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Water Search and Landslides Study Using Electroprospecting

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ABSTRACT

Electrical exploration is a large group of geophysical methods that study electromagnetic fields of various nature. The purpose of these studies is to determine the electromagnetic characteristics of the geological environment (resistance, conductivity, polarizability, etc.), knowing which you can get valuable information about the structure of the studied area or region. By the type of electromagnetic fields, electrical exploration can be divided into two groups: the first - combines methods that study natural, the second - artificial electromagnetic fields. The first ones are called natural electric fields methods, and the other - methods of resistance. The materials presented in our work have been obtained with resistance (vertical electric sounding) method. The article provides a brief overview of the results of various types of work. Studies results on the possible moisture of rocks and the existence of groundwater at different depths are presented. Also presented are the results of lithology of rocks in landslide zones, studies of the possible moisture and evaluation of landslide safety coefficient (FS) for several landslides.

Key words: Vertical Electrical Sounding, Resistivity, Groundwater, Landslide

Introduction

In electroprospecting (resistance method) is used artificial power source. The electricity reaches the ground through the power electrodes and the difference between the arised potentials is measured by the receiving electrodes on the earth surface. If the environment is homogeneous, the resistance method gives us true conductivity, which will not depend on the configuration of electrodes and the position of electrodes on the surface of the earth, since the true conductivity is a constant. In electric resistivity imaging (ERI) electric currents are injected into the ground and the resulting potential differences are measured at the surface, yielding information about the distribution of electrical resistivity below the surface. Finally this gives an indication of the lithological and structural variation of the subsoil (since resistivity depends on sediment porosity and pore water). In the shallow subsurface, the presence of water controls much of the conductivity variation. Measurement of resistivity is, in general, a measure of water saturation and connectivity of pore space. This is because water has a low resistivity and electric current will follow the path of least resistance. Increasing saturation, increasing salinity of the underground water, increasing porosity of rock (water-filled voids) and increasing number of fractures (water-filled) all tend to *decrease* measured resistivity. Increasing compaction of soils or rock units will expel water and effectively increase resistivity.

In environment ΔV, and therefore impedance ρ should be dependent on the configuration and location of electrodes, as secondary fields influence on the primary field [2]. Therefore, the measured ρ value in nonhomogenous environments is called an apparent resistivity and is signed as ρ_a. The coefficient of reaccount for uneven environment depends on the configuration of electrodes. Different configurations of the electrodes are used according to the type of problem. In our tasks we used the Schumerberger method. Receiver MN electrodes are fixed in the center of the device, while the distance between the current AB electrodes increases gradually [3].

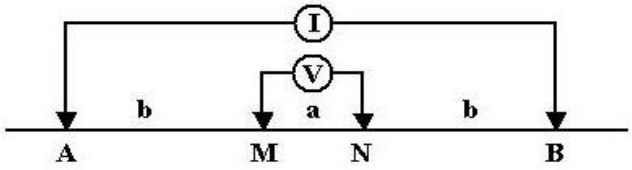

Fig.1. Schlumberger method of vertical electrical sounding

The vertical electrical sounding (VES) method relies on the fact that the greater is the distance between of current electrodes (AB), deeper penetrating the current, than from more deep layers we receivs information by measured potential on the electrode.

Electrical resistance table for some of the rocks

The name of the rock	Electrical resistivity (Ohm/m)		
	min	typical	max
Clay	5	10	15
Loam	10	30	50
Sand clay	30	50	80
Water-saturated sands	50	80	200
Sands slightly moist	100	150	500
Dry sands	200	500	10000
Carbonate rocks weakly cracked	500	1000	5000
Intrusive rocks weakly fractured	1000	2000	10000
Bulk	30	50	500
Permafrost rocks of various ice content	500		80000
Ores minerals conductors(in mostly sulphides)	0.001		1-5

As we see from this table [2], the electrical resistance is different for different rocks that allow us to be more confident about the definition of rocks, the water content in them, and to overcome various geophysical tasks.

Search for water

We carried out one of the interesting works through vertical electric sounding for water searching in Sachkhere district, in the valley village of Savane, in the vicinity of the river Kvirila. The works were carried out by the Italian electrometer equipment (Earth Resistivity Meter PASI 16GL-N).

In the search range, up and down to the Kvirila River, several electrical survey profiles were conducted. The measurements were carried out at several points on each profile using the method of vertical electrical sounding. In total, 26 points of vertical electrical sounding (Schlumberger methods) on the left bank of the Kvirila River, north of the village of Savane. The length of each spreading was 500 meters and a depth of about 170 m.

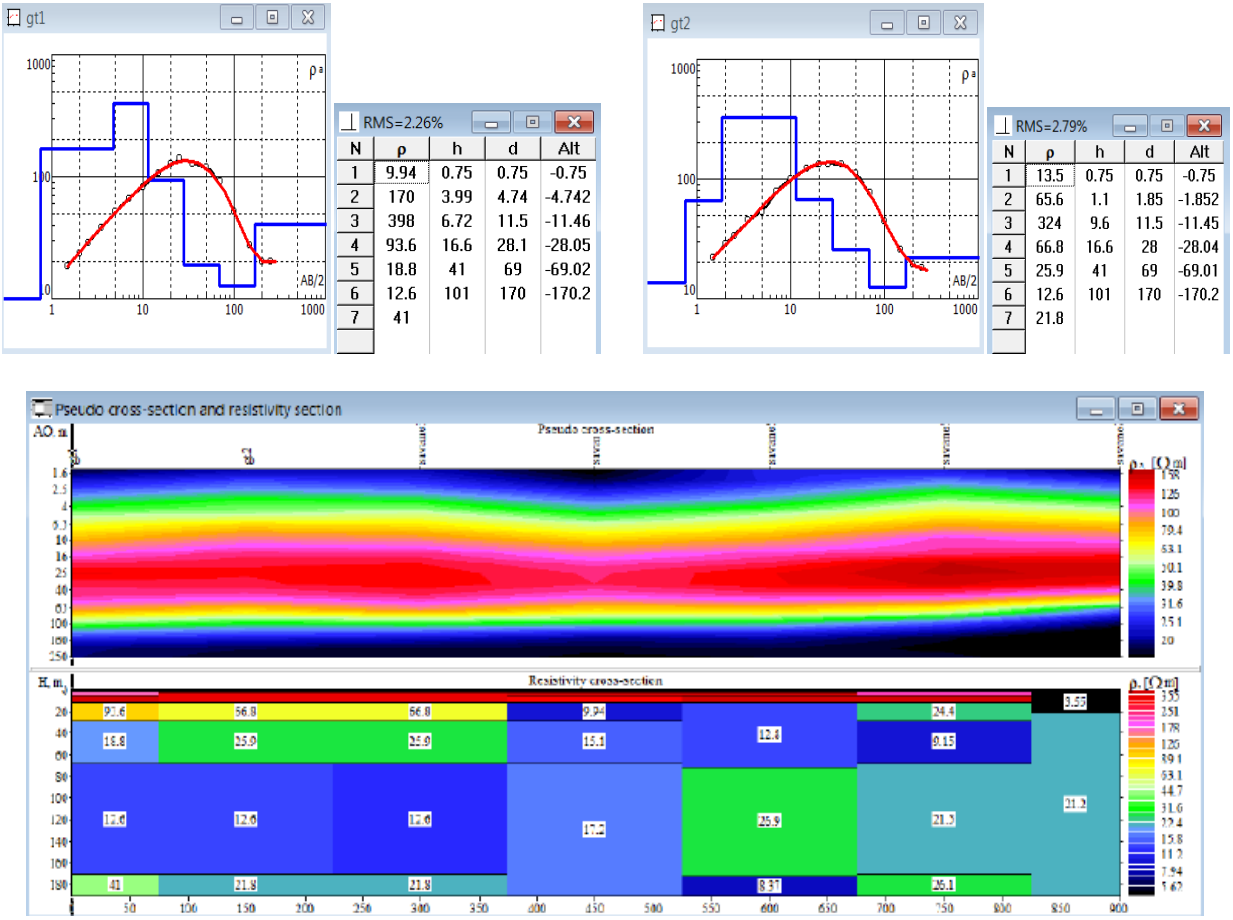

Fig 2. Vertical electric sounding in two different points with appropriate resistance and separated layers and one of the long resistivity profile

Figure 2 shows that in both cases VES-a stands out wet layers, relatively dry layers, clay, loam, which is quite good matches with the actual results of drilling. It also presented a long profile (about 1200 meters) obtained by joining several small profiles on one line. Several such profiles were made along the Kvirila River.

Assessment of landslide hazard

Complex geophysical studies were conducted on the Khoko landslide at the Enguri reservoir. We took part in the works with electro prospecting equipment (Earth Resistivity Meter 16GL-N). On the Figure 3, presented the process carrying of the above works and the results of the vertical electrical sounding, in one point, measured by three electrode method. The graph shows that with increasing of the depth is reduced by the imaginary resistivity, grows the moisture layers. The obtained results allow us to conclude that landslide processes are developing in the local area. The thickness of the layers in the process is not large (about 5-10 meters). The process is activated periodically during the rainy season.

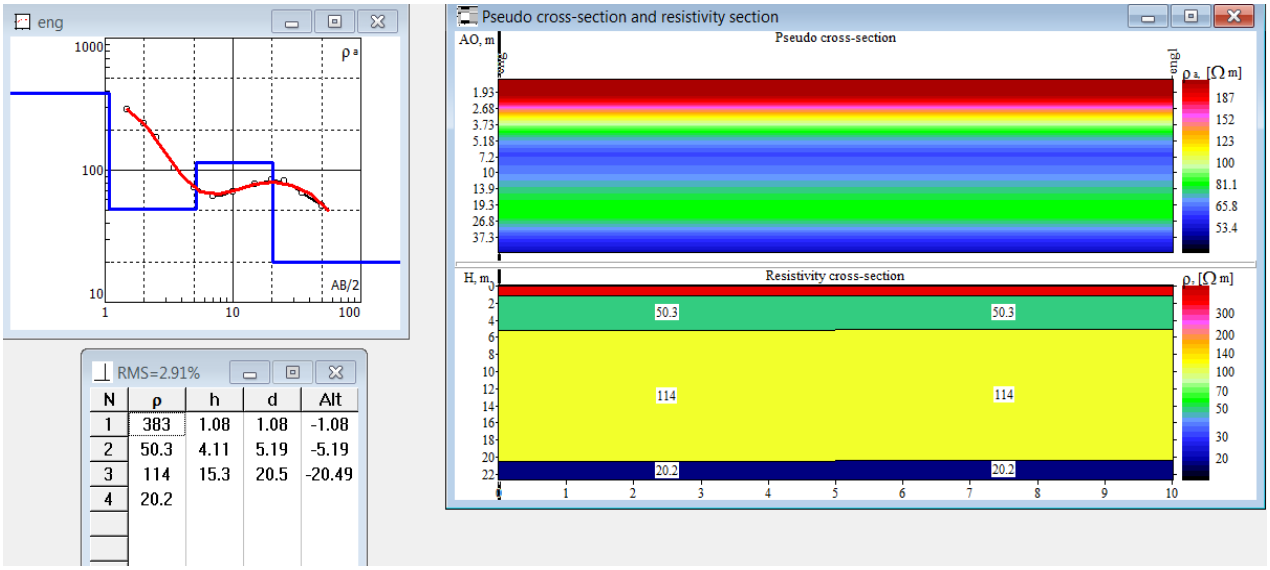

Fig.3. Carrying works on the Khoko landslide and the results of vertical electric sounding measured by three electrode method in one point of the landslide

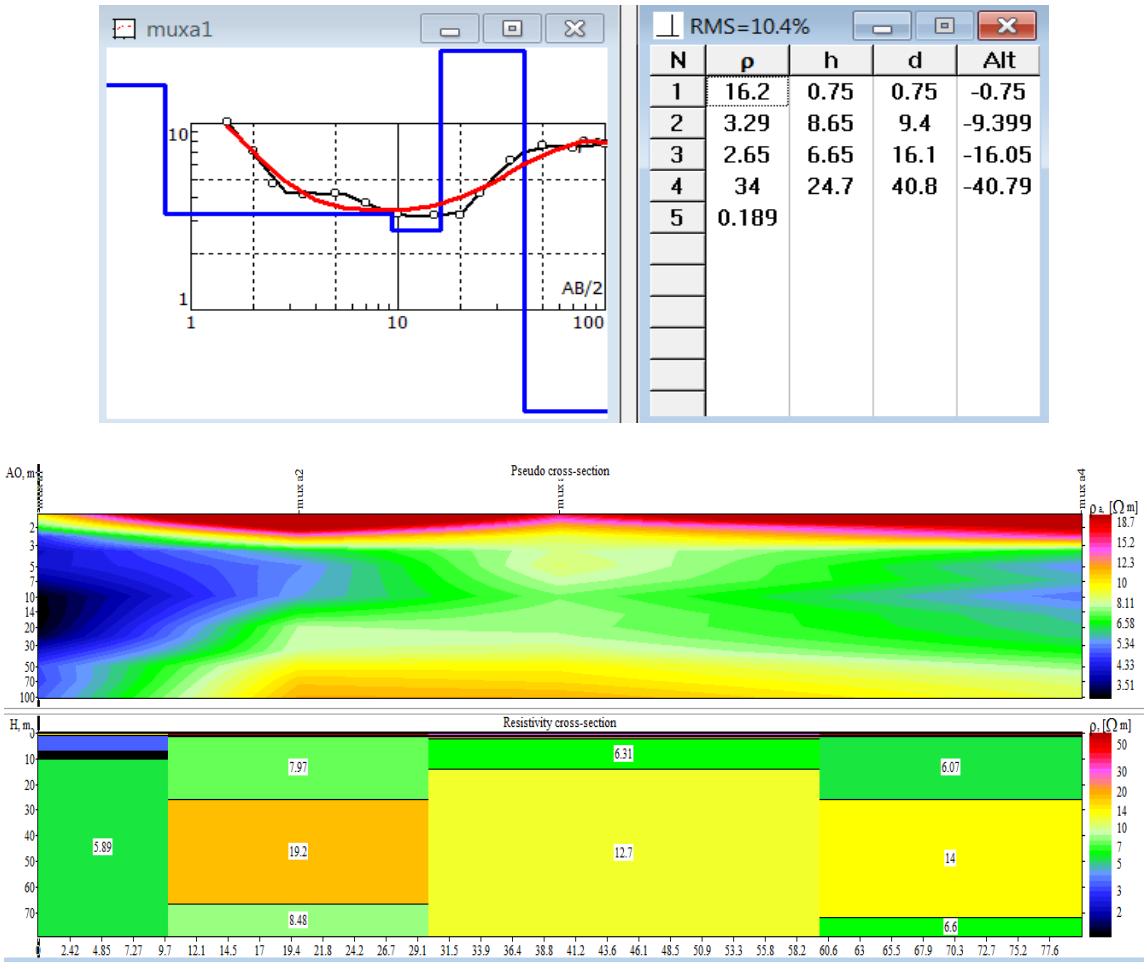

Fig.4. Results of vertical electrical sounding on Mukhatgverdi landslide

Works were also carried out on the Gombori landslide. On the above-mentioned landslide was made of vertical electrical sounding by Schlumberge's method. Were conducted assessment of the risk factor of the landslide .

In order to assess the risk of landslide, exist a factor of safety [4]:

$$FS = \frac{c + hgcos^2\theta(\rho_r - \rho_w m)\tan\phi}{\rho_r hg \sin\theta \cos\theta}$$

Where c is the cohesion, h - the thickness of the potential sliding mass, g - acceleration of free fall, θ surface slope angle, ρ_r - density of landslide rocks , ρ_w - water density, m - moisture layer part in the sliding layer, ϕ - internal friction angle.

When FS> 1 → landslide is stable, FS <1 → landslide is unstable, FS = 1 → The condition of the landslide is critical.

We also conducted electroprospecting works on one of the landslides near Mukhatgverdi road, which potentially threatens the road to Mukhatgverdi cemetery.

Mukhatgverdi landslide consists of several blocks, some of which are active (moving) and some are stable (immovable). We took measurements on all moving and immovable blocks.

The obtained results show unstable conditions in case of large rainfall (as well as in case of earthquake) and relatively stable conditions in dry period.

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წყლის ძიება და მეწყრების შესწავლა ელექტროძიების გამოყენებით

ნ. ვარამაშვილი, დ. ტეფნაძე, დ. ამილახვარი, ლ. დვალი, თ. ჭიკაძე, გ. ქაჯაია, დ. ვარამაშვილი

რეზიუმე

ელექტროძიება არის გეოფიზიკური მეთოდების მიმართულება, რომელიც სწავლობს სხვადასხვა ბუნების ელექტრომაგნიტურ ველებს. ამ კვლევების მიზანია გეოლოგიური გარემოს ელექტრომაგნიტური მახასიათებლების დადგენა (წინააღმდეგობა, გამტარობა, პოლარიზაცია და ა.შ.), რომლითაც შეგიძლიათ მივიღოთ ღირებული ინფორმაცია შესწავლილი ტერიტორიის ან რეგიონის აგებულების შესახებ. ელექტრომაგნიტური ველების ტიპის მიხედვით, ელექტრული გამოკვლევა შეიძლება დაიყოს ორ ჯგუფად: პირველი - აერთიანებს მეთოდებს, რომლებიც სწავლობენ ბუნებრივ, მეორე - ხელოვნურ ელექტრომაგნიტურ ველებს. პირველ მათგანს ბუნებრივი ელექტრული ველის (ბევ) მეთოდებს უწოდებენ, ხოლო მეორეს -წინააღმდეგობის მეთოდებს. ჩვენს ნაშრომში წარმოდგენილი მასალები მიღებულია წინააღმდეგობის (ვერტიკალური ელექტრული ზონდირების) მეთოდით. სტატიაში წარმოდგენილია სხვადასხვა ტიპის სამუშაოების შედეგების მოკლე მიმოხილვა. წარმოდგენილია ქანების გაწყლიანების და მიწისქვეშა წყლების შესაძლო არსებობის კვლევა სხვადასხვა სიღრმეებზე. ასევე მოყვანილია მეწყრულ ზონებში ქანების ლითოლოგიის, შესაძლო გაწყლიანების კვლევის შედეგები და მეწყრის უსაფრთხოების კოეფიციენტის (FS) შეფასება რამდენიმე მეწყრისათვის.

Поиск воды и изучение оползней с использованием электроразведки

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Резюме

Электроразведка - это область геофизических методов, которая изучает электромагнитные поля различной природы. Целью этих исследований является определение электромагнитных характеристик геологической среды (сопротивления, проводимости, поляризации и т. Д.), которые могут предоставить ценную информацию о структуре исследуемой области или региона. В зависимости от типа электромагнитных полей электрическое зондирование можно разделить на две группы: первая - объединяет методы исследования естественных, вторая - искусственных электромагнитных полей. Первый называется методами естественного электрического поля (bv), а второй - методами сопротивления. Материалы, представленные в нашей работе, получены методом сопротивления (вертикального электрического зондирования). В статье представлен краткий обзор результатов различных видов работ. Представлены результаты исследований возможной влажности горных пород и наличия подземных вод на разных глубинах. Также представлены результаты литологии горных пород в зонах оползней, исследования возможной влажности и оценки коэффициента безопасности оползней (FS) для нескольких оползней.