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# 3D VISUALISATION IN ARCHEOLOGY WITH USING BLENDER PROGRAM, BASED ON THE KOMAROWA CAVE AND LUBIN EXCAVATION SITES

## Abstract

**Introduction and aim:** Using of the 3D visualisation program is an alternative way of the archeological documentation process. This model can be shown from all points of view, this is not possible even during the excavation. The  method  shown in the paper is considered to be an innovation in the archeological documentation.
**Material and methods**: There has been prepared the accurate picture of every excavation meter in GIMP program. The model is being made in *Blender* program with the textures made in GIMP.
**Results and conclusions**: Three-dimensional model of Komarowa Cave excavation was made to show the interactive model that can be an alternative to present the archeological documentation in a way that is not possible in reality. Every view can be exported to the graphic file.
**Keywords:** Archaeology, 3D visualization, GIMP, program *Blender*.
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# *WIZUALIZACJA TRÓJWYMIAROWA W ARECHEOLOGII Z UŻYCIEM PROGRAMU BLENDER, NA PRZYKŁADZIE STANOWISKA KOMAROWA ORAZ LUBIN*

## *Streszczenie*

***Wstęp i cel:*** *Trójwymiarowy model stanowiska w jaskini Komarowej ma na celu przedstawić alternatywny sposób wykonywania dokumentacji archeologicznej.*
***Materiał i metody:*** *Zdjęcia poszczególnych metrów wykopu przedstawione zostały za pomocą programu GIMP. Następnie przygotowano szkielet modelu w programie Blender.*
***Wyniki:*** *Wykonany model można oglądać z każdej strony, poszczególne zaś widoki można eksportować do pliku graficznego.*
***Wniosek:*** *Przedstawiona metoda prezentacji materiału archeologicznego uznawana jest za innowacyjną. Pozwala ona na prezentację wykopalisk archeologicznych w sposób niemożliwy do uzyskania w rzeczywistości.*
***Słowa kluczowe:*** *Archeologia, wizualizacja 3D, GIMP, Blender program.*
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## 1. Introduction

Archaeological documentation presented in the three-dimensional programme enables simple and clear presentation of archaeological researches. This model has presentational and educational values. With a few screen shots one can present the result of the work to a wide audience, put pictures on f. ex. archaeological information boards etc.

Attractive graphic form is interesting for both specialists and non-specialists. Graphical model of archaeological excavations makes it easy to understand the essence of the archaeological excavation sites.

## 2. The Komarowa Cave

### 2.1. Brief description of the Komarowa Cave

Komarova Cave is located about 10 km to the South-East of Czestochowa, in the Sokole Mountains, which is part of the cliff zone formed in Jura, geographical area round Czestochowa.

The position is located within the area AZP 88-50, the number of positions in the area - 41, the number in the settlement (Zrębice) - 5. The opening of the cave is located on the northern slope of Puchacz massif at a height of about 340 meters above sea level. The cave is located as a single corridor oriented NE and length of approx. 40m. There are three holes in the cave, a corridor with a height of 2-3 m runs on for about 12 m horizontally and expands into small rooms. Further parts of the cave are almost unavailable.

Until 1997, there was no studies conducted besides speleological inventory work. Excavation began in 1998, as a result of the analysis of the bones of Pleistocene animals being found during previous geological work.

During the 4 seasons of research (1998 to 2001) there has been opened 4 excavation fields with a total area of approximately 44m$^2$ and a depth of 0.8 to 4.3 m. During the research there was collected many items which are representing different periods of cave occupation, from the Middle Paleolithic until Modern Times[1].

### 2.2. Brief characteristics of the archaeological documentation methodology

The archaeological site consists of a separate excavations based on the archeological analysis. Each excavation is made of layers that has been successively removed, in the case of a Komarowa Cave, each subsequent layer was 5 centimeters deep. Layers are divided into square meters, named based on the coordinate system. The numerical system is described in quadrant III where X-axis determines the letters of the alphabet, and the Y-axis, the number indicating the depth, given in centimeters. The depth counts from the level zero which is the ground level.

For volume reasons, further description of the methodology in archaeological documentation and methods of preparing the images during the excavation will be omitted[2].

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[1] Urbanowski M.: *Badania w Jaskini Komarowej w Zrębicach, województwo śląskie*, [in:] *Badania archeologiczne na Górnym Śląsku i ziemiach pogranicznych w latach 1999-2000.* or *Badania w Jaskini Komarowej – sezony 1999-2000,* Szczecin 2011.

[2] Tyszczuk K. *Stratygrafia Archeologiczna. Plany Archeologiczne*, 2002, https://www.archeotyszczuk.republika.pl/plany_w_fotogrametrii.htm.

## 2.3. Preparing of the each meter in the GIMP program

Captured images of each excavation meter are being made at an specific angle, they vary in color and saturation. It is of the great importance to crop every picture, align them to the proper angle and fit them together to give the photos a uniform appearance, structure and color. For this purpose, the GNU Manipulation Program GIMP will be used.

Interface description and a detailed description of the preparation of images for further three-dimensional processing will be described only briefly and in the course of this article.

To prepare the images in GIMP, one will need to use the following features:

➢   must cut out a square meter using *Hand masks* or *Rectangular sel- ection* tool.
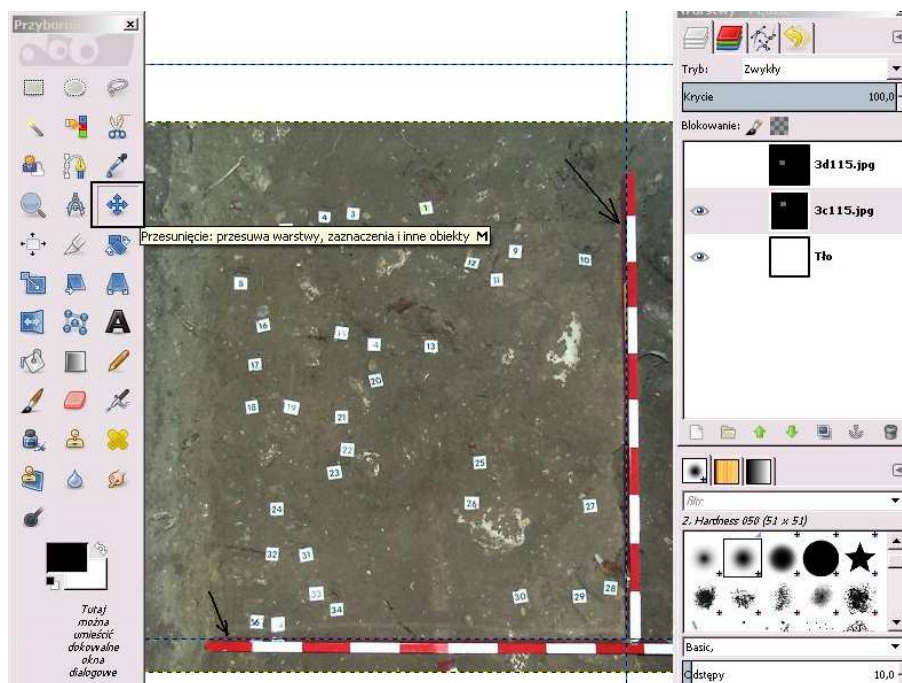


Fig.1. Preparation of images in GIMP
*Source: Elaboration of the Authors*

The each layer meter must be exported as the JPEG file (*Menu/Export*) and saved in one folder by *Textures* name for further use in *Blender* program.

## 2.4. Preparing the visualization of archaeological excavation in the *Blender* program

Blender is a freeware program for three-dimensional visualizations and projects creating, with the Game Engine (BGE) built in which it is allows to create simple (and more complicated) interactive projects. Thanks to the BGE it can be used for both proffesional and home purposes. The intire project made in BGE can be saved as an executive .exe file. Originally developed by the company "Not a Number" (NaN), *Blender* now belongs to the free software movement ("Free Software"), with sources available under the GNU GPL[3].

Key features of the program are: fully integrated package which is offering a wide range of tools needed to create 3D content, including modeling, UV mapping, animation, simulating, rendering, post-production and video game development.

More information about the options and the capabilities of *Blender*, including the use of scripting language *Python* are available in many manuals and tutorials on the web at

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[3]  Kolmaga J.: *Blender - kompendium*. Helion, Warszawa 2007, p. 4.

official and unofficial pages of the program. The tools used to create a three-dimensional model of the cave will be described in the course of its work.

A three-dimensional model of the archaeological site Komarowa Cave was created in *Blender*, versions 2.63-2.66a. For demonstration purposes there has been created only model of the first trench of the excavation. For the sake of clarity of this presentation, there was presented only every sixth layer of the first trench. So the model actually presents the following layers which are lying at depths of 85, 115, 145, 175, 205, 230, 260, 290, 320, 350, 390, 415 and the lowermost, 435 cm relative to the site temporary benchmark.
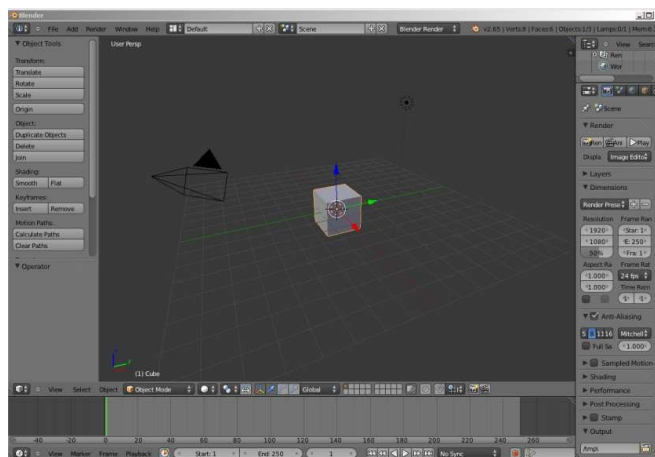


Fig. 2. Blender 2.63  main screen
*Source: Elaboration of the Authors*

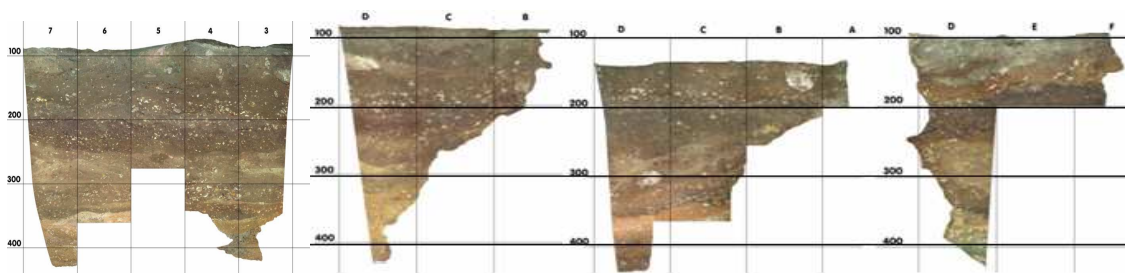Four trench profiles, shown in the picture below, will be placed onto the project:



Fig. 3. Profile of the trench DE
*Source: University of Szczecin*

To build the trench meters into the *Blender* program there will be used *plane* objects invoked by the command *Add mesh / Plane.*  On the first layer at a depth of 85 cm, there are four meters: respectively, 3B, 3C, 3D and 4D. Already put together in GIMP they appear as on the Figure 4.
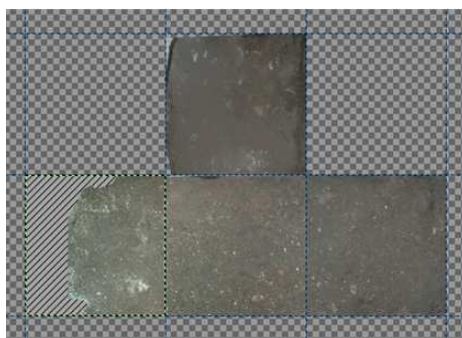


Fig. 4. The trench layer no. 85 composed of four meters in GIMP
*Source: Elaboration of the Authors*

*Plane* object must be placed properly. This can be done by inserting each time a new *plane,* or by copying the object already inserted. Copying an object can be done by using the *shift* key *D,* the mouse cursor must remain in the main window.

After pressing a combination of keys, the active copy of the object appears, which can now be moved to any place. It is advised to lock the padlock by closing the determinants of X, Y, Z, then they will not be moved accidentally, while working on the besides planes. It is no longer possible to transform the object according to this coordinate. It is preferred to copy the *plane* object with all of the properties adjusted.
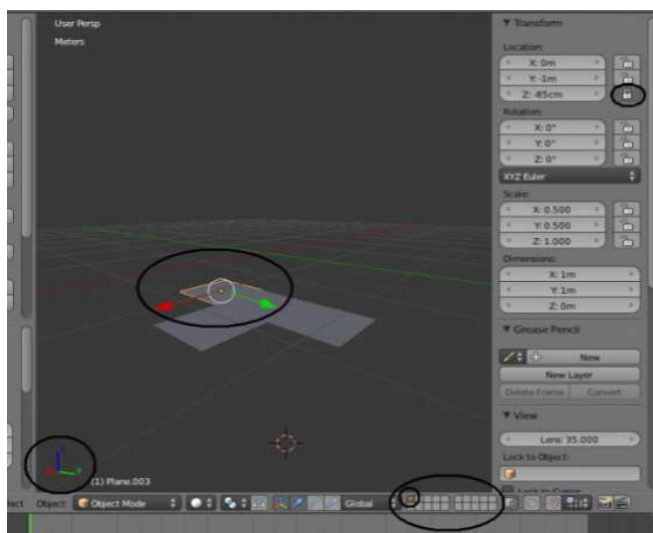


Fig. 5. The first layer with selected options
*Source: Elaboration of the Authors*

The first layer is located at the same height -85cm (Z coordinate), but it has different coordinates for X and Y. This layer is located on one of the twenty available levels (*Blender* layers), which is marked with a yellow dot (as the active element is at this level).

When the first layes is being insterted at tle height of -85 cm, it is easiest to copy the whole layers with its properties, paste it, change the Z coordinate to -115 and lock the Z at once. Then one can choose which planes should be deleted and which ones should be multiplied.

To maintain the tra nsparency of work it is advised to keep every trench level on the separate *Blender* layers. To move the entire trench layers, one must choose all the required objects with the left mouse button while holding the *Shift* key. After selecting, use the keyboard shortcut *F / Move this layer* and choose the layer with left mouse button. To run multiple *Blender* layers at once, one must press and hold *Shift* and choosing layers one by one. The second step is to place the profile into the project with the following result (shown from the different angle):
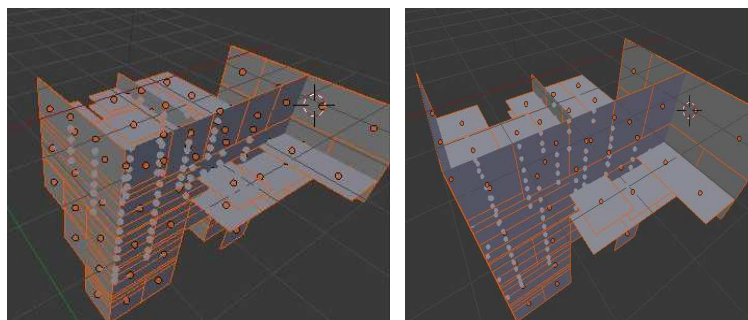


Fig. 6. First trench layers with profiles in 3D
*Source: Elaboration of the Authors*

Texture will be imported on the model of the cave, that will be the photos saved in GIMP and exported to JPEG format thet was described above.

## 2.5. Applying textures in *Blender* program

To apply textures in *Blender*, one must choose the *Properties* window, there finds there *Material* and *Texture* ark.

It is needed to apply the *Material* first, and then to apply the *Texture*. *Material* is added by pressing the *New* element. After application of the material, one can begin to apply the texture.

After one have named the texture, the image for the texture itself must be loaded again just to be seen in the viewport, by using the *Open Image or Movie* button. After selecting the desired file, select *Open.* However, to view the texture in *vieport,* or in the *3D Image* window, it must additionally be loaded in the *UV / Image Editor,* but not from the file, but from the *Blender* database. From the bottom of the menu bar one can select *UV/ Image Editor,* which allows the texture to be loaded the preview in viewport.
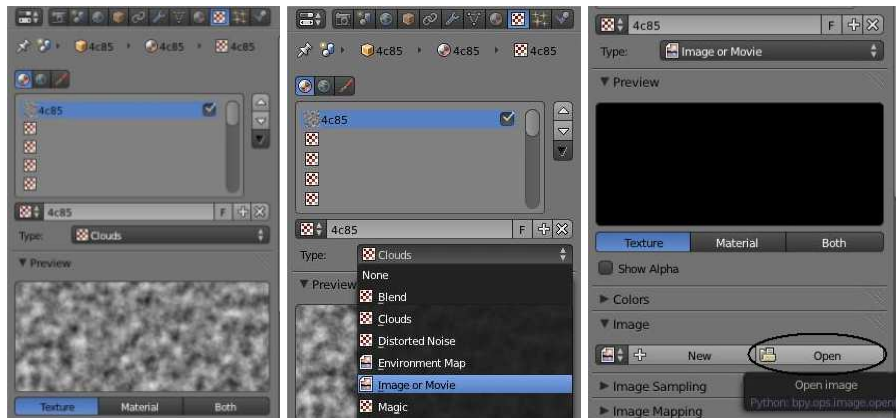


Fig. 7. Application of textures
*Source: Elaboration of the Authors*

After selecting an image editor, change the workspace options in *viewport* from the *Object Mode* to *Edit Mode.* One can use the *Tab* key, which is the keyboard shortcut to switch between this modes. In the lowermost menu select the file to be visible in *viewport.* After loading the file, select *Unwrap UV's* (shortcut *E*).
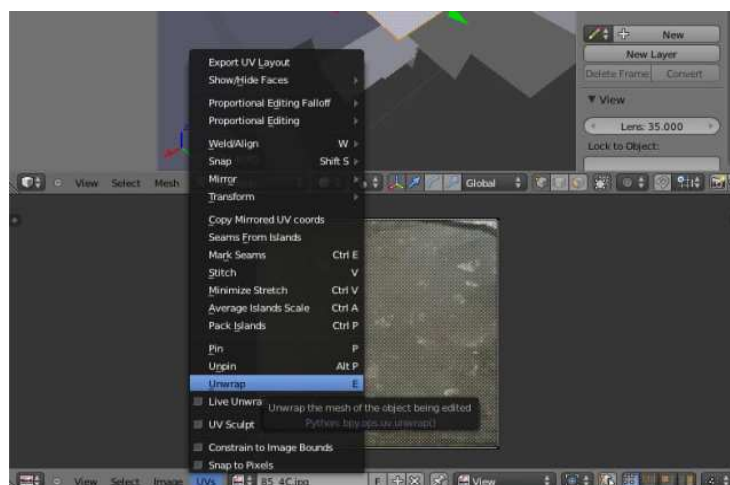


Fig. 8. Loading file viewport and Unwrap option
*Source: Elaboration of the Authors*

For images in the Komarova Cave, on the squares (objects of the *plane* type*)* there has been some missing space on the texture. Those places were filled up with the huchuring, as it being shown in the picture above. For the clarity reasons, one needs to remove some unnecesarry part of the huchuring. It can be removed by the *Knife* tool that is available in *Edit Mode.* To cut unnecessary part, activate an item with mouse button in the *Object Mode* then go to the *Edit Mode.*
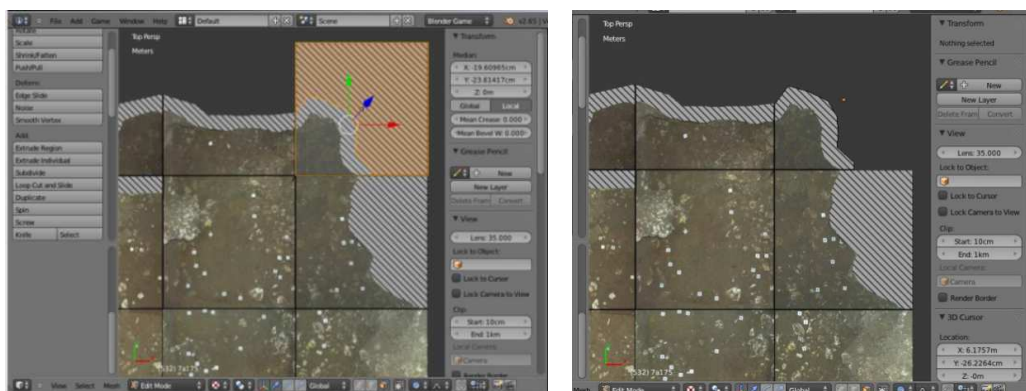


Fig. 9. Using *Knife* tool
*Source: Elaboration of the Authors*

After selecting the area to be cut, The cutting area must be closed by pressing the space button on the keyboard. Unnecessary surface are being highlighted and can be removed by using the *Delete* button and *Only Faces* deleting option. Cutting out unnecessary spaces will allow the model to be more transparent.

There is also a possibility to add *The text* into the visualisation with option *Add Mesh/Text.* The text itself can be changed in the *Edit Mode*.
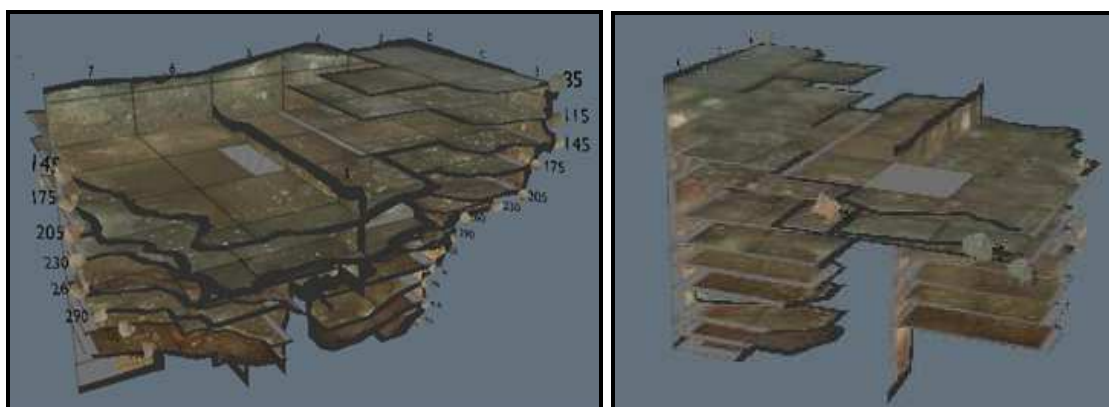


Fig. 10. The Komarowa Cave's first trench visualisation model
*Source: Elaboration of the Authors*

With the help of scrolling the mouse, the object can zoom in and out, pressed and moved left mouse model allows to navigate around the model and rotate it.

The individual view of the model can be saved to a file. To do this, one must select *the Properties window,* the first option on the left: *Rendering* (camera icon), after selecting the file extension, save folder and a variety of side options, choose the option *Render.* The file will render in the active preview window, options from the drop down menu allow his record in the previously selected format. To render the file properly, one must adjust lightning to the project. It can be done in by choosing *Add/Light* and adjust in the *Properties/Light* window.

It should also be noted that it is possible to save the file as an image using the *Print Screen*. The image generated in this way will have a original resolution of the computer screen or laptop.

## 3. Lubin excavation site: Miedzyzdroje, 1 AZP 21-04/1

### 3.1. Description of the excavation site

Until 2008 the settlement has never been a place of archaeological excavations.It was discovered accidentally on the castle treasure of silver coins dating from year 951, and from the early nineteenth century. A simultaneous experiment surface led to the discovery of another early medieval settlements around, which indicates that in the period between the X and XII century, Lubin was a cluster of settlements with a very important sense. In the central place of the hill with the characteristic shape of the old fortifications were there discovered relics of the foundations of the oldest Pomeranian church (XII-XIII century). While studies there wasalso found the foundations of a medieval church-tower residential and burial[4].

There has been prepared trench XIV of the excavation with its burials, first in GIMP, and the in the *Blender* program.

### 3.2. Preparing of the burial visualisation in GIMP and *Blender* program

Available dravings was scanned and by using GIMP program, there was deleted white area around the drawings. It is possible when the *Alpha Channel* mode is on and can be seen only in the pictures later saved in PNG format.
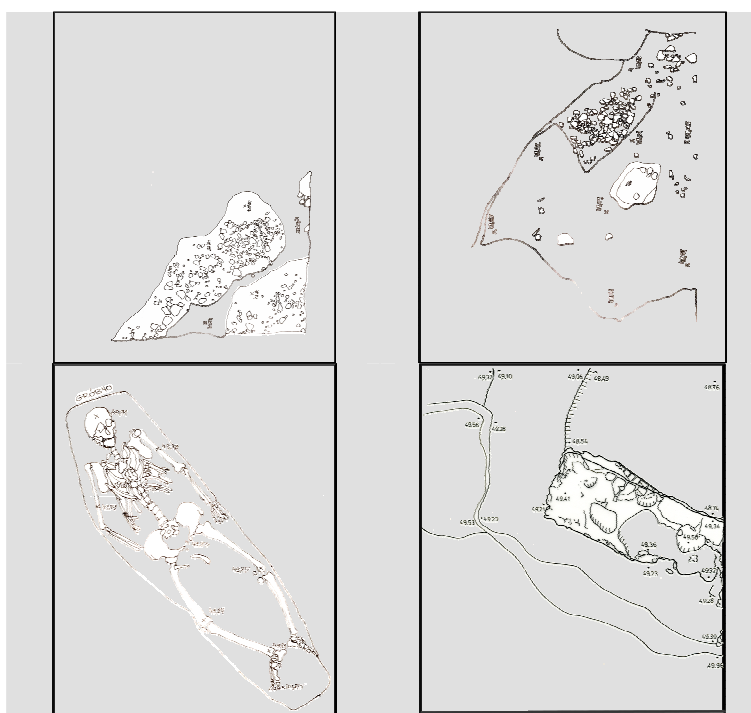


Fig. 11. Selected graves pictures in the GIMP file
*Source: Elaboration of the Authors*

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[4] *Settlement in Lubin*, Source: http://zp.pl/lubin--grodzisko,artykul_1_12_0_3 or
http://www.grodziskolubin.pl/index.php?site=grodzisko. It is recommended to see also: Rębkowski M.:
*Chrystianizacja Pomorza Zachodniego. Studium archeologiczne*, Szczecin 2007.

With the method described above in the *Blender* program, by using of the *planes* located in the area, was there prepared a visualisation of this site with selected layers and the trench profiles.

The burials has been presented in the easier way, as 2D pictures presented in the 3D space. One could have surely presented burials as 3D objects, but it would required many 3D figure sculpting, which can become the topic for next articles.

To show the pictures as transparent textures with *Alpha Channel* on in *Blender*, one must activate the *Color and Alpha* button shown in the *UV/Image Editor* below:
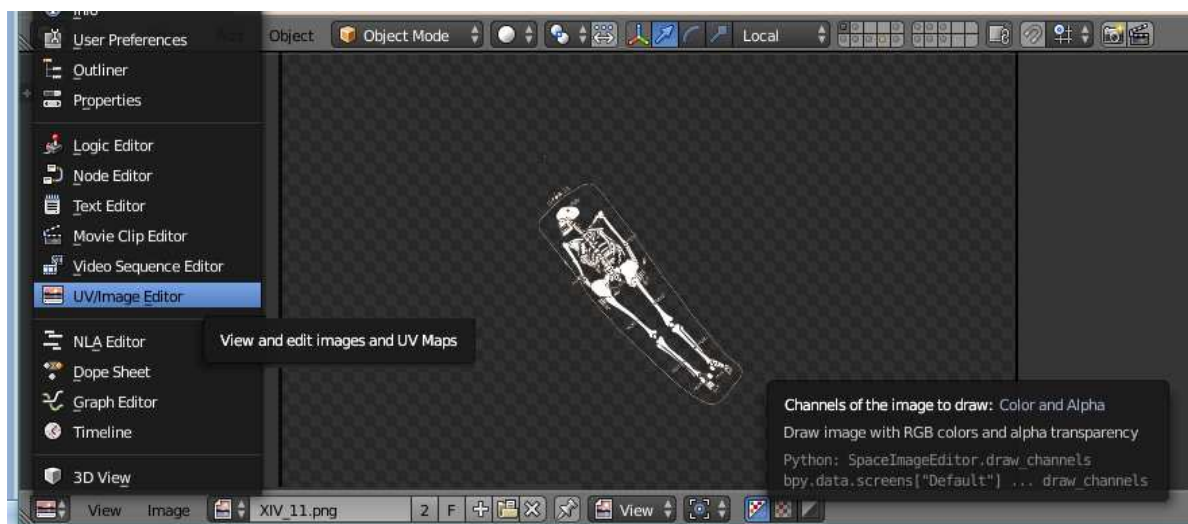


Fig. 12. Selected graves pictures in the GIMP file
*Source: Elaboration of the Authors*

The final 3D view preparation is being shown on the pictures besides. The *World* colour can be adjusted in the *Properties /World* window.
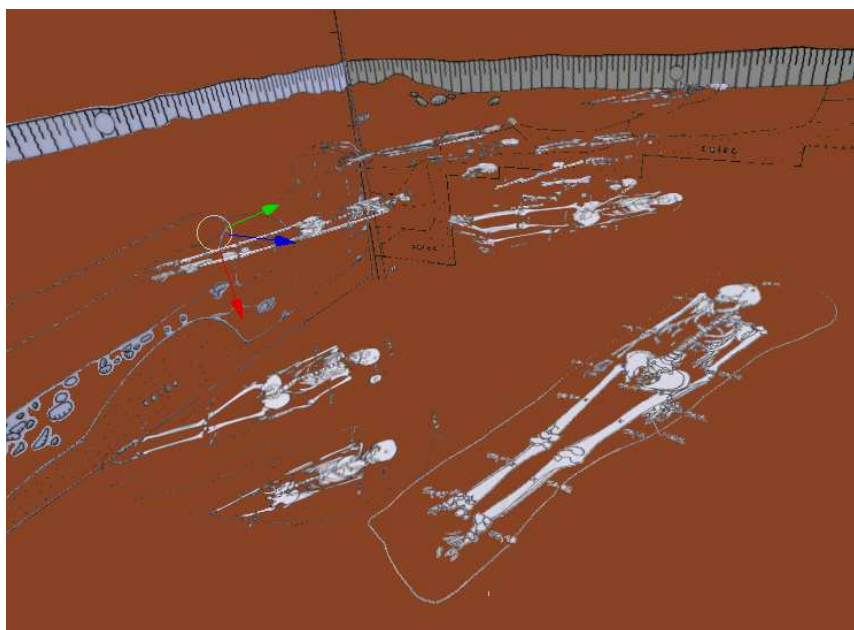


Fig. 13. The final model
*Source: Elaboration of the Authors*

The model, despite its simplicity, is the way to present complexity of the excavation site, has a value of presentation and education. Same as above presented model for Komarowa Cave, it can briefly visualize the result of the work to a wider audience.

## 4. Conclusions

- Attractive graphic form can be interesting for both specialists and attract the attention of non-archaeologists. It can help to arouse interest in the archaeology.
- Graphical model of archaeological excavations makes it easy to understand the essence of the archaeological work and helps to present it in the innovative way.
- Modelling can ease the process of analysis of the excavation site so it can be the great source of interpretation for the archaeologists.
- The proposed models are only a basic version and at the same time, the proposal for inter-active work with archaeological documentation.
- In the future, the options used for the production of the model can expand and propose a more complex work.
- The method shown in the paper is considered to be an innovative one in the archeological documentation.

## Literature

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[3] *Settlement in Lubin*, Source: http://zp.pl/lubin--grodzisko,artykul_1_12_0_3 or http://www.grodziskolubin.pl/index.php?site=grodzisko.

[4] Tyszczuk K. *Stratygrafia Archeologiczna. Plany Archeologiczne*, 2002. https://www.archeotyszczuk.republika.pl/plany_w_fotogrametrii.htm.

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