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).

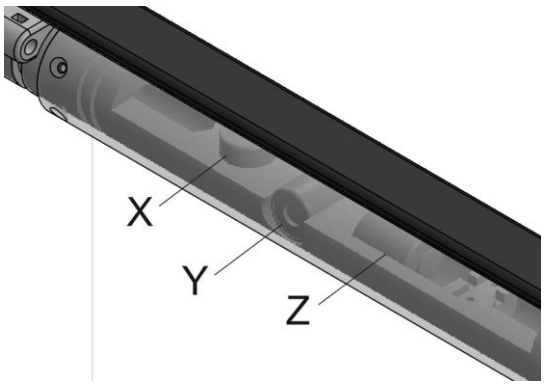

Fig. 2: Sensor orientation

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).

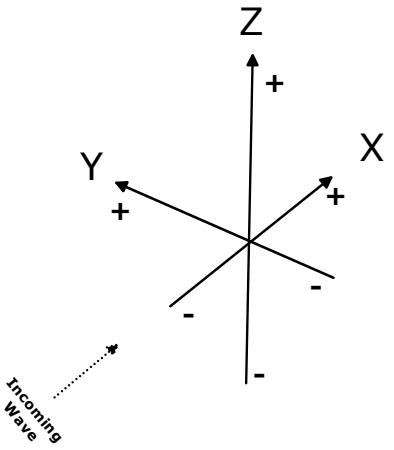

Fig. 3: Sensor polarity

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.

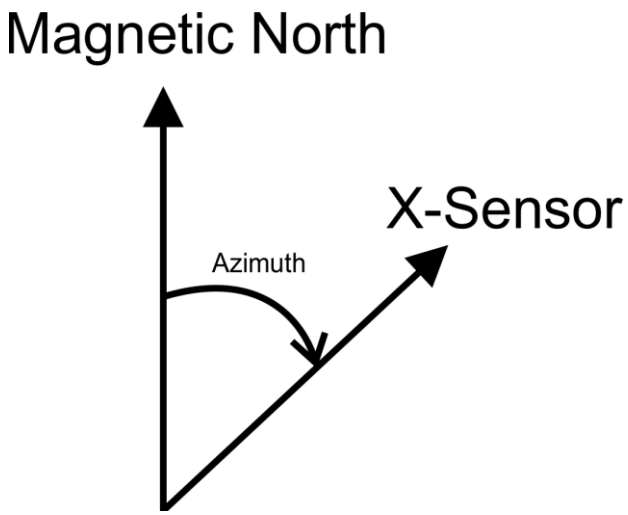

Fig. 4: Schematic sketch showing angle measure

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 continuously (press again illumination stops)
RESET/CAL (Calibration)	→	Press shortly to display water pressure Press longer (~ 2 sec) hard iron compass calibration is made. For calibration hold BGK vertical and turn twice within the calibration time (20sec).

3. Air packer system and air supply

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 mounted on a drum at surface.

A water pressure sensor is mounted at the bottom MBAS station (see figure 6). It is hold in place with a spring and protected by a brass screw with in inner hole of 10mm. This allows it to float the cap with water.

Fig. 6: Pressure sensor at bottom station

The pressure sensor measures the water pressure, i.e. if 10 m below water table it will give 1 bar and so on. The accuracy of the pressure sensor is 0.1 bar. The brass screw is to protect the sensor against mechanical shocks.

To check the water pressure P_w you need to switch on the compass display and shortly press the RESET/CAL button.

Do not touch or mechanically clean the sensor face. Use water to clean the bottom cap and sensor. You may remove the brass screw for better cleaning.

To allow a proper clamping of the stations at the borehole wall the air packers need to be inflated according to the water pressure P_w. In table 2 the recommended air pressure is listed.

Table 2: Recommended air pressure for coupling

	MBAS-A (8 Stations)		MBAS-A (6 Stations)	
	Spacing 1 m	Spacing 2 m	Spacing 1 m	Spacing 2 m
	if $P_w > 0.3$ bar	*if* $P_w > 0.6$	*if* $P_w > 0.2$ bar	if $P_w > 0.4$ bar
Lower	$P_w + 1.6$ bar	$P_w + 1{,}6$ bar	$P_w + 1.6$ bar	$P_w + 1.6$ bar
Upper	$P_w + 1.2$ bar	$P_w + 0{,}8$ bar	$P_w + 1.3$ bar	$P_w + 1.0$ bar
	if $P_w < 0.3$ bar	*if* $P_w < 0.6$ bar	*if* $P_w < 0.2$ bar	*if* $P_w < 0.4$ bar
Lower	1.6 bar	1.6 bar	1.6 bar	1.6 bar
Upper	1.6 bar	1.6 bar	1.6 bar	1.6 bar

3.1 Assembly and how to apply pressure

Connect air hose between drum and downhole station, i.e. blue to blue and black to black hose. Make sure the hose connections are tight inside the connector and tightly fixed to the cable.

Fig. 7: Connect air hose to downhole air system

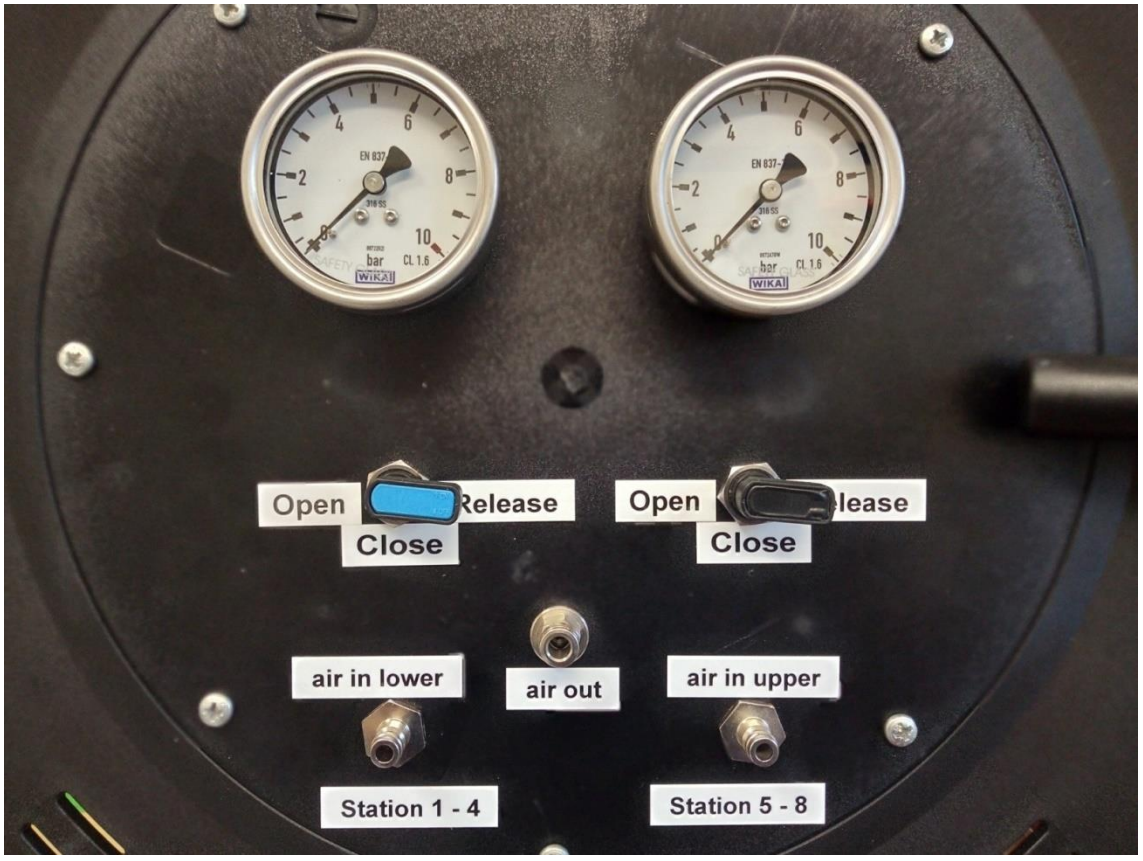

Fig. 8: Surface air hose drum

Make sure you are not squeezing the air hose to much while tightening to the main cable.

Air can be supplied to the lower stations by connecting air pump to blue air inlet (see figure 8). Check the water pressure by reading the water pressure value P_w at the display (see fig. 5). Add overpressure according to table 2 to clamp air packer to borehole wall. Close valve and connect air pump to inflate packers for upper stations (black hose). Apply recommended air pressure (see table 2) and close valve.

Once the MBAS is properly clamped lower the main cable a little bit to release tension. Clamp cable again after releasing tension.

Carry out your survey and once finished you may release air pressure while opening the valves.

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 regularly.