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## SOME RESULTS OF THE INVESTIGATIONS AROUND SVETITSKHOVELI CATHEDRAL

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### **Annotation**

*Geophysical investigations have been carried out in order to reveal the reason for wetting some areas of the southern wall and rampart of Svetitskhoveli Cathedral; mainly, electrical and seismic prospecting methods have been used. On the bases of the investigations we have found out that in the northern part of the cathedral yard, from the rampart to the cathedral wall, in the 4 m depth from the earth surface two clay structures.*

key words: hydro-geological state, seismic prospecting methods.

### **Preface**

**Svetitskhoveli Cathedral**, a XI century (1010-1029) monument of Georgian architecture, among four vast cathedrals it is the biggest historical ecclesiastical building among those, which have been survived so far in Georgia. During centuries it has been a religious center of Christian Georgia.

During visual examination of the southern wall of Svetitskhoveli it becomes obvious even for naked eye that the wall is wet and in the south-eastern part of the wall, in its base, near the foundation some disintegration of the stone panel has begun. The wetness is also seen on the walls of the rampart.

The goal of the investigation was finding out the reason for the dampness of the southern wall and the rampart walls of Svetitskhoveli Cathedral.

In order to define the hydro-geological state of the cathedral and its surroundings it was necessary to conduct complex geophysical investigations.

Firstly we paid attention to the existence of the Zahesi reservoir. According to the investigations by Professor D. Mshvenieradze it is well known that in April 1950 the reservoir was discharged and after lowering by 8 meters the horizons of the rivers Aragvi and Mtkvari (it was the sinking of the whole horizon) the underground water horizon was lowered by 10 cm during 24 hours.

Thus, the nearness of the Zahesi reservoir (taking into consideration its water mirror level ( $448.0 \pm 0.5$  m)) is no obstacle for the discharge of the underground waters. The level of the water resistant bottom (mainly clay) of the aquifer horizon is 450.30 - 452.70 m and is located 2-4 meters higher compared the water level of the reservoir.

According to D. Mshvenieradze we may conclude that minimizing the water level in rivers does not significantly change the level of the underground water horizons, i.e. it is to be supposed that the influence of the reservoir is minimal on the variation of the underground water level in the cathedral yard.

However, the measurements show that today the underground water horizon level is considerably (by 1-2 meter(s)) high compared to that in 1950.

We have no information about the state of the cathedral and the rampart in 1950. However, the dampness of the southern wall and some parts of the rampart of the cathedral is absolutely

obvious. The wetness of the wall and rampart of the cathedral means that there really exist some factors for damaging the cathedral. However, there is no mention in D. Mshvenieradze's work about it. Therefore, we suppose that either the wall was not wet for that time or the wetness was imperceptible for naked eye.

In the viewpoint of engineering hydrogeological investigations the works conducted in 2010 ordered by the National Agency for Cultural Heritage Preservation in Georgia in the cathedral yard are very interesting. The goal of the investigation was verifying the engineering geological conditions in the yard and carrying out one-year-long observations on the underground water levels.

During the works done on the territory of the cathedral yard 4 boreholes were drilled in 10-13 m depth on the selected areas around the cathedral.

According to the conducted works the geologic-lithologic columns of the boreholes and the geological sections of the area were drawn up. From different depths of the boreholes 24 soil samples were taken.

The underground soil water was revealed in all four boreholes in 4.2-5.6 m depth from the diurnal surface in the thick-fragmented soil layer. During a day the underground water level increased up to 3.8-4.4 m depth from the earth surface. While installing protective tubes and after entering the basic rocks the flow of the water into the boreholes was stopped (the main clay layers are characterized with low filtration features and are actually water resistant).

The time cycle for the systematic observation on the underground water levels was one year.

On the basis of the one year systematic observation the underground water mirror oscillation amplitude compared to the average yearly one is 0.40-0.82 m, the ascending level is 0.82 m and the descending one - 0.40 m. The underground water on the territory of the cathedral yard is the result of precipitation infiltration. The variation of its level depends on the intensity of the precipitations. The underground water circulates in alluvial stones and discharges to the south-east direction.

The fact can be explained by the nearness of the gorges of the rivers Aragvi and Mtkvari that makes good conditions for water drainage in this direction. For illustrating of the above said we constructed a hydro-isohypse map of territory.

The above investigations defined that the underground waters run from the north and north-west and discharge to south and east (more precisely to the south-eastern direction).

### **Investigation:**

In order to find out the reason for wetting of the cathedral walls and rampart and to specify hydrogeological picture, in the northern part of the cathedral we carried out electrometric (vertical electrical sounding (VES)) and seismic works using geophysical prospecting methods.

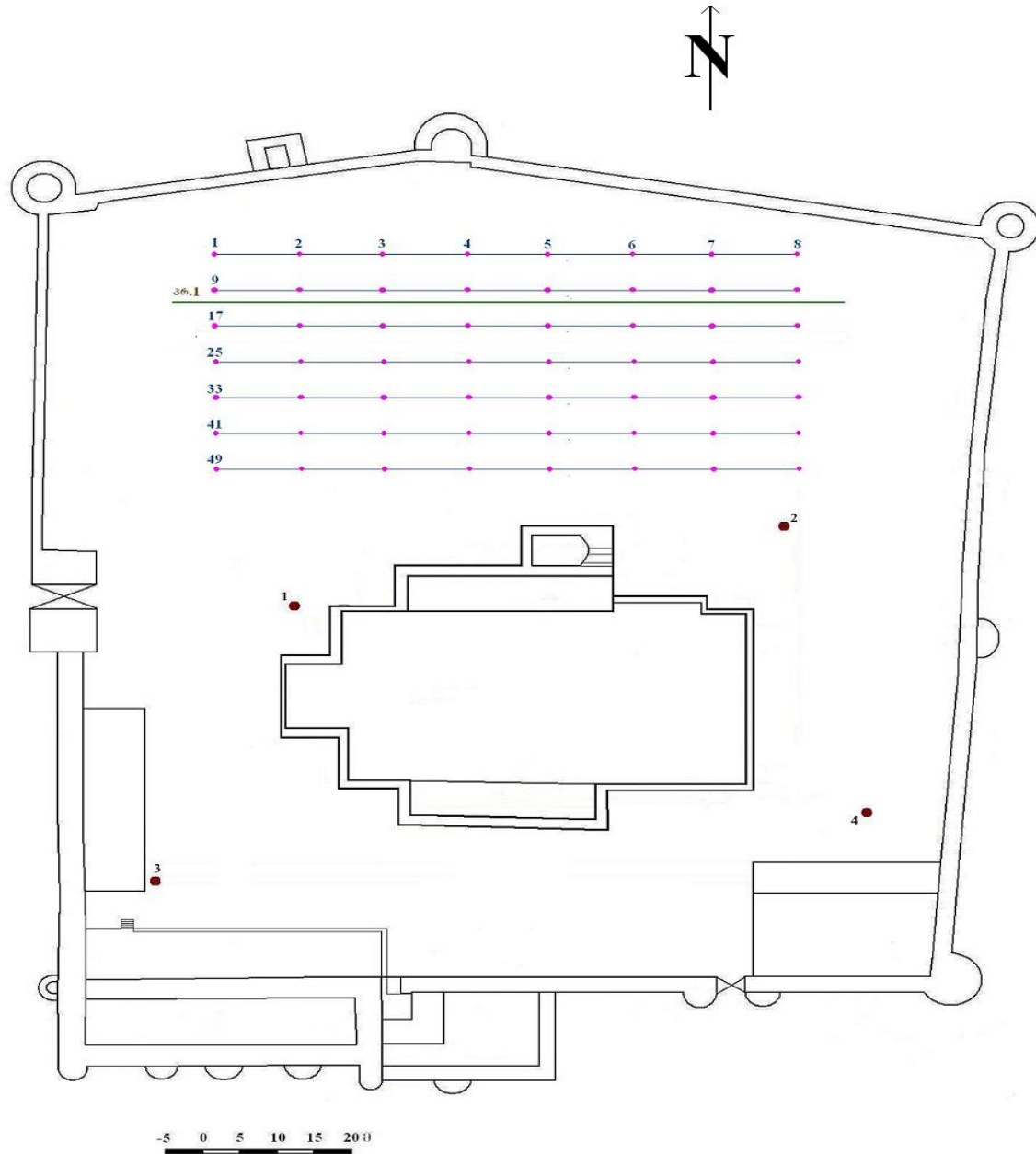


Fig. 1. The scheme of VES points ( ● ), seismic profile ( — ) and well locations ( ● )

Fig. 1 and Fig. 2 based on the investigation results show that the depths of clay arcual layers start from 4m. The works were conducted in 140 meters from east to west. And 30 m distance from north to south, on the north side of cathedral, between rampart and cathedral. Here two clay layers in the arch form were discovered. The bottoms of each of them start from different depth from the surface and join each other approximately at 7-8 m depth from the earth surface. It is to be emphasized that according to their seeming resistance they are clay layer.

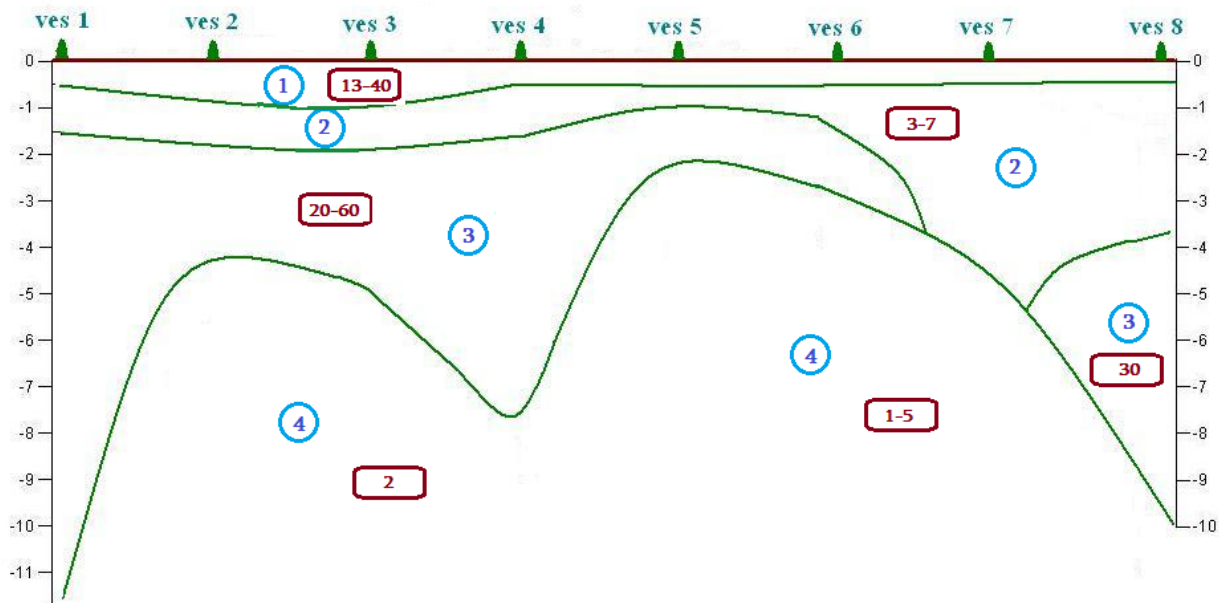


Fig 2. Geological cross-section along the profile from VES-1 To VES-8: 1- the bulk of clay including the waste bulding materials; 2- dark brown caly; 3- Gravel with clay filler; 4- bedrock- shale.

**1-5** specific electrical resistivity in ohm; **ves 7** - VES points;

Searching was carried out by Seistronix Ras-24 (24 Channel Acquisition System). On the basis of the obtained results we constructed seismic profiles (Figure 3, Figure 4).

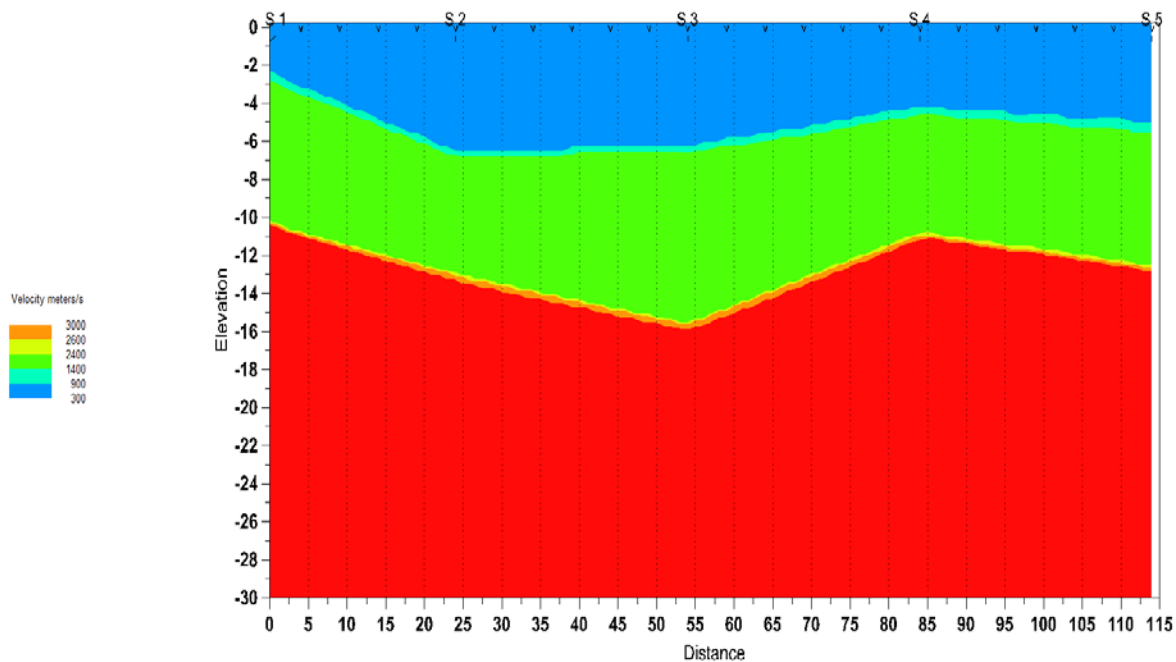


Fig. 3. The material obtained by Ras-24

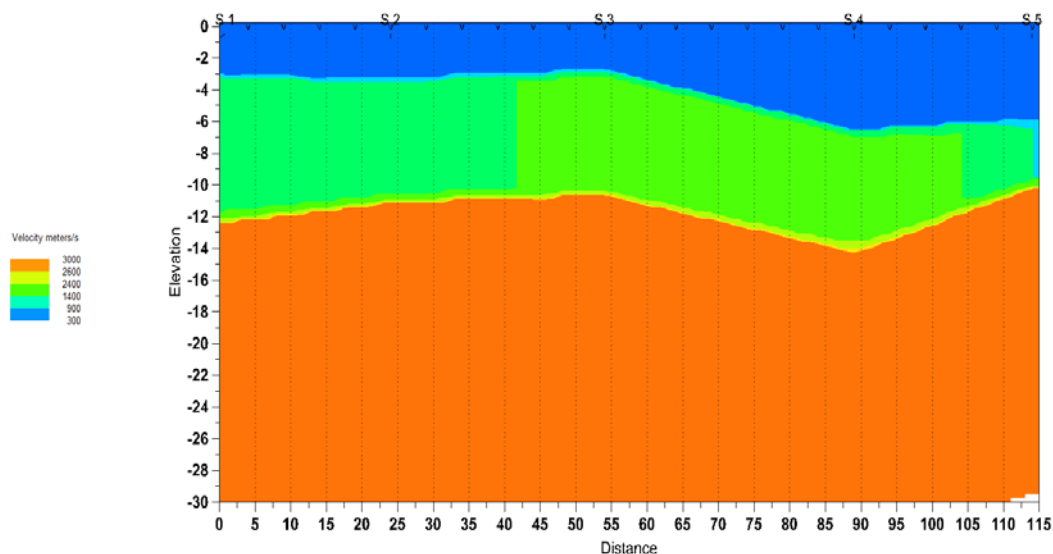


Fig. 4. The material obtained by Ras-24

These investigations also proved that in the northern part of the yard, in the 4 m depth from the earth surface there are two arch shaped (oval) clay layers, which are located almost symmetrically regarding the cathedral. These results coincide with the results obtained by the VES.

Moreover, we had the analysis of the water in the cathedral done. The chemical and microbiological analysis of the samples taken by us was carried out by scientific-research company GAMA. Results of analysis showed that there is quite high concentration of potassium in the water.

On the basis of the water sample analysis we assume that the increased potassium concentration in the cathedral well may be caused by the fact that the water level in the cathedral foundation and generally in the yard has increased to such level that the graves are being washed out.

Thus, by summing up the results of the investigations carried out on the territory of Svetitskhoveli Cathedral and its surrounding area we may conclude:

1. The influence of the rivers Aragvi and Mtkvari in the viewpoint of water accumulation may not assumed as a significant factor;
2. Accumulation of the water is mainly caused by the existence of the underground waters;
3. The water level is continuously changing;
4. There is no water drainage system;
5. The reason for the wetting of the cathedral walls and rampart must exactly be the facts mentioned in the items 3 and 4.
6. As a result of the state of the cathedral area the graves on the territory may be washed out by the underground waters and this factor may be intensified during wet weathers.

The existing circumstances mean that the alarming situation on the territory of Svetitskhoveli Cathedral and its surrounding area has been caused by so called acquired factors. These factors are intensifying from day to day and we suppose it is necessary to continue fully work using different and among them geophysical prospecting methods.

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