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Geophysics

Electrical Prospecting at a Design Stage of Tunnel Construction in Mountain Regions (Marabda-Kars Main Line, Kartsakhi Village Site)

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ABSTRACT. Geoelectrical sections for different topography levels are given; electric parameters of geological formations and hydrogeological conditions are described; efficiency of the electrical prospecting method in mountain regions is established and the continuation of the research is recommended with a view to carry out further detailed work. *© 2010 Bull. Georg. Natl. Acad. Sci.*

Key words: *electrical prospecting, mountain regions, geoelectrical sections, topography.*

The driving of tunnels for construction of railway main lines and highways in mountain regions requires that a detailed study of the geology of the area be carried out at the design stage. The execution of drilling and other mining work under conditions of a composite topography for the above purposes is connected with great technical problems and costs, being sometimes even impossible. These difficulties may be significantly reduced by employing in the complex of study at the stage of design geophysical, namely electrometrical, surveys, which will make it possible to investigate, expediently and without much expense, the site's geology, hydrogeological characteristics, physical parameters of existing formations, etc.

A composite topography in the course of electrometric surveys frequently leads to significant distortions of the electric field and, consequently, the formation of "false" anomalies, which are appropriately reflected in geoelectrical sections.

Given the theoretical and experimental study results [1-4], the field electrometric study may be conducted purposefully with certain limitation, which will make it possible to exclude in the survey data effects of the topography and to obtain real geoelectrical sections.

The purpose of the study at the site of a project tunnel construction for the Marabda-Kars main line (Akhalkalaki Plateau) was to compile geoelectrical sections at the depth of 200-250 m from the surface, to identify individual formations and to determine their hydrogeological characteristics.

In terms of geomorphology, the area under study is located on the so-called Akhalkalaki tableland and forms a plateau-like structure. It is generally characterized by a rolling terrain, although the relative height of some of its forms is found to be within 300-400 m. Rocks of the Mio-Pliocene and Quaternary age are present in the structure of the Akhalkalaki Plateau. Deposits of the Pliocene and Low-Middle Quaternary age are represen-

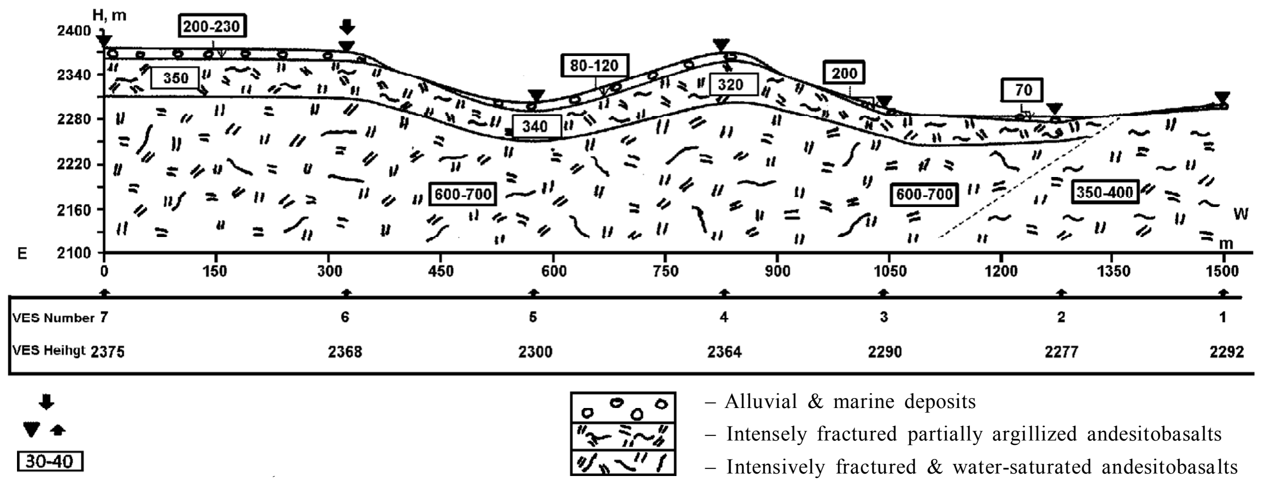

Fig. 1. Geoelectrical section I

ted by lava beddings composed of andesites, andesito-basalts and dolerites, alterations of tuff-breccias, volcanic sands and lava breccias. Rocks of the Upper Quaternary and Holocene age are represented by deposits formed as a result of mountain denudation and erosion. Their main types are thin-layer clays, sands and gritstones [5].

Different modifications of resistance techniques were used during the field electrometric surveys. The maximum reach of the AB transmitter lines equalled 1000m which guaranteed the depth of logging up to 250m and the determination of specific resistance values of individual geological formations.

Geoelectrical sections (I-III) were compiled at different hypsometric levels. Below is given a description of the geological and hydrological characteristics of the sections according to individual profiles.

According to the data of VES #4-7 of the section I, 3 geoelectrical horizons are generally distinguished (Fig. 1). Horizon I is characterized along the profile of a variable thickness, fluctuating within 0 to 14m; their resistance is also variable – from 40 to 230 ohms. It must be represented by topsoil and a weathered zone. The second layer, with resistance of 320-350 ohms and of 30-50m thickness, must correspond to intensively fractured, argillaceous andesitobasalts. The underlying third layer (depth 250m, resistance 600-700 ohms) must be completely represented by fractured andesitobasalts. Within the section of VES #1 and #2, at the depth of up to 200-300m, a low-resistance (350-400 ohms) medium is identified which, according to geological data, also corresponds to fractured andesitobasalts. The above horizon in the said direction seems to undergo abrupt facies variations, or it can be the result of a tectonic dislocation in the vicinity of VES #2, which can be easily determined by means of a detailed electrometrical survey.

In the geoelectrical section II (VES #10-15, Fig. 2) three horizons are present. The first horizon, with 35-40

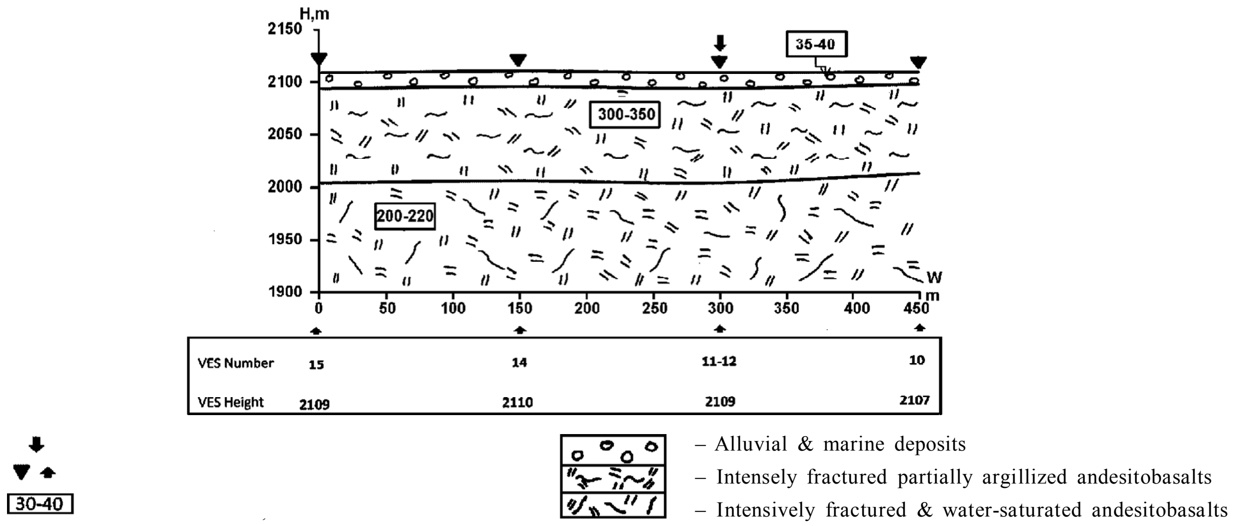

Fig. 2. Geoelectrical section II

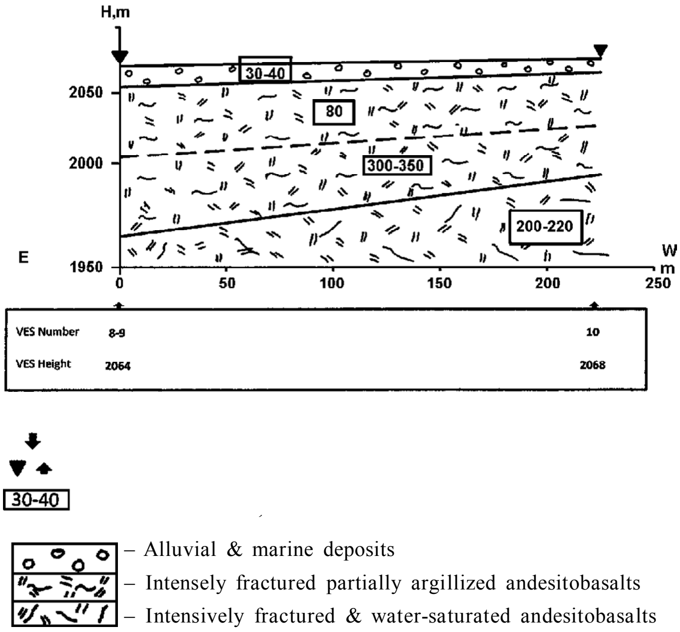

Fig. 3. Geoelectrical section III

ohm resistance and 12-15m thickness, must correspond to alluvial and deluvial deposits. The second layer, with the resistance of 300-350 ohms and thickness of 80-90m, corresponds to the intensively fractured and partially weathered andesitobasalts. The third layer, with the resistance of 200-220 ohms and thickness of 80m, must also correspond to the intensively fractured andesitobasalts. The relatively low-resistance values must be conditioned by water-saturation of the layer.

The geoelectrical section III is located 50m westwards of the drill hole. It is generally represented by 3 horizons (Fig 3). The first horizon, with resistance of 30-40 ohms and thickness of 12-15m, must correspond to alluvial and deluvial deposits. The third horizon, with resistance of 200-220 ohms and thickness of HH>100m, corresponds to the intensively fractured and water-saturated andesitobasalts. The geoelectrical horizon II, with resistance of 300-350 ohms and thickness of 70-80m, must also correspond to the intensively fractured andesitobasalts. In the upper part of horizon II, with the thickness of 35-40m, a low-resistance layer (80 ohms) is observable, which must be conditioned by its high content of an argillaceous fraction.

Thus, based on the above, the area under study is characterized by the following features of geological structure:

The geological horizon I must be represented by soil, alluvial and deluvial deposits, whose thickness in different profiles varies from 0 to 15m. Their resistance is by material content and significantly varies according to water-saturation (30 to 230 ohms). The second and third horizons, with the thickness of 250m and over, correspond to a thick layer of andesitobasalts. This geological formation, as seen from the sections, is characterized by a pronounced heterogeneity, both horizontally and vertically.

In the first profile, the resistance of andesitobasalts (600-700 ohms) should be conditioned by fissuring of the basic rocks and deep presence of underground waters. The high-resistance values (300-350 ohms) in different profiles must be associated with the intensively fractured argillaceous zones, while the low-resistance values (200-220 ohms) must be conditioned by water-saturation of the intensively fractured andesitobasalts.

Proceeding from the above, the electrical prospecting methods may be effectively used to conduct further detailed surveys at the design stage of tunnel construction in the said mountain region.

გეოფიზიკა

ელექტროძიება გვირაბების მშენებლობის საპროექტო სტადიაზე მაღალმთიან რაიონებში (მარაბდა-ყარსის სარკინიგზო მაგისტრალის სოფ. კარწახის უბანი)

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მოცემულია გეოელექტრული ჭრილები რელიეფის სხვადასხვა დონისათვის, დახასიათებულია გეოლოგიური ფორმაციების ელექტრული პარამეტრები და ჰიდროგეოლოგიური პირობები. დადგენილია ელექტროძიების მეთოდის ეფექტურობა მთაგორიან რაიონებში და რეკომენდებულია კვლევების გაგრძელება შემდგომი დეტალური სამუშაოების ჩატარების მიზნით.

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