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GEOME 2
Manuscript received: July 30, 2015
Accepted: October 21, 2015

Geologica Macedonica, Vol**. 29**, No. 2, pp. 227–232 (2015)
In print: ISSN 0352 – 1206
On line: ISSN 1857 – 8586
UDC: 550.37/.38 : 528.94.021.6(497.742)
Original scientific paper

GEOELECTRICAL MODEL OF STRUMICA VALLEY – BANSKO SPA

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A b s t r a c t: Geoelectrics is a branch of geophysics which studies and monitors electrical and, along with geomagnetism, electromagnetic fields of the Earth. Possibility for application of geoelectrical explorations is based on the fact that minerals, that composed the rock complex, have different electrical, and partially magnetic characteristics. Electrical methods study natural and artificial electrical flows in the Earth and give data for distribution of the rocks with different electrical features. Geoelectrical mapping and sounding represent two basic methods of geoelectrical research of Earth interior structure. Using geoelectrical mapping, as a part of this method, is measured specific electrical resistance along the profile, with constant distance between the probes or constant depth of exploration. This paper will present process of geoelectrical measurements of Strumica valley or terrain around Bansko spa. Described is procedure of measurement, data processing, the obtained models and profiles of the terrain and the correlation between the models and the geological structure. Modern computer systems and programs (software) enable processing of large amounts of data in a relatively short time and models can also be with many parameters. The paper is based on data from field measurements.

Key words: geoelectrics; model; valley; Bansko

INTRODUCTION

Geoelectrical researches in Strumica valley were conducted in order to correlate geological structure of the terrain with obtained geoelectrical model. Measurements were conducted with the instrument for geoelectrical measurements Terrameter SAS 1000, and results are processed with the software IPI 2 win. Method of specific electrical resistance was used.

This method allows getting quantitative electrical data from the terrain results obtained with the investigations. Thus, it can calculate the average resistance of underground space, which increases the possibility of getting more accurate results than the methods of self-potential. Changing the actual resistance in depth, field work can be connected with the change of the depth to which is related the electrical data from the surface of the ground. This method consists in conducting of electricity with known strength through research terrain and monitoring of the fall of the potential of electricity or other electrical parameter that is associated with the electric current. Decreasing of the potential denotes presence of ore body which apparently disturbs the "homogeneity" of the certain area which means detecting the ore body.

GEOLOGICAL AND TECTONIC STRUCTURE OF STRUMICA VALLEY

In the geological structure of the Strumica valley are present rocks from Precambrian, Paleozoic and Quaternary age. Geological composition of the wider vicinity of the explored area is presented on the geological map (Fig. 1) [1].

Investigated area belongs to Strumica–Radoviš trench which has orientation east–west, and toward northwest cuts the structures of Vardar zone and Serbian-Macedonian massif.

Disjunctive tectonics had much influence on the final shaping of the area, which has repeatedly reflected and made various rupture forms, including Belasica fault passing through the researched field and on which are sources of thermal waters [7].

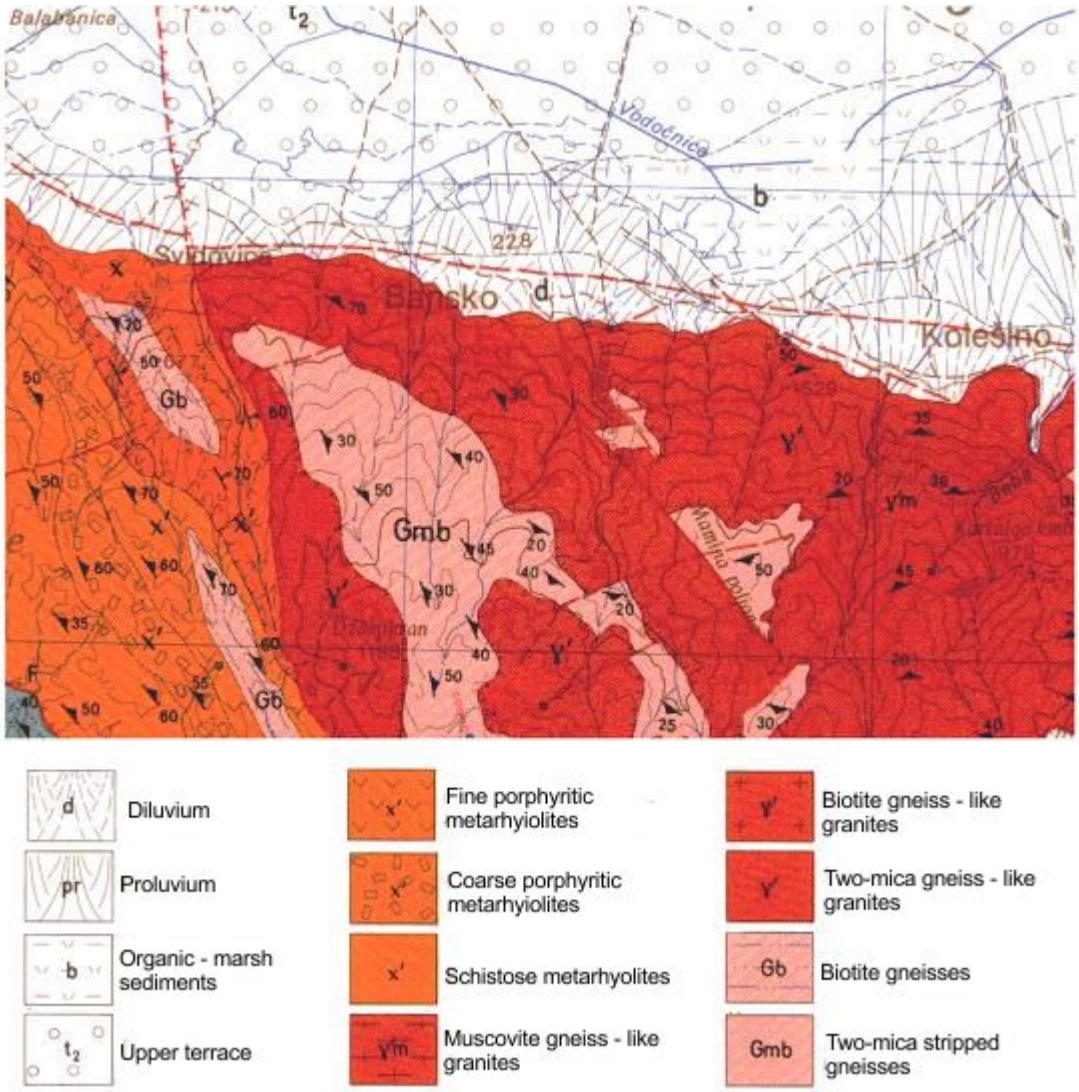

Fig. 1. Overview geological map of the wider vicinity of Bansko spa

GEOELECTRICAL MODEL OF BANSKO SPA

Geoelectrical model of the explored area in Strumica valley – Bansko spa, is obtained using geoelectrical measurements or vertical electrical sounding (VES), method of apparent electrical resistivity of the area with Schlumberger array of probes (Fig. 2) [11].

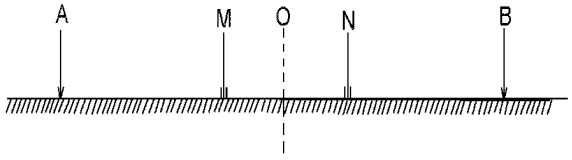

Fig. 2. Schlumberger array of probes

Symmetrical array of four probes where AO = OB = AB/2, and OM = ON = MN/2 and MN/2 is significantly lower than AB/2, is called Schlumberger array of probes.

Unit for voltage drop of the medium is mV, and unit for electric current which is passed through the electrodes is mA.

Unit with which is measured apparent geoelectrical resistance is Ωm [2].

Geoelectrical model of the explored area in Strumica valley or Bansko spa is conducted with three profiles with total of 21 probes (Fig. 3). The paper presents the results from one profile (Profile 1). Obtained diagrams (for two probes) are presented on Figs. 4 and 5. [3].

Measured data obtained with Terrameter SAS 1000 of eight probes on profile 1 are given in Table 1 [4].

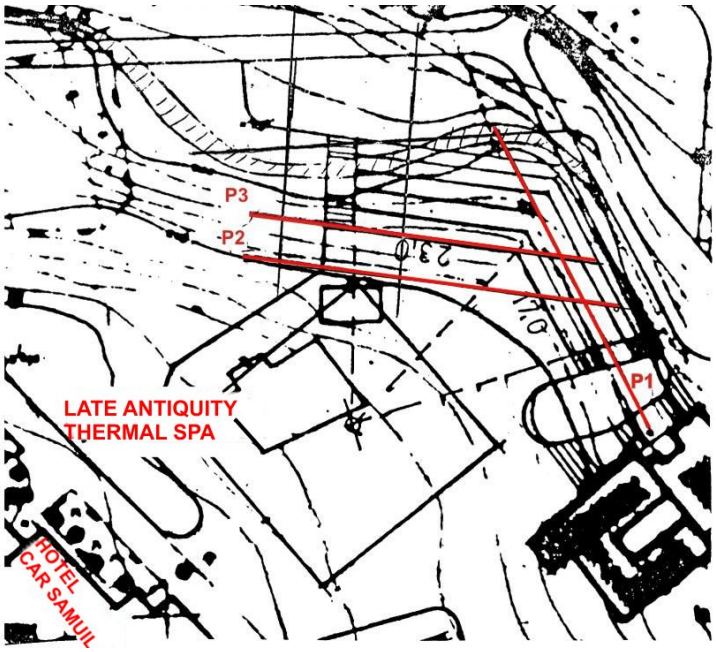

Fig. 3. Map with placed geophysical profiles

T a b l e 1

Measured data from profile 1

		Apparent resistivity (Ωm)							
		PROBE							
AB/2 (m)	MN (m)	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8
2,5	0.3	179.4607	1360.267	87.5311	524.419	596.638	838.413	964.896	1096.148
4	0.3	127.83	1624.9	102.515	429.2	567.15	599.05	1032.55	1821.6
6	0.3	104.3216	716.9172	97.63426	227.4803	534.5239	727.0307	1496.233	1869.359
8	0.3	96.65889	616.4871	99.96936	217.281	561.8352	731.8008	2199.744	1853.964
10	1	95.62776	586.4681	92.65739	152.7158	420.3277	597.2353	835.6474	1568.318
15	1	70.6692	363.7941	66.96372	99.77865	289.1558	471.504	1245.03	941.175
20	1	33.60388	428.2311	41.2004	57.21922	172.4998	84.98735	13993.25	585.9219

As can be seen from the table, the measured depth is from 2.5 to 20 m, and measured apparent resistivity (ρ) for the probes ranged:

- probe S-1 –< 70.6692 < ρ < 179.4607
- probe S-2 – 363.7941 < ρ < 1360.267
- probe S-3 – 41.2004 < ρ < 102.515
- probe S-4 – 57.2192 < ρ < 524.419
- probe S-5 – 172.499 < ρ < 596.638
- probe S-6 – 84.9873 < ρ < 838.413
- probe S-7 – 835.6474 < ρ < 13993.25
- probe S-8 – 585.9219 < ρ < 1869.359

N	ρ	h	d	Alt
1	179	2.5	2.5	-2.5
2	33			

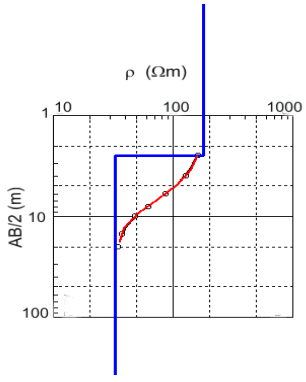

Fig.4. Diagram of probe S-1 on profile 1

N	ρ	h	d	Alt
1	103	2.5	2.5	-2.5
2	41			

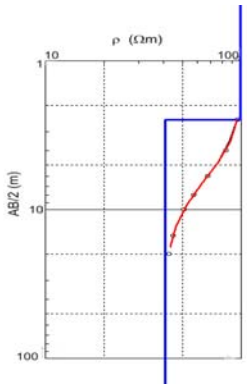

Fig. 5. Diagram of probe S-3 on profile 1

Apparent resistivity for the eight measured probes is ρ_1 = 179 Ωm, ρ_2 = 1360 Ωm, ρ_3 = 103 Ωm, ρ_4 = 524 Ωm, ρ_5 = 596 Ωm, ρ_6 = 838 Ωm, ρ_7 = 964 Ωm and ρ_8 = 1096 Ωm. From these results is obtained the geoelectrical model of the profile 1 (Fig. 6).

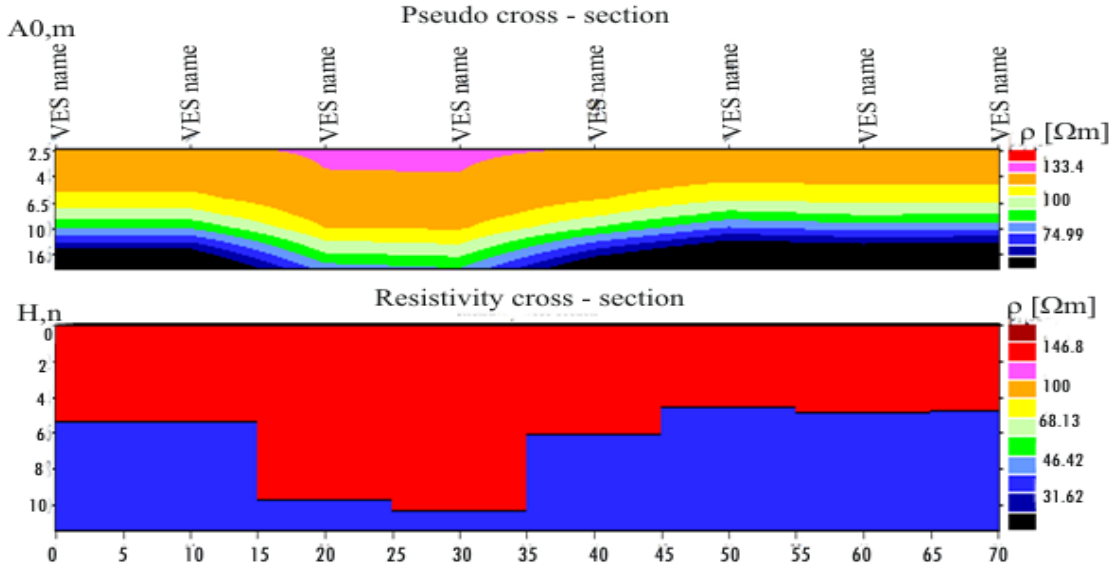

Fig. 6. Geoelectrical model of profile 1

INTERPRETATION OF GEOELECTRICAL MODEL

Geoelectrical profiles Pseudo cross-section and Resistivity cross-section (Fig. 6) present the media, or geological layers with apparent electrical resistivity [9, 10].

If we correlate the data obtained from these measurements and measurements from previous surveys, it is evident that general interpretation is the same, stating that in these measurements is mostly covered area up to 20 meters depth, which detailed separate layers with different apparent resistance.

The resistance profile clearly separated two areas with different specific electric resistance. Analyzing these profiles in this area in particular are: environments with resistance of about 30 Ωm to about 60 Ωm actually represent collection systems and environments with resistance above 60 Ωm are insulators [4, 6].

From the analysis of the geological map of the investigated area it can be concluded that the separated layers for different values of resistivity correlate well, or that areas with reduced specific resistance (collection systems) are represented by Quaternary sediments.

CONCLUSION

Geoelectrical investigations, or sounding, clearly mark the borders of horizontal layers with different specific resistance [8].

On the investigated area, the volume of the field measurements doesn't give possibility for definition of vertical structures (faults or contacts).

From the analysis of the obtained results, or diagrams, can be concluded that correlation between geological medium and geolectrical model is very good, or it can be said that separated layers according the various values of specific resistance are in good correlation, i.e. media with decreased specific resistance are present with Quaternary sediments.

Clearly are separated zones with expressed hydropotential (decreased specific resistance), or confirmed are collection systems which have low electrical resistance and insulating systems.

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Р е з и м е

ГЕОЕЛЕКТРИЧЕН МОДЕЛ НА СТРУМИЧКА КОТЛИНА – БАЊА БАНСКО

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Клучни зборови: геоелектрика; модел; котлина, Банско

Геоелектриката е гранка на геофизиката која ги изучува и следи електричните и, заедно со геомагнетизмот, електромагнетните полиња на Земјата. Можноста за примена на геоелектричните испитувања се базира на фактот дека минералите кои го сочинуваат карпестиот комплекс поседуваат различни електрични, а делумно и магнетни својства. Електричните методи ги изучуваат природните и вештачките електрични текови во Земјата и даваат податоци за распределбата на карпите со различни електрични својства. Геоелектричното картирање и сондирањето се две основни методи на геоелектрично истражување на Земјината внатрешна градба. При користење на електрич-

ното картирање како дел од оваа метода, се мери промената на специфичниот електричен отпор надолж профилот при, главно, константно растојание помеѓу електродите или константна длабочина на истражување. Во овој труд е презентиран процесот на геоелектрични мерења на Струмичката Котлина, односно теренот околу бањата Банско. Опишана е постапката на мерење, обработката на податоците, добиените модели и профили на средината и корелацијата помеѓу моделите и геолошката средина. Современите компјутерски системи и програми (софтвери) овозможуваат обработка на голем број податоци за релативно кратко време и моделите наедно можат да бидат повеќепараметарски. Трудот се темели на податоците од теренските мерења.