MBAS-A

Analogue Multistation Borehole Acquisition System

Operating and Maintenance Instructions

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

Content

Introduction

High-resolution P-wave tomographic investigations between boreholes are routinely applied for the exploration of development sites considered for larger building projects, e.g., power stations, dams and high-rise buildings. However, the geotechnical benefits of P-wave tomography are rather limited and information about S-wave velocity distribution is additionally required to derive geotechnically relevant parameters, such as dynamic soil parameters. Up to now, only little efforts have been made to develop equipment enabling the competitive acquisition of S-wave crosshole tomographic data.

The Multistation Borehole Acquisition System (MBAS-A) is designed for efficient recording of S-waves in boreholes at different levels. The system is analogue and has to be connected to a seismograph. Each station is equipped with a 3C sensor arrangement and can be pneumatically coupled to the borehole wall by an air packer. All sensor components are aligned to each other. For orientation a magnetic compass is mounted within the bottom station.

The MBAS-A system consists of

1. Multi-core cable on drum with eight stations (each with tri-axial sensor arrangement)

2. Air packers mounted to the stations

3. Twin air hose on drum with manometers

1. Geophone stations

The MBAS-A consists of eight 3C stations separated 1 m or 2 m (see figure 1). Stations are connected to each other with a rotary pipe string. In this way, all seismic channels are aligned to each other.

Fig. 1: MBAS-A stations

Depth reference (z=0m) is lowest station.

Each station contains three sensors (X,Y,Z) in a tri-axial arrangement. The X-sensor points in the opposite direction of the air packer, the Y-sensor is 90° off and Z is vertical (see figure 2).

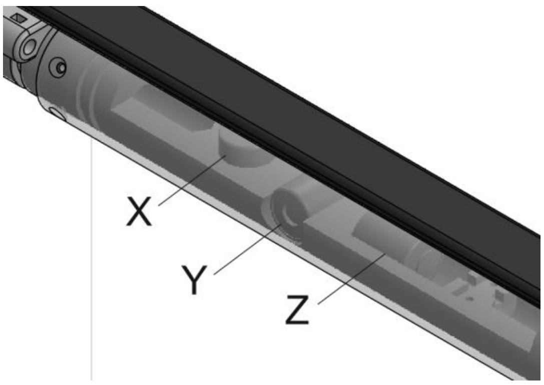

Fig. 2: Sensor orientation

The sensors give positive raising signal in direction according to the sensor assembly (see figure 3, a seismic impulse towards the marker line produces a positive rising signal).

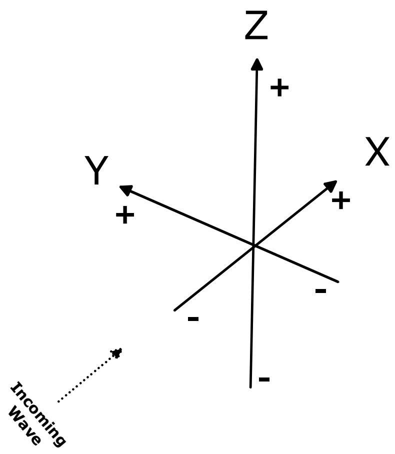

Fig. 3: Sensor polarity

Table 1 shows the wiring scheme.

Table 1: MBAS-A wiring scheme

MBAS-A		
Channel	**Comp**	Station
1	**X**	**1 (lowest)**
2	**Y**	
3	**Z**	
4	**X**	**2**
5	**Y**	
6	**Z**	
7	**X**	**3**
8	**Y**	
9	**Z**	
10	**X**	**4**
11	**Y**	
12	**Z**	
13	**X**	**5**
14	**Y**	
15	**Z**	
16	**X**	**6**
17	**Y**	
18	**Z**	
19	**X**	**7**
20	**Y**	
21	**Z**	
22	**X**	**8 (topmost)**
23	**Y**	
24	**Z**	

2. Compass Unit

Main part of the compass unit is a two-component magnetometer sensor placed in a non-magnetic housing. The compass unit is mechanically connected to the lowest geophone station.

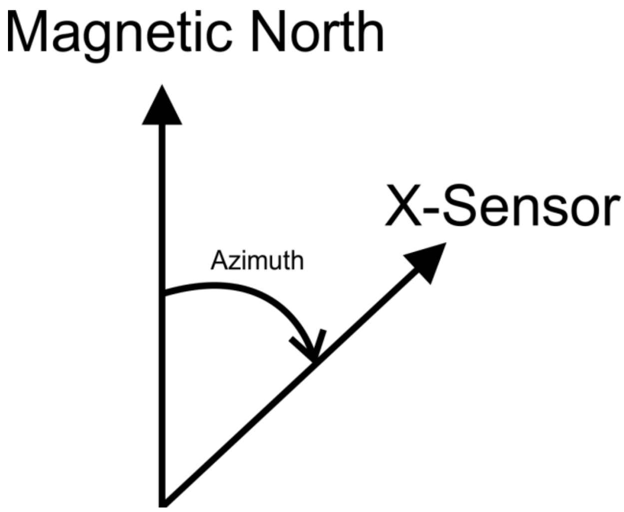

Fig. 4: Schematic sketch showing angle measure

The angle between magnetic north and the direction of the X-sensor can be correctly measured and is displayed on the surface unit. The magnetic sensor is connected to the display box at surface via three pairs of borehole cable wires.

Resolution and accuracy of the compass readings is 5°. A display at the drum shows the measured magnetic azimuth of the downhole sensor.

Fig. 5: Compass Display at drum

USB	→	USB Interface to read magnetic azimuth using PC
ON/OFF	→	Switch on/off display
CHARGING (CHARGER)	→	Adapter to charge the internal batteries of the compass
LIGHT	→ →	Press shortly once display will be illuminated for 30sec Press longer, illumination is continuosly (press again illumination stops)
RESET/CAL (Calibration)	→	Press shortly compass is reset (resets basic values) Press longer (~ 2 sec) hard iron calibration is made. For calibration hold BGK vertical and turn twice within the calibration time (20sec).

3. Air packer system

Air is supplied through a twin air hose. One hose supplies air to the lower four stations (1-4) and the other hose supplies air to the upper four stations (5-8). Air pressure can be controlled through two independent manometer gauges. A schematic diagram is shown in figure 6.

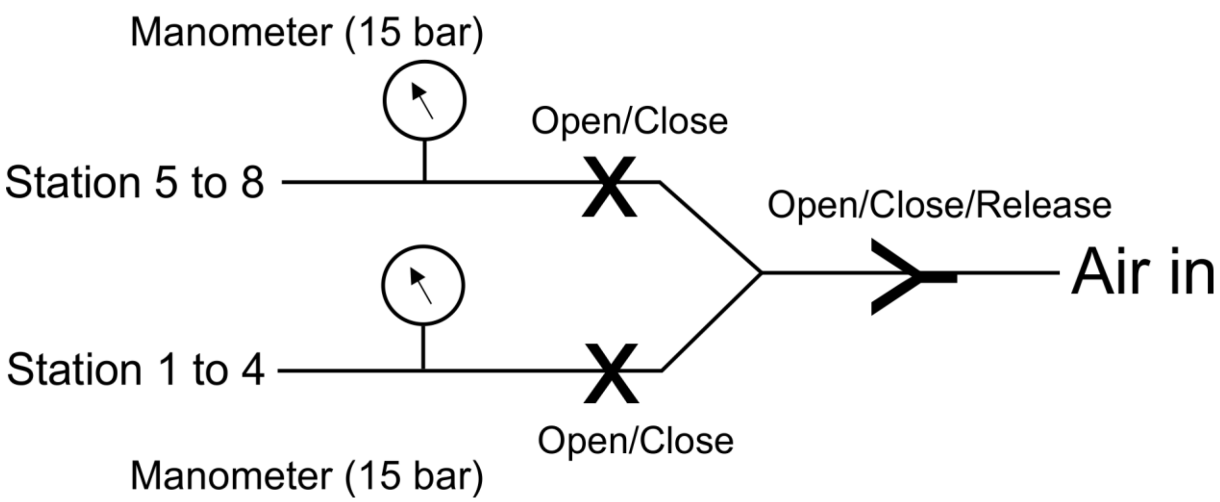

Fig. 6: Schematic diagram for air supply

Depth reference (z=0m) is lowest station.

<u>Measurements above water table</u>

If measurements are carried out above the water table all air packers (from 1..8) are exposed to atmospheric pressure. In this case a uniform pressure of 1 to max. 1.5 bar can be applied to all air packers.

<u>Measurements below water table</u>

If measurements are carried out below water table each consecutive air packer is exposed to a pressure difference of 0,2 bar (= 2m station spacing) due to hydrostatic pressure.

Air can be supplied separately either to the lower four stations (1-4) or to the upper four stations (5-8).

The air bladders are designed to allow the uniform expansion under different hydrostatic pressure due to different rubber material.

Fig. 7 shows the schematic diagram of the air packer system. Lower four stations (1-4) are in orange colour, upper four stations (5-8) are shown in yellow colour.

According to the hydrostatic pressure the pressure at the lowest station #1 is P2 and P2 = P1 + 0.8bar.

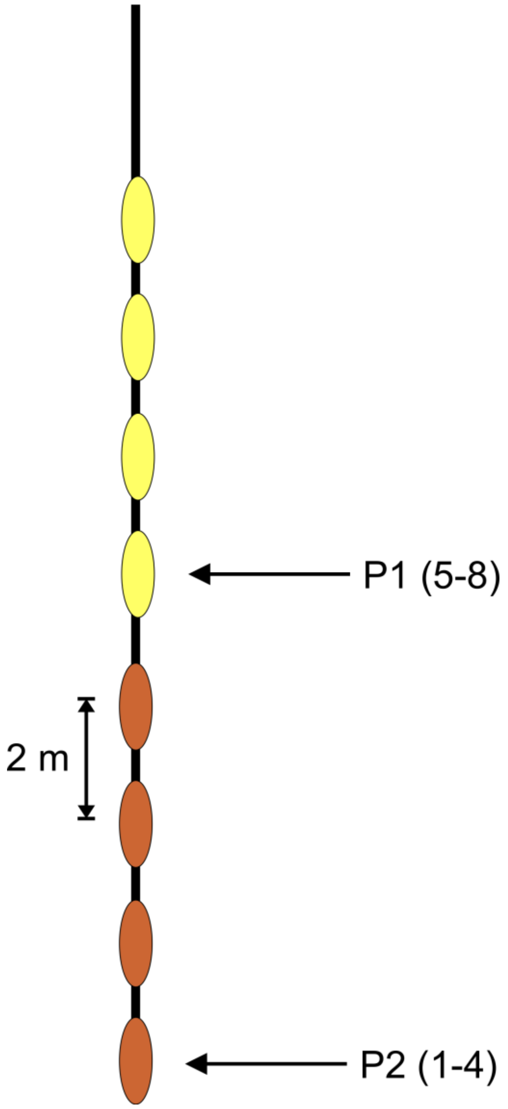

Fig. 7: Sketch for pressure design

Assuming the water table is at depth Z_{water}. We recommend the following procedure to apply air to the bladders.

1. Calculate relevant “hydrostatic depth” for station #5 (pressure rating P1) as follows:

   $Z_{P1} = Z - 8$ m where Z is the reading at the depth marker below ground

   Hydrostatic pressure P1 at Z_{P1} is $P1 = (Z_{P1} - Z_{water}) * 0.1$ bar

2. Open valve for “Air in” and open both valves (1..4) and (5..8)

3. Apply over pressure $P1_+$ with $P1_+ = P1 + 1.5$ bar. At this pressure all upper stations 5-8 are completely clamped.

4. Close valve for upper stations 5-8 ! Read pressure $P1_+$ at manometer (5-8).

5. Apply pressure to lower air bladder system with $P2_+ = P1_+ + 0.8$ bar

6. At this pressure all lower stations 1-4 are completely clamped.

7. Close valve for lower stations 1 - 4 !

8. Switch main valve at “Air in” to “release” position.

9. Start acquiring data.

   It is very important to open the main valve to release pressure to avoid a short circuit between lower and upper air bladders if air is released from lower bladders !

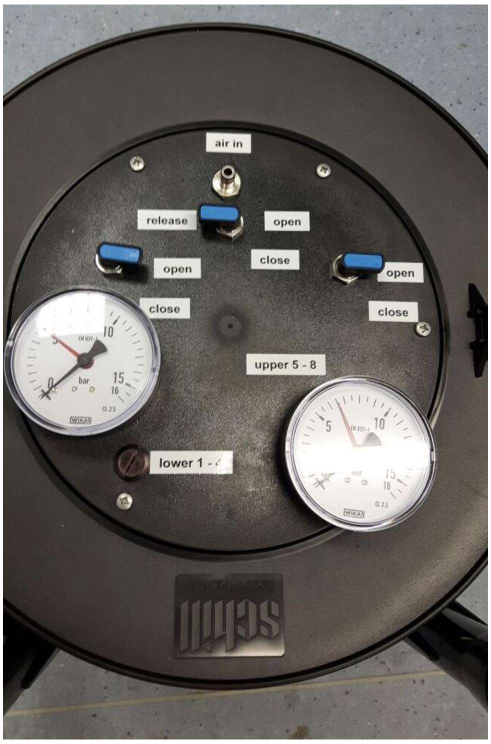

Fig. 8: Air supply on drum

Air packers are supplied as spares with colour coding (see figure 9).

Black: Use for station 1,2 and 5,6

Green: Use for station 3 and 7

Red: Use for station 4 and 8

Fig. 8: Colour coded air bladders

4. Maintenance

No special maintenance instruction for the seismic sensor system. Seismic sensors do have a natural frequency of 10Hz +/- 2.5%. Coil resistance is 375 Ohm +/- 2.5% with a spurious frequency of larger 240Hz.

Do not bend seismic cable below a radius of 20 cm. Do not cut cable, do not override.

Charge internal compass batteries on regular basis.