the quick connector on the probe head to the clamping unit to supply the pneumatic clamping device.

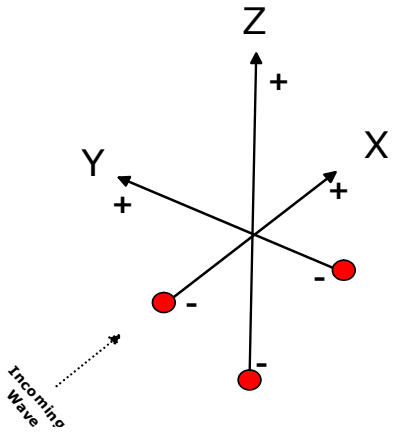


Figure 1: Sensor orientation and signal polarity

1.2 Geophone wiring

The following seven channels are active:

Channel 1	Geophone H1	Pin A	Signal +
		Pin B	Signal -
Channel 2	Geophone H2	Pin C	Signal +
		Pin D	Signal -
Channel 3	Geophone H3	Pin E	Signal +
		Pin F	Signal –
Channel 4	Geophone H4	Pin G	Signal +
		Pin H	Signal -
Channel 5	Geophone H5	Pin J	Signal +
		Pin K	Signal –
Channel 6	Geophone H6	Pin L	Signal +
		Pin M	Signal –
Channel 7	Geophone V	Pin N	Signal +
		Pin P	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.

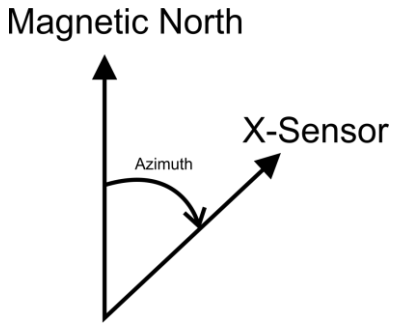


Figure 2: Schematic sketch showing angle measure

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 and the display 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 and lift the cable slightly up and down • Stop applying pressure when BGK starts to clamp (lifting up and down is no longer possible) • Gently close the valve (turn to the right) • The geophone is now fixed. Slightly 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 immediately if the system clamps. Check pressure frequently to see if the system is still clamped.

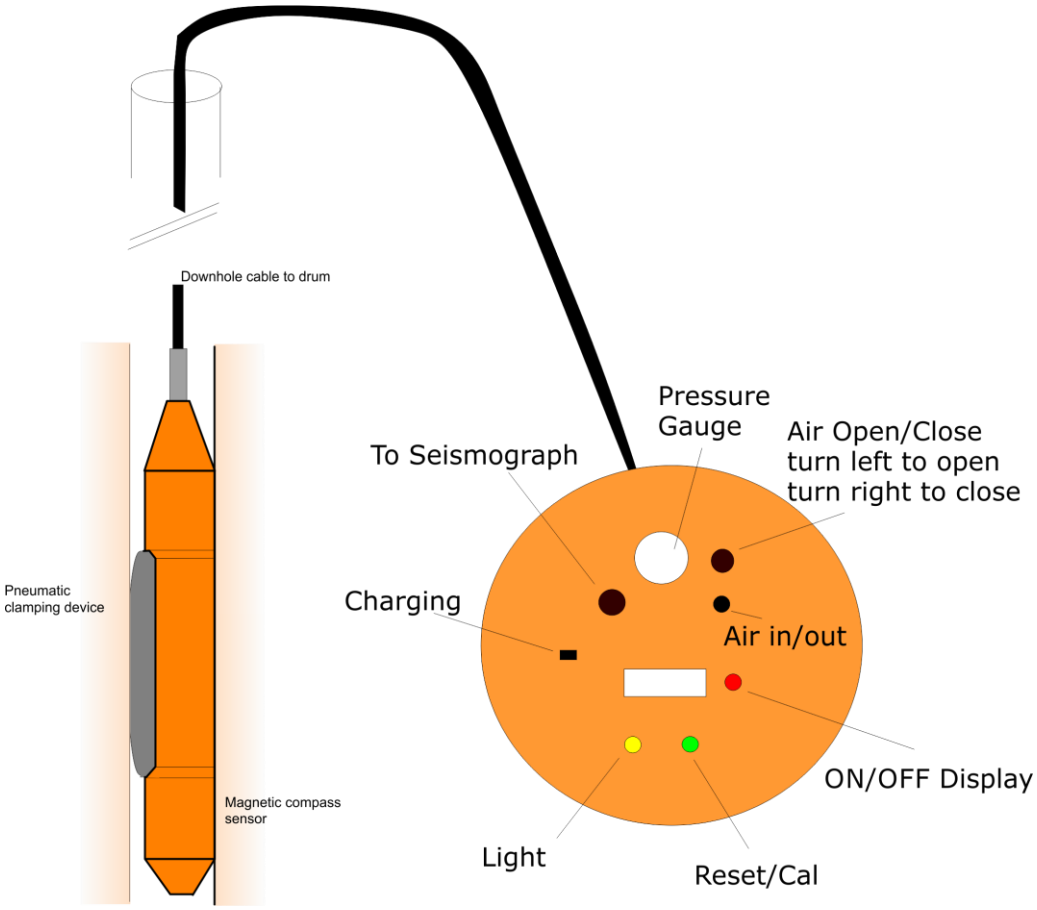


Figure 5: Clamping and Release of the borehole geophone

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, i.e.
- 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 BGK7

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 contact 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 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 the 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