NOTES ON AN ALMOST FORGOTTEN ROMAN FRONTIER SECTOR FROM THE MESEȘ MOUNTAINS (DACIA POROLISSENSIS)

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In the past decades the *limesforschung* of Dacia Porolissensis produced a series of studies that clarified some key issues regarding the spatial distribution of the minor fortification from the north-western (Sălaj and Cluj counties)[1] and northern (Cluj County and Bistriţa County)[2] areas, the functionality of these physical elements (watchtowers, fortlets and linear fortifications)[3] and (little of) their chronology[4]. The extensive field surveys were combined with remote sensing, geophysics[5] and archaeological excavations[6] in order to obtain a clearer picture of this particular *limes* and to understand its true functionality and evolution. This huge demarche is a natural successor of the studies conducted by

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[1] Torma 1863; Torma 1880; Téglás 1907, 573–754; Buday 1912, 103–118; Buday 1914, 95–105; Marţian 1921, 55, fig. 4; Daicoviciu 1935, 255; Ferenczi 1941, 189–214; Radnóti 1945, 137–138; Ferenczi 1967, 143–162; Gudea 1985, 143–218; Matei 1996, 63–73; Gudea 1997; Matei 2007, 250–269; Marcu, Cupcea 2013, 569–589.

[2] Ferenczi 1969, 75–98; Ferenczi 1972, 37–46; Ferenczi 1973, 79–105; Ferenczi 1974, 181–189; Ferenczi 1975, 285–289; Ferenczi 1976, 107–133; Ferenczi 1988, 251–289; Ferenczi 1991, 127–151; Zăgreanu *et alii* 2017, 25–45; Marcu *et alii* 2017, 20–24.

[3] For particular analyses see Ferenczi 1968, 75–98; Ferenczi 1971, 599–625; Gudea 1997, 20–33; Marcu, Cupcea 2013, 569–589; Cociș 2016, 41–76; Lăzărescu *et alii* 2016, 275–304; Cociș 2018, 34–77.

[4] See in this direction Nedelea *et alii* 2019, 186–252.

[5] See especially Opreanu, Lăzărescu 2016, 49–114.

[6] For recent archaeological excavations see Cociș, Bejinariu 2020, 83–102; See also Gudea 1997.

the parents and grandparents of the Dacian frontier studies, starting from 1861[7] and continued throughout the 19th and 20th centuries[8].

However, in contrast to the predecessors, there is a strongly visible research preference for certain particular areas. In this case, the area is represented by the most complex frontier sector from Dacia Porolissensis namely Porolissum, the *vault wrench* of this Roman province, as it was once called[9]. The focus on this sector has led to a slightly ignorance of the frontier organized on the Meseş Mountains, summing up almost 60 km of watchtowers, fortlets and several linear fortifications.

This study is considering such a sector, being practically a reinterpretation of a heavily fortified frontier area located on the Meseş Mountains peak, at approximatively 8 km South-west of Porolissum (see Pl. II). In this case study, several research methods were used in order to clarify its full topographic extent and functionality: field surveys, ground and low-aerial mapping surveys, post-processing and filtering, consulting the older accounts on the area and verifying the historical cartographic support. The studied area is composed of four surveillance towers (of which one is completely destroyed), a linear fortification of 1.5 km length and a possible minor gateway observed as gap in the fortification's structure, controlled most probably by the nearby watchtower.

From a geographic point of view, the area of interest is represented by a quite regular ridge road (general altitude 537–754 m), a road that constitutes the most facile connection path between the four watchtowers of which two of them (the southern and the northern extremities of the researched area) are located within two predominant hills (*Vârful Teghișului = Dealul Cărbunarii*/598 m in south and *Vârful Păstaie = Hegyes hegy = Csókás = Păstăiasa*/701 m in north; see Pl. III). West of this paths, several valleys and crossing routes are known since the beginning of the 18th century onward.

The archaeological remains from this particular area of 1.8 km length were integrated in a series of larger field surveys and extensive excavations projects since the 19th century. In order to describe in a coherent manner, the history of research regarding our objectives, we will deal separately with each site from south to north.

1. The surveillance tower from "Vârful Teghișului = Dealul Cărbunarii" (Pl. II)

The watchtower is located on top of a dominant hill on the main course of the Meseş' ridge road. It was identified by the Hungarian scholar Torma Károly

[7] Torma 1861, 37–38.
[8] See Cociş 2016, 41–46.
[9] Gudea 1988, 195–214.

at the end of the 19th century[10]. Later, it was described by another Hungarian frontier researcher, namely by Buday Árpád[11]. Neither Torma nor Buday have not excavated the structure; they were limited to a summary description only.

Later, in 1977, Nicolae Gudea took a step forward and excavated the watchtower (together with other 65 similar structures[12]), being the last one who documented the precinct wall of the fortification. According to his research, the surveillance element is framed within the *circular-type* watchtowers[13], the most numerous type from Dacia Porolissensis so far. It is built in the *opus incertum* technique, having an outer diameter of 7.5 m, this particular aspect placing it in the group of the large circular watchtowers[14], those who have the diameter between 7–11 m[15]. The width of the precinct wall is varying between 0.9–1 m, having a little thicker foundation with a preserved height of 0.3-0.4 m[16]. The interior of it was quite affected by some modern interventions, a direct consequence being the fact that the habitation layer was not found and the archaeological material was chaotically mixed[17].

However, the discovery of a high number of *tegulae* and *imbrices* fragments from the wooden roof structure are indicating that, in this case, the roofing technique did not involve organic material but tiles and pantiles for a solid structure. Together with this scattered archaeological material (which also involves animal bones, common pottery and whetstones), N. Gudea identified a *denarius* from Septimius Severus[18], thus confirming the use of the tower in the late 2nd – early 3rd centuries AD. On the occasion of this study the structure was only re-mapped, due to the fact the GPS-RTK was out of service range in this area.

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10 Torma 1880, 69.

11 Buday 1912, 115.

12 See mainly Gudea 1997.

13 Gudea 1985, 172; Gudea 1997, 63.

14 After Gudea's typology (Gudea 1997, 28).

15 See for example the similar watchtowers from *Sub Padină = Coasta Ogrăzii* (Torma 1864, 35; Gudea 1985, 169; Gudea 1997, 56–57), *Vârful Ciungii* (Torma 1880, 69; Petri 1900, 170; Buday 1912, 115; Ferenczi 1967, 147; Gudea 1985, 171–172; Gudea 1997, 61–62), *Poiana Moigrădanilor = La Maje* (Buday 1912, 94–95; Radnóti 1945, 144; Ferenczi 1967, 147; Gudea 1985, 175–176; Cociș 2018a, 402–403; Cociș 2019, 45–59) or *Făjiște* (Matei 1996, 64; Matei 2007, 252; Cociș 2018b, 21–24).

16 Gudea 1985, 172; Gudea 1997, 63.

17 Gudea 1985, 172; Gudea 1997, 63.

18 Gudea 1997, 63.

2. The surveillance tower from "La Șuvar = Cărbunarea" (Pl. II).

The second element is located not far from the first one, on a relatively high plateau (568 m), an eastern deviation of the main ridge road, at precisely 808 m from the previous element. The structure was recently identified based an oral testimony of a villager from a nearby settlement; he systematically removed stones for a cattle stable back in 1980–1981. Later, we identified the traces on the field, thus confirming the supposition that the destroyed structure is actually belonging to a watchtower. On the surface of the ruins one can still observe common Roman potsherd, mortar and animal bones. Based on the field measurements the ruins have a diameter a 12 m and a preserved height of 1.5 m. The type of structure is unknown at this moment but based on the traces is more than clear that we are dealing with a stone structure built in the *opus incertum* technique. The site was mapped and surveyed in order to obtain the *digital terrain model*.

3. The surveillance tower from "Sub Păstaie = La Șuvar" (Pl. II)

The third tower is strategically located at 20 m behind the turf and timber palisade and near the presumed minor gateway. It is possible to have been identified by Torma K. in the late 19th century[19]; the first comprehensive description is written by Buday A.[20]. In 1967 Ferenczi István integrated the watchtower and the linear fortification in his important study about the structure and function of the Roman frontier from the Meseș Mountains including also several photos and detailed description[21]. Later, N. Gudea excavated the structure (in 1974 and 1975) but because of the dense trees his trenches did not identified a coherent structure only some roof tile fragments[22]. Based on these, he concluded that the mound could be of geologic origins or at least the remains of a wooden watchtower[23].

In contrast to the other two cases, the ruins from *Sub Păstaie* were subjected to a low altitude UAV (*Unmanned Aerial Vehicle*)-based photogrammetry survey in order to obtain a scaled, high detail digital surface model of the site, including a part of the palisade and the presumed gate. Based on the digital surface model obtained from the classified ground points we can observe that, in fact, the top surface of the mound is actually square, having the calculated dimensions of approximatively 7.2 × 7.3 m. Due to the fact that on the last

19 Torma 1880, 66.
20 Buday 1912, 115.
21 Ferenczi 1967, 149.
22 Gudea 1985, 172–173; Gudea 1997, 64–65.
23 Gudea 1985, 173; Gudea 1997, 65.

field survey we were able to find stones and traces of mortar it is highly probable for the ruins to belong to a square watchtower. Obviously, this hypothesis need a future archaeological excavation to affirm or to deny the real structural configuration.

4. The surveillance tower from "Vârful Păstaie = Hegyes hegy = Csókás = Păstăiasa" (Pl. II)

If the other three watchtowers are visible on the field in a greater or lesser extent, the last element of interests is nowadays completely vanished both because of the complete stone removal and for the construction of a military antenna in close proximity to the site. Due to the fact that the watchtower was located in such way to completely observe the nearby landscape, the archaeologists observed it in turn due to its massiveness[24] (only known from an altimetric profile made by Buday A. in 1912; it is seems that in 1912 the ruins had a diameter of 8–10 m a height of 2 m[25]).

Its historiographic accounts are starting again with Torma K. who originally identified it in 1863[26], being also integrated in his *Limes Dacicus*[27]. Later, Buday A. described this impressive structure realizing its scaled altimetric profile[28]. It seems that also Ferenczi I. observed some traces of it in 1967[29]. N. Gudea tested in 1977 the previous theories regarding the existence of this watchtower from *Dealul Păstaie* by the means of an archaeological trench. The structure was so destroyed that he could not establish the dimensions or the planimetry[30]. However, it is quite clear from the older descriptions that the ruins are belonging to a stone watchtower. Even if he did not identified the wall, N. Gudea identified a huge quantity of archaeological material like iron nails, tiles and pantiles, common potsherds and two undetermined coins, one from Faustina (unspecified which one) and one from Severus Alexander[31]; based on their TPQ, we can assume that the watchtower from *Vârful Păstaie* is operational in the 2nd century-early 3rd century AD being therefore contemporary with *Vârful Teghișului*. Due to the fact that the structure is completely destroyed, we were not able to survey it but only to map the exact location.

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24 Petri 1900, 170.
25 Buday 1912, 112–113.
26 Torma 1864, 35.
27 Torma 1880, 65–68.
28 Buday 1912, 112, Fig. 5.
29 Ferenczi 1967, 149–150, Fig. 6–7.
30 Gudea 1985, 173; Gudea 1997, 65..
31 Gudea 1985, 173; Gudea 1997, 65.

5. The turf and timber palisade from "Pârâu Spoielii-Sub Păstaie-Vârful Păstaie" and the presumed gateway (Pl. II)

The other type of fortification from the surveyed area is the (quite ignored) turf and timber palisade. This particular element is following the ridge road and is blocking several transit ways and valleys located west of it. Its older accounts are the same like those of the watchtowers: initially identified by Torma K. in the late 19th century[32] (it is worth mentioning that on the first Austrian cartographic survey the area is called *La Schanz*, translated as *At The Ditch*, observed, described and photographed by Buday A.[33] and Ferenczi I.[34]), and later, 1977, excavated by N. Gudea[35] (although it is not clearly exactly where[36]). I. Ferenczi calculated (by foot) a length of 1.3 km[37] and N. Gudea a length of 1.5 km. Based on our RTK mapping, the exact length of the turf and timber palisade is 1.33 km. Based on Gudea's archaeological results, the earth *vallum* is about 4.5–6 m wide with a preserved height of 1.2 m. The defensive ditch is known to have an opening of 4.5 m and depth of –1.1 m[38]; thus, only a single functioning phase[39]. Beside mapping the full length of the remains, 60 m of its trajectory were scanned using the UAV-based photogrammetry techniques in a low forested area.

At *Sub Pătaie-La Şuvar*, Buday A. noticed a gap in the trajectory of the linear fortification, still visible today. Based on our filed research and UAV scanning to which we add other examples nearby Porolissum[40], we presume that this gap could have been a minor transit gateway used primary as a controlled crossing point, in the vicinity of the watchtower. The gap has a length of 4.5 m calculated on the digital model.

The documentation techniques applied within this case study includes several topographic and remote sensing methods as well as a series of post-processing geostatistical analyses, all of them applied in order to have a clear image of the real topographic and functional extents within the Roman frontier landscape.

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32 Torma 1880, 66.
33 Buday 1912, 114–116, Fig. 11–12.
34 Ferenczi 1967, 155, Fig. 13–14.
35 Gudea 1985, 173; Gudea 1997, 64–65.
36 Cociş 2016, 47–48, 66, Pl. 12, a-b.
37 Ferenczi 1967, 153.
38 Gudea 1985, 173; Gudea 1997, 64.
39 Gudea 1985, 173; Gudea 1997, 65.
40 See for example the two-phase turf and timber palisade from *Poiana Mogrdanilor*, in Cociş 2019, 47.

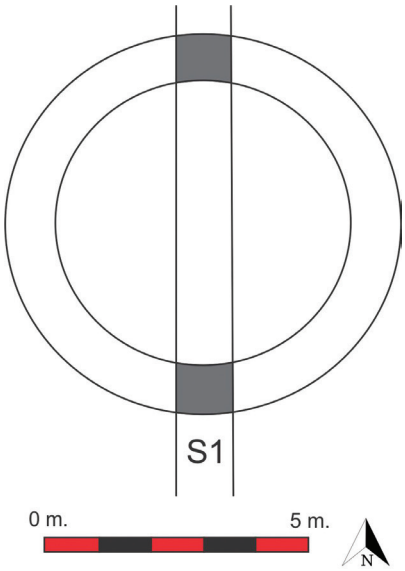

Fig. 1. The archaeological plan of the watchtower from *Vârful Teghișului* (redrawn after Gudea 1997, 121, Fig. 39, nr. 39). / Planul arheologic la turnului de observație de pe *Vârful Teghișului* (redesenat după Gudea 1997, 121, Fig. 39, nr. 39).

The workflow started with a general mapping of the structures with a high precision GPS RTK-based (Hi-Target V90 plus) to create an exact site map suitable for our study. The second step was to survey all the elements, as much as the relief and the forest density allowed. The aim of these surveys was to obtain a high definition digital terrain and surface models for the structures. Two different methods were applied in order to gather the necessary data: grid-based GPS survey (applied on the surface of the watchtower from *La Șuvar*) and low altitude UAV-based photogrammetry (on the surface of the watchtower, the palisade and the presumed gate from *Sub Păstaie* and on the surface of the palisade in a deforested area, close to *Vârful Păstaie*).

In the first case was obtained a digital terrain model (*Triangulated Irregular Network*)[41] with the general resolution of 0.6 m. In the second case the workflow applied involved a completely different method. The two surfaces mentioned above were subjected to a grid-based mapping process by using an UAV vehicle. In the first case the data was composed of 210 photos and in the second one of 175. After collecting them, we introduced the photos in a photogrammetric-based workflow known as SfM (*Structure from Motion*)[42]. The dataset was

[41] See in this direction Floriani, Magillo 2009.

[42] Koenderink, van Doorn 1991, 377–385; Fonstad *et al.* 2012, 421–430; Westoby *et al.* 2012, 300–313.

introduced in a software that applies a SIFT-based algorithm (*Scale Invariant Feature Transform*)[43] that identified the common points (known as *tie points*) from a variable set of photos. Further, by calculating the internal and external geometries of the camera together with the 3D references within the process called *bundle adjustment*[44], we obtained the *sparse point cloud* of the scanned surfaces. The next step was mainly a densification process based on the MVS (*Multi View Stereo*) algorithm through which we transformed the *sparse cloud* in a *dense cloud*[45], the models including also the (low) vegetation (mainly some scarce, young trees).

Due to the fact that the GPS of the UAV (Phantom 4 Pro) has an error of several meters, we used GCPs (*Ground Control Points*) in order to obtain an exact spatial reference of the models[46]. Thus, every point from our *dense cloud* model received a set of coordinates in the Stereo 70 projecting system (Romanian national grid). The georeferenced point clouds were introduced in a GIS-based software, previously exported as laser (.las) points. In this phase the dense clouds were subjected to a process of classifications (as in the case of LiDAR points classification)[47] that eliminated the medium and high vegetation), filtering the cloud and remaining only the ground classified points[48]. The resulted ground points were used to create a digital surface model (*bare ground surface*) of the scanned areas (with the mention that the low vegetation as the bushes or thorns were impossible to remove due to the fact that the method is using pixels not airborne or ground laser beams). The resolution of the 3D surfaces is 0.5 m.

Adjacent to these scans we used several other GIS-based analyses in order to be able to observe the particular topographic features and the functionality of the area: CVA (*Cumulative Viewshed Analyses*)[49] to obtain the visibility and inter-visibility pattern of the structures (combined with LOS-*Lines of Sight* analyses) and LCP (*Least Cost Path*)[50] to observe the most accessible ways between the frontier elements and *Barbaricum*. Both of the analyses are based on SRTM's 30 m elevation support. As a secondary tool, we used the first Austrian cartographic survey (*Josephinische Landesaufnahme*, 1763–1787)[51] on which the main

43 Lowe 2004, 91–110.
44 Triggs *et al.* 2000, 298–372; Liu, Zayer 2012, 1–12.
45 Ştefan, Ştefan 2016, 255–270. See also Ştefan, Ştefan 2016a, 25–35.
46 See the methodology in Hummel 2016, 797–802.
47 Sithole, Vosselman 2004, 85–101; Chang *et al.* 2008, 457–462.
48 Tomaštik *et al.* 2017, 151.
49 See in particularly Wheatley 1995, 171–186.
50 Fadlalla *et al.*2016, 1–6.
51 https://mapire.eu/en/map/europe–18century-firstsurvey/.

transit roads over the Meseș Mountains are drawn, roads actively before the 19th century when it was constructed the transit route as we know it today.

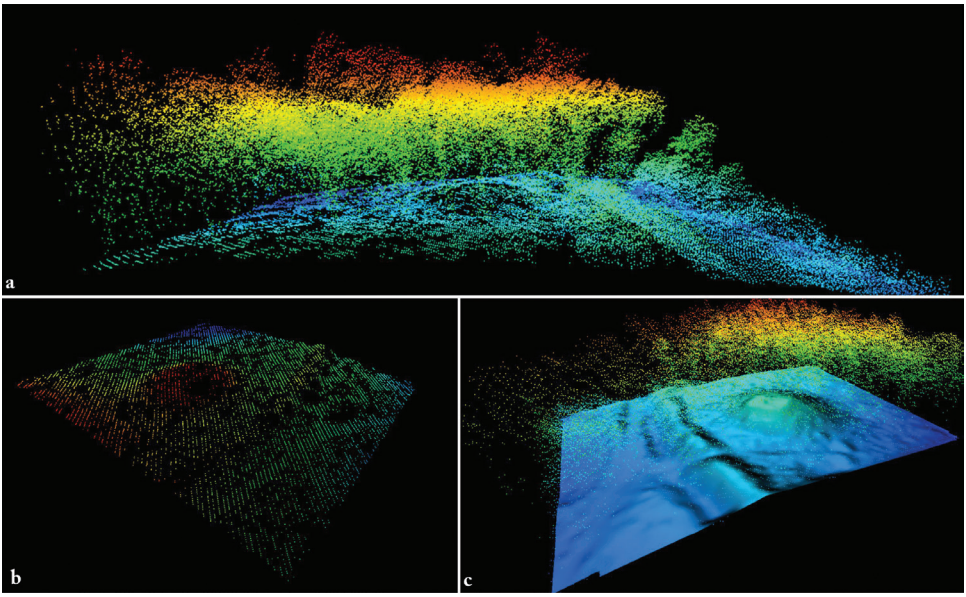

Fig. 2. The UAV-based workflow: unclassified ground points (a), classified ground points (b), TIN-based digital surface model (c) overlapped by classified high vegetation points. / UAV Fotogrametrie: puncte neclasificate (a), puncte clasificate (b), TIN model digital (c) suprapus de puncte clasificate cu vegetație înaltă.

More than other frontier sectors from Dacia Porolissensis, the frontier located within the frame of the Meseș Mountains could be easily integrated in the mountain frontier type, as D. Breeze concluded[52], partly due to its terrain configuration[53], partly because of the physical deployment of the minor installations in order to fulfil a coherent tactical surveillance and control of the sensitive areas[54]. Due to its particular terrain features and politic situation[55], the Roman frontier from the Meseș Mountains has a quite unique layout, with the watchtowers on the top of the hills, the fortlets controlling the valleys and the linear fortification ensuring extra security traffic control in the hot areas.

Several observations emerge from the study of the envisaged sector for each element in part and for the system as a whole in the landscape settings.

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52 Breeze 2011, 133–145; See also Breeze 2011a, 1–18.

53 Clichici 1968, 53–70; Gudea 1997, 20; Luca, Gudea 2010, 10.

54 See in this direction Cociș 2018, 49–53.

55 See especially Opreanu 1998; Opreanu, Lăzărescu 2015; Stanciu 2016, 347–372.

The watchtowers are meant to accomplish two essential tasks: to observe and communicate (to which we add the use of projectiles)[56] with the nearby watchtowers, with the fortlets and with the auxiliary forts in order to transmit viable data[57] about the observed situation. The four watchtowers from our area perform these main functions. They have a quite extended radius of observations orientated mainly on the crossing paths and they can communicate directly with each other, being thus naturally integrated in the bigger picture of the communication chain from the Meseș Mountains. If these four elements become non-operational, the frontier will have a communication gap of about 2 km; this argument is partially strengthened by the CVA analyses which indicates a possible inter-visibility link of *Sub Păstaie* and *Șuvar* with the auxiliary fort from Românași.

The frontier of Dacia Porolissensis is not a linear one[58], the artificial barriers being erected only in the most important transit areas[59] like *Poieni* (Cluj County)[60] or the *Meseș Gate* Pass (Sălaj County)[61],- a rather quasi-linear system. The *pax Romana* is using such fortification only where it needs an increased control[62], their presence or absence being a barometer for the local security[63]. It seems that in this sector there are several crossing paths over the mountains, paths that are connecting the barbarian settlements from Zalău with the inner area of the province of Dacia. In our opinion, the area is heavily fortified for this reason. If the *Meseș Gate* Pass represented a key crossing point with a quite complex organization, the transit routes located between *Vârful Păstaie* and *Vârful Teghișului* are organized as secondary routes involving a certain degree of control and security. These routes, if we presume that were used through the Middle Ages up to the modern period are shown on the first military Austrian map (see Pl. VIII). Curiously, these paths are overlapped in a certain degree with the path analyses results, indicating thus a logic in using the most facile ways to cross a heavily fragmented relief (see Pl. V).

The Roman frontier is not a closed frontier[64]. The Roman frontier is rather a controlled economic system with the direct participation of the military

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56 Donaldson 1988, 349–356.

57 Southern 1990, 233–242; Woolliscroft 1989, 5–19; Woolliscroft 2001, *passim*.

58 Cociș 2016, 49.

59 Cociș 2016, 49–50.

60 Buday 1912, 107; Téglás 1907, 373; Ferenczi 1959, 343; Gudea 1971, 509–511; Gudea 1985, 161; Gudea 1997, 38; Marcu, Cupcea 2013, *passim*; Cociș 2016, *passim*.

61 See a detailed discussion in Cociș, Bejinariu 2020, *forthcoming*.

62 Symonds 2018, 3.

63 Symonds 2018, 11.

64 As defined by Fabricius (Fabricius 1926, 642) or Forni (Forni 1959, 1074).

factor[65]. The difference between an open and a closed border is given by the general or the local political situation. That is the reason why also in the province of Dacia Porolissensis we have several (excavated) minor gateways in close connection with the barbarian settlements and the local commerce[66]. The existence of such gateway at *Sub Păstaie* is more that possible: to direct the movement of the human factor in heavily surveyed and controlled area, an organized crossing point[67].

Unfortunately, in this moment the field observation, the UAV and GIS-based scanning and documentation are the only ways to understand how this sector actually worked. What is missing from this image are the detailed data regarding the stratigraphic sequences of the minor and linear installations, detailed archaeological profiles and ground plans of the structures, crucial elements needed to integrate this almost forgotten sector in the larger scheme of the Roman frontier from Dacia Porolissensis. The aim of this paper was not to provide a final analysis but to reopen the discussion about the studied sector together with newly remote sensing and non-invasive field documentation.

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[65] Whittaker 1994, 91, 98–131.
[66] See a detailed discussion in Matei 2007, 250–269.
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NOTE ASUPRA UNUI SECTOR DE FRONTIERĂ ROMANĂ APROAPE UITAT DIN MUNȚII MESEȘULUI (DACIA POROLISSENSIS)

Rezumat

Traseul Munților Meseș traversează de la sud la nord teritoriul administrativ al județului Sălaj, fiind o grupă montană localizată în extremitatea nord-estică a Munților Apuseni, o treaptă de relief cu extensie redusă, relativ uniformă și îngustă (5–8 km lățime). Procesul de organizare teritorială a provinciei Dacia a înglobat acest segment montan în teritoriul său, pe culmea munților fiind stabilite elementele fizice ale frontierei romane, areal

recunoscut astăzi ca fiind *limes*-ul nord-vestic al Daciei Porolissensis. Culmea continuă și fragmentările masivului au dus la o adaptare particulară a sistemului frontalier, acesta fiind compus din turnurile de supraveghere localizate pe vârfurile predominante sau alte puncte strategice, din structurile de tip *burgus* care controlau accesul în provincie prin principalele văi de trecere, din castrele auxilare localizate la câțiva km în spatele acestei linii, respectiv din elementele de extra securitate și control sub forma unor fortificaţii liniare. Prezentul studiu are în vedere reanalizarea unui sector frontalier relativ ignorat. Acesta este amplast în zona *Vârful Păstaie-Sub Păstaie-La Șuvar*, fiind compus din patru turnuri de supraveghere, o fortificație liniară de 1.33 km, respectiv o posibilă poartă secundară de tranzit.

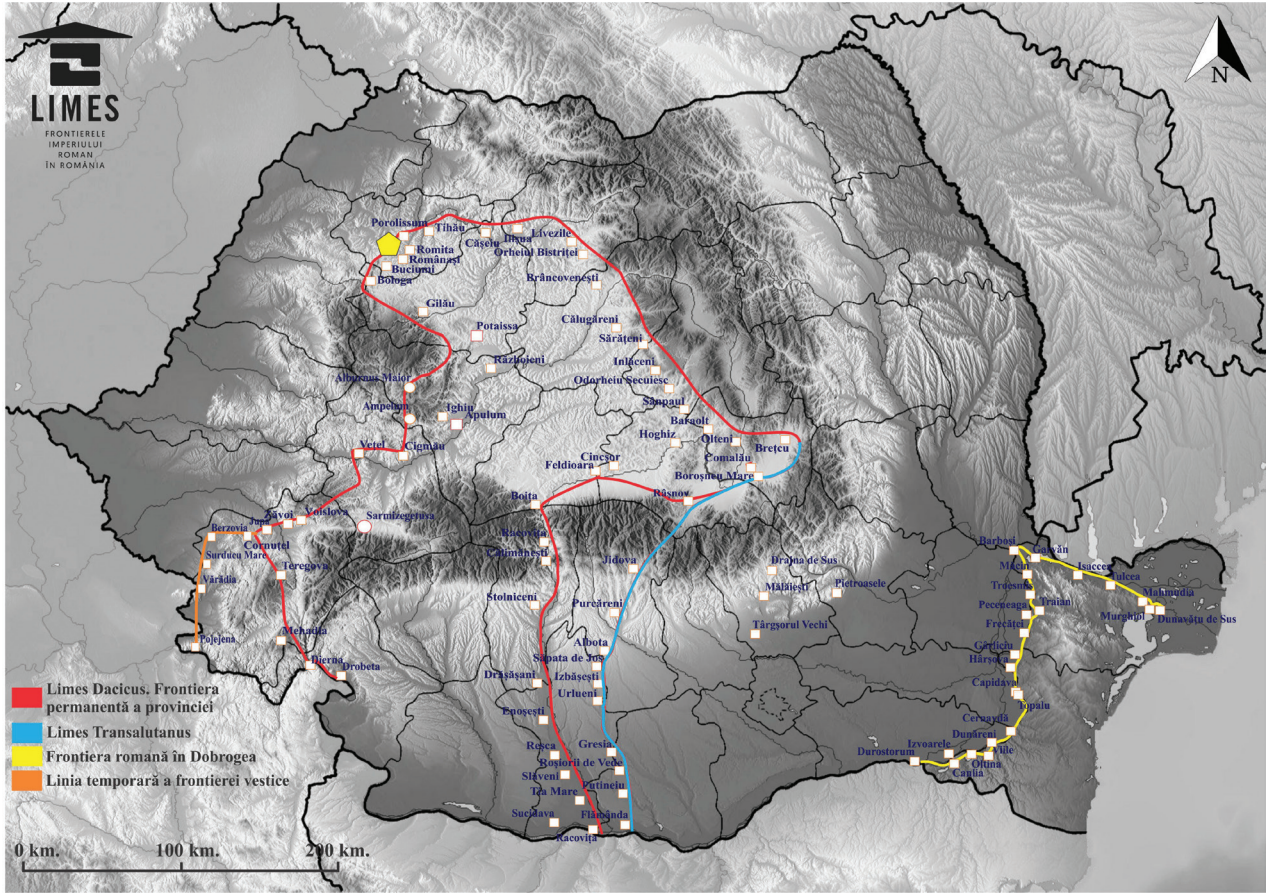

Plate I. The general location of the research sector (based on http://limesromania.ro/). / Amplasamentul general al sectorului de cercetare (http://limesromania.ro).

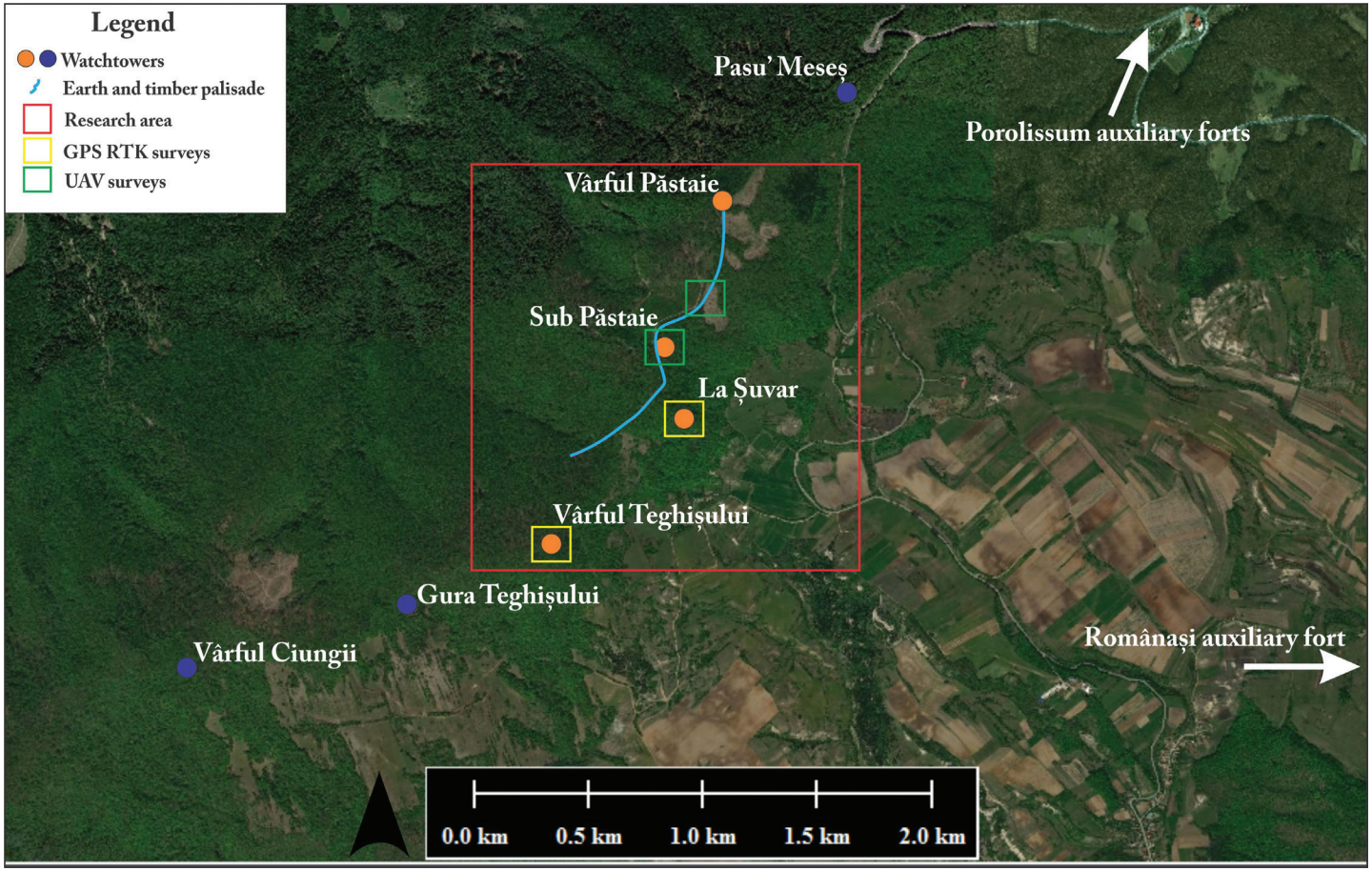

Plate II. The research area. Detail. / Arealul de cercetare. Detaliu.

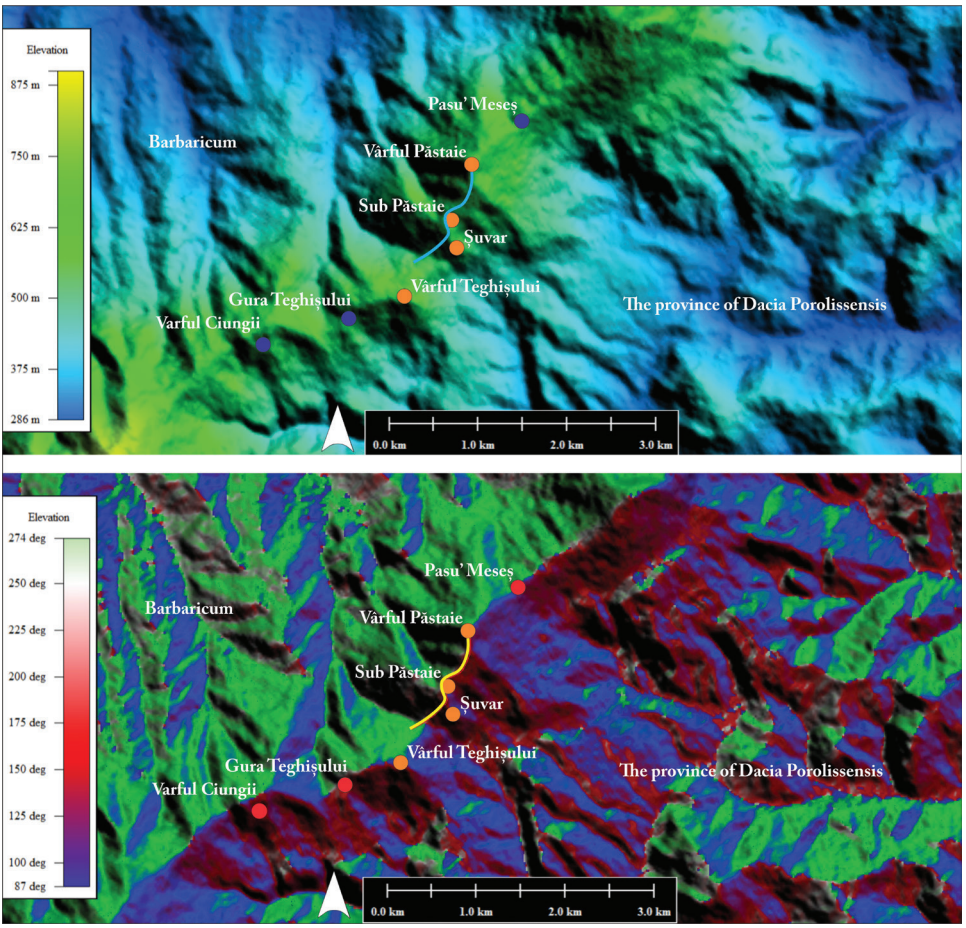

Plate III. The research area on SRTM (*Shuttle Radar Topography Mission*) elevation support with a resolution of 30 m (up); declivity of the research area on the same support (down). / Arealul de cercetare în sistem SRTM, cu o rezoluție de 30m (în sus); declivitatea ariei de cercetare pe același suport (în jos).

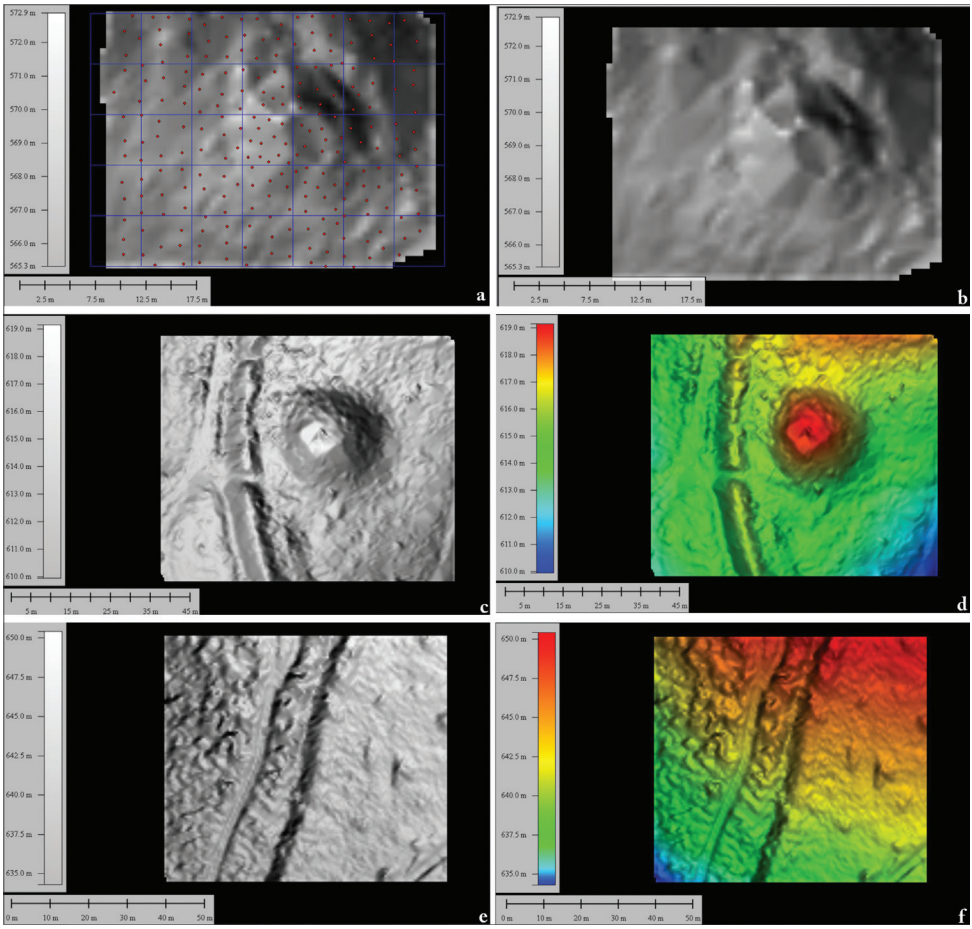

Plate IV. Grid-based survey (a) and *digital elevation model* (b) of the watchtower from *La Şuvar*; *digital surface model*-grayscale (c) and color ramp shader (d) of *Sub Păstaie*; *digital surface model*-grayscale (e) and color ramp shader (f) of the turf and timber palisade near *Vârful Păstaie*. / Analiza in sistem Grid-based (a) şi model digital de ridicare (b) a turnului de observaţie de pe *La Şurvar*; model digital monocolor (c), şi cu inserţii color (d) pentru *Sub Păstaie*; model digital monocolor (e) şi cu inserţii color (f) a gazonului şi palisadei de lemn de lângă *Vârful Păstaie*.

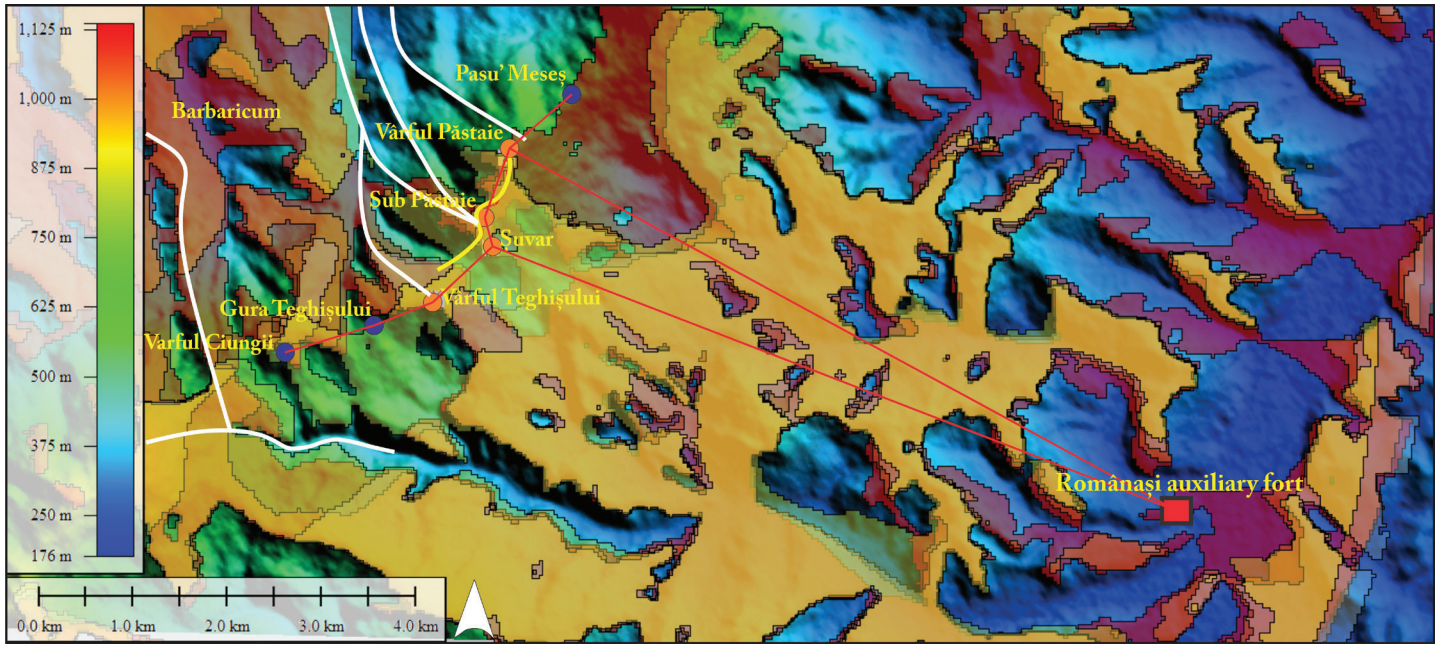

Plate V. Inter-visibility radii of the watchtowers (red-*Vârful Păstaiei,* orange-*Sub Păstaie*, grey-*La Șuvar*, green-*Vârful Teghișului*), lines of sight (red lines) and least cost paths toward the frontier line (white). / Inter-vizibilitate la nivelul razelor create pentru turnurile de observație (roșu-*Vârful Păstaiei*; portocaliu-*Sub Păstaie*, cenușiu-*La Șuvar*, verde-*Vârful Teghișului*), liniile de urmărire (linii roșii) și ultimele poteci de coastă spre linia de frontieră (albă).

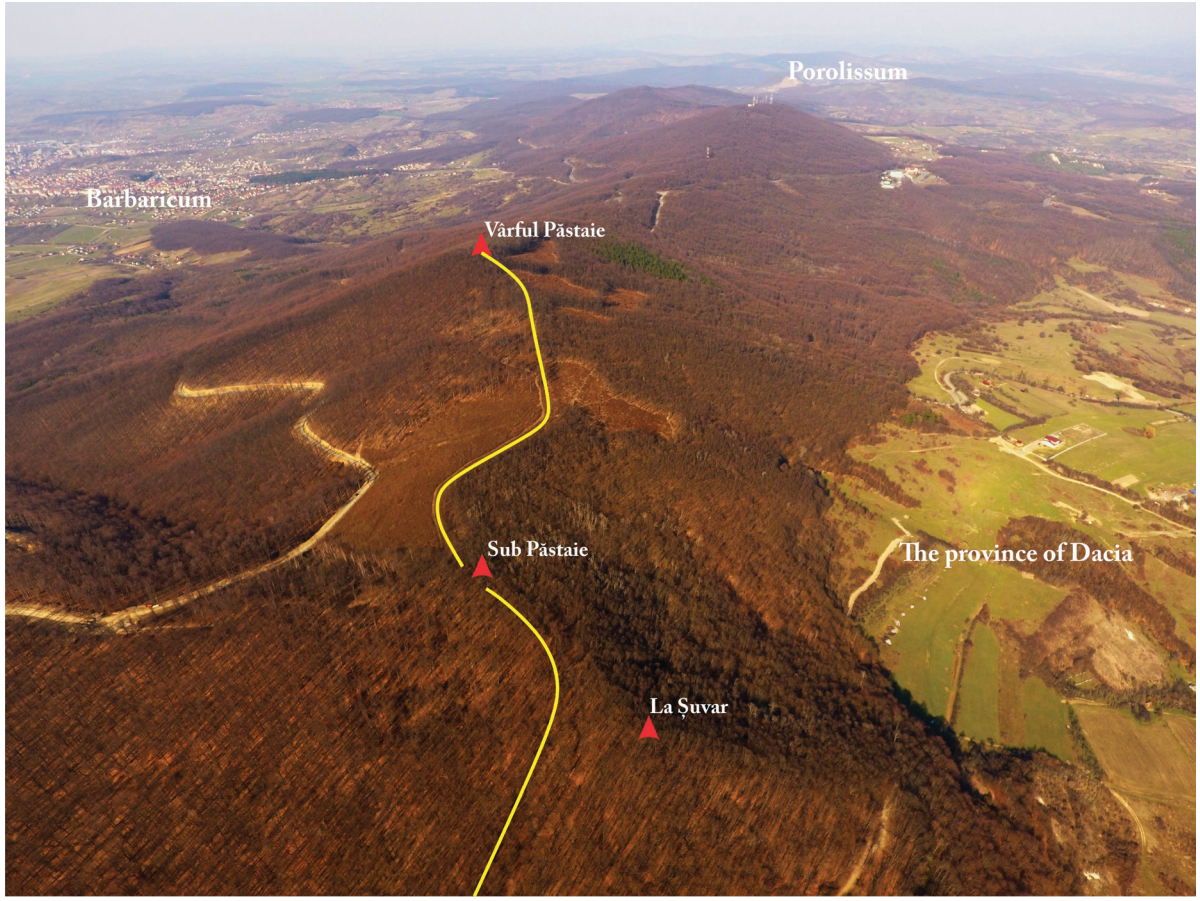

Plate VI. Aerial view of the minor and linear fortifications (photo H. Cociș). /
Vedere aeriană a fortificațiilor minore și de linie (foto: H. Cociș).

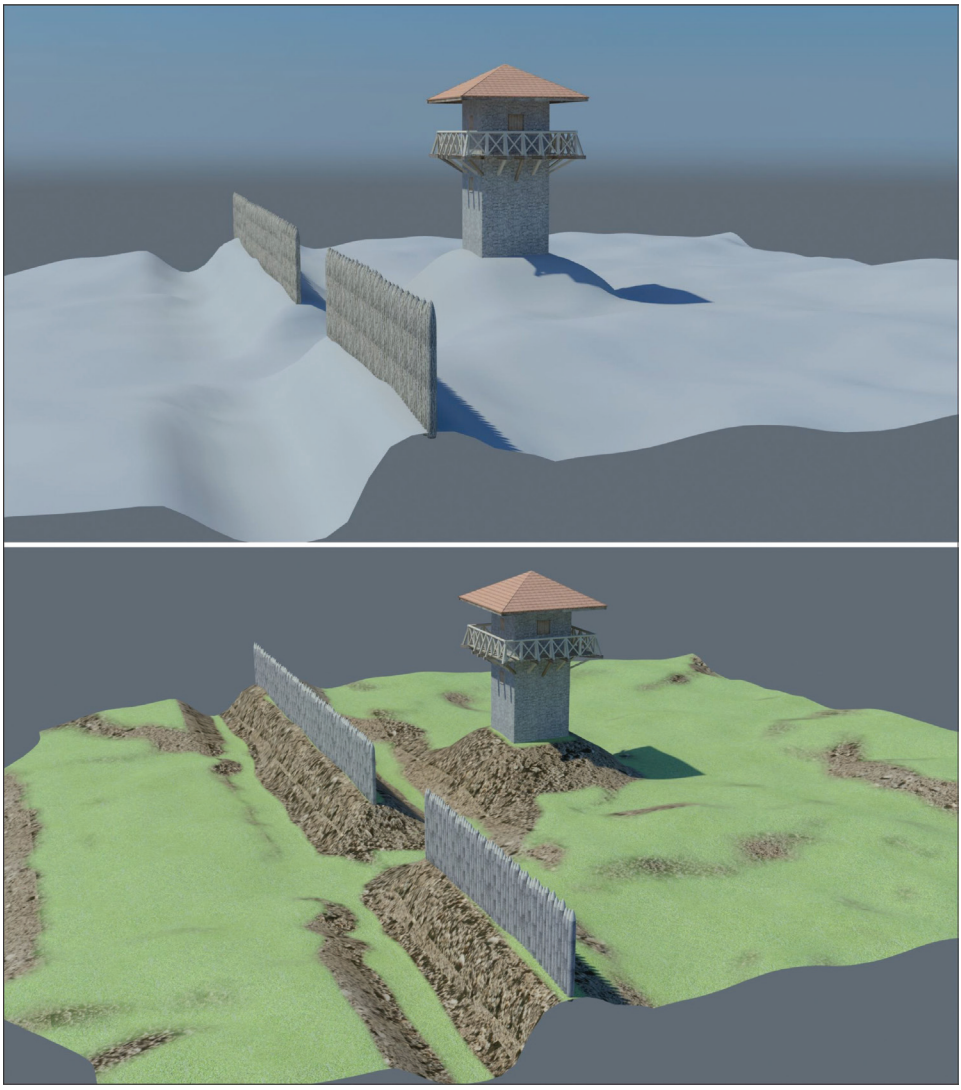

Plate VII. 3D reconstruction of the Roman frontier elements from *Sub Păstaie* based on the digital terrain surface (modeled by A. P. Sabou). / Reconstrucție 3D a elementelor de la frontiera romană la *Sub Păstaie*, pe baza suprafeței digitale (modelată de A. P. Sabou).

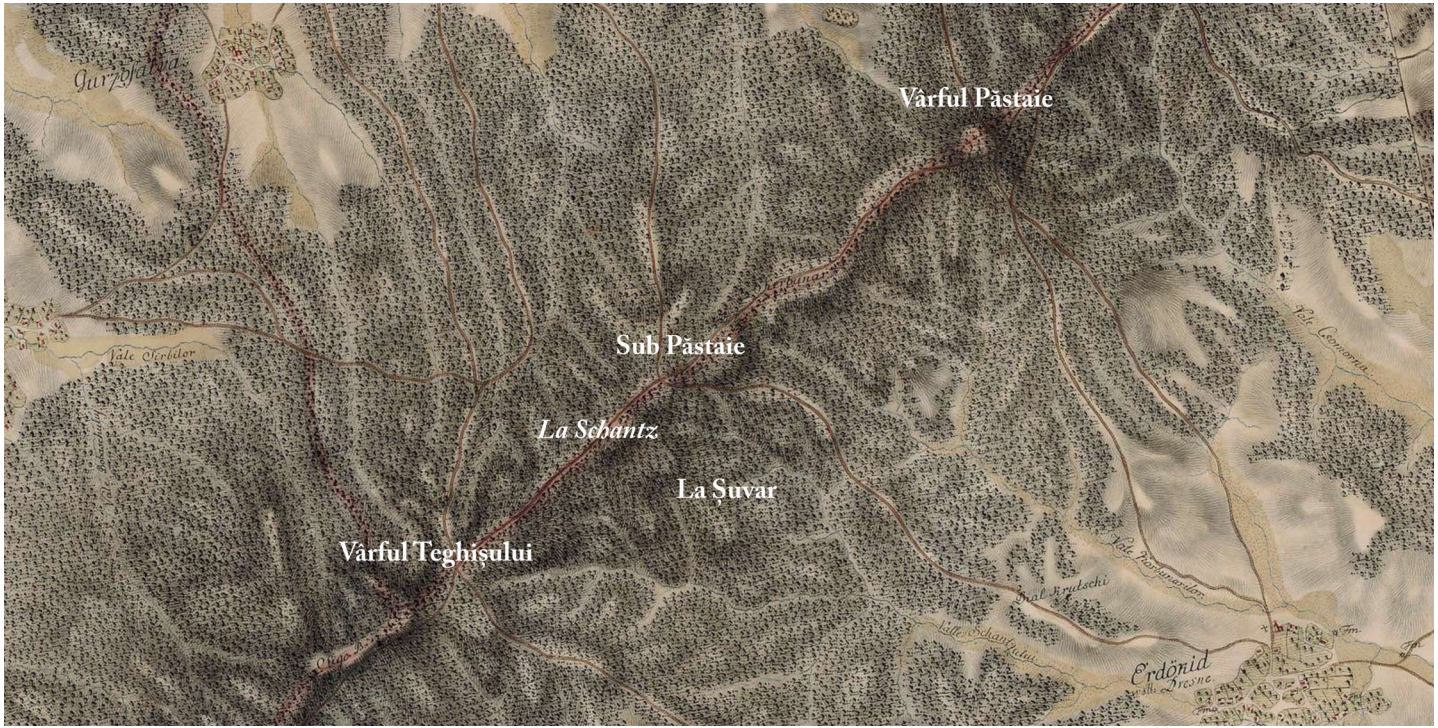

Plate VIII. The depiction of the frontier sector on the first Austrian topographic survey (after https://mapire.eu/en/map/europe-18century-firstsurvey). / Imaginea sectorului de frontieră în prima ridicare austriacă (după: https://mapire.eu/en/map/europe-18century-firstsurvey).