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Izlaganje sa znanstvenog skupa

HOW TO REDUCE THE SURFACE INHOMOGENEITY EFFECTS IN RESISTIVITY SOUNDINGS

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A method is shown how to reduce the effect of surface inhomogeneities on the electrical soundings. A third, distant, curent electrode is used in connection with the left, and then with the right standard electrode. The deformation of the sounding curve due to the surface inhomogeneity is corrected by comparison to the non deformed curve obtained for the electrode not crossing the inhomogeneity. In very deep soundings some additional computation is needed.

Ključne riječi: Geoelektrika, Nehomogenost, Otpor, Sondiranje

Prikazana je metoda reduciranja djelovanja površinskih nehomogenosti na električna sondiranja. Koristi se treća, daleka strujna elektroda u kombinaciji najprije s lijevom pa s desnom standardnom elektrodom. Deformacija krivulje sondiranja zbog djelovanja površinske nehomogenosti ispravlja se usporedbom s nedeformiranom krivuljom dobivenom za elektrodu koja ne prelazi preko nehomogenosti. Kod vrlo dubokog sondiranja potrebno je još dodatno računanje.

In interpeting the geoelectrical sounding surves, a homogeneous and horizontally layered underground is assumed. In that case the measured sounding curves are flat, like the theoretically computed ones. However, in the practive the curves are often afected by deformations. The causes can be different: errors in measurements, computing or plotting, imperfect insulations, changes in the ground near the potential electrodes, or the passage of the current electrodes over electrical inhomogeneities at the surface. The first mentioned causes are normally avoided by an experienced operator, but not the inhomogeneities. However, the inhomogeneities can be recognized and their effect corrected by an appropriate arrangement of the measurements (Fig. 1.).

The arrangement is known as a modified Schlumberger array. In addition to the standard measurement of the voltage on MN electrodes and current on A and B electrodes, the current is applied first to A and C electrodes, and further to B and C, the voltage being measured on MN in all the three cases. The electrode C is kept in the direction perpendicular to AB, and as far as convenient. The apparent resistivities are computed according to the formula $\varrho_a = K.V/_I$. When C lies infinity the constant K is double of the AB constant. In the homogeneous isotropic horizontally layered underground all the three sounding curves should be smooth and identical. I have never met a perfectly homogeneous underground, but the soundings in the fig. 2 are the nearest to such a theoretical case.

When an electrode (B in the fig. 3) is passing over an electrical inhomogeneity at the surface or shallow depth, the sounding curve will be deformed for the standard Schlumberger array AB. The deformation will be doubled when one current electrode (B) crosses the inhomogeneity and the other (C) is very far. However the sounding using the current electrodes A and C will produce a smooth curve, since the moving electrode A is not passing over inhomogeneities. The sounding curve AB is than smoothed according to the AC curve.

When both current electrodes pass over various inhomogeneities at different cable lengths (fig. 4), the AB sounding curve has to be smoothed to look on some parts like the AC curve, and on other parts like BC curve. In the case shown in the fig. 4, the cause of the deformations is known on two locations — it is the passing of the electrode over the line water — dry land. It is placed on AB/2 40 meters on the B side and on 100 meters on the A side.

The distance between the center and the third current electrode is usually about three times larger than AB/2. If the sounding are spread on a short distance, one location of the distant electrode C may be used for several sounding stations.

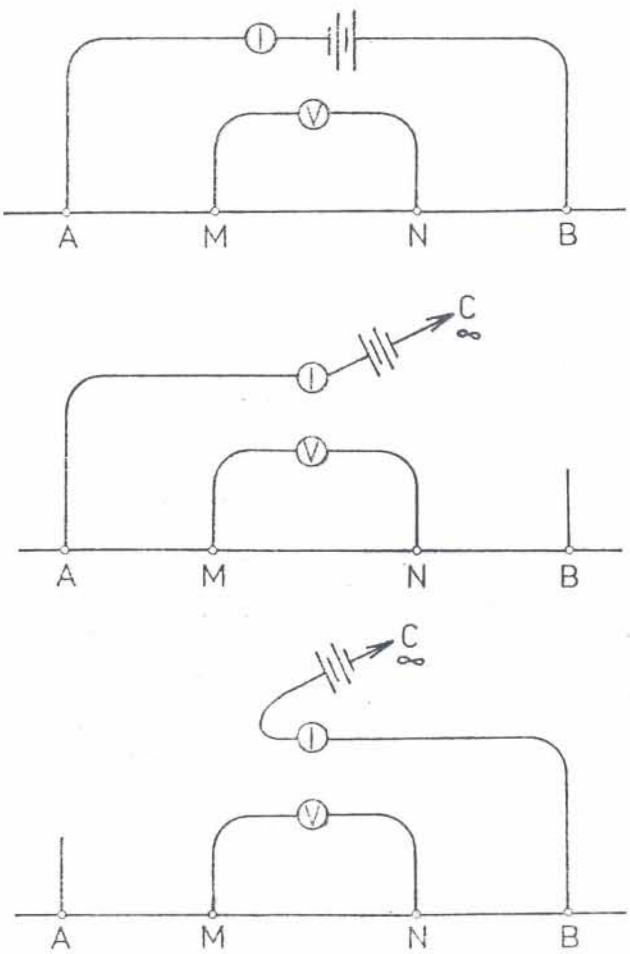

Fig. 1 Modified Schlumberger Array

Sl. 1 Modificirani Schlumbergerov raspored

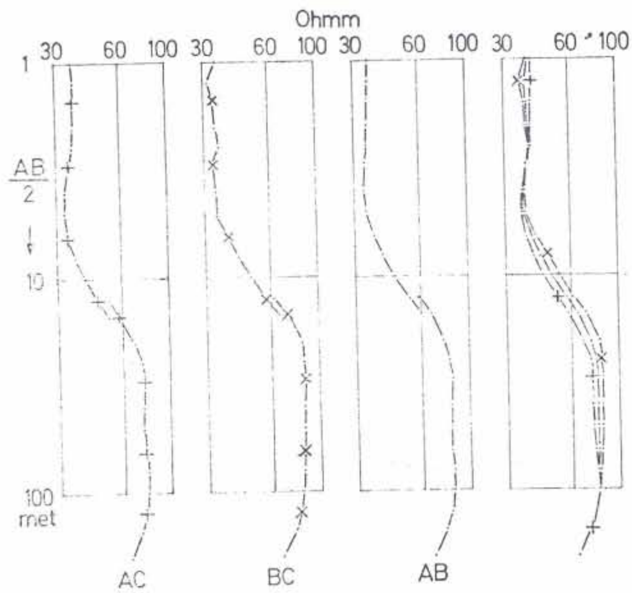

Fig. 2 Resistivity Soundings in a Nearly Homogenoueus Area

Sl. 2 Sondiranje metodom otpora u približno homogenom terenu

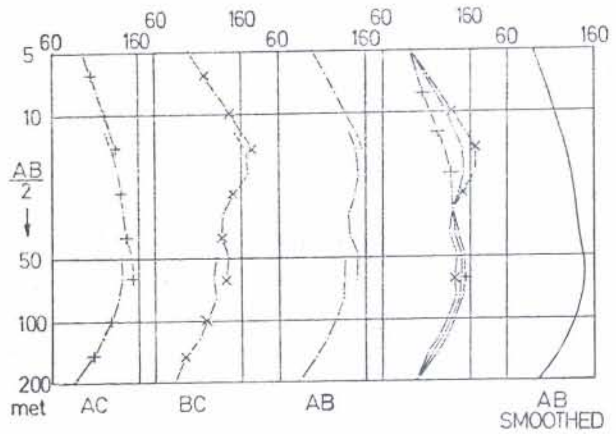

Fig. 3 Smoothing of the Effects of Inhomogeneities at the Electrode B

Sl. 3 Izglađivanje djelovanja nehomogenosti kod elektrode B

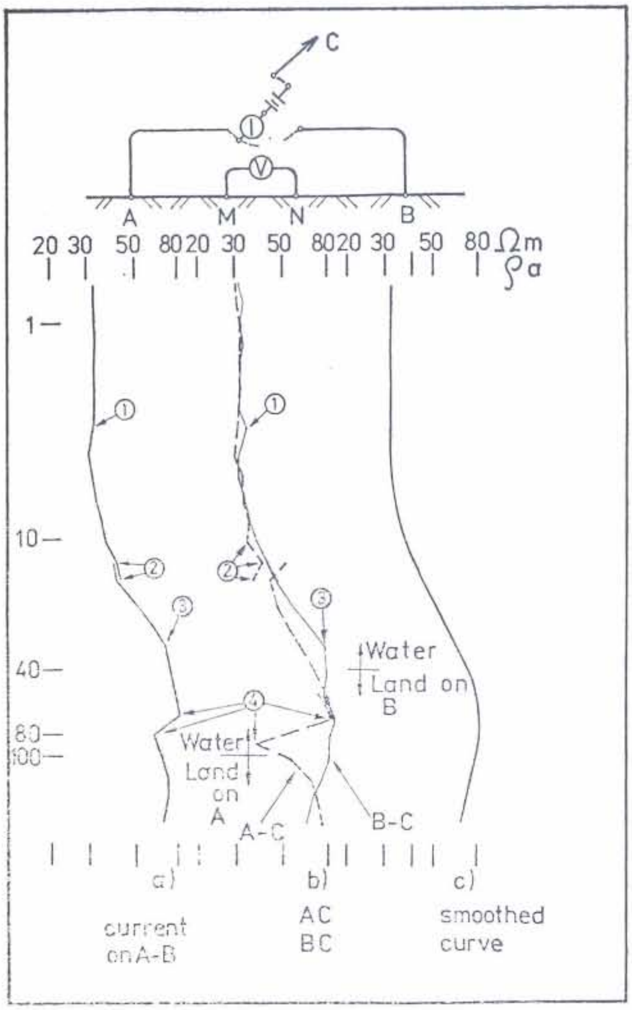

Fig. 4 Smoothing of the Curves, Inhomogeneities on A and B

Sl. 4 Izglađivanje krivulja sondiranja, nehomogenosti na A i B

In deep sounding (several kilometers of AB/2) the use of the third current electrode will be difficult to perform in the way presented. However, we may use a shorter distance to the C electrode in the following way:

It is known, that if the positions of the current electrodes and potential electrodes are exchanged, the measured resistivity does not alter. It is not convenient to do so but it enables an easier explanation of the following:

The fifth electrode should be placed at the electrical zero potential between the inner electrodes (fig. 5). In the homogeneous ground it is on the line of symetry between the inner electrodes. In practice the fifth electrode will be at a certain potential which has to be expressed in milivolts per amper. This potential is the same for all positions of the outer electrodes, as long as the inner electrodes are not moved. We have to find the amount of this potential and to use it to correct all the voltage readings of the same position of the inner electrodes.

The fact, that the fifth electrode is not exactly at zero potential is important only when its potential is large in comparison to the measured potential. In such a case the sounding cur-

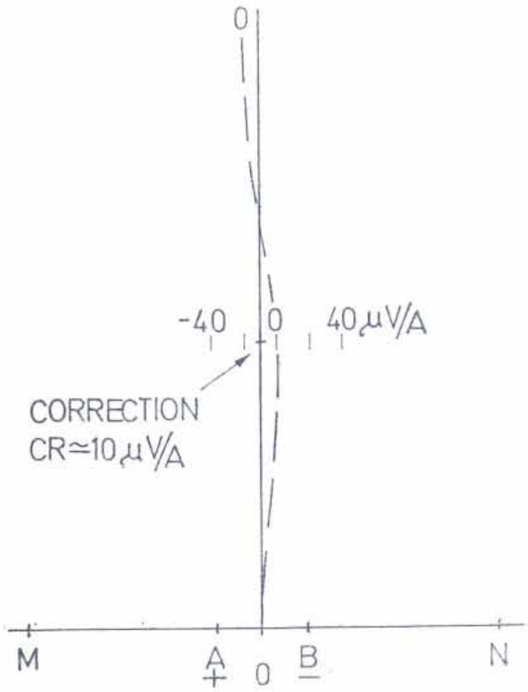

Fig. 5 Electrical Zero-Line and Correlation

Sl. 5 Električna nul-linija i korekcija

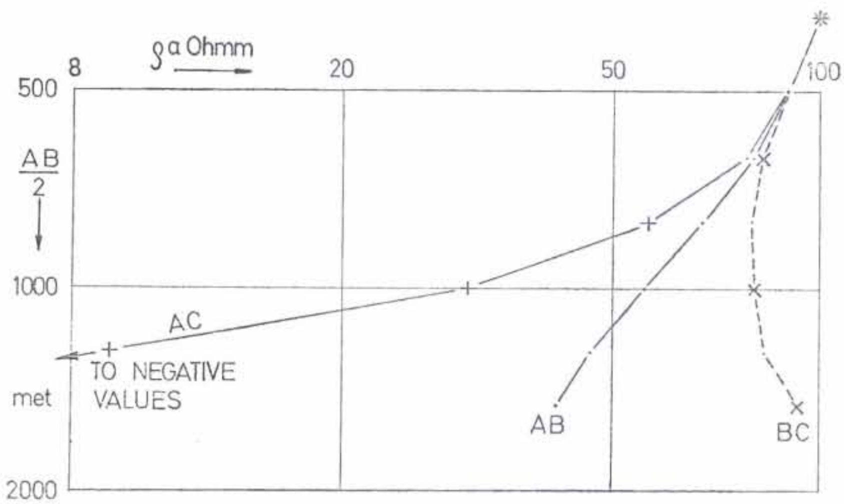

Fig. 6
Deep Sounding without Zero-line Correction

Sl. 6
Duboko sondiranje bez korekcije za nul-liniju

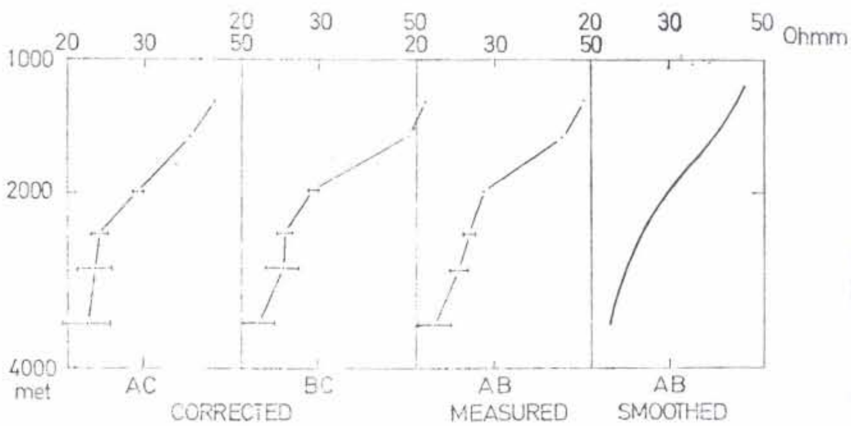

Fig. 7
Deep Sounding, Resistivities and Mean Errors

Sl. 7
Duboko sondiranje, otpornosti i srednje greške

Table I — Correction Computation
Tabla I — Račun korekcije

MN/2 METERS	200
AB/2 METERS	4000
V/I (AC) = (A)	— 0.185 mV/A
V/I (BC) = (B)	0.362 mV/A
V/I aver = (C)	0.088 mV/A
$C = \frac{(A) + (B)}{2}$	
CORRECTION = CR	0.274 mV/A
(CR) = (B) — (C) = (C) — (A)	

Table II — Correction of Resistivities
Tabla II — Korigiranje otpornosti

MN/2 = 200		Correction CR = 0.274 mV/A		
AB/2 Meters		2500	3000	4000
Measured V/I	(A)	—0.032	—0.109	—0.185
Measured V/I	(B)	0.535	0.453	0.362
Corrected V/I	(C)	0.242	0.165	0.089
Corrected V/I	(D)	0.261	0.179	0.088
Corrected ϱ	(E)	23.61	23.22	22.31
Corrected ϱ	(F)	25.46	25.19	22.06
(A) = V/I (AC)	(B) = V/I (BC)		ϱ = K × V/I	
(C) = (A) + (CR)	(D) = (B) — (CR)			

ves may look as shown in the fig. 6, and the mentioned correnction is necessary.

Table I. shows the computation of the correction: For the largest AB/2 separation (in this case 4000 meters) the average of the V/I values of AC and BC is made. In this case it is 0.088 mV/A. The difference of this value and the measured values is the correction, in this case 0.274 mV/I. It has to be applied to the measured values to bring them to the value 0.088 mV/A, which would be measured if the fifth electrode were at the electrical zero. The same correction is applied to V/I values at other outer electrode distances. From the corrected values of V/I the resistivities are computed (Table II).

In the fig. 7. the results are plotted: corrected resistivities for AC and BC, the measured resistivities for AB, means errors and the smoothed curve AB. The measured resistivities at AC and BC are not shown, without the correction they differ to much, and some become even negative. The corrected values are not too much different than the AB resistivities and the smoothing is possible. However, the relatively big mean error at the largest electrode distance causes perhaps more deformation than the inhomogeneities.

Another possibility is to compute the correction at two or more electrode distances and use the average. The fifth electrode for the smoothing of the sounding curves has been used extensively in gravel exploration, for groundwater etc. There is much less experience in deep sounding. In karst areas surface inhomogeneities are more a rule than an exception. Sometimes, the described method helped to reduce significantly their effect, but it also happened that one electrode entered and inhomogeneity before the other electrode came out of another one, and this was repeated for several times on the same sounding. In such cases, all the three curves were totally deformed with no smooth parts left. Sometimes a direction of minimum surface alteration can be chosen visually, or by shallow resistivity profiling before the sounding. The use of a proper electromagnetic method may be even more successful as shown by Overmeeren (1987).

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Overmeeren, van R. A. (1987): Fresh water bearing sandy creeks explored by electromagnetic measurements in higly saline coastal area of the Netherlands. Exploration '87, Toronto.

Smanjivanje djelovanja površinskih nehomogenosti na geoelektrična sondiranja

Ž. Zagorac

Prolaz električne struje kroz električne nehomogenosti na površini zemlje ili na maloj dubini uzrokuje deformacije krivulja geoelektričnog sondiranja. Da bi se dobilo glatke krivulje korištena je treća strujna elektroda u kombinaciji s lijevom i zatim s desnom elektrodom standardnog Schlumbergerovog rasporeda. Treća elektroda postavlja se daleko od ostalih dviju i to okomito na pravac mjerenja i na tom mjestu ostaje za čitavo sondiranje. Crtaju se krivulje otpornosti za raspored s korištenjem lijeve elektrode kombinirane s dalekom, desne s dalekom i za standardni Schlumbergerov raspored s lijevom i desnom elektrodom. Kad jedna od pomičnih elektroda prelazi preko nehomogenosti, krivulja sondiranja dobivena kod korištenja te i one daleke elektrode deformirana je dva puta više nego li standardna krivulja Schlumbergerovog rasporeda. Treća krivulja ostaje neporemećena i koristi se za korigiranje krivulje standardnog rasporeda na tom mjestu. Primjeri iz prakse pokazali su uspješnost ove metode. Kad nehomogenosti ima previše kao npr. u nekim terenima krša, metoda više nije dovoljna. Treća strujna elektroda postavlja se obično na nekoliko puta većoj daljini od najveće daljine pomične elektrode. Kod vrlo dubokog sondiranja to postaje nepraktično, međutim s nešto dodatnog računanja može se izvršiti korekcija krivulje sondiranja i uz korištenje manje daljine treće elektrode.