FS Future Series®

GeoSeeker Mini

User's Manual

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Table of contents

Table of figures

Chapter 1

Introduction

1.1 Preface

Dear Customer,

first of all we would like to thank you in choosing a product manufactured by OKM. The present product is based on a geoelectrical measuring method utilizing the Schlumberger technique to measure the resistivity of different soil layers.

With our team of specialists we guarantee that our products are under recurrent control. Our specialists are constantly implementing new developments in terms of further quality improvements for you. Of course by selling our products we cannot guarantee that you will make a find during your research. The recognition of hidden structures depends on a huge number of factors – as you are already aware of. Determining factors like the dielectric constant of the ground, the grade of mineralization and the conductivity of different soils. Especially in very wet soils like clay and sand with high conductivity or attenuation of the ground. In certain conditions recording of the measured results can be falsified strongly.

For more information regarding where this equipment has been used and operated, please visit our web site. Our equipment is constantly being tested and when improvements or upgrades are available, we will list them also on our web site.

It is necessary for our company to protect our developments and all of the information learned during the “Research and Development” phases in creating our technology. We strive to stay within the given framework of legislation, patents and trademark registration.

Please take the time to read this User Manual and familiarize yourself with the operation, functionality and how to utilize the GeoSeeker Mini. We also offer training for your equipment in our factory. We strive to maintain a worldwide dealer network for assistance and support. Please visit our web site for more information.

1.2 Important Notes

Prior to using the GeoSeeker Mini and its accessories, please read these operating instructions carefully. These instructions give information on how to properly use this geoelectrical detector and shows potential sources where precautions should be taken.

1.2.1 Security Guidelines

The GeoSeeker Mini has a maximum output of 320 V and 0.4 A even if it is not present at all times. But under some circumstances the maximum output can be present at the electrodes of the GeoSeeker Mini. Therefor you have to take special care when handling the electrodes:

- Do not touch any of the electrodes when measuring is in progress.
- Before replacing any of the electrodes unplug the connecting cable to isolate the electrodes from active power supply.
- Do not initiate any measuring as long as someone is handling the electrodes.
- Instruct all your helpers and assistants concerning these security guidelines to avoid unnecessary injuries.

1.2.2 General Notes

Being an electronic device, the GeoSeeker Mini has to be treated with caution and care as with any electronic device. Any failure to observe the safety precautions given or any use for purposes other than the ones it is designed for may result in damage or destruction of the processing unit and/or its accessories or connected components.

The device has a built in anti-tampering module which will destroy the unit if it is improperly opened. There are no end user serviceable parts on the inside of the unit.

1.2.3 Surrounding Area

When moving this unit from a cold place to a warmer place, watch out for condensation. Do not immediately operate the unit until any possible condensation has evaporated. The unit is not weather proof and water, moisture or condensation can destroy the unit.

Avoid strong magnetic fields, which may occur in places where there are large electric motors or unshielded loudspeakers. Try to avoid using this equipment if someone else is using this type of equipment closely.

Avoid using this equipment around active military installations and airports or where there may be other devices that may hamper the signals received. Radars for aircraft, boats and weather reporting may lower the units capabilities.

1.2.4 Voltage / Power Supply

The power supply should not be outside the indicated range of values. Use only approved chargers, batteries and rechargeable batteries which are included in the scope of delivery. Only use the recommended type of batteries or rechargeable batteries as indicated in this user's manual.

1.2.5 Maintenance and Services

In this section you will learn how to maintain your measuring instrument with all of its included accessories. This will keep it in good condition a long time and you will be able to get good measuring results.

The following list indicates what you absolutely should avoid:

- penetrating water
- strong dirt and dust deposits
- hard impacts
- strong magnetic fields
- strong microwave fields
- high and long lasting heat effect

To clean your device please use a dry soft cloth. To avoid any damage you should always transport the device and accessories in the appropriate carrying cases.

Prior to using your GeoSeeker Mini please be sure that all batteries and accumulators are fully charged. Also allow the batteries to completely discharge before recharging them, regardless if you are working with the external battery or with internal accumulators. This way your batteries will have a long and durable life.

1.2.6 Danger of Explosion during Excavation

Unfortunately, the last two world wars also made the ground in many places of the world a potentially explosive scrap heap. A host of those lethal relics are still buried in the ground. Do not start digging and hacking for an object wildly when you receive a signal of a piece of metal from your device. Firstly, you might indeed cause irreparable damage to a truly rare find, and secondly, there is a chance that the object reacts in an insulted way and strikes back.

Note the color of the ground close to the surface. A red or reddish color of the ground is an indicator of rust traces. As regards to the finds themselves, you should definitely pay attention to their shape. Curved or round objects should be a sign of alarm, especially if buttons, rings or little pegs can be identified or felt. The same applies to recognizable ammunition or bullets and shells. Leave that stuff alone and where it is, do not touch anything and, most importantly, do not take any of those items home

with you. The killing machines of war made use of many diabolical inventions such as rocker fuses, acid fuses and ball fuses. Those components have been rusting away in the course of time, and the slightest movement may cause parts of them to break and be triggered. Even seemingly harmless objects such as cartridges or large ammunition are anything but that. Explosives may have become crystalline over time, that is, sugar-like crystals within them have formed, they are still dangerous and should be regarded as a potential killer.

Moving such an object may cause those crystals to produce friction, leading to an explosion. If you come across such relics, mark the place and do not fail to report the find to the police or proper authority. Such objects always pose a danger to the life of hikers, walkers, farmers, children and animals.

Chapter 2

Technical specifications

The following technical indications are medial values. During operation small variations are quite possible. Technical changes due to development are also possible.

2.1 Control Unit

Dimensions (H x W x D) ..... 410 x 340 x 180 mm
Weight ..... 4.50 kg
Input (max.) ..... 11 - 13 VDC, 30 W
CPU ..... 80 MHz Cortex M3
ADC ..... 16 bit
Effective Range (differential) ..... -1400 to +1400 mV
Input Resistance (static) ..... approx. 12 MΩ
Data Sampling Rate ..... 4096 Hz (64 times oversampling of a 512 samples mean value)
Measurement Period per Scan Point ..... min. 16 seconds
Display ..... 3.5” Resistive touch, 480 x 320 Pixel
Display CPU ..... Cortex M3, 32 MHz, 128 KB RAM
Data memory ..... 4 GB
Output (max.) ..... 320 V, 0.4 A
Operating Time (average Power) ..... approx. 6 - 8 hours

2.2 Electrode

Dimensions (L x W x D) ..... 270 x 120 x 35 mm
Weight ..... 0.40 kg

2.3 Cable Drum with Power Cable and Voltage Cable

Dimensions (H x W x D) ..... 360 x 290 x 200 mm
Weight ..... 3.60 kg

Power Cable Length ..... 100 m
Power Markers 10

Voltage Cable Length ..... 10 m
Voltage Markers 10

Chapter 3

Scope of delivery

In the following section you can find all standard equipment and optional parts of the GeoSeeker Mini.

Description	Quantity
Control unit	1
Cable drum with power cable, 100 m (328 ft)	2
Voltage cable, 10 m (33 ft)	2
Extension cable, 2 m (6 ft)	2
Electrode	4
Power Pack with charger and travel adapter	1
User manual	1

Table 1: Scope of delivery

Chapter 4

Control elements

In this section you will learn more about the fundamental use of all control elements for this measuring instrument. All connections, inputs and outputs are explained in detail.

4.1 Control Unit

The control unit is used to inject electrical power into the underground which could be measured afterwards. Figure 4.1 shows all the control elements of the control unit.

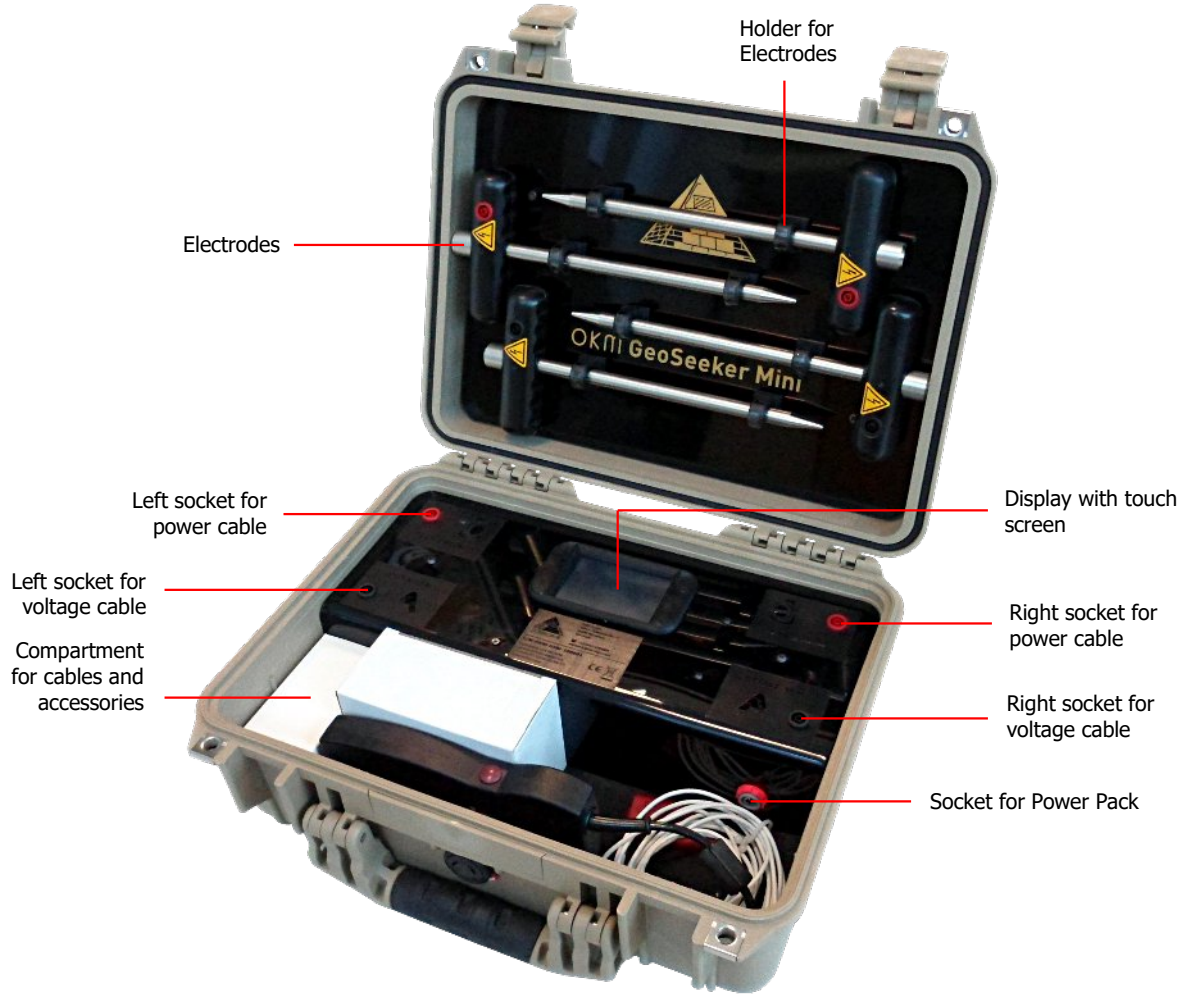


Figure 4.1: Control elements of the Power Box

Sockets for power cable: Use these red sockets to plug in the connectors of the power cables, that are reeled on the cable drums. During measurements, these are the output sockets for the power injection.

Sockets for voltage cable: These black sockets are used to connect the voltage cables (10 m). These are the input sockets for measuring the voltage.

Display with touch screen: The display indicates all measure states and allows you to configure and store your measurements. It is equipped with a touch screen to operate the unit.

Socket for Power Pack: This socket needs to be connected with the external Power Pack for appropriate power supply.

Compartment: The compartment is used to store the Power Pack and all kind of accessories like extension cables (2 m) and charger.

Electrodes: The electrodes are stored in the top of the carrying case by clipping it into the designated clips. There are two Power Electrodes with a red socket as well as two Voltage Electrodes with a black socket. The Power Electrodes are used to inject power - generated by the control unit - into the ground. The Voltage Electrodes are used to measure the voltage of the underground.

4.2 Cable drums with power cables and voltage cables

There are 2 cable drums, each with 100 m of cable. Those are used to connect the Power Electrodes (electrodes with red socket) with the control unit. Additionally there are two 10 m cables coiled up in front of the cable drums. These cables are used to connect the Voltage Electrodes (electrodes with black socket) with the control unit.

Figure 4.2: Elements of the power cable drums

Socket connector for extension cable: This socket is used to connect the extension cable (2 m) and link it to a power electrode.

Plug connector: Put the plug connector into the left or right red socket of the control unit.

Power cable with markers: The cables of each drum are labeled with 10 markers in total. This markers are numbered from 1 to 10 and will help you to place the electrodes at the right position during the measurement.

Voltage cable with markers: The voltage cable (10 m) is also labeled with 10 markers in total. This markers are numbered from 1 to 10 and will help you to place the electrodes at the right position during the measurement.

4.3 Electrodes

There are 4 electrodes in total, 2 electrodes with a red socket (Power Electrodes) and 2 electrodes with a black socket (Voltage Electrodes).

Figure 4.3: Elements of the electrodes

Handle / Shaft: Use the handle to push the electrode's shaft into the underground as deep as possible. You may use a hammer to do so. The shaft is made of stainless steel to be robust against moisture and weird soil conditions.

Socket: The socket is used to connect the cables whereas the red socket is used for the power injection and the black socket is used for measuring the voltage.

Chapter 5

Operating Modes

This section explains the basic functionality and how to operate the GeoSeeker Mini.

After starting your GeoSeeker Mini you will see the main menu as shown in figure 5.1.

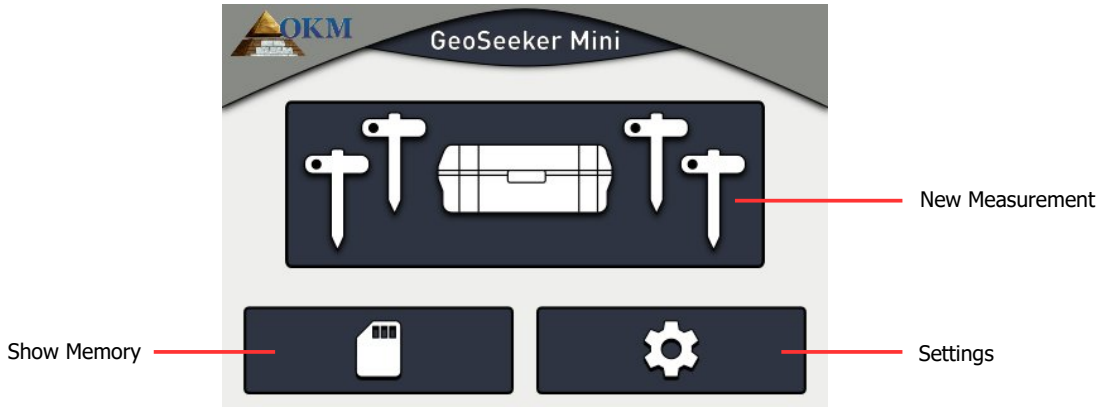


Figure 5.1: Main menu

There you can select one of the following options:

- **New Measurement**
  Choose this option to conduct a new geoelectrical measurement. You will have to follow some additional steps to set up the depth range and the number of scan points.
- **Show Memory**
  If you saved some of your measurements you can open it here to see its results.
- **Settings**
  This option allows you to adjust the display brightness as well as getting information about firmware, serial number and OKM contact details.

5.1 New Measurement

This is the option of your choice if you are going to create a new measurement. There are some additional parameters to choose before the actual measuring takes place. The first parameter you have to adjust is the maximum depth, as shown in figure 5.2.

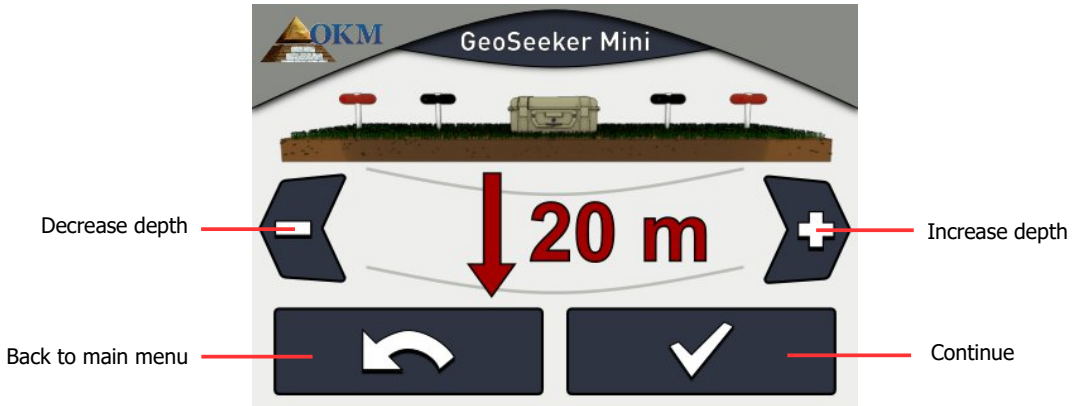


Figure 5.2: Adjusting the maximum depth

Use the buttons and to change the depth value and confirm by pushing the button. This will automatically open the next screen, that is shown in figure 5.3.

Figure 5.3: Adjusting the number of scan points

Use the buttons and to change the number of scan points and confirm by pushing the button.

All parameters have been adjusted now and you can set up your electrodes according to the screen shown in figure 5.4. This measurement screen gives information about the position of each electrode.

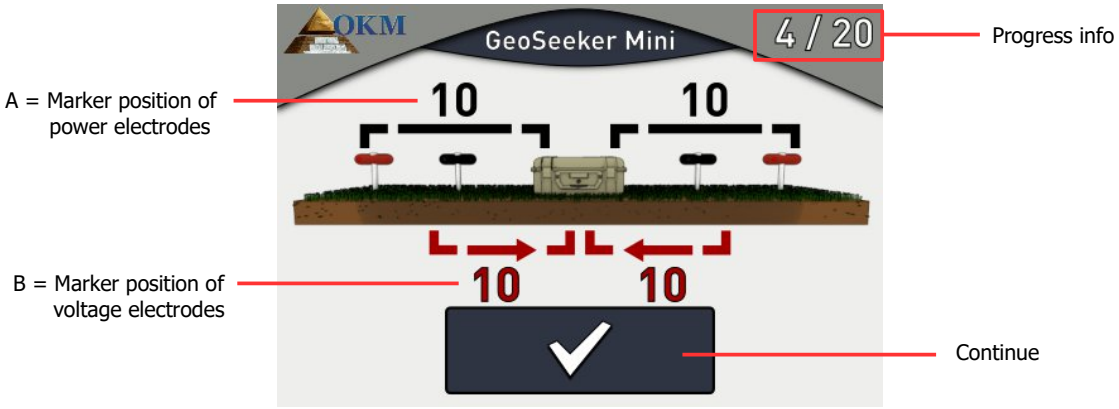


Figure 5.4: Adjust marker positions for next scan

Progress info: The numbers in the top right corner are indicating how many scan points have been measured. In the example of figure 5.4 you have to measure 20 scan points in total, whereas 4 scan points have been measured already.

Marker positions (A, B): This is the place where you get proper information about the upcoming scan point (the scan point that will be measured after tapping the button). The numbers are indicating at which cable marker the electrodes have to be placed into the ground. If the number is written in red color than this value has changed in relation to the previous scan point.

- **A** ... is the distance between left Power Electrode and control unit as well as the distance between control unit and right Power Electrode in terms of distance markers (numbered from 1 to 10). In the example of figure 5.4 you have to place the Power Electrodes at marker “10”.
- **B** ... is the distance between left Voltage Electrode and control unit as well as the distance between control unit and right Voltage Electrode in terms of distance markers (numbered from 1 to 10). In the example of figure 5.4 you have to place the Voltage Electrodes at marker “10”.

Detailed information about the scan points and adjusting the distances you will find in chapter “6 Conducting a measurement” on page 31.

After all electrodes have been adjusted push the ✓ button to start measuring the current scan point. While the scan takes place the screen from figure 5.5 is shown.

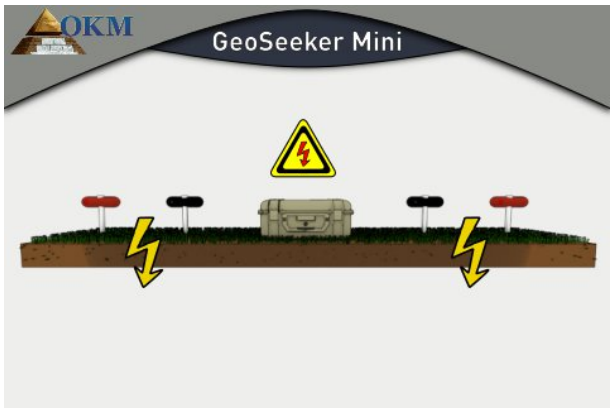


Figure 5.5: Measuring the current scan point

The GeoSeeker Mini is now processing several measurements by generating electricity and measuring the resultant voltage.

DANGER! HIGH VOLTAGE!
While the scanning process is in progress DO NOT touch any of the electrodes.

As soon as the current scan point has been measured the according result will be presented as shown in figure 5.6. All single measure values will be presented to the operator.

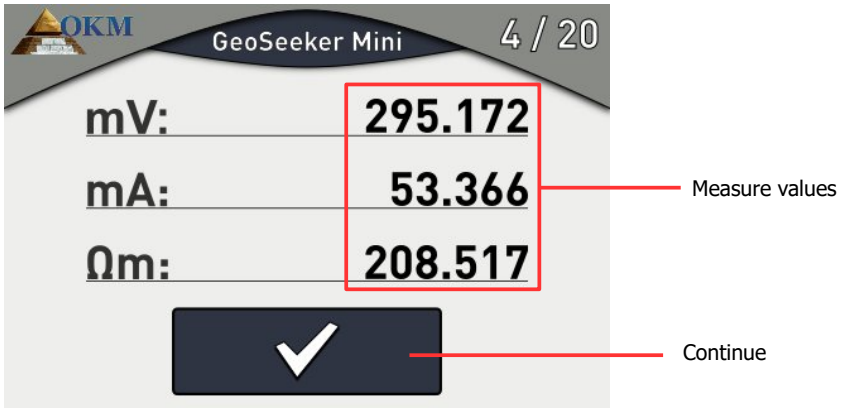


Figure 5.6: Measure values as indicated during a measurement

Detailed information about all measure values and its meanings can be found in section 7.1 “Interpretation of scan values” on page 44.

You can also write down these values if you like to keep the results for own calculations or reports. When you are ready to continue with the next scan point push the ✓ button. Now you have to adjust the electrodes according to the information on your screen again (see figure 5.4 on page 23).

This procedure will repeat until all depths of the current scan point have been measured. Then the screen from figure 5.7 appears.

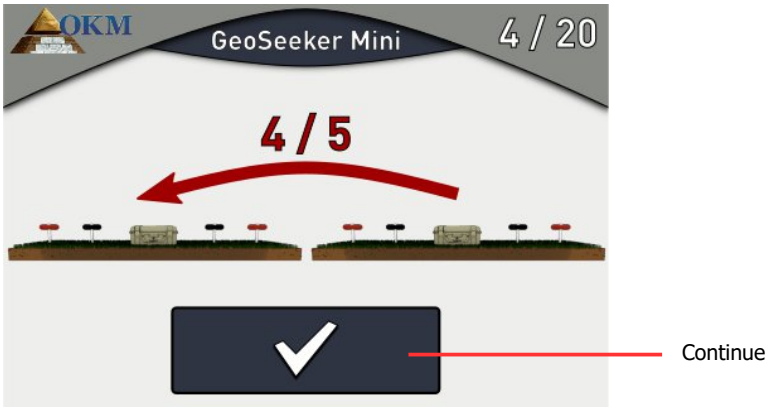


Figure 5.7: Move all equipment to the next scan point

Now you have to move all your equipment left to the next marker. Then you have to adjust all electrodes again to measure all depths of the next scan point. Depending on your configuration you have to move your equipment more or less during the measurement.

This procedure will repeat until the whole measurement is completed. If you want to abort the current measurement push the OKM logo on the top left corner. This will definitely abort the current measurement that cannot be resumed later on.

After the last scan has finished and the measure values are presented as shown in figure 5.6 on page 24, push the ✓ button. Now the screen from figure 5.8 appears.

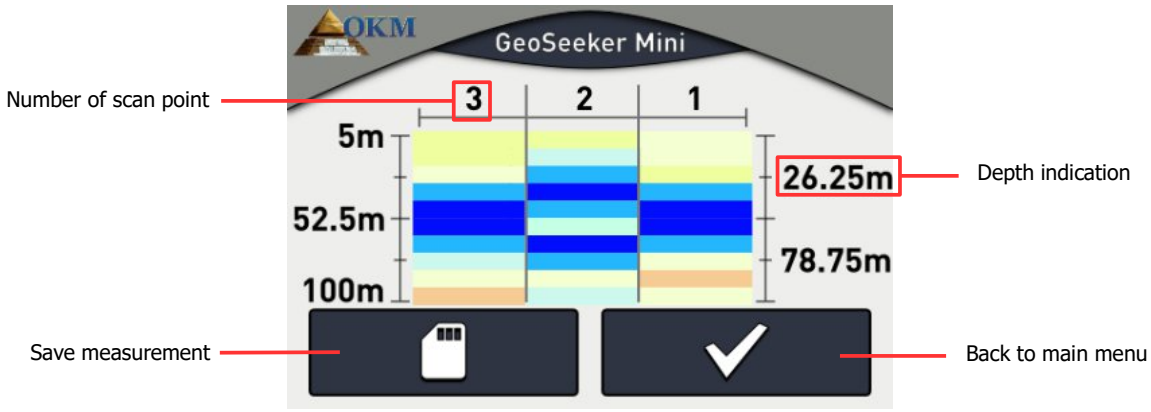


Figure 5.8: 2d graphic of a completed measurement

Here you can see the graphical result of your measurement. More details about this graphical representation can be found in section 7.2 “Interpretation of graphical representations” on page 45.

Now you have to decide if you want to save this measurement into the internal memory. If so, you have to push the button which brings up the screen from figure 5.9. Otherwise push the ✓ button to go back to the main menu without saving your measurement.

Figure 5.9: Select empty memory slot

Select an empty memory slot to save your measurement permanently into the internal memory. If there is no free slot available, you can also pick a used one and overwrite its data. In case you are going to overwrite an existing measurement, the screen from figure 5.10 appears to confirm your decision.

Figure 5.10: Save measurement to memory

If you really want to overwrite the existing measurement push the ✓ button. The measurement is now saved into the memory of your device and can be reopened at later times.

If you do not want to overwrite an existing measurement push the ↶ button to get back to the memory slot selection.

After the measurement has been saved successfully you will be redirected to the graphical representation, as shown in figure 5.8 on page 25.

Push the ✓ button to leave this screen and go back to the main menu.

5.2 Show Memory

When you like to reopen a previously saved measurement to view its resulting graphical representation, you select [ ] from the main menu. Then the screen from figure 5.11 appears, where all memory slots are presented.

Figure 5.11: Memory slots

If a memory slot contains a measurement the number of scan points (3x, 5x) as well as the depth (20m, 50m, 80m, 100m) is indicated. Push the [ ] button to leave this screen and go back to the main menu.

5.2.1 View Measurement

If you like to view one of the stored measurements you simply touch the equivalent memory slot button. Now the data will be loaded and the resulting 2d graphic is displayed on the screen as shown in figure 5.12.

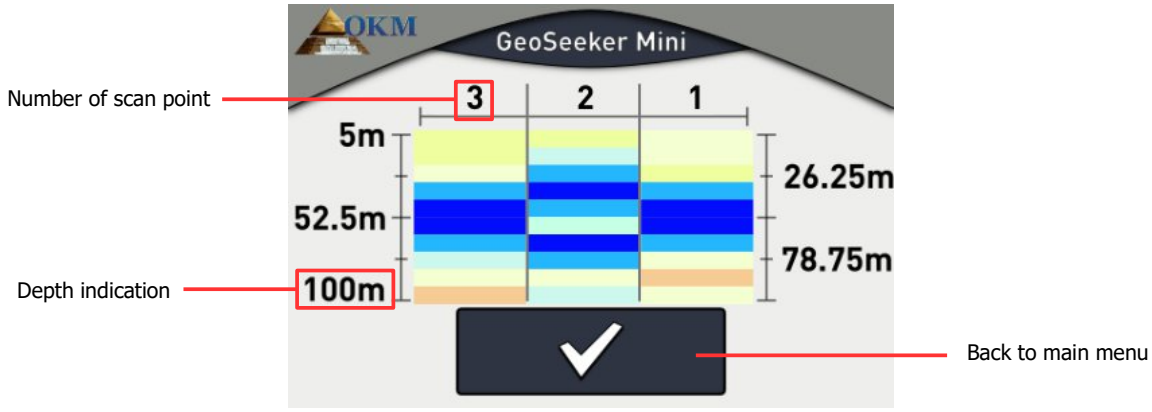


Figure 5.12: 2d graphic of a measurement

According to the colors you can now analyze your measurement to find out if some interesting target is available. Please read chapter 7.2 "Interpretation of graphical representations" on page 45 to learn more about the used color codes.

Push the [ ] button to leave this screen and go back to the main menu.

5.2.2 Delete Measurement

If you want to delete an existing measurement you have to select a memory slot by touching and holding your finger down for at least 5 seconds until the screen from figure 5.13 appears.

Figure 5.13: Delete stored measurement

Now you must decide if you really want to delete the measurement from the selected memory slot. Push the ✓ button to finally delete the measurement. Otherwise push the ↶ button to go back to the memory screen.

5.3 Settings

In this section you will learn how to adjust different settings of your GeoSeeker Mini. After selecting ⚙ from the main menu the screen from figure 5.14 appears.

Figure 5.14: Support Information

The following options can be selected:

- **Brightness**
  Adjust the brightness of the display.
- **Support Information**
  Shows information regarding firmware and serial number.

5.3.1 Brightness

The brightness regulates the background light of the display / touch screen. The brighter the display the better you can read it in sunlight but the more power it will consume. In dark environments you can turn the brightness down.

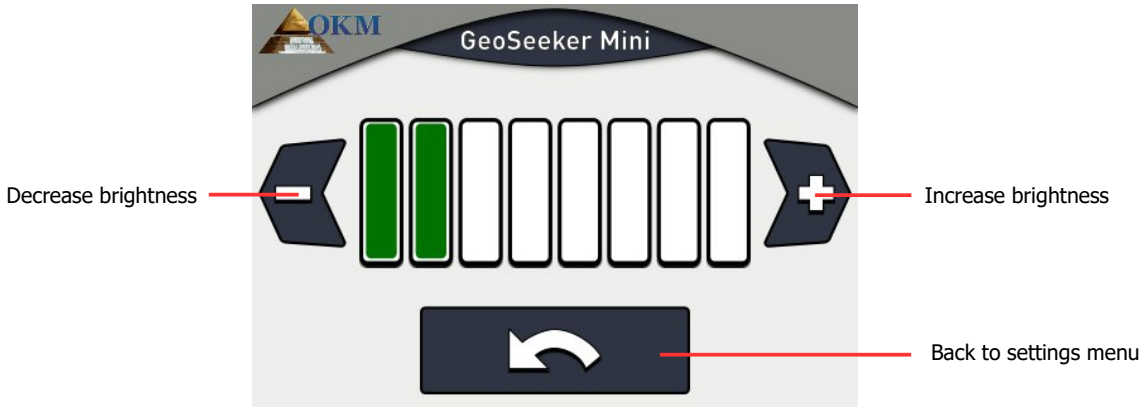


Figure 5.15: Brightness

Use the buttons and to change the brightness value and confirm it by pushing the button. This will automatically return to the settings menu.

5.3.2 Support Information

This option displays information regarding the device's serial number and firmware version as well as OKM's contact details.

Figure 5.16: Support Information

Those information may be useful if you are contacting your local OKM distributor for additional support requests. Push the button to return to the settings menu.

Chapter 6

Conducting a measurement

In this section you will learn how to conduct a measurement with GeoSeeker Mini.

The GeoSeeker Mini is a geoelectrical measuring instrument and thus intended to measure the resistivity of underground layers. The conductivity of different layers can be used to find potential places of water deposits or cavities. The quality of your measured data depends strongly on the accuracy of your conducted measurement.

Before you are going to conduct a new measurement you have to make sure that all your equipment is intact and ready to use. Check all cables and connectors for possible damages and recharge all batteries. Also ensure that no parts are missing before going to your scan field. Keep your equipment always clean and dry.

6.1 Basic Information

Before you are going to set up a new measurement you have to investigate about your specific scan area. There are some important aspects you have to be aware of before starting your measurement.

- If you are scanning for cavities the overlying layers must not be too wet otherwise the injected power will not reach its final depth. The injected power always uses the easiest and most conductive way to flow through the underground soil.
- Never conduct a measurement during or directly after a thunderstorm. Lightning strikes are not only influencing your measurement, they are also very dangerous while laying out the cables and putting the electrodes into the ground.
- When conducting a measurement the surface of your scan field should be equally dry and not wet. So it will be a bad idea to run a measurement during or directly after rainy days. Wait some days until the ground is not too wet anymore before conducting a measurement.
- The electrodes have to be in good electrical contact with the surrounding soil. The deeper the electrodes are placed into the ground the better the contact and the better the final measuring result.
- The deeper you are scanning the larger the underground objects must be. You cannot detect very small cavities or water deposits at very high depths. It is also much more easy to detect thick objects that overlap more depth layers than flat objects as shown in figure 6.1.

Figure 6.1: Detection of thick objects is better than flat objects

- The distance between two scan points must match the object's dimensions. This means you can only detect underground anomalies if you scan right on top of the hidden targets as well as the surrounding ground.
- Additionally it will be a good idea to observe the present vegetation since special plants can indicate the presence of underground water deposits. There also might be areas with more plants or greener plants than others.

6.2 General Measurement Procedure

Before starting any measurement you have to divide your scan field into single scan points. You have to choose a consistent distance (resolution) between your scan points according to your preferred accuracy. You can decide to use 3 or 5 scan points for a measurement with GeoSeeker Mini. Later, during your measurement, you will collect measure values at each of those scan points from certain depths.

It is a good practice to mark each of that scan points with some kind of marker (flag, stick, color point, stone, etc.) to speed up the final measurement. So you have to measure the distances between the scan points only once during the preparation of your scan field and you can move your equipment from point to point easily afterwards.

In figure 6.2 you can see an exemplary scan field with 3 scan points. The distance between the scan points is all the same and can vary from one measurement to another.

Figure 6.2: Dividing the field into scan points and setting up markers

At each of this marked scan points, electrical power is injected into the ground using the two Power Electrodes (electrodes with red socket) and the resulting voltage is measured with the two Voltage Electrodes (electrodes with black socket). By increasing (or decreasing) the distance of the Power Electrodes step by step the measure depth also increases (or decreases) accordingly, as shown in figure 6.3.

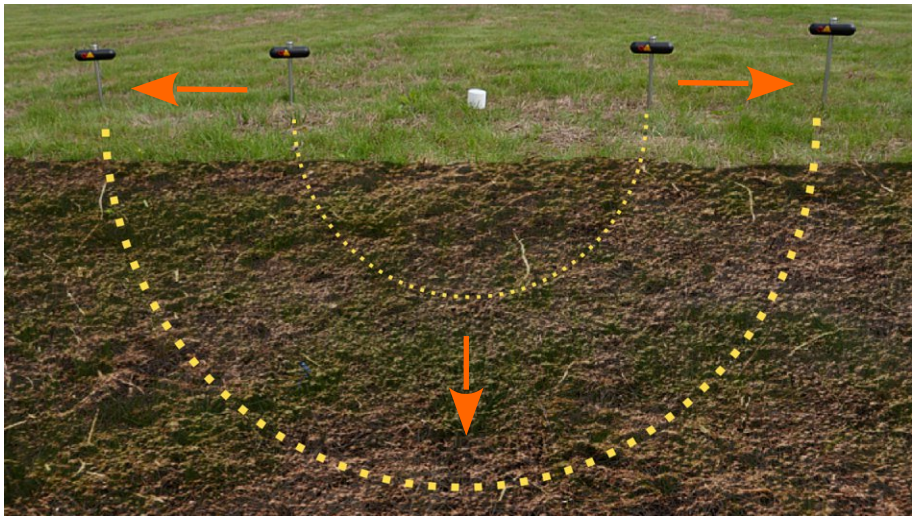


Figure 6.3: Power injection depth depends on electrodes distance

You have to keep in mind that for a maximum depth penetration of 100 m (328 ft) you will also need 100 m (328 ft) free space to the left and right of your scan point to put your electrodes into the ground. So it can be possible that you cannot always scan up to 100 m, e.g. if there is no free space for your electrodes.

Before starting the actual measurement you have to investigate your area to find out what parameters are useful. While creating a new measurement you have to set up several settings regarding scan points and maximum depth.

See section 5.1 “New Measurement” on page 22 for setting up a new measurement. As soon as all parameters have been adjusted and the screen from figure 6.4 appears, you have to put your electrodes at the correct positions into the ground.

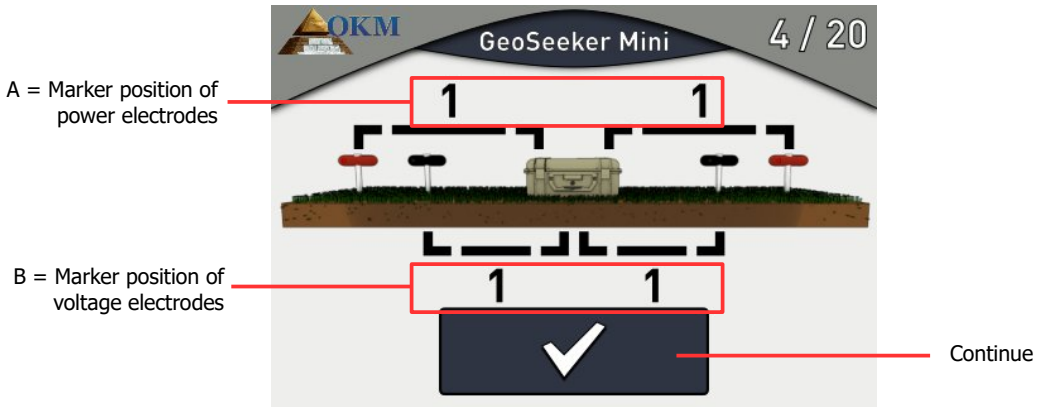


Figure 6.4: Instruction screen for setting up a measurement

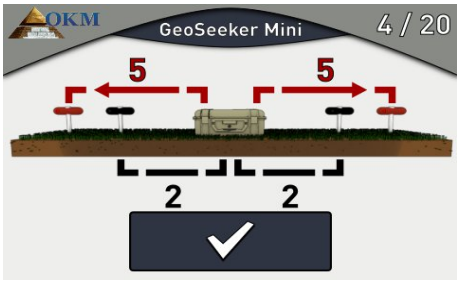
You will now arrange all your equipment according to these instructions. For our example it will be as follows:

- **A** ... In this example each Power Electrode has to be placed in a distance of 5 m to the left and right of the control unit. This corresponds to the power cable marker “1”. So you will unroll your cable until the marker “1” is reached and then you put the electrode into the ground.

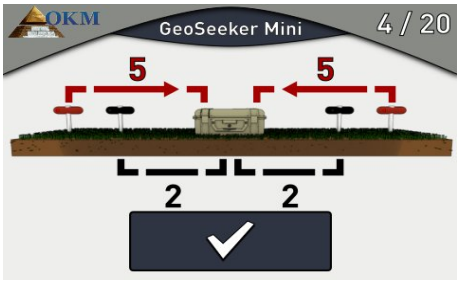
- **B** ... In our example each Voltage Electrode has to be placed in a distance of 1 m to the left and right of the control unit. This corresponds to the cable marker “1”. So you will put the electrode at voltage cable marker “1” into the ground.

For all coming steps you will simply follow the instructions on this screen. After each measuring process the device will show you how to replace the electrodes in the field before measuring the next scan point.

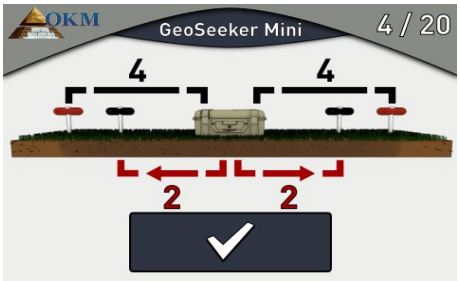
The following instruction scenarios might occur during your measurement:



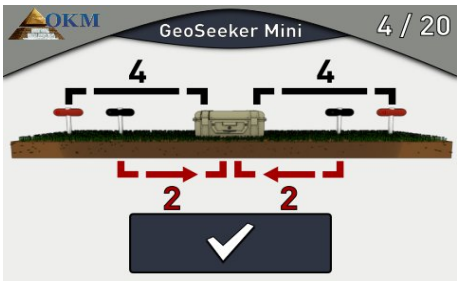
- You have to move the Power Electrodes (red socket) outwards to the next cable marker. This will increase the depth of the current scan point.



- You have to move the Power Electrodes (red socket) inwards to the previous cable marker. This will decrease the depth of the current scan point.



- You have to move the Voltage Electrodes (black socket) outwards to another cable marker (several cable markers might be skipped). This will be necessary if the measured voltage is too low.



- You have to move the Voltage Electrodes (black socket) inwards to another cable marker (several cable markers might be skipped). This will be necessary if the measured voltage is too high.

- After one scan point has been measured completely at all depths both the Voltage Electrodes (black socket) and the Power Electrodes (red socket) as well as the control unit needs to be moved to the next scan point (left to the current one).

After recording all measured values in all scan points the screen will display a graphical 2d representation of the measured values as shown in figure 7.2 on page 45.

6.3 Setting up a measurement

While preparing your measurement you will set up your scan point markers, place the control unit to its initial position and put the electrodes into the ground as indicated by the GeoSeeker Mini measurement screen.

Please follow these basic steps to prepare your measurement:

1. Investigate your scan field and find out how you are going to process your measurement.
2. Prepare your scan field with scan point markers.
3. Prepare your control unit and start a new measurement. Adjust all parameters according to your field preparation.
4. Place the control unit at the first scan point (the one on the right side) and put the Voltage Electrodes according to the device's instructions into the underground.
5. Also put the Voltage Electrodes according to the device's instructions into the underground.
6. Start measuring the first scan point and follow the device's instructions until your measurement has been completed successfully.

6.3.1 Setting up your scan field with markers

After investigating your area you should place markers at each scan point. The distance of your 3 or 5 scan points can vary from situation to situation. The picture from figure 6.2 on page 33 shows an example of how to mark your scan points.

6.3.2 Setting up the voltage measurement

The voltage measurement equipment consists of the control unit with Voltage Cables (10 m) as well as the Voltage Electrodes. All those parts are equipped with black plugs or black sockets. This Voltage Line is used to measure the generated potential difference of the Power Line, that we will setup later.

1. Place the control unit at the first scan point marker.

2. Remove the voltage cable (10 m) completely from the Cable Drums.

3. Connect the first plug of the Voltage Cable with the control unit. Make sure to use the end with the lowest marker number “1”.

4. Unroll the voltage cable completely by laying it out in a straight line.

5. After reaching the end make a U-turn and bring back the cable to the cable marker indicated by the measurement screen of your device. Laying out the cable completely makes it easier to rearrange the electrodes afterwards.

6. Put the Voltage Electrode next to the cable marker into the ground as deep as possible. Use a hammer if necessary.

7. Connect the Voltage Cable with the Voltage Electrode.

8. Repeat steps 2 to 7 for the second Voltage Cable and Electrode.

6.3.3 Setting up the power injection

The power injection equipment consists of the control unit, the Power Cable Drums (100 m) as well as the Power Electrodes with Extension Cable (2 m). All those parts are equipped with red plugs or red sockets. This Power Line is used to inject electrical power into the underground to generate a potential difference (fall of voltage).

Follow these steps to set up the Power Line for a measurement:

9. The control unit is already placed during the process of setting up the Voltage Line.

10. Now connect the plug of the first Power Cable Drum into the appropriate socket of the control unit.

11. Unroll the cable of the Power Cable Drum by moving away from the control unit until you reach the cable marker indicated by the measurement screen of your device.

12. Put the Power Electrode next to the cable marker into the ground as deep as possible. Use a hammer if necessary.

13. Use the Extension Cable (2 m) and connect it with the Power Drum.

14. Now connect the second end of the Extension Cable with the Power Electrode.

15. Repeat steps 10 to 14 for the second Power Cable Drum and Electrode.

6.3.4 Processing a measurement

Now you have set up the equipment to process a geoelectrical measurement. Figure 6.5 shows the final situation.

Figure 6.5: Complete preparation for measurement

Now you have to switch on your GeoSeeker Mini as follows:

1. Connect the Power Pack with the approriate socket. While pushing the plug into the socket turn the plug around until it slips in.

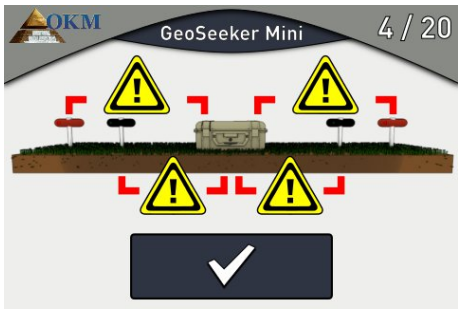
2. After switching on the Power Pack itself, the GeoSeeker Mini will be powered on too. After a short while, you should see the main menu in the display.

After all the equipment has been prepared and the GeoSeeker Mini has been powered on, you can start to process the measurement according to the instructions of chapter 5.1 “New Measurement” on page 22.

Under certain conditions the control unit might display some warnings or error messages during the measurement:

- **Power induction failed**
  If this screen appears the device can not inject power into the underground. Please check all connections and make sure there are no cable breaks or unconnected plugs.
  Then try again to measure the current scan point.

- **Voltage failure**
  If this screen appears the device cannot measure any voltage between the electrodes. Please check all connections and make sure there are no cable breaks or unconnected plugs.
  Then try again to measure the current scan point.



- **General measurement error**
  Under extreme conditions it might be possible that your device is not able to induct enough power into the underground. After several trials the device will abort the current scan and will show this screen.

  You should replace the power electrodes for at least 1 - 2 meters and try again. Alternatively you can try to water the electrodes to get better electrical contact to the surrounding soil as explained in section 8.3 on page 52.

Chapter 7

Analyzing a Measurement

In this section you will learn how to analyze a measurement by using the Android application.

While scanning an area you will see the measured values (power, voltage and resistivity) of the current scan point on the display of the control unit. Based on that values you can make first conclusions about your scan field conditions.

You always have to take the following aspects into your considerations:

- You always have to inform yourself about the geological structures in your area to know about the underground conditions.
- Soil composition, ground moisture and temperature are influencing the soil resistivity. Soil is rarely homogeneous and the resistivity of the soil will vary geographically and at different soil depths.
- Very low resistivity values are indicating a good conductance, which could indicate a high probability of water deposits.
- Very high resistivity values are indicating a bad conductance, which could indicate a high probability of cavities.

7.1 Interpretation of scan values

There are 3 basic values indicated after each single scan process. So you will get a rough idea about the underground conditions while scanning the area. The measure values are shown in figure 7.1.

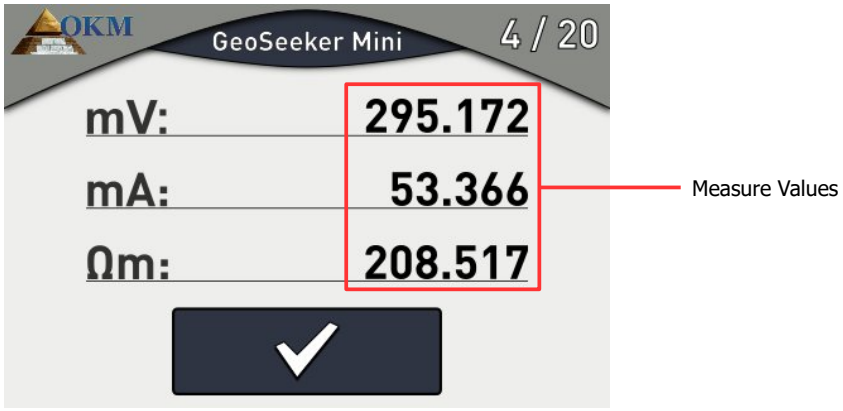


Figure 7.1: Measure values as indicated during a measurement

The available measure values are:

- **Voltage (mV):** The voltage is measured in Millivolt (mV) and indicates the potential difference measured by the voltage electrodes.
- **Power (mA):** The power is measured in Milliampere (mA) and indicates how much electrical current has been injected into the underground through the power electrodes.
- **Resistivity (Ωm):** The ground resistivity is measured in Ohm-Meter (Ωm) and indicates the resistance of the underground at the current scan point and depth. It is mainly calculated by the power, voltage and distance of the electrodes.

The resistivity value is the basis of further calculations concerning underground water deposits and cavities.

If you want to keep the measure values for later calculations, reports or other uses, you have to write it down. You can not access these values later.

7.2 Interpretation of graphical representations

After completing a measurement you can also generate a 2d graphic of the measured values. The graphic is representing the ground resistivity values in different colors, as shown in figure 7.2, to highlight potential places of very high and low conductivity. The color's meanings are:

- **Blue:** This color indicates a high conductivity and a low resistivity as typical for underground water deposits.
- **Yellow / White:** This color indicates a medium conductivity and resistivity as typical for normal underground soil.
- **Red:** This color indicates a low conductivity and a high resistivity as typical for underground cavities or impervious layers.

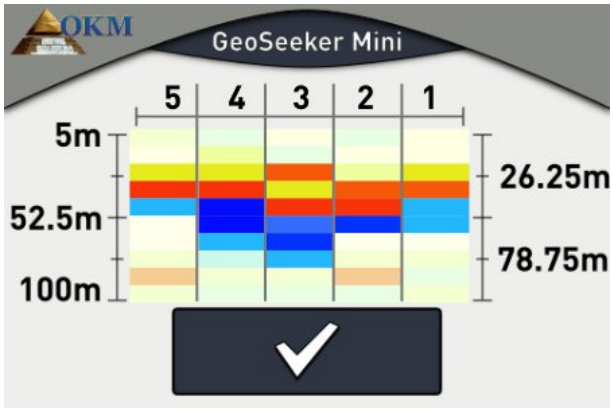


Figure 7.2: Graphical 2d representation of a measurement

After conducting a measurement you will also get some kind of depth estimation. Please keep in mind that the indicated depths are maximum depths only. In most cases the indicated depth is often higher than the real depth might be but it will give you a rough estimation where the objects of your desire may be.

7.3 Examples

Here you will find some additional examples to get a better understanding of possible values and its representation. Please keep in mind that your own measurements may look different than these graphical representation as your local environment, ground conditions and hidden anomalies may be very different too.

7.3.1.1 Water Deposits

The typical color of water deposits is blue. The following 2d graphics are showing an indication of water in the ground.

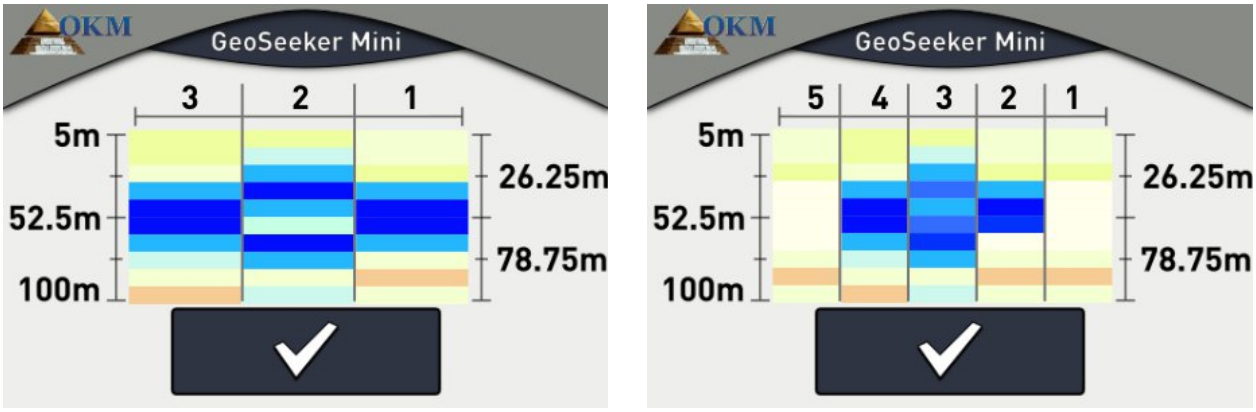


Figure 7.3: Example of a water deposit

7.3.1.2 Water deposits with areas of high resistivity

In this example you will find two different kind of anomalies at the same time. There is an area of high resistivity at the top, shown in red and yellow colors. At the bottom of the graphic there is another area of high conductance (very low resistivity), mostly indicating a high probability of a water deposit.

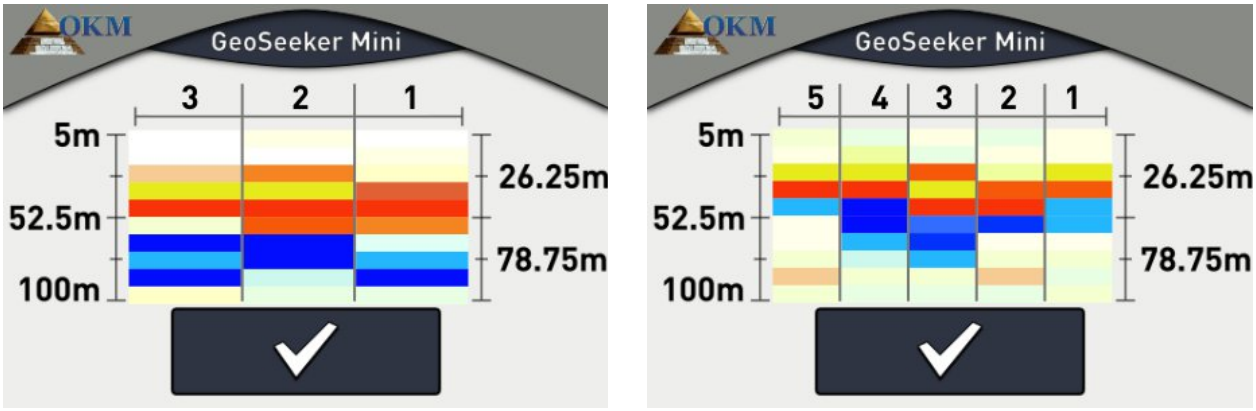


Figure 7.4: Example of a water deposit and barrier

7.3.1.3 Cavities

Underground cavities (if big enough) are typically shown in reddish colors. Cavities have a very high resistivity as long as it has not been refilled with any conductive material.

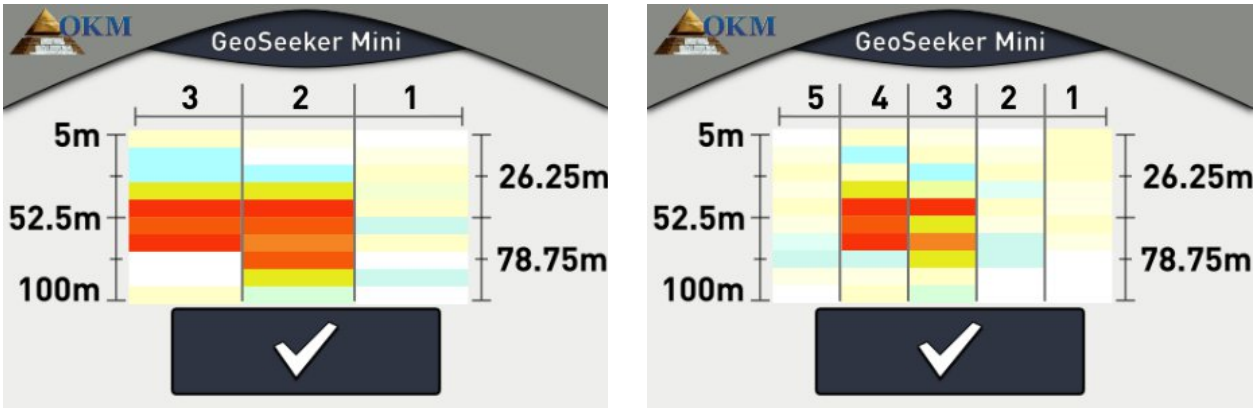


Figure 7.5: Example of a cavity

7.3.1.4 Impervious layers

A typical structure you can see after measuring in mountain areas are impervious layers or barriers under the ground. This layer mostly appears at the transition of loosely soil to massive stone.

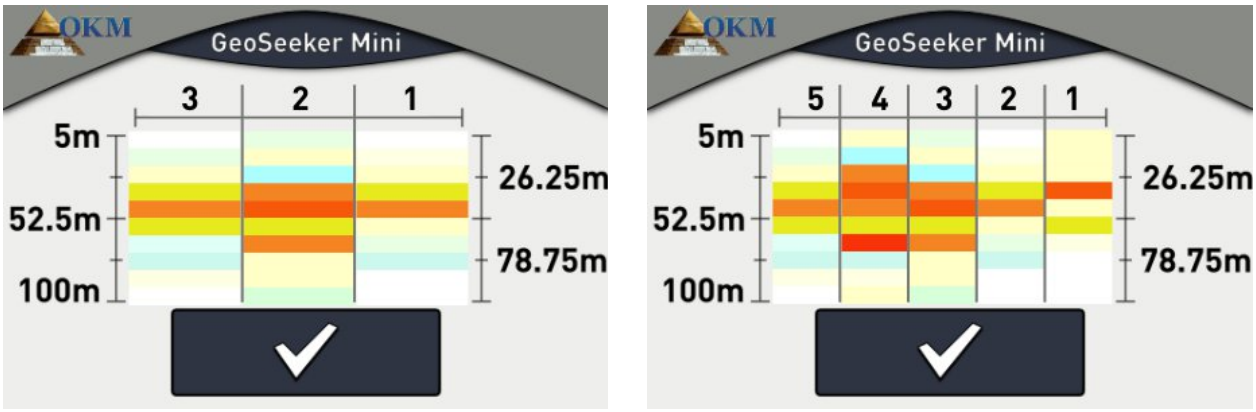


Figure 7.6: Example of an impervious layer / barrier

Chapter 8

Tips and Tricks

In this section you will get some additional tips you should consider during your measurements.

8.1 Improving your scan results

There are some aspects to keep in mind for improving the results of your scanning process. Please pay attention that the electrodes have good electrical contact with the surrounding ground. Therefor it is necessary to put the electrodes as deep as possible into the underground, as shown in figure 8.1.

Figure 8.1: Electrodes need good electrical ground contact

Even if you cannot put all electrodes very deep into the ground all electrodes needs to be placed in the same depth as shown in figure 8.2.

Figure 8.2: Electrodes have to be equally set into the ground

Only then an equal electrical distribution is guaranteed.

8.2 Speeding up your measurement

The electrodes have to be replaced a lot while conducting a measurement. This is really tough when you are operating the device just by yourself. So it is strongly recommended to work in a group of 3 or better 5 people.

8.2.1 Operation with 3 people

The first person is responsible to operate the control unit of the GeoSeeker Mini. Furthermore this person adjusts the inner Voltage Electrodes (black socket).

Figure 8.3: Operating the GeoSeeker Mini with 3 people

The other two persons are responsible for the adjustment of the Power Electrodes (red socket). So each of that two persons has control over a Power Cable Drum. One to the left and the other one to the right. Both persons rearrange the electrodes according to the instructions of the first person who operates the control unit. It is very recommended to use 3 walkie-talkies to give instructions because the distance to the operator can be up to 100 meters (depending on the depth settings).

Make sure each participant knows about the possible danger of high voltage.

8.2.2 Operation with 5 people

This situation is similar to the previous one but there are two additional persons responsible for the Voltage Electrodes (black socket) which are connected to the control unit.

Figure 8.4: Operating the GeoSeeker Mini with 5 people

So finally there is one person per electrode and the operator of the control unit is only giving instructions and takes care about the whole scanning process.

Make sure each participant knows about the possible danger of high voltage.

8.3 Measurements under tough soil conditions

Some environmental conditions make it really hard to conduct a resistivity measurement. There can be really tough situations like

- very dry soil or sand and
- very hard rock.

But there are also some ways to measure the ground resistivity in that kind of environments.

Sometimes it is not possible to push the electrodes into the ground with bare hands. Then you should use a hammer. But on really hard rock even that is not possible and you need more helpful tools like a drilling machine. First drill a hole into the hard underground before placing the electrode. After that the hole needs to be refilled with wet sand or other good conductive soil to create a good electrical contact to the surrounding environment as shown in figure 8.5.

Figure 8.5: Drilling a hole and refilling it for the electrode

If you are working on really dry soil like sand you should use some water (better salt water) and just give a little splash (small cup) over each electrode shaft to improve the electrical ground contact. You have to assure that you water all electrodes with the same amount of water. This procedure has to be repeated each time after replacing the electrodes.