

Archaeogeoradiolocation Near-Surface Survey of the Area Surrounding Svetitskhoveli Cathedral

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ABSTRACT

Georadiolocation work was carried out in the vicinity of Svetitskhoveli Cathedral in 2025 with a georadar Zond 12e and 500 MHz receiving-transmitting shielded antenna. Interpretation of georadar sections revealed radio features of anthropogenic objects at depths of 1m and up to 3m. Radio features of objects with both cylindrical and angular surfaces were recorded at depths of 4-6m. Interpretation of separate georadiolocation sections conducted with a 150MHz dipole antenna revealed radio features of continuous layered, anthropogenic objects at depths of 1-3m. The radio feature of an object with a cylindrical segment was partially identified at depths of 6-7m. According to the results of the geo-radiolocation work performed, the surveyed area is loaded with archaeological sites

Keywords: archaeogeoradiolocation, radargram, radio face.

Historical situation of the research area

Svetitskhoveli Cathedral — the main patriarchal cathedral of the Georgian Orthodox Church, the mother church of Georgia, the place of the enthronement (enthronement) of the Catholicos-Patriarchs of Georgia, the burial place of many medieval Georgian kings, their family members and patriarchs. It is a monument of Georgian architecture of the 11th century, one of the four great cathedrals (Oshki, Bagrati Cathedral, Alaverdi) [1 - 9], located 20km from Tbilisi, in the city of Mtskheta. The Lord's Robe and the cloak of St. Elijah the Prophet are buried in Svetitskhoveli, the UNESCO World Cultural Heritage Site.

Svetitskhoveli is the largest historical church building in Georgia that has survived to this day. It was the religious center of Christian Georgia for centuries. King Mirian, who converted Georgia to Christianity in the 4th century, built the first church here on the advice of Saint Nino, which has not survived to this day.

Before the adoption of Christianity, pagan centers existed on the territory of Svetitskhoveli, including the idol of the sun and the tombs of the kings of Kartli, where rituals were performed in honor of the deities of Mtskheta-Caucasus; after Christianity, Christian churches were built on the remains of pagan buildings, symbolically uniting pagan and Christian Georgia, where the Svetitskhoveli Temple, "connecting heaven and earth", stands.

Pagan period:

Idol of the sun: On the site of the Svetitskhoveli Temple, there was an idol of the sun, which symbolically meant "connecting heaven and earth".

Royal necropolis: This area was the tombs of the kings of Kartli (Iberia), which gave it a special religious significance in Georgia during the pagan period.

Rituals: Rituals of worship of deities (including Mtskheta-Caucasus deities) were performed here.

Christian period (and its connection with paganism):

Spread of Christianity: After the proclamation of Christianity as the state religion in Georgia by Nino, Mtskheta remains the religious center of Georgia.

Construction of the temple: Instead of pagan idols, the first churches were built on this very site, and eventually the Svetitskhoveli Cathedral, which symbolically represents the connection between the pagan past and the Christian future.

Archaeological excavations: Archaeological excavations conducted on the territory of Svetitskhoveli have revealed the remains of buildings of different times, including signs of the pagan period.

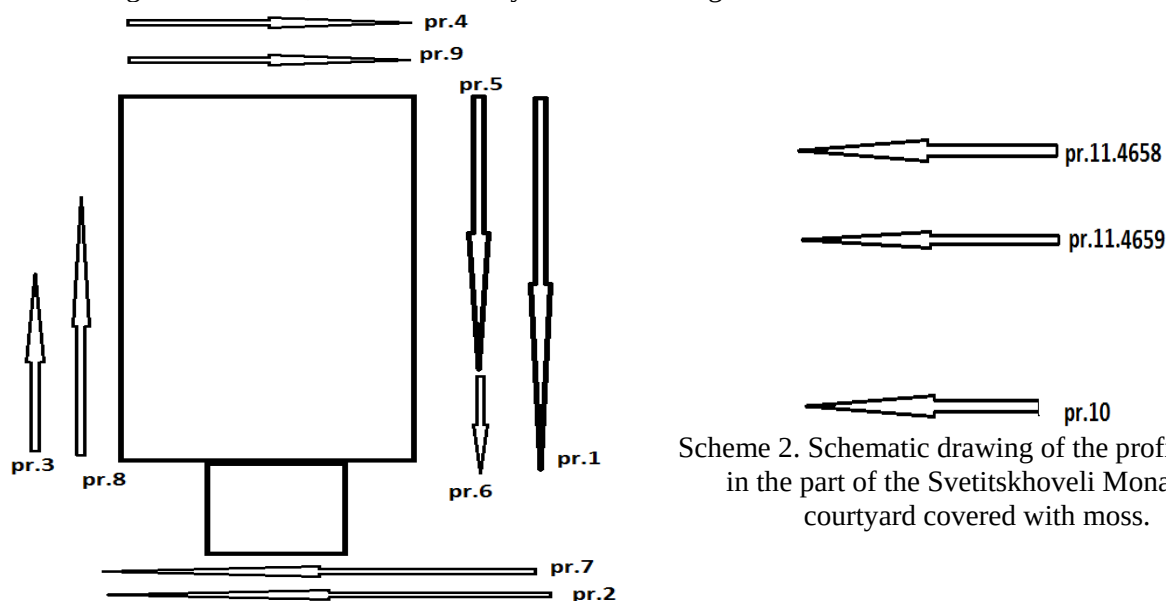
Svetitskhoveli is therefore not only a Christian sanctuary, but also historically the place where Georgian statehood and religious center stay from the pagan era to the Christian era.

Svetitskhoveli Cathedral is surrounded by a square-shaped fence (121.6m; X 110.5m). It was built in 1787 by the order of the king Erekle II.

Archaeogeoradiolocation instruments and placement of georadiolocation profiles

Archaeogeoradiolocation[10 - 20] works were carried out to record the radio features of near-surface archaeological sites in the vicinity of the Svetitskhoveli Cathedral. Georadiolocation profiles/cuts were conducted around the temple, a schematic diagram of their placement is shown in Scheme 1, with a 500MHz frequency shielded georadar „Zond 12e” receiving-transmitting antenna, soft Prizm 2.7.

Three parallel georadar profiles were also conducted with a 150MHz frequency dipole receiving-transmitting radar antenna, the schematic layout of which is given in the Scheme -2.



Scheme 2. Schematic drawing of the profiles taken in the part of the Svetitskhoveli Monastery courtyard covered with moss.

Scheme 1. Schematic drawing of a 500 MHz transceiver with a shielded antenna deployed around Svetitskhoveli.

Results and conclusion

Below are the plots of geo-radiolocation profiles around the Svetitskhoveli Monastery.

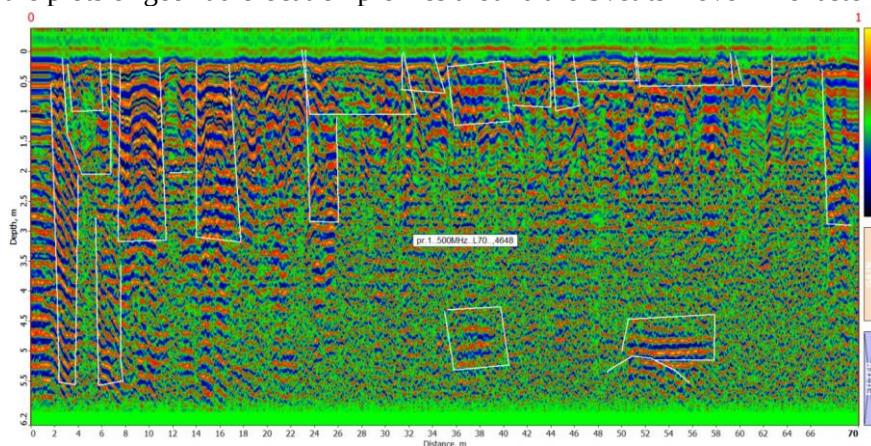


Fig. 1. The radargram of profile-1, performed with a shielded GPR antenna at 500MHz. The length of the profile is 70m, its approximate location is given in the Scheme 1.

In Fig. 1, on the radar image of profile-1, at a distance of 2-4 meters, a radio image of a possible architectural plane with a slope was marked with lines. At a distance of 4-5 meters, a deformed radio image with a depression was marked. The radio image of the object marked at a distance of 6-8 meters partially coincides with the radio image of the object recorded at a distance of 2-4 meters. At distances of 8-10 and 24-26 meters, radio images of the remains of the foundation or the remains of a covered wall were marked, their symmetrical placement is striking. At distances of 26-32 meters, a radio image of an object with a type of overlap, presumably of anthropogenic origin, with depressions up to 1 meter. The location of an object with a similar radio image is considered at distances of 46-50 meters. A number of depressions were marked at 1.5 meters. The radio image of a highly reflective object was observed at a distance of 36-40m, with a depth of 4.5-5.5m. It is noteworthy that at distances of 50-56m and 58m, the cylindrical-like object was overlapped by a highly reflective flat object, with an average depth of 5m.

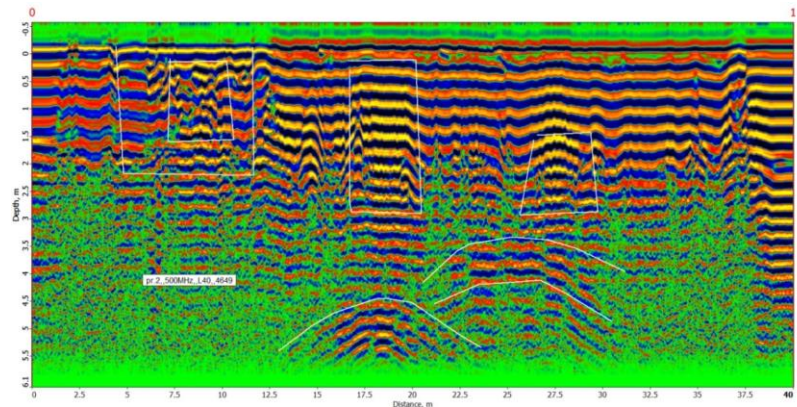


Fig. 2. The radargram of a profile-2 made with a shielded antenna of a georadar, 500MHz. The length of the profile is -40m, its approximate location is given in Scheme 1.

Fig. 2, at distances of 6-8m and at a depth of 2m, shows a complex, structured object with a cavity. At a distance of 17-20m, up to a depth of 3m, a radio image of a presumably foundation remnant is recorded, which surrounds the cylindrical, tubular cavity object, marked with a white hyperbolic line at distances of 16-20m. The radio image of the object recorded at a distance of 23-27m, which surrounds the 3.5-5m depth, is important. At a distance of 26-28m, at a depth of 2-3m, a radio image of an object with a diameter of up to 1m was noted.

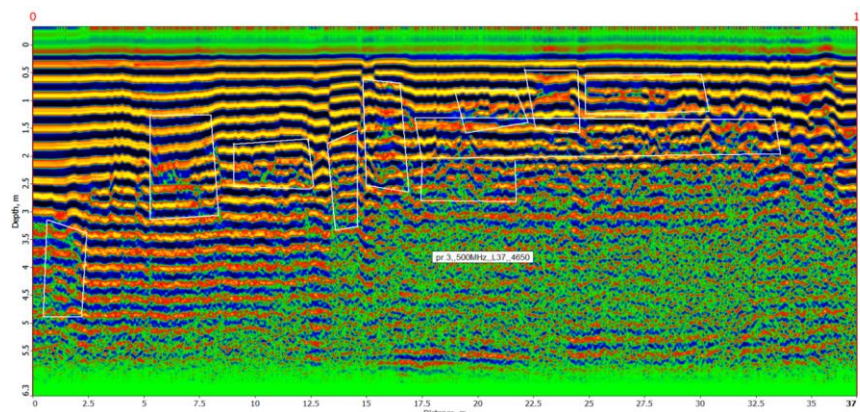


Fig. 3. The radargram of the profile-3 performed with a shielded antenna of a georadar, 500MHz. The length of the profile is 37m, its approximate location is given in Scheme 1.

From the radargram presented in Fig. 3, according to profile-3, a partially deformed cavity radio image is visible from 3m depressions and at 1-2m distances. The texture of the axes of disturbed synphasicity is read at 5-12m distances. A certain structural integrity is created by the combination of the types of objects marked at 15-35m distances.

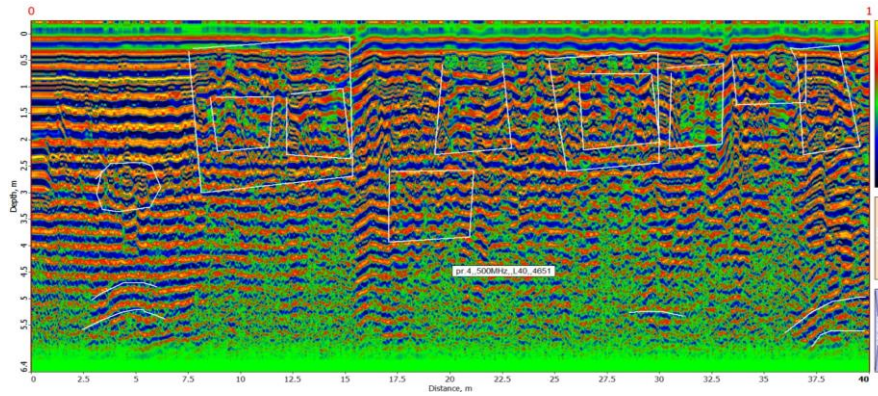


Fig. 4. The profile-4 made with a shielded antenna of a GPR, 500MHz. The length of the profile is 40m, its approximate location is given in the Scheme 1.

Fig. 4, presenting the profile-4, shows the radio images of objects with cavities of probable anthropogenic origin at distances of 7-30m, which are similar to the radio image marked on profile 2 at distances of 7.5-10m. Also interesting are the radio images of cylindrical objects at distances of 5 and 40m, at depths of 5m.

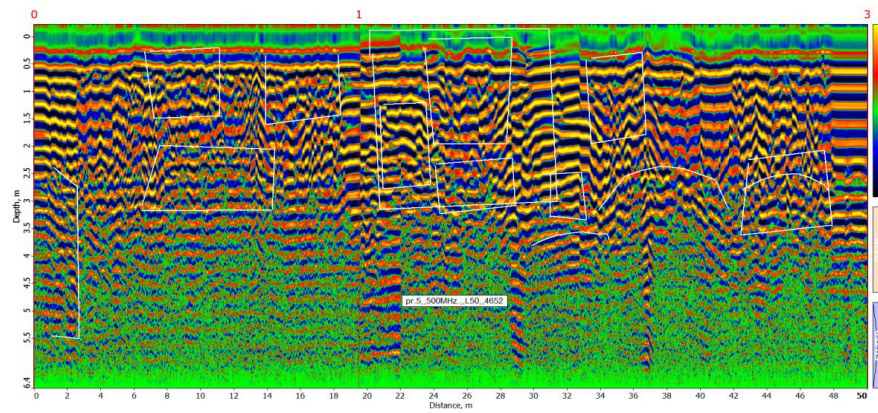


Fig. 5. The profile-5 made with a shielded antenna of a georadar, 500MHz. The length of the profile is 50m, its approximate location is given in the Scheme 1.

From the radargram of Prof-5 presented in Fig. 5, a radio face is read, which coincides with Prof-1 at distances of 1-2m. At distances of 7-11m and 14-19m, objects with similar radio face cavities were noted, perhaps the cavities were partially filled with other material due to the passage of time or external interference. At distances of 8-14m, a radio face of an object with an overlap was noted. A radio face with a structurally uniform face is at distances of 22-30m. There are overlapping radio faces for objects at distances of 38m and 40m.

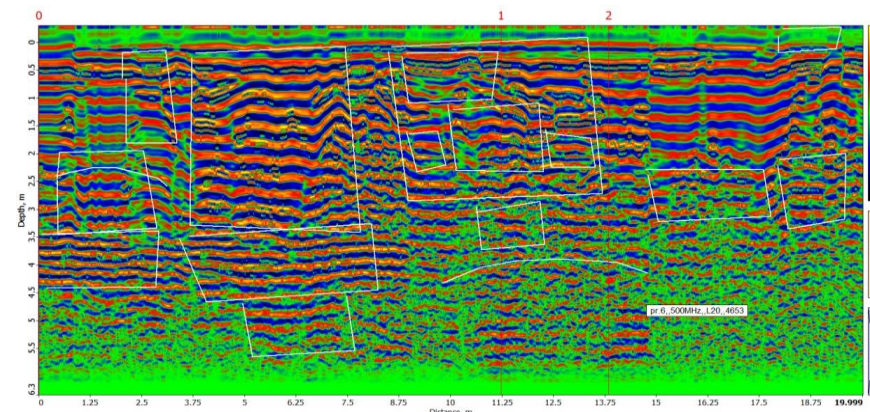


Fig. 6. The profile-6 made with a shielded GPR antenna, 500 MHz. The length of the profile is -20m, its approximate location is given in the Scheme 1.

The profile 6, presented in Fig. 6, shows a number of radio faces that correspond to objects with a cavity at distances of 1, 2, 3m with a deepening of 3.5m. The radio face of a symmetrical object at distances of 9-13m. An object with a possible overlap at distances of 11-13m was marked.

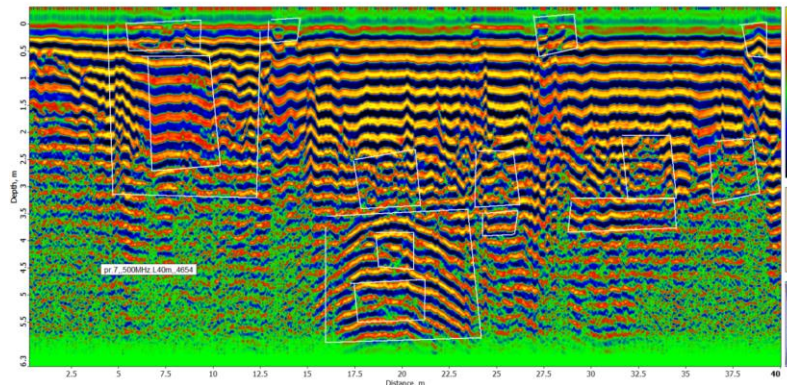


Fig. 7. The profile 7 made with a shielded antenna of a georadar, 500MHz. The length of the profile is -40m, its approximate location is given in the Scheme 1.

From the radargram of profile 7, shown in Fig. 7, 1-2m wide depressions were marked at depths of 0.5-0.8m and distances of 7.5-14-28-39m. At distances of 5-12.5m and up to 3m depth, a partially concave symmetrical inhomogeneous cavity was recorded from the left. At distances of 20-22-25-32.5-37m we record, on average, 2m wide hollow objects, possibly partially filled with permeable material. At a distance of 15-25m, a clearly expressed complex structured radio face of an object with double, superimposed cameras was noted. The upper part of this radio face coincides with the radio face of the object marked on Prof-2, both in terms of location and dimensions, they must have been continuous intersections of the object. The radio face of a similar object on Prof-2 is weakly readable at a depth of 5m, at distances of 30-32m.

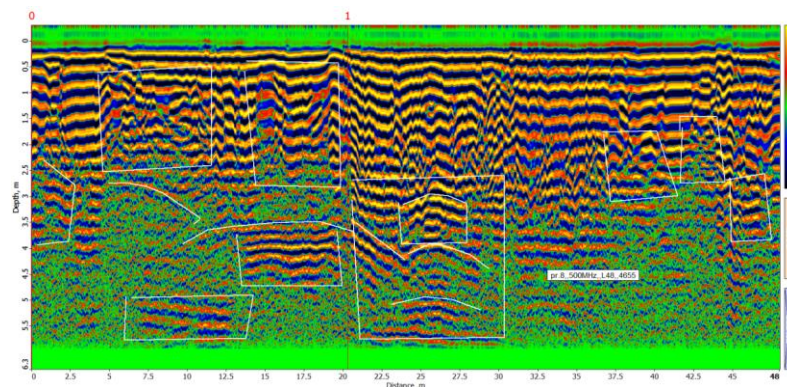


Fig. 8. The profile 8 made with a shielded antenna of a georadar, 500MHz. The length of the profile is -48m, its approximate location is given in the Scheme 1.

Fig. 8 shows the radargram of profile 8, where at distances of 5-11m and a depth of up to 2.5m, a cavity of anthropogenic origin was marked. At distances of 15-20m, there is an area with textural changes, possibly a concave cavity. At distances of 37-40m, cavities of anthropogenic origin are marked. At distances of 22-30m and depths of 3-5.5m, a radio image of a hollow object is presented, it is possible that the cavity is located above a cylindrical object, the left side is partially buried. At distances of 6-12m, a radio image of a horizontally located object with an overlap above was marked. A similar, but heavily deformed, radio image of a symmetrically located object may be seen at distances of 32-37.5m, 4m below the ground.

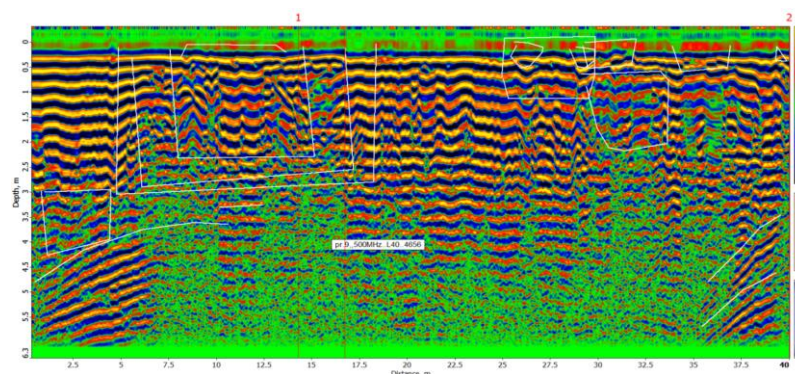


Fig. 9. The profile 9 made with a shielded antenna of a georadar, 500MHz. The length of the profile is -40m, its approximate location is given in the Scheme 1.

Fig. 9 (profile 9) shows a radio image of a practically symmetrical complex-structured object at distances of 5-15m, deepened to 3m. Surface, up to 0.8m indentations are marked at distances of 26-40m. At distances of 0-4m, at depths of 3-4.5m, a radio image of an object containing a deformed cavity was marked. At distances of 0-7m, deepened to 4m, a radio image of an object with strong reflectivity was marked, presumably - part of a structure. There is also a sloping wall, part of the foundation, radio-imaged at distances of 35-40m, and a depression - from 4m down.

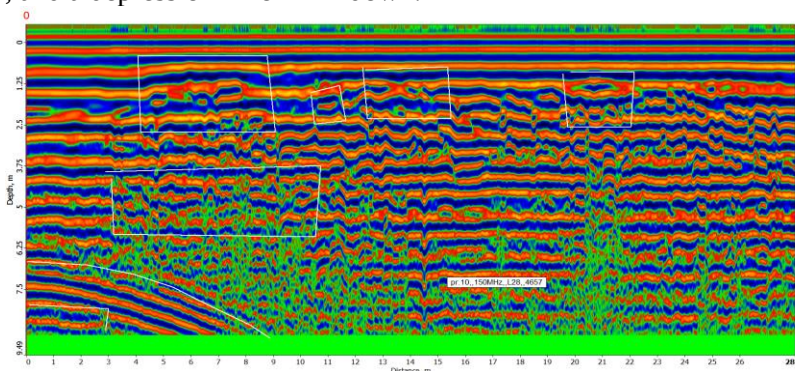


Fig. 10. The profile 10 made with a georadar dipole antenna, 150 MHz. The length of the profile is -28m, its approximate location is given in Scheme 2.

The radargram shown in Fig. 10 (profile 10) revealed the presence of a hollow object of possible anthropogenic origin at a depth of 1-2m and at distances of 4-9m, as well as radio images of various hollow objects at distances of 11-14-21m. At a distance of 11 m, there is a radio image of a pipe-type cross-section, at 14, a radio image of a hollow object 2m wide and 1.5m high, and at 21m, there is also a radio image of an anthropogenic object. At a depth of 3.37m to 6m and at distances of 3m to 10m, a radio image of a converted object with two cavities, presumably an old object, was noted. The radio image of the object, visible at distances of 0-9m from 7m depths, is important.

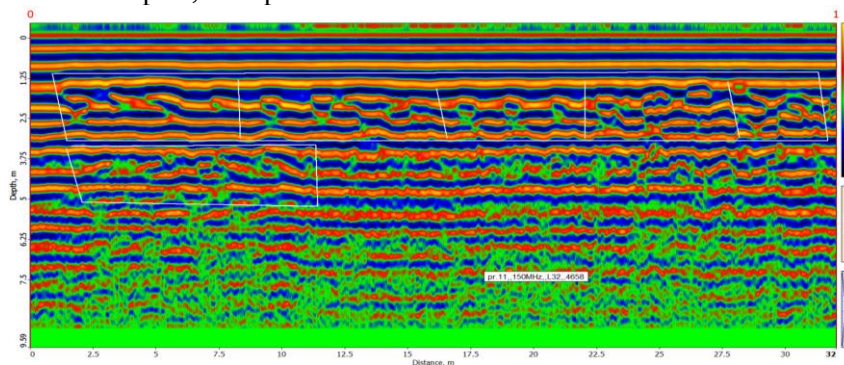


Fig. 11. The profile-11 (4658) made with a georadar dipole antenna, 150MHz. The length of the profile is - 32m, , its approximate location is given in Scheme 2.

At distances of 2.5-32m (Fig. 11- profile-11), at depths of 1-3m, the radio faces of structurally uniform objects were marked, for periodically alternating hollow structures. At distances of 2.5-10m, at distances of 3.37-6m, the radio face of a structurally uniform object was marked. It is symmetrical and contains hollows and its radio face extends downwards without interruption.

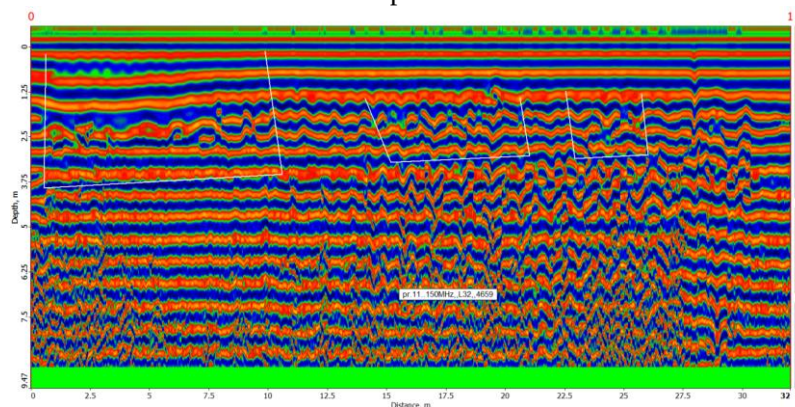


Fig. 12. The profile-12 (4659) made with a georadar dipole antenna, 150MHz. The length of the profile is - 32m, , its approximate location is given in Scheme 2.

Fig. 12 (profile-12) shows a radio image of a symmetrical structure at distances from 3.37 to 10m, similar in size and location to the radio image of the corresponding object marked in Fig. 11. The structure of the subsoil layer is quite heterogeneous, which may be due to the violation of the integrity of the soil at different times.

Conclusion

The following is observed from the profiles 1-11 obtained by interpreting the georadiolocation cuts made with a 500 MHz receiving-transmitting shielded antenna of the georadar;

In the studied area, both at depths of 1m and up to 3m, radio features of anthropogenic objects, fully or partially deformed, are recorded, marked on radargrams with white lines.

In the depths of 4-6m, radio features of objects with both cylindrical and angular surfaces are recorded, marked on radargrams with white lines.

Interpretation of georadiolocation cuts conducted with a 150MHz dipole antenna reveals continuous layered radio features of anthropogenic objects at depths of 1-3m. A radio feature of an object with a possible cylindrical segment was partially recorded from depths of 6-7m.

According to the results of the performed georadiolocation work, the studied area is loaded with archaeological objects.

References

- [1] Material from Wikipedia - The Free Encyclopedia.
- [2] Beridze V. Old Georgian Architecture, Tbilisi, 1974.
- [3] Chubinashvili G. Georgian Architecture in the Middle Ages and Its Three Main Cathedrals, tr.: Aril, Tbilisi, 1925.
- [41] Gverdtsiteli R. Mtskheta, Tbilisi, 1962.
- [5] Description of Monuments of History and Culture of Georgia. Editorial Board: V. Dolidze, S. Kintsurashvili, U. Sidamonidze, Tbilisi, Vol.5, 1990.
- [6] Natroev A. Mtskheta and its Cathedral of Sveti-Tskhoveli. Historical and Archaeological Description. 1900.
- [7] Opening of the 11th Century Gate in the Svetitskhoveli Wall. // Journal. Friend of the Monument, No.1 Tbilisi: Soviet Georgia, 1964. — pp. 6-10.
- [8] Svetitskhoveli as a resting place. //Journal. Friend of the Monument, No. 69 Tbilisi: Soviet Georgia, 1985. — pp. 25-32.

- [9] Kudava B. The burial place of the Georgian king: personal choice, tradition or political decision?, "Historian" (a scientific collection dedicated to the 80th anniversary of the birth of Roin Metreveli), Tbilisi, 2019, pp. 139-167.
- [10] Odilavadze D., Goguadze N., Jakhutashvili M., Vepkhvadze S., Kachakhidze M., Kachakhidze N. Results of primary georadiolocation searching of Svetitskhoveli Temple. GESJ: Physics, ISSN 1512-1461 31, No.1(9), 2013.
- [11] Ioseliani P. Description of the antiquities of the city Tiflis. 1866, pp. 132-133, (in Russian).
- [12] Georgian Soviet Encyclopedia, T. 7, Tbilisi., 1984, p. 440, (in Georgian).
- [13] Odilavadze D., Kiria J., Ghlonti N., Yavolovskaya O. The Results of archaeogeoradiolocation investigations of the territory inside the rampart of St. Sophia Church of Khobi. „Moambe”, Bulletin of the Georgian National Academy of Sciences, V.14, n.4, 2020, pp. 51-56.
- [14] Chelidze T., Odilavadze D., Pitskhelauri K. Archaeogeophysics in Georgia-New Results, New Prospects. Proceedings of the Georgian National Academy of Sciences. Series of History, Archeology, Ethnology and Art History, №.15, 2013, pp. 24-34.
- [15] Odilavadze D.T., Chelidze T.L. A Preliminary GPR investigation of Metekhi Cathedral and the surrounding area. Journal of Georgian Geophysical Society, № 14, 2010, pp. 32-38.
- [16] Kofman L., Ronen A., Frydman S. Detection of model voids by identifying reverberation phenomena in GPR records. Journal of Applied Geophysics. (59), 2006, pp. 284-299.
- [17] Odilavadze D., Chelidze T., Yavolovskaya O. Some georadiolocation images of cylindrical bodies built with different dielectric fillers, placed in a dielectric environment. International Scientific Conference "Geophysical Processes in the Earth and its Envelopes". Proceedings, ISBN 978-9941-36-147-0, Tbilisi, Georgia, November 16-17, 2023, pp. 217-220.
- [18] Odilavadze D., Chelidze T., Ghlonti N., Yavolovskaya O. Determining the presence and structure of a subsurface radioactive burial when interpreting the results of the GPR method by analyzing a three dimensional rotating radio image. Journal of the Georgian Geophysical Society, e-ISSN: 2667-9973, p-ISSN: 1512-1127. Physics of Solid Earth, Atmosphere, Ocean and Space Plasma, v. 25(1), 2022, pp. 21-28.
- [19] Odilavadze D., Chelidze T., Yavolovskaya O. The radio image of an object with an elongated, face-fragmented, dielectrically complex structure was studied using the method of georadar physical modeling. Journal of the Georgian Geophysical Society, e-ISSN: 2667-9973, p-ISSN: 1512-1127, Physics of Solid Earth, Atmosphere, Ocean and Space Plasma, v. 27(2), 2024, pp. 15-28.
- [20] Odilavadze D., Chelidze T., Yavolovskaya O. Preliminary archaeogeophysical survey of the construction site in the vicinity of the Narikala Citadel. Journal of the Georgian Geophysical Society, e-ISSN: 2667-9973, p-ISSN: 1512-1127. Physics of Solid Earth, Atmosphere, Ocean and Space Plasma, v. 28(1), 2025, pp. 27-35.
- [21] Odilavadze D., Chelidze T., Ghlonti N., Kiria J., Yavolovskaya O. Archaeogeoradiolocation Research of the Territory of the Ninotsminda Monastery Complex. Transactions of Mikheil Nodia Institute of Geophysics, ISSN 1512-1135, vol.LXXVIII, 2025, pp.20-34.

სვეტიცხოვლის საკათედრო ტაძრის მიმდებარე ტერიტორიის არქეოგეორადიოლოკაციური ახლოქვეზდაპირული კვლევა

დ. ოდილავაძე, თ. ჭელიძე, ო. იავოლოვსკაია

რეზიუმე

სვეტიცხოვლის საკათედრო ტაძრის გარშემო სიახლოვეში 2025წ ჩატარდა “Zond 12e” გეორადარის 500მჰც მიმღებ-გადამცემი ეკრანირებული ანტენით გეორადიოლოკაციური სამუშაო. გეორადარული ჭრილების ინტერპრეტაციით გამოიკვეთა, როგორც ზედაპირთან ახლო 1 მ, ასევე 3-მდე დაღრმავებებზე ანტროპოგენული წარმოშობის ობიექტთა რადიოსახეები. დაღრმავებებზე 4-6 მ ფიქსირდება, როგორც ცილინდრული ზედაპირის მქონე

ასევე კუთხოვანი ზედაპირის მქონე ობიექტების რადიოსახეები. 150მჰც სიხშირის დიპოლური ანტენით გატარებული ცალკეული გეორადიოლოკაციური ჭრილების ინტერპრეტაციით იკვეთება 1-3 მ დაღრმავებებზე განგრძობითი ფენობრივი, ანტროპოგენული ობიექტების რადიოსახეები. მოინიშნა, ნაწილობრივ, ცილინდრული სეგმენტის მქონე ობიექტის რადიოსახე 6-7 მ დაღრმავებიდან. შესრულებული გეორადიოლოკაციური სამუშაოს შედეგების მიხედვით, გამოკვლეული ტერიტორია, დატვირთულია არქეოლოგიური ობიექტებით.

საკვანძო სიტყვები: არქეოგეორადიოლოკაციური სამუშაოები, გეორადარი, რადიოსახე, რადაროგრამა.

Археогорадиолокационное приповерхностное обследование территории, прилегающей к кафедральному собору Светицховели.

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Резюме

В 2025 году в окрестностях собора Светицховели были проведены георадиолокационные работы с использованием экранированной приемопередающей антенны георадара «Зонд 12е» с частотой 500МГц. Интерпретация георадарных срезов выявила радиохарактеристики антропогенных объектов на глубинах от 1 до 3 м. На глубинах 4-6м были зарегистрированы радиохарактеристики объектов как с цилиндрической, так и с угловатой поверхностью. Интерпретация отдельных георадиолокационных срезов, проведенная с помощью дипольной антенны с частотой 150МГц, выявила радиохарактеристики сплошных слоистых антропогенных объектов на глубинах 1-3м. На глубинах 6-7м была частично идентифицирована радиохарактеристика объекта с цилиндрическим сегментом. По результатам проведенных георадиолокационных работ, обследованная территория насыщена археологическими памятниками.

Ключевые слова: археогорадиолокационные работы, георадар, радио образ, радарограмма.