Cultural Heritage & Modern Technologies

www.aaatec.org ***ISSN** 2837-0759*

DOI: 10.24412/2837-0759-2024-2291299
UDC: 904+004.9

3D reconstruction based on archival materials: the case of the Genoese castle on the Panea rock (XV century, Crimea)

Nikita D. Denisenko[1], Larisa N. Vodolazhskaya[2], Egor O. Akhunov[3], Gleb A. Burlin[3], Kirill A. Korolev[3], Oleg V. Pipa[3]

Abstract

The paper is devoted to the study of the prospects of 3D-reconstruction of archaeological monuments landscape on the basis of archival materials. This approach may be relevant for monuments that have not been preserved to date (or are poorly preserved) due to the influence of anthropogenic and natural factors. This is especially relevant for seismic zones and zones of military operations. In some cases (for example, in the case of the Byzantine fortress Gaspra-Isar (XII-XIII centuries, Crimea) - the monuments may have been destroyed during large construction projects. The research is based on the reconstruction of the landscape of the Genoese fortress on the Panea rock (XV century, Crimea) based on the materials of the works of the South Coast detachment of the Department of Ancient and Medieval Archaeology of the Ukrainian SSR Academy of Sciences Institute of Archaeology in 1966-1968. These materials are stored in the Scientific Archive of the Institute of Archaeology of Crimea RAS. The study uses a technique that can provide a very accurate reconstruction of the landscape on the basis of topographic maps and photographic materials. The methodology can be applied to the reconstruction of now lost archaeological monuments.

Keywords: 3D reconstruction, 3D modeling, medieval archaeology, archival materials, Crimea.

1. Introduction

In recent years we have seen an increase in examples of the use of 3D modelling in archaeological research. 3D models derived from scanning or photogrammetry are usually used to visually accompany the material in an article. Nevertheless, 3D models are increasingly used for spatial analysis of archaeological monuments, their illumination, and composition. 3D-reconstruction in this context means the restoration of the external appearance of a monument at a certain time of its existence for representative purposes (Matej 2020, p. 155). The virtual space of the reproduced monument allows to re-examine it in a new plane: to assess its illumination,

[1] Institute of Archeology of Crimea RAS, Simferopol; e-mail: medievale.urbano@gmail.com
[2] Southern Federal University, Rostov-on-Don; V.I. Vernadsky Crimean Federal University, Simferopol; e-mail: larvodol@gmail.com
[3] V.I. Vernadsky Crimean Federal University, Simferopol

dependence on the surrounding landscape, as well as to compare scientific hypotheses of the details of buildings and assess the possibility of their existence (Georgopoulus 2014, p. 160).

Another goal of virtual reconstruction - to recreate the appearance of monuments that have been completely lost to date. Recently, more and more methods for achieving this goal have appeared in science. In this article we summarise the experience of landscape reconstruction based on archival materials of the past years. Such a method is relevant for Crimea, where anthropogenic impact threatens many partially explored monuments. The Genoese castle on the Panea rock in Simeiz (fig. 1), investigated by archaeologists in 1966, was chosen to test the method. Its example is important for future studies of castles on the Crimean south coast, but above all for the reconstruction of the Byzantine castle in the village of Gaspra, which was blown up together with the rock on which it stood during the construction of a highway in 1968.

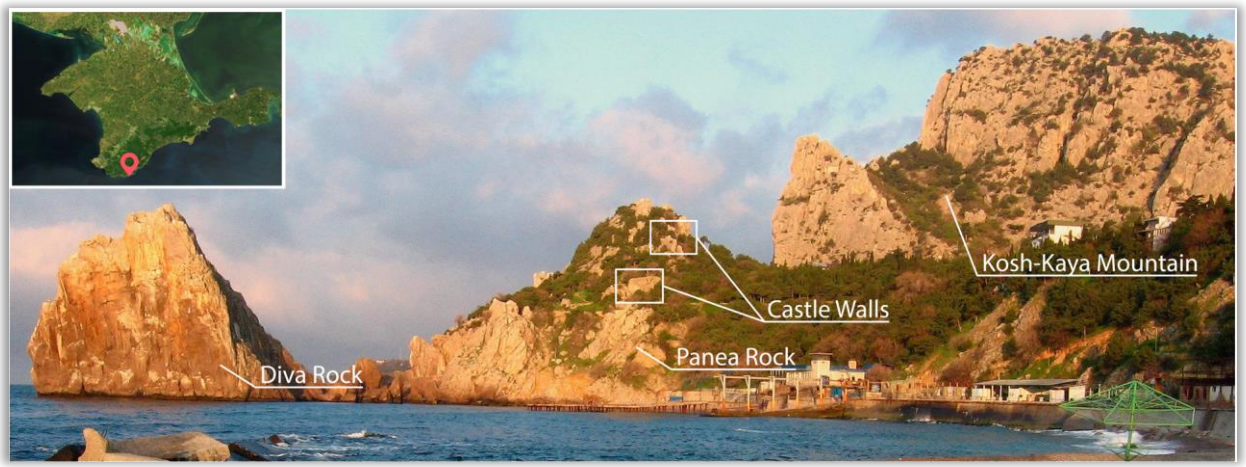

Figure 1. Panea Rock and its surroundings.

2. Genoese castle on the Panea Rock

The Genoese castle on the Panea Rock is located on the outskirts of the village of Simeiz on the southern coast of Crimea. At the moment it represents by several sections of walls, preserved almost to the level of the battle passage. The area of the castle is 0.27 hectares. The structure has an irregular shape in plan, close to a rectangle, three sides of which form fortress walls, the fourth is a rocky cliff 56 m long, 60-70 m high. The largest dimensions of the fortress site are about 40.0x61.0 m (excluding the area of the cliff) (Bocharov 2021, p. 290). The total length of the fortress walls is about 175.0 m. The castle consisted of one tower (according to S. G. Bocharov) or two or three (according to O. I. Dombrovsky) towers and five curtain walls. Panea - a narrow rock protruding into the sea with sharp precipices and a small area that served as the inner court of the fortress. The rock is located on the southern slope of the Kosh-Kaya mountain. In front of Panea, in the sea, rises the sharp Diva rock.

The first mention of fortifications on the Panea rock is made by P. Pallas in his '*Observations made during a journey through the southern provinces of the Russian state in 1793-1794*'. He describes an unnamed rock '*in the form of an arrow*' and a fortress wall two *arshin* thick (1.42 m) with an outer shell made of large stones laid on lime mortar. In addition, P. Pallas reports that on the plateau behind the rocks on the same cliff he saw the foundations of an old building of unhewn stones with quadrangular rooms, and next to it - a fragment of a column of white marble (Pallas 1999, p.73). Based on this description, we can assume that P. Pallas saw the remains of a medieval temple, discovered and studied during archaeological surveys in 1966 by O. I. Dombrovsky. P. Pallas also gives the Tatar name of the fortress: '*Tshiva*'. (Pallas 1799, p. 54). It is noteworthy that

I.M. Muravyov-Apostol visited in 1820. Simeiz called the rock with the fortress '*Dziva*', assuming, among other things, its Genoese origin (Muravyov-Apostol 1820, p. 167). Travelling in the Crimea in 1831-1833. S. Montandon, travelling in the Crimea in 18-1833, describing the remains of the fortification near the rocks of '*Limen Cape*' (Kosh-Kaya), mentions the large number of fragments, '*pieces of bricks covered with glaze, sometimes with relief images*' and also gives the name of the fortress: '*Tsiva*' (Montandon 2011, p. 143). (Montandon 2011, p. 143). *Dziva* in translation from Crimean Tatar - 'demon, demonic'. It is possible that *Dziva* is a derivative of *Genevez* - 'Genoese', as this name is often found in the Crimea on the site of former Genoese fortifications. Either way, apparently, the name of the fortress became the name of the rock in front of it and survived to this day as Diva. The name Panea in relation to the fortress rock is given by P. Keppen in 1837, referring to the remains of the castle described by P. Pallas (Keppen 1837, pp. 198-200). The same name is found in V.H. Kondaraki, he notes that the fortress is called so by the Simeizians (Kondaraki 1867, p. 37). Up to the Soviet time, references to the fortifications on the Panea rock only occasionally appear in guidebooks. For the first time the fortress as an archaeological monument is noticed by N. L. Ernst and dates it to the IX- XII centuries (Ernst 1935, p. 433).

The first archaeological research of the monument is carried out by the South Coast detachment of the Crimean department of the Institute of Archaeology of the Academy of Sciences of the Ukrainian SSR under the leadership of O. I. Dombrovsky in 1965, in connection with the robbery excavations carried out by holidaymakers a year earlier. In addition to determining the boundaries of the monument and examining the protruding remains of the walls, they excavated a building (which they called '*donjon'* for some reason) on the middle platform of the rock and a temple on the lower one. After the works were completed, in 1968, a topographic plan of the area was drawn up, which was used to create a plan of the fortress, indicating the discovered and proposed buildings.

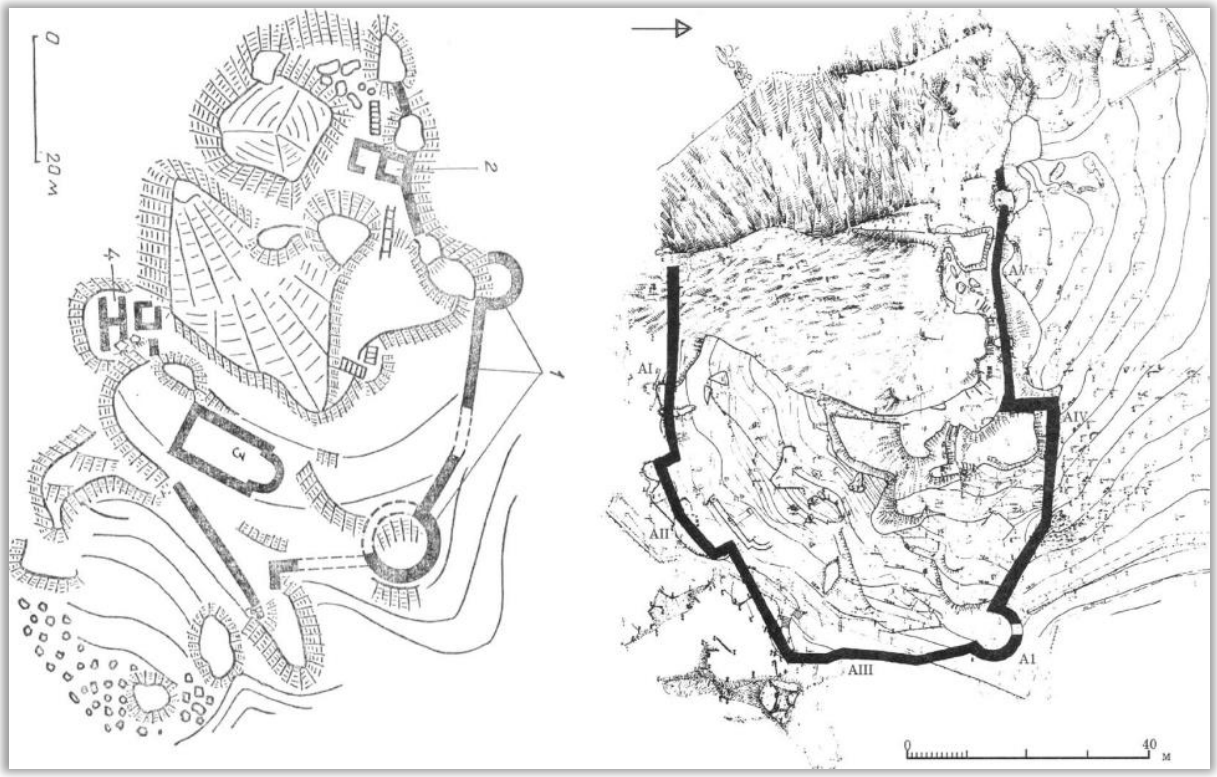

Figure 2. Plans of the castle (on the left by O. I. Dombrovsky, 1974, on the right by S. G. Bocharov, 2004).

The archival materials of the expedition preserved plans for the reconstruction of a number of objects on the territory of the fortress and plans for the construction of outbuildings for the creation of a museum of the Genoese fortress in Simeiz, as well as artistic details for the design of the stand plan of the fortress, but these ideas remained unrealized (Parshina, 1966, Sh. 1-7). In 1974, the results of the 1966-1968 work were summarised by O. I. Dombrovsky (Dombrovsky 1974, pp. 27-30). The article describes the character of the fortifications and a large house adjoining it on the middle ground, called the guardhouse (ex-donjon). However, the plan attached to the article does not show a building on the middle ground, but it does show a large building on the upper ground, the presence of which is not reflected in any other plan or report (not to mention the fact that the upper ground could not accommodate a building of that size). Obviously, there is a serious error in the plan attached to the article (fig. 2). The following thorough description of the fortifications of Panea was prepared by L. V. Firsov for the work 'Isars of the mountain Crimea', but the chapter devoted to them was lost, or never compiled by the time of publication (the monograph was published after his death) (Firsov 1990, p. 289). In 1990 V. L. Myts gives a brief description of the fortress with measurements given in the above-mentioned reports of the South Coast detachment in 1966, confidently calls the fortress Genoese and dates its construction to the middle of the XV century (Myts 1990, p. 143).

In 2004, the staff of the East Crimean expedition of the Crimean branch of the Institute of Archaeology of the National Academy of Sciences of Ukraine conducted a survey of Panea. A new plan of the fortress was published the same year by S.G. Bocharov (Bocharov 2004, p. 203) (fig. 2). The key difference of the new plan from those drawn up by O. I. Dombrovsky is the absence of the second round tower in the middle part of the walls in the north of the fortification. C. Bocharov suggests that single-tower castles were a characteristic feature of small south coast Genoese fortresses. However, further development of the discussion about the character of the fortifications on the Panea Rock requires full-scale archaeological research of the fortress.

3. Landscape reconstruction based on archival materials

The project was proposed by Nikita D. Denisenko to the initiative group of students of the V. I. Vernadsky CFU Institute of Physics and Technology and was supervised by the faculty member Larisa N. Vodolazhskaya. In order to develop effective methods of museification of complex archaeological objects, it was decided to make an attempt to restore the landscape only on the basis of archival data.

The first stage of the work consisted in the search and identification of necessary materials. In the scientific reports stored in the Scientific Archive of the Institute of Archaeology of Crimea of the Russian Academy of Sciences we found a topographic plan of the Panea rock with archaeological complexes plotted on it, drawn up according to the results of the works in 1968 (Parshina, 1966, Sh. 12-13). The plan is large in size, divided into two sheets. A widescale A2 scanner was used to digitise the plan. The scans were merged in the Adobe Photoshop 2023 and then the two sheets of the plan were stitched together (fig. 3).

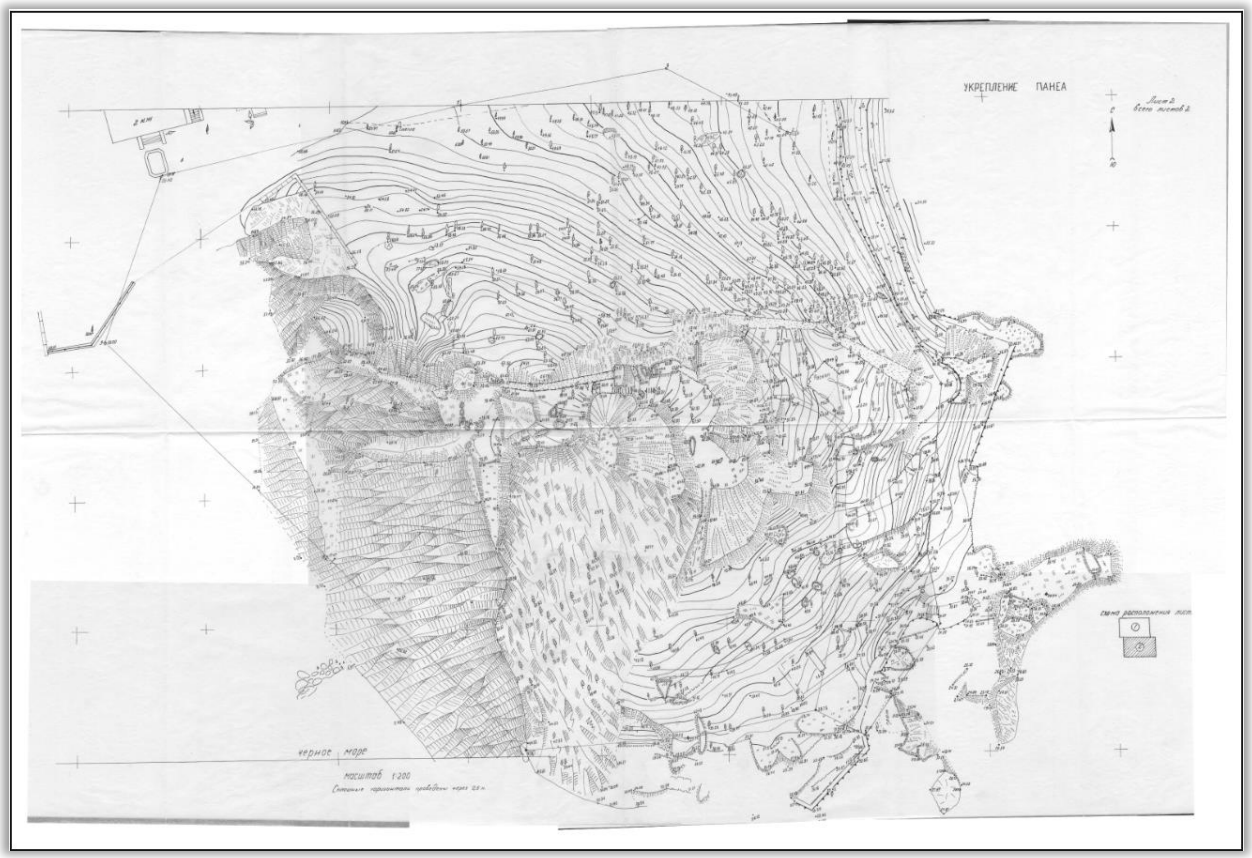

Figure 3. Sheet №2 of the topographic plan of the Panea Rock, connected in Adobe Photoshop.

The plan was refined and outlined in Adobe Illustrator (fig. 4). It was necessary to obtain a vector plan that could be used in further work without loss of quality. Outlining was performed in several stages, first isolines were drawn on the plan. Wide isolines were given 3 pixels, metre isolines were given 1.5 pixels. Drawing was performed with the Curvature tool. Individual height points were marked with red pixels. Then modern paths, park buildings, trees and green spaces were plotted. Additional height points were taken from the expedition diaries. Archaeological sites are not mapped on the final plan (they were planned to be added at a later stage of the work). Larisa. N. Vodolazhskaya vectorised the original plan in Adobe Photoshop to transfer small objects and shading from it.

At the next stage of work, the plan was transferred to the virtual environment of the three-dimensional editor Sketch-Up at a scale of 1 to 1. This allowed to work with the object in full size without the risk of mistakes in proportions. In order to build the 3D landscape model, each isoline and elevation point attached to individual objects (rocks, trees, etc.) was raised from the plan to the required height. To do this: 1. Using the Pencil tool, the required object was outlined on the plan; 2. Using the Move + Ruler tool, the object was moved along the y-axis to the height specified in the plan. Thus, the two-dimensional topographic plan became three-dimensional (fig. 5, 6).

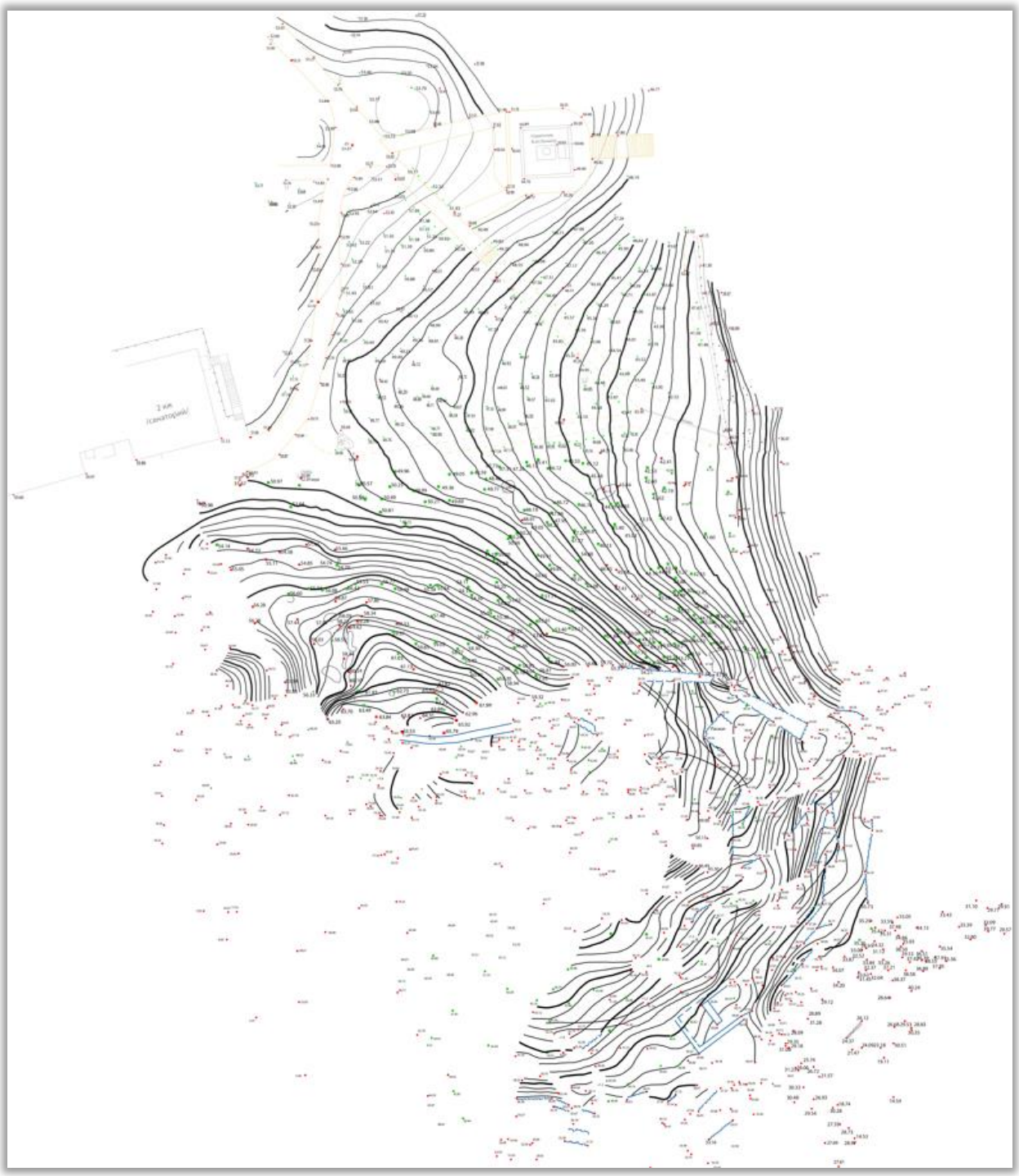

Figure 4. Final plan with elevations.

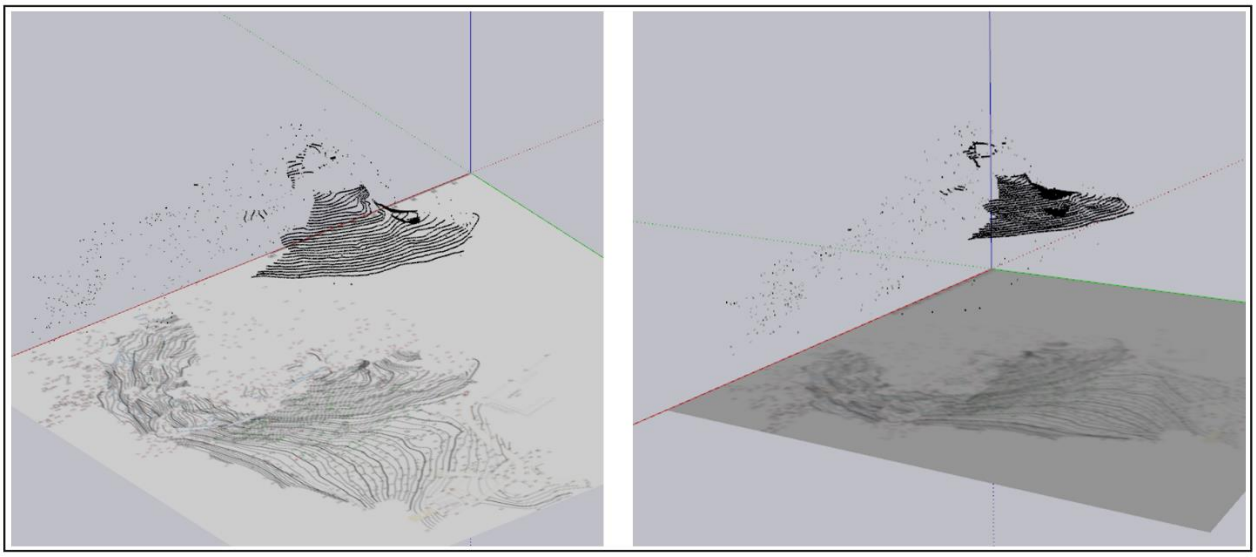

Figure 5. The process of creating a three-dimensional topography from a two-dimensional plan.

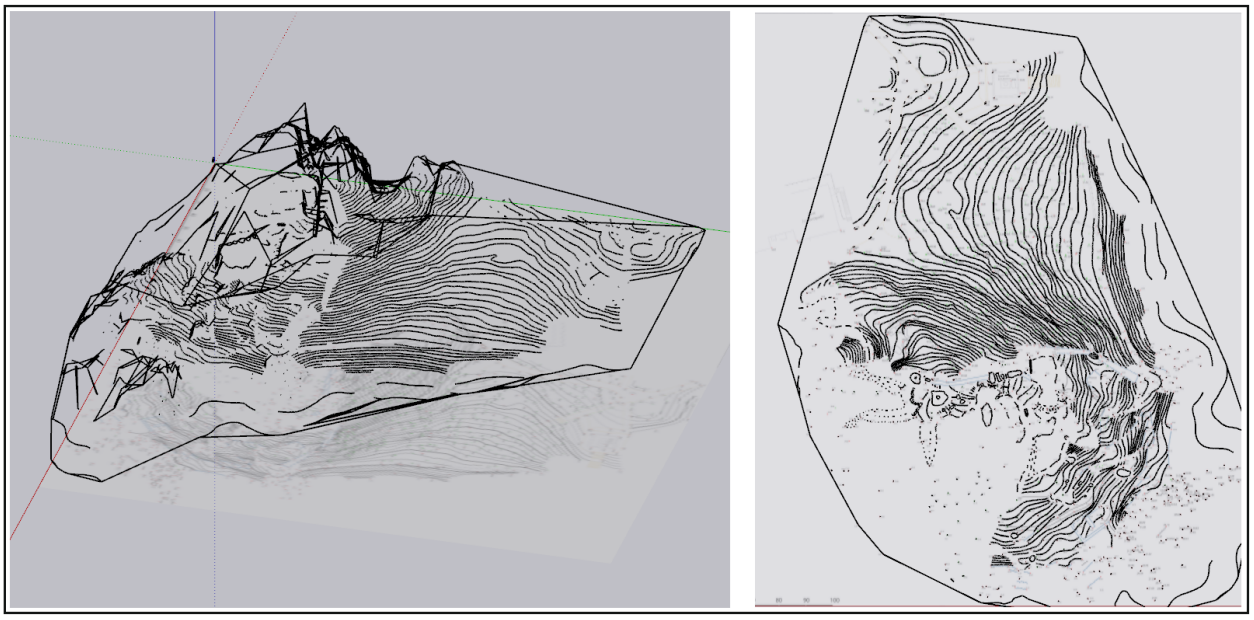

Figure 6. Three-dimensional topography of Panea Rock.

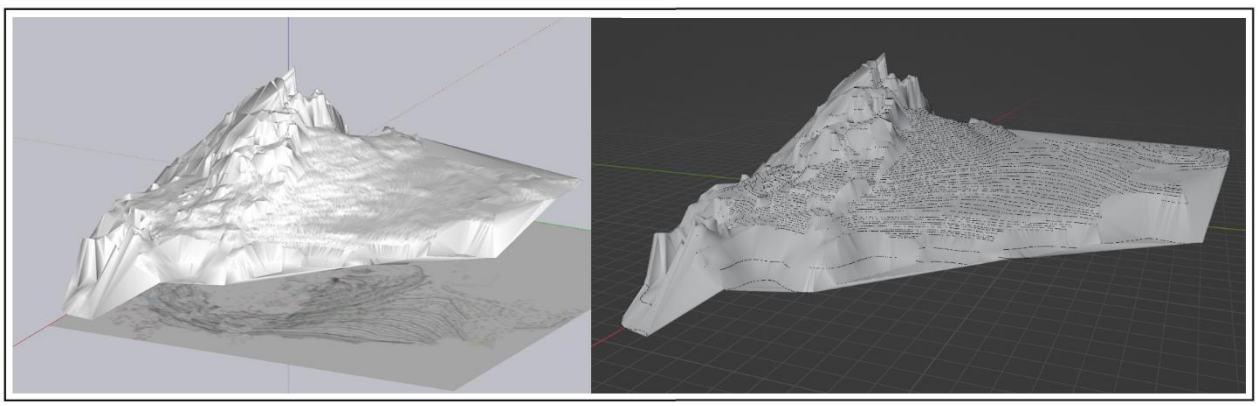

Figure 7. Three-dimensional elevation model of Panea Rock.

During the transfer process, a number of points were found to have been incorrectly plotted by the topographer. This is hardly noticeable on the two-dimensional plan, but creates serious errors on the three-dimensional model. These errors were eliminated and corrected on the final plan, which is also being prepared for publishing.

The resulting 3D plan was grouped and then applied to the Sandbox tool. This tool creates polygons between the three closest points, which is ideal for fast landscape modelling. As a result, a reliable 3D model of the Panea Rock landscape was obtained, modelled using only archived plans (fig. 7).

4. Conclusions

The results of the work were presented at the scientific conference dedicated to the 110th anniversary of O. I. Dombrovsky (30 October 2024) and aroused the interest of the audience. Among the advantages they noted the simplicity and adequate accuracy of this method. The method also solves the problem of impossibility of photogrammetric scanning on inaccessible monuments (Panea rock is covered with dense protected juniper forest). The initiative group is going to continue the work - we are planning to visit the monument to survey the coordinates of characteristic points by GNSS-station in order to give the final plan an actual geographical reference. In addition, there are plans to carry out photogrammetric capture of the exposed sections of the walls to place their 3D models on the virtual landscape, as well as to take photos of local stone rocks to texture the elevation model of the rock. Coordinate points will help to further refine the terrain model. The resulting 3D model will be transferred to the Yalta Historical and Literary Museum for online exposition, and will also be offered to historians and archaeologists as a basis for historical reconstruction of the Genoese castle.

In addition, we have already begun to collect research materials of the Byzantine castle in Gaspra. Our method will be extended by the involvement of a large collection of photographs, with the help of which we will try to reconstruct the relief using AI - such methods have been developed in recent studies (Pan et al, 2024).

Refernces

Bocharov S. G. Between the Byzantium, the Mongols and the Ottomans - The studies of the history of Crimea in the 13th-18th centuries / Sergei G. Bocharov ; ed. by Ludmila Bacumenco- Pξrnău. Bucureşti : Editura Academiei Romβne ; Brăila : Editura Istros a Muzeului Brăilei "Carol I", 2021. 433 p.

Bocharov S. G. Zametki po istoricheskoy geografii genuezskoy Gazarii XIV-XV vv. Yujniy bereg [Notes on the historical geography of Genoese Gazaria of the XIV-XV centuries. South Shore]. ‘O drevnostyakh Yujnogo berega i gor Tavricheskikh’: Sb. nauch. Trudov (po materialam konferencii v chest’ 210-letiya so dnya rojdeniya Petra Ivanovicha Keppena) [‘On the Antiquities of the Southern Coast and the Tauride Mountains": Collection of scientific papers (based on the conference in honour of the 210th anniversary of the birth of Peter Ivanovich Keppen).]. Kiev: Stilos, 2004. pp. 186-204.

Dobrovskiy, O. I. Srednevekoviye poseleniya i ‘isary’ Krymskogo Yujnoberejya [Medieval settlements and ‘isars’ on the Crimean South Coast]. Feodalnaya Tavrika [Feudal Taurica] Kiev, 1974. pp. 294-296.

Georgopoulus A. 3D virtual reconstruction of archaeological monuments // Mediterranean Archaeology and Archaeometry. Athens, 2014. Vol. 14. No. 4. P. 155–164.

Kondaraki V. H. Podrobnoye opisaniye Yujnogo berega Kryma [Detailed description of the South Coast of Crimea]. Nikoayev, 1867. 143 p.

Pallas P. S. Bemerkungen auf einer Reise in die südlichen Statthatlerschaften des russischen Reischs in den Jahren 1793 und 1794. Vol. 1. Leipzig: Joh. Phil. C. Theod. Werthes, 1799. 525 p.

Pallas P. S. Nabl'udeniya, sdelannye vo vrem'a puteshestviya po yujnym namestnichstvam Russkogo gosudarstva v 1793-1794 gg. [Observations made during a journey through the southern provinces of the Russian state in 1793-1794] Moscow, 1999. 246 p.

Pan J., Li L., Yamaguchi H., Hasegawa K., Thufail F. I., Brahmantara, Ban X., Tanaka S. Reconstructing, Understanding, and Analyzing Relief Type Cultural Heritage from a Single Old Photo. Proceedings of the 32nd ACM International Conference on Multimedia (MM '24). Association for Computing Machinery. New York, 2024. pp. 7724–7733.

Parshina E. A. Razvedki na skale Panea (Simeiz) v 1966 g. Polevye materialy (dnevnik, chertejy) [Exploration on the Panea rock (Simeiz) in 1966. Field materials (diary, drawings)]. Nauchiy arkhiv Instituta arkheologii Kryma RAN [Scientific archive of the Institute of Archaeology of Crimea RAS]. F. 1. O.1. D. 1475.

Matej S., Pazinova B. 3D Reconstruction as a Form of Interpretation: Example of Excavation of the Medieval Peťuša Castle (Central Slovakia) // Interdisciplinaria archaeologica. Natural sciences in archaeologyiansa. Prague, 2020. Vol. XI. Issue 1. P. 73–87.

Montandon Sh. Putevoditel puteshestvennika po Krymu, ukrashennyi kartami, planami, vidami I vin'etkami i predvarennyi vvedeniyem o raznykh sposobakh pereezda iz Odessy v Krym [A traveller's guide to the Crimea, embellished with maps, plans, views and vignettes, and preceded by an introduction on the different ways of getting from Odessa to the Crimea] Kiev, 2011. 416 p.

Muravyov-Apostol I. M. Puteshestviye po Tavride v 1820 g. [Travelling through Taurida in 1820.] Saint-Petersburg, 1823. 337 p.

Myts V. L. Ukrepleniya Tavriki X-XV vv. [Fortifications of Taurika in X-XV]. Kiev, 1991. 164 p.

Firsov L. V. Isary: ocherki istorii srednevekovykh krepostey Yujnogo berega Kryma [Isary: sketches of the history of medieval fortresses of the Southern coast of Crimea]. Novosibirsk, 1990. 472 p.

Ernst N. L. Istoriko-arkheologycheskiye pamyatniki Yujnogo berega Kryma [Historical and archaeological monuments of the Southern coast of Crimea]. Socialisticheskya rekonstrukciya Yujnogo berega Kryma [Socialist Reconstruction of the Southern Coast of Crimea]. Simferopol, 1935. pp. 425-443.