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Research paper

Practical aspects of field work carried out by Electrical Resistivity Tomography

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Abstract: The following article collects and describes several practical problems that can be encountered when performing geophysical field measurements using the electrical resistivity tomography (ERT) method. The methodology of work carried out with the Terrameter LS apparatus of the Swedish company ABEM (currently the company has changed its name to GUIDELINE GEO) was presented and discussed. The attention was paid to interesting solutions that increase the efficiency of works, especially in works related to linear investments. Errors that may appear during the use of the roll-along method are indicated, in particular, those appearing in measurements where too long measurement sections are transferred, as well as problems resulting from high electrode earthing, nonlinear profile traces and variable morphology. It describes how the use of different measurement systems affects the depth of prospecting, and which systems cope well in the area with disturbances. The article also emphasizes that the work should be properly planned before starting field research.

Keywords: ABEM, Electrical Resistivity Tomography, ERT, geophysical field measurements, measurement systems, Terrameter LS

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1. Introduction

Traditional resistance measurements are made by performing vertical electrofusion soundings (VES) [1] or electrofusion profiling (PE) [2]. Due to the fact that the electrofusion tomography (ERT) method was developed at the latest, it is classified as a new method, currently developing very dynamically. This method has gained great popularity, both in Poland [3–5] and abroad [6, 7], as evidenced by numerous geological and hydrogeological studies in which it is used [8–10], as well as numerous publications describing the method and the results of works with its application [11–16].

In Poland, in recent years, the newly created or updated instructions and guidelines also recommend the use of this method. An example here is the new Polish State Railways guidelines [17], Ordinance No. 22 of the General Director of National Roads and Motorways of June 27, 2019 on the introduction of "Guidelines for the performance of soil tests for road construction" [18], in which ERT tests are required. Also in the case of methodological publications, such as the Principles of Geological and Engineering Documentation [19] it is recommended to perform geoelectric surveys in the ERT variant.

Electric resistivity tomography is currently used in many fields of geology, i.e. geological mapping, deposit geology, engineering geology, geohazards, hydrogeology and environmental protection [6, 20–23]. One of the reasons for the high popularity of geoelectric research, alternative to e.g. seismic research [24] or GPR investigations [25], is undoubtedly the fact that soil resistance is a complex parameter, depending on many factors and processes, e.g. temperature, water content and its quality, presence of chemical compounds, porosity and permeability, lithology and soil mineral composition. Resistance values can vary within a very wide range, from one ohm in saline formations to tens of thousands of ohms, e.g. in granites. On the one hand, this means that we can deal with the ambiguity of interpretation, on the other hand, it allows the method to be used in many areas of geology, while solving many research problems.

2. Development of the ert method and specificity of field works

With the development of computers, and especially processors, there has been a significant increase in computing power, with the simultaneous miniaturization of devices for data acquisition in the field. In just the last dozen or so years, the progress in the development of equipment for electric resistivity tomography has been very visible. Every few years, new generations of equipment appear on the market, which bring a number of improvements and increase the quality of research. New filters are used, which remove interference more and more effectively, new generation cables with better parameters appear, and the power of the apparatus is increased. It also increases the considerable amount of data that is obtained when measuring in a short time. The latter element was a milestone in the development of the ERT method [26]. All these elements made it possible to more and more accurately reproduce the geological model of the medium through the geoelectric model.

In order to achieve a good representation of the model of the geological structure of the medium, by visualizing changes in the resistance value on geoelectric cross-sections, good coverage of the entire studied space with high-resolution data is required. A large number of measurement points is closely related to the time of work in the field, therefore, often compromises are made to measure as much data as possible in the shortest possible time. This issue seems to be extremely important in all kinds of commercial works, where the scope of works is often large (it can be tens of kilometres of geophysical profiles).

Various measuring systems are used during field measurements. These systems can be divided into the classic ones (known for many years, e.g. the Wenner system) and those whose development came along with the development of new measurement techniques, e.g. multi gradient, a system designed for multi-channel measurements, significantly accelerating the work. Much information can be found, for example, in the article [26] on the subject of measurement systems, their applicability, advantages and disadvantages.

Before starting field investigations, the technique of performing the works is often analysed, i.e. the selection of the appropriate measurement step (distance between successive electrodes, the element related to the research resolution), determination of research prospects, the possibility of disturbances and the length of the measuring line. All these elements must be adapted to the purpose of the research.

In particular, the minimum and maximum depth of prospecting should be analysed, and in the case of using the roll-along method, also what is the distribution of measuring points and what is the depth of the zone in which there is a continuous coverage of the space with data, in relation to the research depth that can be obtained from the basic length of the measurement line and the adopted geometric system.

Roll-along method can be used if the profile length is not sufficient to perform measurements using one standard set of cables (this length can be defined as the basic measurement line). The term itself means an action that takes place after measuring all data points using the original cable layout. Then one cable (the first in the spacing) is moved to the end of the entire span (Fig. 1). As the extended cable now has a new position, you can take

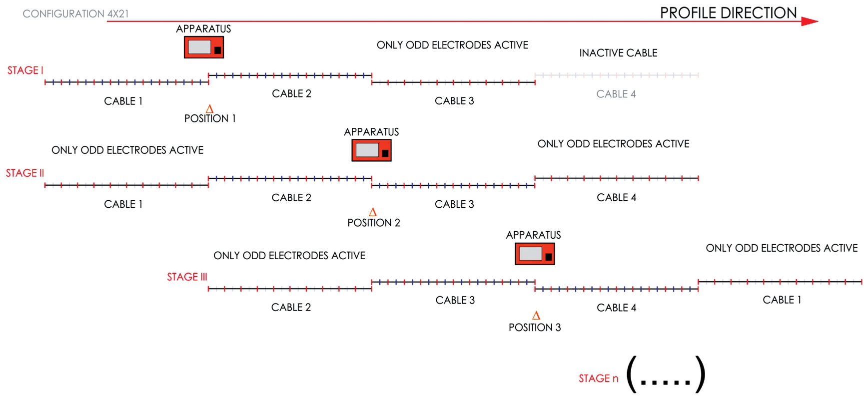

Fig. 1. Scheme of the measuring system for the Terrameter LS apparatus, 4 × 21 configuration, roll-along method (based on ABEM training materials; instruction for the Terrameter LS apparatus [27])

measurements at new points. The roll-along method can be used once or as many times as needed to obtain the desired profile length.

Profiles with roll-along usage usually should not be shown with data at the greatest depths, as they will contain zones with no data. It is assumed that continuous data coverage occurs only up to the range of 75–80% of the maximum depth and it mainly depends on the length of the transferred cable. The use of the roll-along technique becomes practically indispensable when performing works for linear objects.

3. Analysis of the methodology of field work on the example of the terrameter LS apparatus

The authors' experience shows that not all devices allow for the optimization of working time and the amount of obtained data, especially in tasks with a large scope of field work. The solutions adopted by the producers differ from each other. On the example of the Terrameter LS apparatus, it can be seen that the creators of the device have solved the optimization of field work in a very interesting way.

The following cable configurations are most often used in these tests: 2 × 21, 2 × 32, 4 × 21 and 4 × 16 (the first digit indicates the number of cables in the basic measurement system, the second digit indicates the number of active channels in a multi-core cable). The most popular configuration recommended by the manufacturer is 4 × 21.

The apparatus allows you to perform measurements for 64 active channels. For this number of active channels, the natural configuration of the cables is 2 × 32 (Fig. 2). The system works symmetrically, so we can unwind the cable with 32 outputs on the left side of the apparatus and 32 on the right. This gives us the ability to connect 64 electrodes. It should be noted that the equipment is always in the middle of the profile line. On the cable, each connector (electrode connection point) has its own number and the measurement is performed from the connector with the number 1 towards the increasing numbers. The cable cannot be distributed arbitrarily, it must always be distributed in the direction of increasing numbers in the direction in which the measurement takes place.

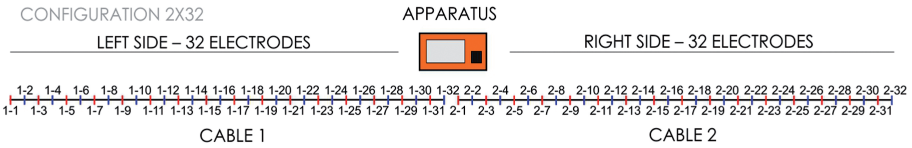

Fig. 2. Scheme of the measuring system for the Terrameter LS apparatus, 2 × 32 configuration (based on ABEM training materials; instruction for the Terrameter LS apparatus [27])

However, this solution is not optimal, as will be shown in a moment, so a different system was used, namely cables with 21 active channels were designed.

The measuring set consists of 4 basic cables and is called 4 × 21. On the left side of the apparatus, there are 2 cables (the cables are connected with each other with a special multi-wire connector – popularly known as a barrel). On the right side there are also 2 cables connected in an identical way (Fig. 3).

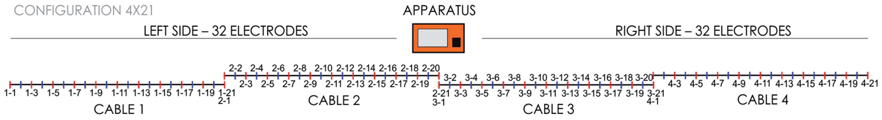

Fig. 3. Scheme of the measuring system for the Terrameter LS apparatus, 4 × 21 configuration (based on ABEM training materials; instruction for the Terrameter LS apparatus [27])

Thanks to this, the measuring system, after disassembly, consists of 84 electrodes, with 64 active channels. Due to the fact that the apparatus works with only 64 active channels, for measurement only odd electrodes are taken on the first and the last cable. One more element of such a solution should be noted: the last and the first electrodes on adjacent cables are connected to the same active channel.

If you want to make a longer profile than it results from the arrangement of 4 cables, you should move the cable from the beginning to the end of the set – this cable placement is called roll-along and was already described (Fig. 1).

Moving the cable from the first position to the last one makes it possible to make longer, continuous profiles. This method, however, has a certain disadvantage, because places without data appear on the ERT cross-section when moving the cables (Fig. 4).

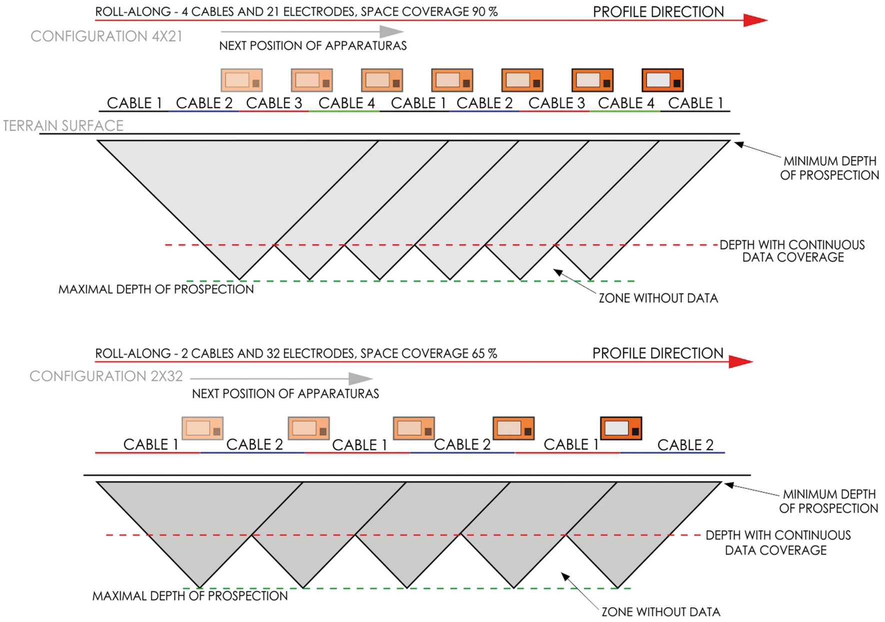

Fig. 4. Data coverage of the space under the ERT profile line for the roll-along method for 4 × 21 and 2 × 32 configuration (based on ABEM training materials; instruction for the Terrameter LS apparatus [27])

When analysing the geoelectric cross-section obtained in the ERT method (Fig. 4), it is possible to distinguish 3 zones in the cross-sectional plane, different due to the data coverage. Figure 4 shows a graphical comparison of how the space under the ERT profile is covered with data during measurements with the 2×32 and 4×21 configurations. From the top there is a zone in the cross section where there is no data. We are talking about the minimum depth of prospection, which depends on the spacing of the electrodes and the geometric arrangement (the general rule is that the greater the distance between the electrodes, the zone will be deeper). Below, in the ERT cross-section, there is a zone in which the data coverage is fairly even, the amount of data will depend on the spacing of the electrodes and the geometric arrangement that will be used. In the lower part of the ERT cross-section, when we apply the roll-along method, zones with no measurements will appear. The size of the zones without data will depend mainly on the length of the cable that is shifted. Cables with too many electrodes create vast zones without data, which can later lead to numerous errors in the data processing and interpretation of test results. A sensible solution then seems to manually "cut" the cross-section to the depth to which there is even data coverage. However, as can be seen when analysing the data in Table 1, the resulting data acquisition depth is much shallower. Table 1 presents the values of the minimum depth, i.e. the depth to which we have continuous data coverage, and the maximum depth of prospecting for 4 geometrical systems: Wenner, Schlumberger, gradient, dipole–dipole, in relation to three different cable configurations used in the Terrameter LS apparatus system, i.e. 2×32, 4×16 and 4×21 [28].

Table 1 summarizes the data for 3 different electrode spacings, i.e. 2 and 5 meters. All calculations are based on the mid-depth examination ([29]; Table 2).

Table 1 shows that there are clear differences in the depth of prospecting for zones evenly covered with data depending on which cables will be used in the roll-along method. For example, for the Wenner system in the 2×32 configuration, the difference between the maximum depth and the zone of continuous coverage of the cross-section with data is twice as large.

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The resolution of the method is related to the distance between successive electrodes, as well as the geometric system used. The depth, in turn, depends on the spacing (distances between each other) of the current electrodes and the selected measuring system. The following presents the dependence of the depth of the prospecting obtained for several popular geometric systems in relation to the length of the ERT profile (Table 2). For example, for the L-length profile, the depth range is 18% for the Wenner system, 19% for the Schlumberger and gradient, and 23% for the dipole–dipole [29, 30].

Table 1. Dependence of the depth of prospecting on measuring steps and applied geometrical systems on the example of the Terrameter LS apparatus

Elektrodes spacing	Geometrical array	Cable configuration	Minimum depth of prospection [m]	Depth of even data coverage [m]	Maximum depth of prospection [m]	Length of basic measuring line	% range of depth for measuring basic line	% range of depth with continuous data coverage
2	Wenner	2 × 32	1	11	22	126	17%	9%
		4 × 16	1	16	22	126	17%	13%
		4 × 21	1	21	28	160	18%	13%
	Schlumberger	2 × 32	1	12	24	126	19%	10%
		4 × 16	1	18	24	126	19%	14%
		4 × 21	1	23	31	160	19%	14%
	Gradient	2 × 32	1	12	24	126	19%	10%
		4 × 16	1	18	24	126	19%	14%
		4 × 21	1	23	31	160	19%	14%
	Dipole–Dipole	2 × 32	0.8	14	28	126	22%	11%
		4 × 16	0.8	21	28	126	22%	17%
		4 × 21	0.8	27	36	160	23%	17%
	Pole–Dipole	2 × 32	1.8	23	45	126	36%	18%
		4 × 16	1.8	34	45	126	36%	27%
		4 × 21	1.8	43	58	160	36%	27%
5	Wenner	2 × 32	2.6	27	54	315	17%	9%
		4 × 16	2.6	41	54	315	17%	13%
		4 × 21	2.6	52	69	400	17%	13%
	Schlumberger	2 × 32	2.6	30	60	315	19%	10%
		4 × 16	2.6	45	60	315	19%	14%
		4 × 21	2.6	57	76	400	19%	14%
	Gradient	2 × 32	2.6	30	60	315	19%	10%
		4 × 16	2.6	45	60	315	19%	14%
		4 × 21	2.6	57	76	400	19%	14%
	Dipole–Dipole	2 × 32	2.1	35	71	315	23%	11%
		4 × 16	2.1	53	71	315	23%	17%
		4 × 21	2.1	67	90	400	23%	17%
	Pole–Dipole	2 × 32	4.4	57	114	315	36%	18%
		4 × 16	4.4	85	114	315	36%	27%
		4 × 21	4.4	108	144	400	36%	27%

Table 2. List of 6 popular geometric systems and their depth range [29]

Geometrical layout ‘L’ length profile	Prospection depth
Wenner	0.18 L
Schlumberger	0.19 L
dipole–dipole	0.23 L
pole–dipole	0.3–0.35 L
pole–pole	0.45–0.5 L
gradient	0.19 L

However, it should be remembered that the values presented in the Table 2 refer to the maximum depths that are obtained for one or several points and this does not correspond to the entire space under the ERT profile. It seems that it is better not to say about the maximum prospection but about the one for which the measured space is covered fairly evenly with the measuring points (Table 1, column: depth of even data coverage; Fig. 4).

As already mentioned, when planning a study, the method of performing the measurements should be planned in detail, as this may lead to serious errors in the process of interpreting the test results. It is also worth mentioning here that there is a view that too much data may also lead to problems with matching the model to real data [26]. A large number of measured points may increase the difficulty in achieving a good fit of inversion data and possibly increase the number of artifacts due to unknown characteristics of noise [31].

On the example of the analysis of measurement protocols used in the Terrameter LS apparatus, it can be seen that for some measurement systems, the protocol does not include all the combinations of measurements that would result from the number of electrodes. There are several reasons for this, and one of the main reasons is the time and economy of the research. The measurement points were selected in such a way as to optimally cover the tested area with them, while performing the tests relatively quickly. In order to effectively and efficiently use appropriate measurement systems and adequately efficient conduct data acquisition in the field. Companies offering ERT measurements use different solutions, consisting of different times of a single measurement (pulses), different configurations of cables, measuring systems, etc.

In practice, when performing field tests, we can expect that the test results may be burdened with numerous errors. These errors can come from, for example, disturbances from the infrastructure, they can be the sum of various elements, including the geology itself [32]. One of the most unfavourable areas for field research are those with dry sands on the surface, which in many cases make it impossible to make correct measurements and this often leads to numerous errors that cannot be eliminated. The main reason for this is a decrease in signal strength and the associated low electricity values that are received by the potential electrodes. Unfortunately, in such a case we deal with the lack of repeatability of the measurement result, despite the fact that most of the devices are equipped with the functions of combining several measurements and taking the mean from them, with a defined and acceptable measurement error.

It is also worth referring to the results of research presented by Dahlin and Zhou [26]. The results of their research show that for the analysed cases for different disturbances, individual measurement systems are differently exposed to those disturbances. This is important information because it can lead to conclusions that in a given place or for given geological conditions, the choice of the measurement system is extremely important. Moreover, their paper presents the conclusions that Wenner and multi gradient systems are least exposed to random disturbances, which means that in places where disturbances can be expected, it is the use of these systems that can give the best test results. Choosing the right measurement system, often overlooked in research planning, seems to be an important element for several reasons. The first reason is the disturbance mentioned above, and the next ones are: selection of the appropriate resolution, depth and speed of data acquisition.

In the literature, you can find several studies on the characteristics of individual geometric systems [26, 30, 31, 33]. In short, it can be said that the most popular are the Schlumberger (SC) system or the combination of Wenner–Schlumberger (WN–SC), Wenner (WN) dipole–dipole (DD), pole–dipole (PD), gradient (GD). The (WN) and (SC) systems are characterized by similar capabilities when it comes to imaging geological structures, except that (WN) is less susceptible to interference, but at the same time we obtain lower imaging resolution. These systems also have a good signal-to-noise ratio, which in turn is important for measurements made at greater depths. Undoubtedly, the disadvantage (in terms of the efficiency of field work) of the (SC) system is the large number of measurements and the low time efficiency of the tests.

(DD) is a system which, on the one hand, has a greater depth range than the previous ones, has a higher resolution and can accurately reproduce the geological structure, in particular vertical changes (faults, vertical geological boundaries), but is nevertheless exposed to disturbances. Unfortunately, the signal quality for this system is very poor. This leads to many errors, both in measurements and in subsequent interpretation. The advantage of (DD) system is the ability to perform measurements in a multi-channel variant. This system is also highly susceptible to 3D geology changes, much more so than other measurement systems [26, 34]. Interestingly, Dahin and Loke [34] do not recommend using this circuit for N greater than 6 (N – and potential electrodes receiving the current from the medium) as it causes a very strong signal-to-noise decline.

An interesting system seems to be the gradient system (GD), recommended for use in multi-channel measurements. The Terrameter LS apparatus uses this system to perform tests for 12 active channels (depending on the type of apparatus used). This system can be characterized as efficient, effective, with good resolution, giving a good representation of the geological structure in the geoelectric model.

Due to the fact that in relation to such systems as Wenner, Schlumberger or dipole–dipole, this system is less popular, its short characteristics are presented below.

Measurements with the use of a gradient system (GD) consist in using a pair of external electrodes (electric current electrodes) in the measurement to “inject” the electric current into the tested medium (similarly to the Wenner or Schlumberger system) and several pairs of internal electrodes (this is the greatest advantage of this system, significantly accelerating field work) to measure the potential which is the response of the medium to a given electric current (potential electrodes). This system is therefore multi-channel, which means that during one cycle we have the possibility of receiving a signal through several pairs of potential electrodes. Traditional gradient measurements (mainly used for single-level profiling) often included electric current electrode measurements at only one fixed location. Multiparameter gradient testing uses a large number of electric current electrode combinations, selecting an electrode array with several different spacing and separations (*S-factor)*, similar to multiple electrode measurements with other electrode arrays.

It can be seen that the gradient system is a combination of different layouts. It will be primarily a combination of the characteristics of the pole–dipole and Schlumberger systems. Depending on the position of the electric current and potential electrodes, there is a similarity to the pole–dipole system (Fig. 5, large *S-factors*, small *N-factors*) or Schlumberger (*S, N factors* in the middle). Thus, it can be seen that the gradient system will combine the characteristics of the dipole system and the Schlumberger system, but there is no need to use a remote electrode in it, which can be disruptive in some terrain conditions [35].

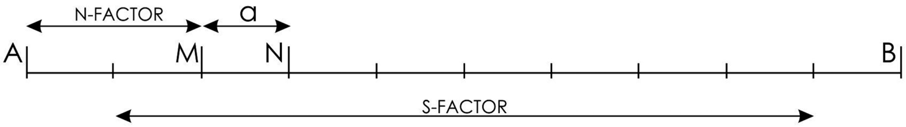

Fig. 5. Sketch of the gradient system showing the position of the electrodes during measurements with the coefficient S = 8 and N = 2 ([36] – modified). AB – supplying electrodes, MN – potential electrodes receiving the current from the medium

4. Negative resistances

High values of electrode grounding resistance values (this problem is commonly referred to as “weak/grounding” of electrodes) are undoubtedly one of the more serious problems that are encountered especially in research, e.g. in the Polish lowlands, in areas where there are dry sands on the surface. This problem mainly concerns forest areas (often covered with pine trees), completely devoid of moisture on the surface. As already mentioned, high values of grounding lead to a situation in which the electric current gets deeper into the medium only in a small fraction (or not at all due to insulation such as dry sand and the lack of ionic conductivity) in relation to what the converter sends. As a consequence, potential electrodes get very poor readings, often less than noise and interference, and the results are not repeatable. Additionally, as a result of charges remaining on the electric current electrodes, a polarization is created and this leads to, for example, obtaining negative values in the measurements (these are the so-called “negative data”). The cause of negative results may also be moisture in the connectors of multi-core cables, damage to the ends of cables or collectors, or leaky insulation of cables. These symptoms often appear during measurements on a rainy day, when the cables are wet and the air is characterized by high humidity (an interesting fact is that taking measurements in fog also leads to many negative resistances). Most manufacturers recommend that you test the cabling periodically to catch any cabling damage.

High values of electrode grounding resistance can be one of the main causes of measurement errors and poor data quality. In such cases, it is recommended to improve the electrode grounding. This can be done in several ways [37]. Typical methods include irrigating the ground where the electrodes are inserted (salt saturated waters are often used to further reduce soil resistance), parallel connection of several electrodes, or simply a stronger (deeper) electrode insertion. The authors' experience shows that the latter method is better in the case of ERT, as water with brine may lead to polarization effects. Most modern devices today are equipped with testers that allow you to measure the value of electrode grounding before starting the measurements, as well as monitoring the grounding during measurements (it may happen that during data acquisition, e.g. the electrode is disconnected from the cable). The record of the grounding values of individual electrodes can be traced in graphs, in real time in the field or later during the interpretation process. This can be useful information about the near-surface geological structure. An example in Fig. 6 shows what a illustrative file with electrode grounding values looks like. The places where the resistance values of the electrodes are very high are marked in red. In these places, the electrodes should be better grounded so as not to cause later errors during the test. Depending on the apparatus, these values may be different, in which case it is best to follow the recommendations of the apparatus manufacturer. In the case of Terrameter LS devices, grounding values above 5000 Ωm are considered as bad ones and electrodes with such values should not take part in the measurements. An additional possibility of previewing a cross-section (pseudo-section) makes it possible to check the quality of data in the field (Fig. 7).

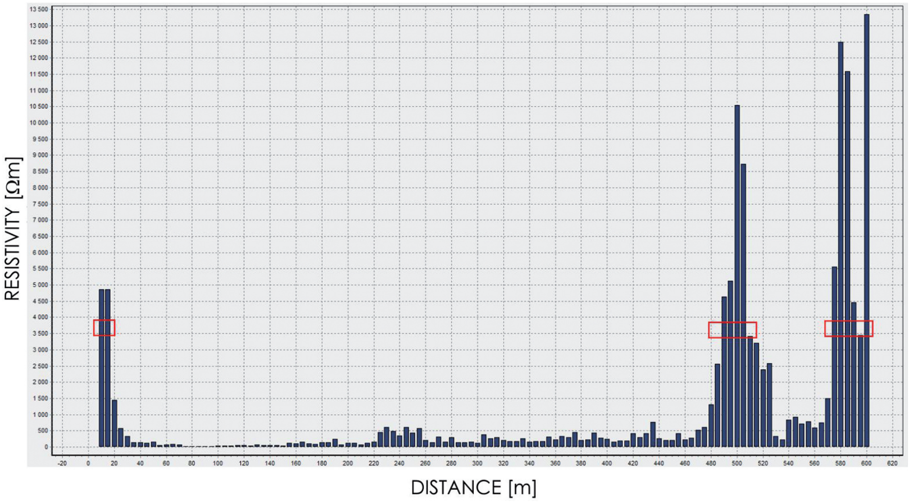

Fig. 6. An example of viewing the resistance of individual electrodes on the ERT profile (ABEM Terameter LS apparatus)

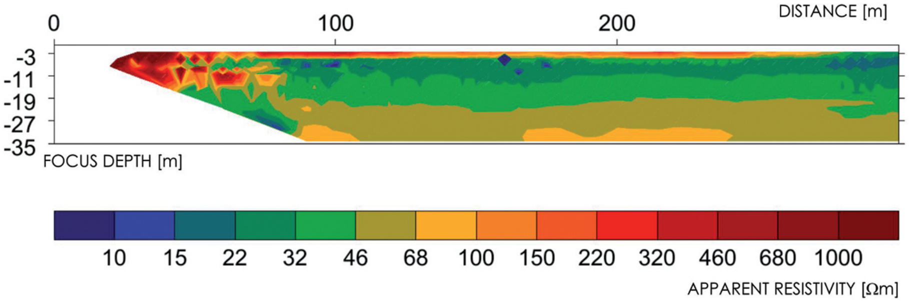

Fig. 7. An example of a preview of a pseudo-section during field measurements (ABEM Terrameter LS apparatus)

Figure 8 shows how the grounding resistance of an electrode changes with increasing its depth in the ground (sandy medium with an average resistance of 100 Ωm; steel electrodes, 1 cm in diameter). Subsequent measurements of the electrode grounding resistance after the electrode penetration by 10 cm in the soil show how the grounding resistance drops.

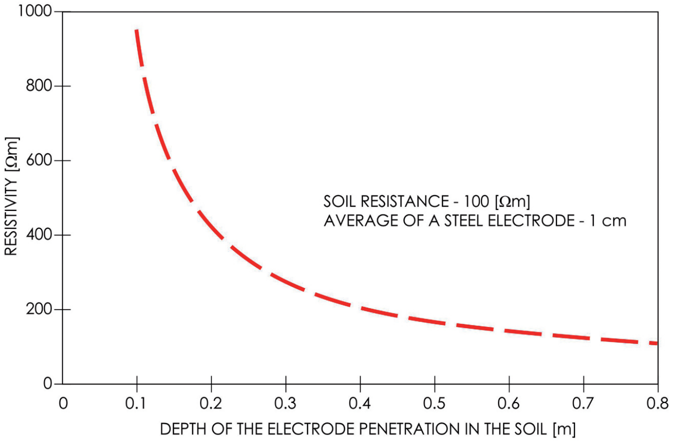

Fig. 8. Graph of changes in the resistance of the steel electrode immersed in the ground by 0.1 m (based on ABEM training materials; instruction for the Terrameter LS apparatus [27])

In some geological conditions the material near the surface is loose or coarse (electrode contacts are poor), using water to improve contact is ineffective as the water drains off quickly. In such cases, it is necessary to use something that keeps the moisture in place for the duration of the measurements. This may, for example, be a bentonite fluid or locally available clay. Generally, it is not recommended to accept negative data, if possible, improve the electrode grounding or switch off the electrodes that cause negative data, sometimes in this case it is also worth considering changing the measuring system to one that gives a better signal or is more resistant to interference .

Performing measurements in an urbanized area, where there may be cables, pipes or other infrastructure elements in the ground, often leads to numerous measurement errors. The urban environment is, in many cases, not a good place for the ERT method.

The quality of measurements may also be indirectly influenced by weather conditions. Rainy, humid weather is not conducive to research. Short-circuits can form on cables, which will result in the possibility of recording negative data, and in extreme cases, short-circuits on the measuring line, which may even damage cables or equipment.

High temperatures and sun can negatively affect the stability of the device, when the equipment heats up or overheats, which causes problems with the operation of the processors inside the equipment. These problems were described in the article [38], where the heating of the apparatus resulted in forcing the measurement to be stopped. It is recommended to protect the equipment from the sun as much as possible, e.g. by covering it with an umbrella.

In winter conditions, at low temperatures (below zero), there are problems with the frozen ground, which makes it difficult or impossible to insert electrodes in the ground. Frozen ground may be one of the main limitations for testing with this method in winter. In addition, negative temperatures slow down the operation of the apparatus (Terrameter LS shows a significant slowdown in operation) and frequent damage to the cables (mainly plugs, as well as cracking of the insulation on the cables).

The new generation of equipment also allows you to trace the data quality in relation to the number of stacks, the size of the current intensity or the average standard deviation for the data. In addition, the test results are given without the geometric coefficient K, which allows you to make topographic corrections (you can measure geodetic spatial position of each electrode with high accuracy and then make corrections to the data, recalculating the values of apparent resistances).

5. Conclusions

Performing field work is one of the most important stages in the process of documenting geophysical surveys. During these works, as described in this article, we can encounter many situations that reduce the quality of data obtained during the measurement. Therefore, the operator must make every effort to ensure that the data quality is the best possible. The cases described in this article, which may lead to a reduction in data quality, do not exhaust all the possibilities – they only show some of the problems that we may encounter during the work. The operator's experience, high-quality measuring equipment, cable diagnostics are the elements that will most effectively eliminate errors during measurements.

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Praktyczne aspekty prac polowych wykonywanych metodą tomografii elektrooporowej

Słowa kluczowe: ABEM, ERT, geofizyczne badania terenowe, systemy pomiarowe, Terrameter LS, tomografia elektrooporowa

Streszczenie:

W niniejszym artykule zebrano i opisano kilka praktycznych problemów, z którymi można się spotkać w trakcie wykonywania geofizycznych pomiarów polowych, stosując metodę tomografii elektrooporowej (ERT). Przedstawiono i omówiono metodykę prac wykonywanych aparaturą Terrameter LS szwedzkiej firmy ABEM (obecnie firma zmieniła nazwę na GUIDELINE GEO). Zwrócono uwagę na ciekawe rozwiązania, które zwiększają efektywność prac, szczególnie w pracach związanych inwestycjami liniowymi. Wskazano błędy jakie mogą pojawić się podczas stosowania metody roll-along, w szczególności pojawiające się w pomiarach gdzie przenoszone są zbyt długie sekcje pomiarowe, a także problemy wynikające z wysokich uziomów elektrod. Opisano jak stosowanie różnych układów pomiarowych wpływa na głębokość prospekcji, a także które układy radzą sobie dobrze w obszarze z zakłóceniami. W artykule zwrócono uwagę na to by w odpowiedni sposób planować prace przed przystąpieniem do badań terenowych.

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