

Multi-Component Miniature Geophone M40



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1. Parts of the M40

The Mini-Geophone M40, 405 mm long and weighing 3 kg, is used to receive P and S waves in horizontal boreholes of small diameter. It is specifically designed for seismic surveys in small dry boreholes with a maximum diameter of 50 mm. The outer diameter of the probe is approximately 40 mm.

The M40 consists of the following parts, the geophone unit - a tri-axial sensor (1) which is directly connected to a rotary string (2) and a surface unit (3) with a connection to the valve and a pressure gauge (4) and the connection to the seismograph (5).

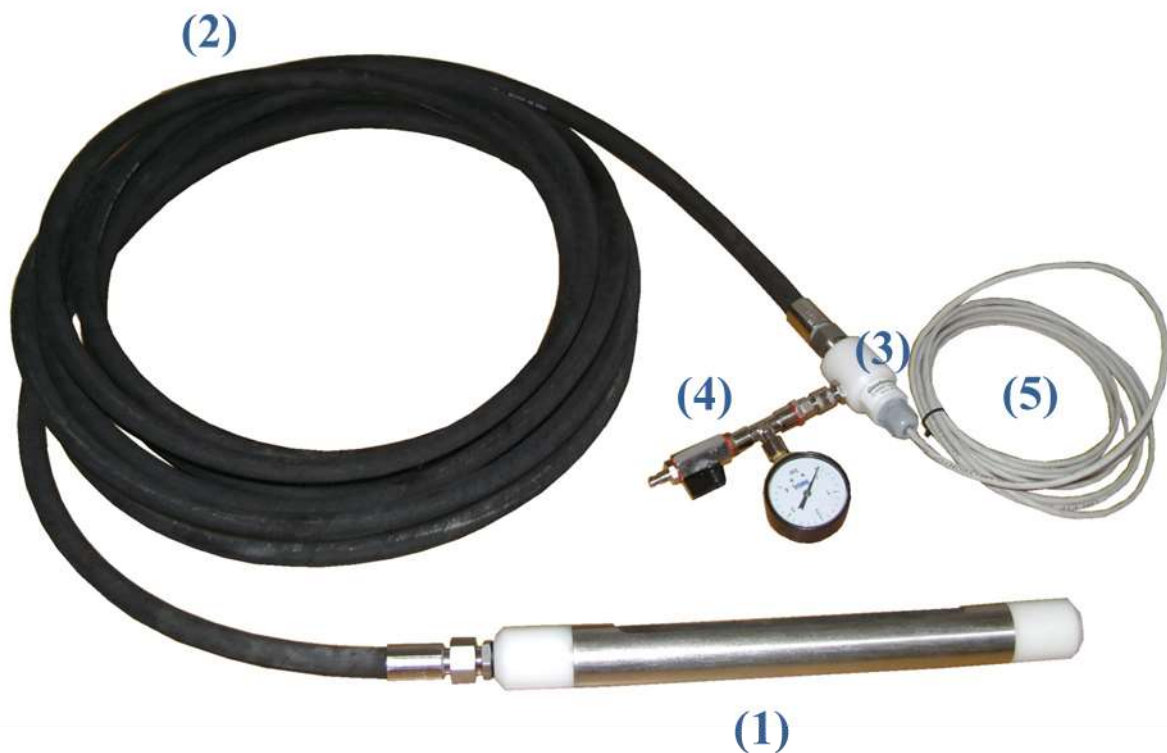


Figure 1: Parts of M40

The geophone is coupled to the borehole wall by a pneumatic clamping system (inflatable bladder). Air is supplied to the M40 through the cable and controlled by the pressure gauge. The orientation of the M40 geophone is controlled from surface by a torsional stiff hose. The maximum recommended clamp pressure is 0.2 to 0.4 bar in a 2 inch borehole under dry conditions.

1.1 Geophone unit

Two horizontal geophones (H1[X], H2[Y]) and a vertical geophone (V[Z]) are placed inside a stainless steel tube to act as a multi-component seismic receiver. All horizontal components are arranged in 90° steps clockwise. The main chassis consists of a PVC cylinder containing the geophones and signal cables.

The reference direction of the geophone unit is the axis of the H1 element. This direction can be followed along the **markings on the rotating string** (see Figure 2).



Figure 2: Marking along the rotary string is aligned to the H1 geophone

A seismic impulse in the direction of the marker line will produce a positive rising signal. A test pulse by tapping the centre of the geophone unit with a simple ballpoint pen or pencil will give such a signal.

All other H-components can be tested in the same way. The **reference direction is H1** plus 90° in a clockwise direction as seen from the top of the geophone.

The bladder tube is located between the PVC cylinder and the outer steel casing. Replacement of the rubber tube is described in Chapter 3.1.

1.2 Rotary pipe string

The rotating tube has two functions

- (1) supply air and protect the signal cable; and
- (2) to orientate the borehole probe within the borehole.

The rotary pipe string can be coiled up but it is stiff for rotation. The string is terminated at the surface by the probe and a splitter.

1.3 Surface splitter and seismograph connection

A surface PVC unit is designed to be split between the air supply and the signal cable. The signal cable ends in a connector box and connection can be made to seismograph (see Figure 3).



Figure 3: Connector box to seismograph (similar or different design possible for 2 x M40 units only)

The air supply arrangement is shown in the Figure 4 below. Air can be supplied by a manual air pump. The air clamping pressure in a 2 inch sized borehole is about 0.2 to the maximum of 0.4 bar. To stabilize the air pressure it is recommended to close the valve.



Figure 4: Air supply arrangement

1.4 Channel arrangement

The sensors give a positive raising signal in the direction according to the sensor assembly (see Figure 5, a seismic impulse towards the marker line produces a positive rising signal). All other H-components can be tested in the same way (reference direction plus 90° for the 3-component unit, seen from the top of the geophone).

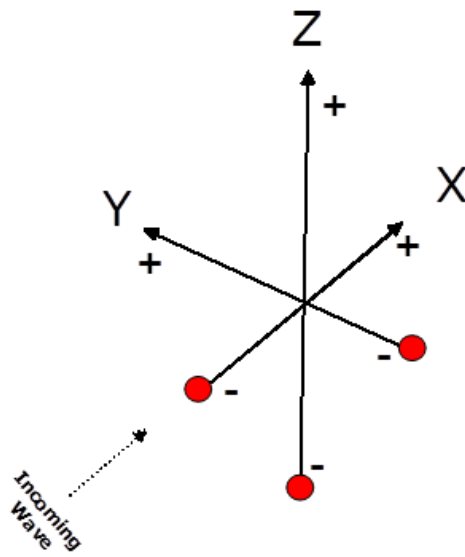


Figure 4: Sensor polarity

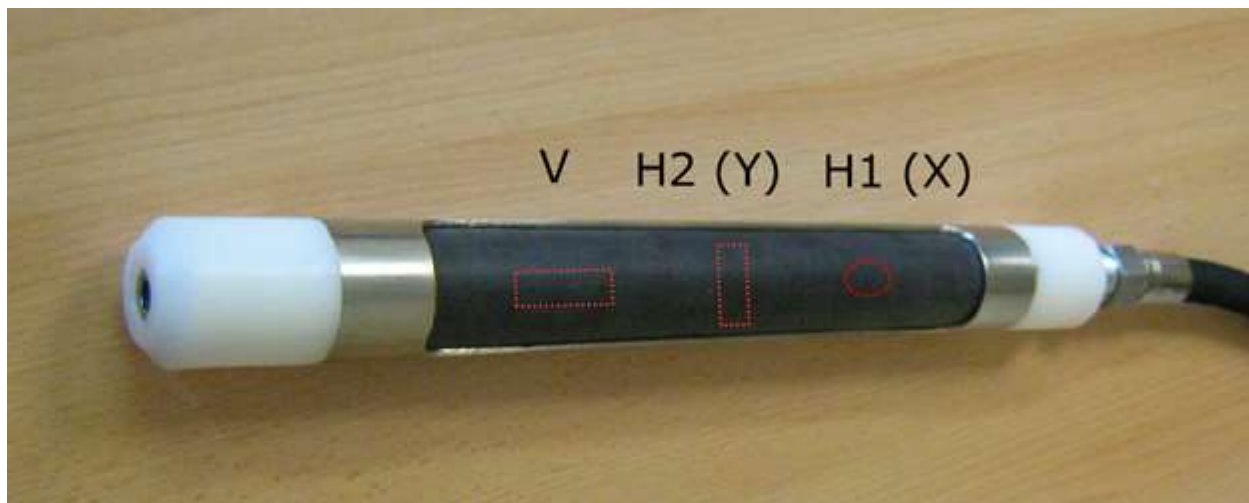


Figure 5: Sensor orientation inside the probe

Following channels are active:

Channel 1	Geophone H1 (X)	Contact 1	Signal +
		Contact 2	Signal -
Channel 2	Geophone H2 (Y)	Contact 3	Signal +
		Contact 4	Signal -
Channel 3	Geophone V	Contact 5	Signal +
		Contact 6	Signal -

2. Operation

2.1 Measurement Set-up

The maximum borehole diameter for anchoring the geophone is approximately 50mm (without extension).

- (1) Lower geophone to the desired depth
- (2) Connect the manual air pump
- (3) Apply pressure
 - **Coupling starts at rates of 0.2 - 0.3 bar**
 - **Clamping is achieved at about 0.4 bar**
- (4) Stop applying pressure when the system starts to clamp.
- (5) Gently close the valve

**Apply gentle pressure to the system.
Stop immediately if system clamps.
Check pressure frequently to see if system is still clamped.
Geophone coupling starts at pressures of 0.2 bar.
Clamping is achieved at approximately 0.3 to 0.4 bar for a 2 inch hole.**

2.2 Moving the Geophone

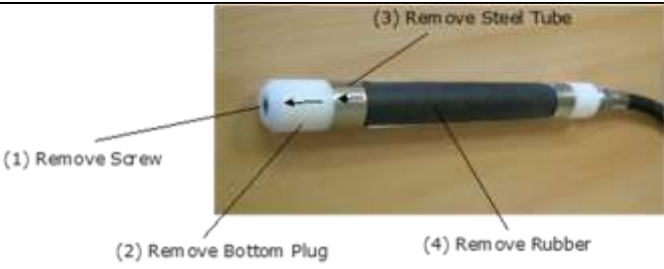

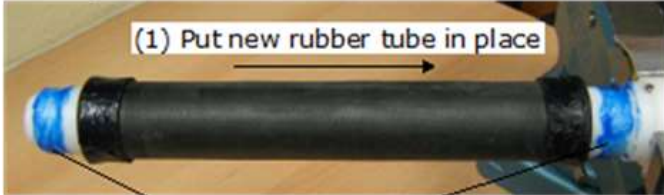


- (1) Disconnect the manual air pump from the valve
- (2) Open the valve (turn left)
- (3) Move the geophone to the next position

3. Maintenance

3.1 Exchange of the rubber housing

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

Please also see the **preparation steps** described in Chapter 2.1.

<p>1</p>	<p>Unscrew the lower bottom screw with Allen wrench. Remove the bottom PVC plug. Remove the stainless steel tube.</p>	 <p>(1) Remove Screw (2) Remove Bottom Plug (3) Remove Steel Tube (4) Remove Rubber</p>
<p>2</p>	<p>Remove the damaged rubber hose. Clean the PVC parts.</p>	 <p>Clean PVC Millings</p>
<p>3</p>	<p>Place a new rubber tube over the PVC cylinder.</p>	 <p>(1) Put new rubber tube in place (2) Put Blue HYLOMAR grease</p>
<p>4</p>	<p>Apply blue sealing grease (Hylomar) on the cleaned PVC cylinder (milling above and below geophone part)</p>	
<p>5</p>	<p>Place winding wire (3-4 loops) around the hose. Solder the wires carefully. Wrap around with black tape.</p>	 <p>Put winding wire around (3-4 loops) and solder</p>
<p>6</p>	<p>Assemble the geophone.</p>	 <p>Assemble system</p>