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VERTICAL ELECTRICAL SOUNDING AND GEORADIOLOCATION TO ASSESS LANDSLIDE AREA WATER SATURATION

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Summary: *The vertical electrical sensing method is effectively used by studying landslides. The georadiolocation method is also a powerful tool for studying structure and watering at shallow depths. The paper presents a brief analysis of the landslide works carried out in 2021 on Machavariani Street in Tbilisi. For the landslide study the methods of vertical electrical sounding and ground penetrating radar were used. Together, these two methods yielded reliable results at different search depths, which was additionally confirmed during the drilling process.*

Key words: *Vertical electrical sounding (VES), georadiolocation, Landslide*

Introduction

In the spring of 2021, a landslide activated on Machavariani Street in Tbilisi, endangering the surrounding road and territory. Along with other research works, geophysical surveys were conducted in the landslide area, including methods of vertical electrical sensing and georadiolocation. The study was conducted with modern equipment (Fig. 1a), by the method of vertical electrical sounding. The measurements were performed with modern Italian (PASI GL-15N) equipment (Fig. 1 a).Ground-penetrating radar work was carried out using the Zond-12e GPR (Fig.1b).

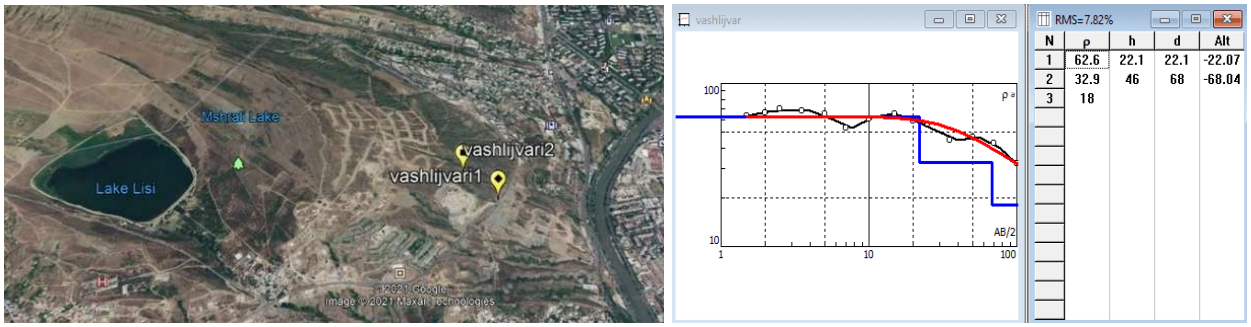
a. b.

Fig.1. a) Earth Resistivity Meter PASI 16GL-N, b) ground penetrating radar ZOND 12

Electroprospecting

In electroprospecting (resistance method) 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. Finaly this gives an indication of the lithological and structural variation of the subsoil (since resistivity depends on sediment porosity and pore water).

On March 29, 2021, electrical prospecting works were carried out on the landslide on Machavariani Street by the method of vertical electrical sounding. The measurement was performed at two points (Fig. 2). The paper presents the results of measurements performed in the language of landslides in the first point (Vashlijvari1).



a. b.

Fig.2. a) Location of vertical electrical sounding points on the landslide body. b) Vertical electrical sounding curve obtained by measurement near the landslide toe.

The first measurement was performed near the landslide toe, on Machavariani Street (Fig. 2a). The measurement was performed by the vertical electrical sounding method, with the Schlumberger spread. The maximum spread of the power electrodes was 100 meters. The corresponding vertical electrical sounding curve is shown in Fig.2 b.

The analysis of the vertical electrical sounding curve shown in Fig. 2b allows us to assume that a clay-enriched layer starts from a depth of about 25-30 m. The clay-enriched layer, under certain conditions, can play the role of a sliding surface. This result is quite consistent with the results obtained by drilling wells in the vicinity of the vertical electrical sounding point.

Georadiolocation prospecting

What is GPR? The GPR emits ultra-wideband pulses in the meter and decimeter range of electromagnetic waves and receives signals reflected from irregularities, objects or other inclusions in the soil that have a dielectric conductivity different from the medium. In order to obtain data from different depths, antenna units are used that operate at different frequencies. It is necessary to take into account the general rule: the lower the operating frequency of the antenna, the higher the signal penetration depth, but the lower the antenna resolution. GPR allows the operator to "see" through water, soil and stone.

In our case, we use the GPR Zond 12- e with our standard receiving and transmitting antenna using a frequency of 75 MHz (Fig.1). To receive and process georadar data, we use the PRIZM 2.5 software.

Four 50-meter profiles were selected on the section of Machavariani Street near the Vashlijvari landslide and georadiolocation works were carried out (Fig.4). For our work, we selected the results obtained by measuring with a 75 MHz dipole antenna, for the second precinct, located near the vertical electrical sensing point (vashlijvari1, Fig.1a). We were interested in how the results of vertical electrical sensing and georadolocation work correlated with each other.

Fig.3. Georadar work area along the concrete wall

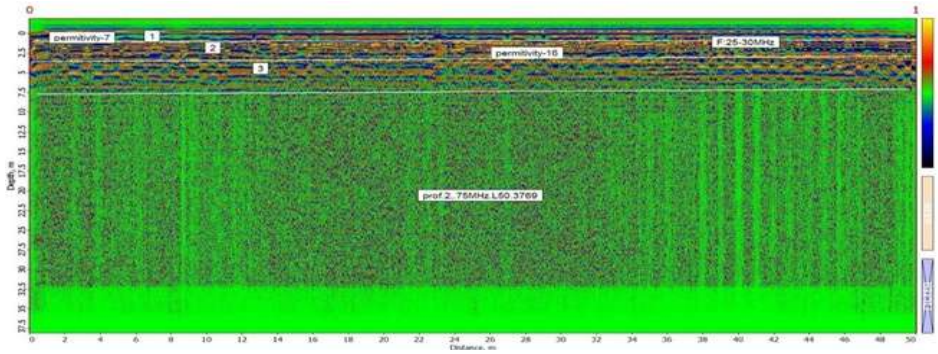


Fig.4**.** Prof.2, radarogram performed by Georadar Zond-12e, software Prizm 2.5, staff dipole antenna 75 MHz, distance -50 m.

On the 75 MHz radarogram of Prof.2 (Fig. 5) a georadiolocation layer -1 with electromagnetic wave synchronization axes about 1 m thickness, was distinguished, the texture being different from the second layer-2, whose relative dielectric permeability corresponds to that of mixed clay. Layer-2 is about 7.5 meters thick. Next, the texture layer is distinguished by a vertical layering, homogeneous clays, and crumbling limestone. Layer-2, for depths of 3-4 m, is characterized by a high level of hydration, and from a distance of about 26-30 m, to the end of the profile contains signs of watering.Therefore, with the activation of geodynamic processes, this section of the road can play the role of a sliding surface and contribute to the intensification of landslide.

Conclusion

1.Georadiolocation and electrometric search methods are effective in determining groundwater levels, lithology of subsurface and estimating moisture of the subsurface rock. Also, to evaluate the thickness of moistened areas.

2.Each of these methods has its limitations. In the complex they complement each other and can be used without geological restrictions.

3. The results of vertical electrical sounding and georadiolocation measurements, based on the available materials, correlate with each other to determine the possible location of the sliding surface.

4. However, it should be noted that the work done is not sufficient to study the issue in depth. Further studies are needed.

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