

Surveying and 3D modeling of a natural underground cavity. Nandru cave, Hunedoara County

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Abstract: - Nandru cave is a cave with a great archaeological value, whereas inside it was discovered signs of prehistoric living. From the desire of creating a prehistoric village and transforming this cave in a prehistoric house, emerged the need to survey this cave and the realization of a 3D model of it. For 3D modeling of this cave the necessary measurements was performed using a Leica GPS receiver and a Leica total station TPS 407 model.

Key-Words: - cave, surveying, total station, 3D modeling, archeology, prehistoric village.

1 Introduction

Nandru cave, named by the cave explorers the Clean Cave or the Lower Cave, it is located at the outskirts of the Nandru stream which crosses the Nandru village. Nandru village is administratively placed in Pestis commune, Hunedoara County (Fig. 1).



Fig. 1. Geographical location of the Nandru cave

The first archaeological excavations in the Nandru cave were performed in 1877 by Baroness Zsófia von Tórma. His discoveries were presented at an exhibition in Sibiu and in a report published by C. Gooss. The research results have been published much later by an archeologist named Márton Róssa in 1941 and 1942 [4].

The archaeological materials find in this area can be classified into several historical periods:

Paleolithic, Neolithic, the transition period to Bronze Age and medieval Age [2].

Unusually high temperatures inside the cave (about 20°C) and the archaeological materials led to the conclusion that the cave was inhabited since the Paleolithic period.

Even though the cave was repeatedly ravaged by amateur “archaeologists”, with 1998, the Museum of Dacian and Roman Civilization from Deva tried a revitalization program of systematic archaeological research of this area.

Due to lack of funds, until 2013 the only works undertaken in the area were those to block the access to the cave through metal doors [1]. Currently, it is desirable the tourist development of the area (in the Nandru cave area aim being to build a prehistoric village).

For this to be possible it was necessary to perform a detailed cave surveying from which to result a 3D model of the cave.

2 Topographic surveys

The topographic surveys were performed using a Leica total station, TPS 407 model, with the possibility of reflectorless distance measuring (using the laser mode).

In order to achieve a map in the national projection system (The Stereographic Projection 1970) the points from outside the cave were determined through GPS, by static measurement method, using a Leica GPS receiver model SR 20.

The Nandru cave is formed from three rooms (Fig. 2), two small secondary rooms of

approximately 15m² (separated one from another by concrete walls, made by humans in the last century) and a main chamber of about 150m².

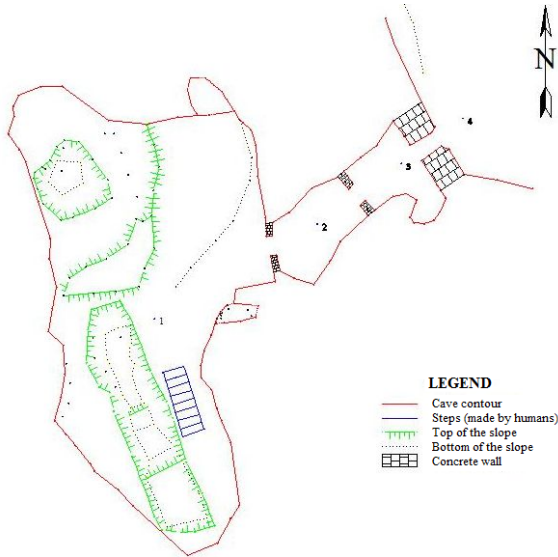


Fig. 2. The map of the Nandru cave

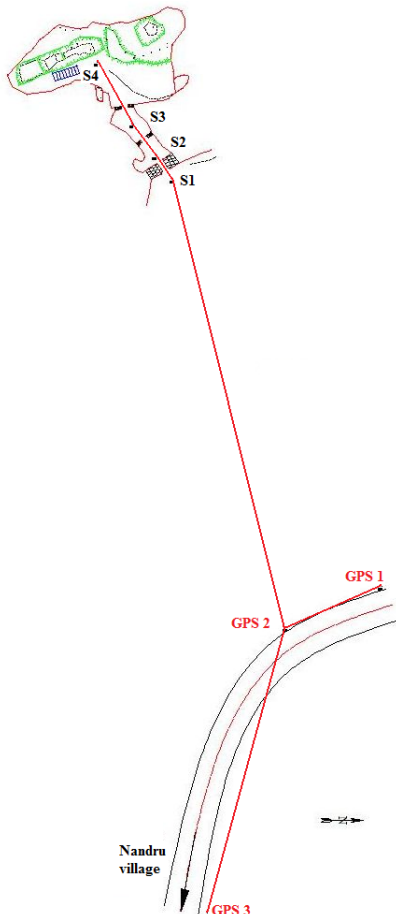


Fig. 3. Surveying preparation

For the topographic measurement of the cave necessary for drawing up the 3D model of this underground cavity, 3 GPS points were determined outside the cave, at the edge of the Nandru stream at

the exit of the village with the same name (see Fig.3).

From this points a floating traverse has been done consisting of four points, a point in each chamber and one point at the entry into the cave.

For drawing up the map and the 3D model of the cave, first were measured points of detail from the floor of the cave and its contour using a reflective environment (a prism). With this points a situation plan was created (see figure 2) and a contour levels plan (Fig. 4).

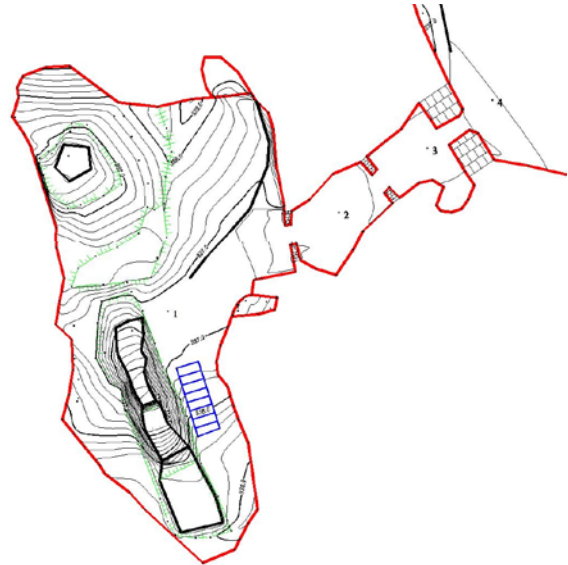


Fig. 4. Contour levels plan of Nandru cave

Also, a digital elevation model has been created as shown in figure 5.



Fig. 5. DEM

Further have been measured points on the walls and on the cavities ceiling using the reflectorless mode (distance measuring module without prism).

3 Creating the 3D model

In order to achieve the 3D model of the Nandru cave (Fig. 6) the AutoCAD Civil 3D 2012 software was used [6].

For it has been created two layers for each chamber, a layer for the floor of the cavity and one layer for the walls and the roof.

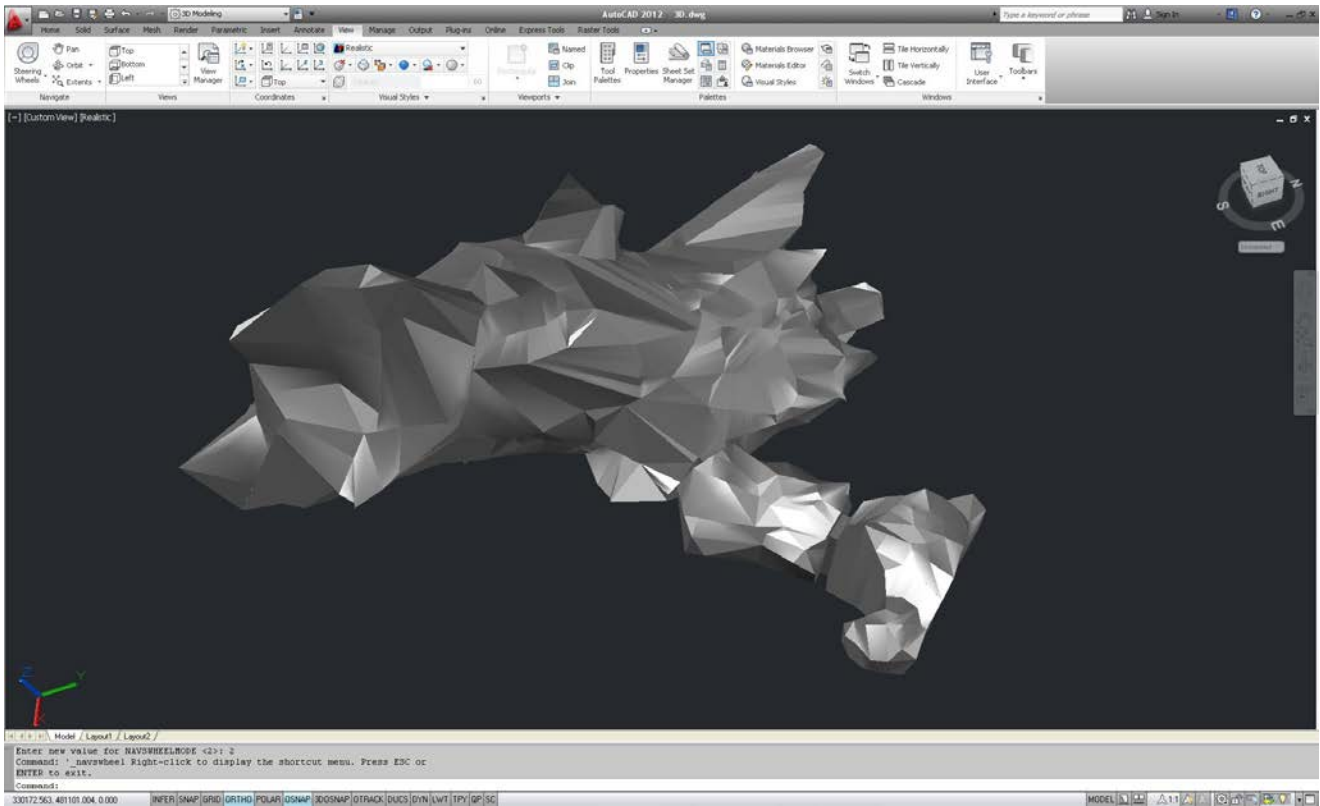


Fig. 6. 3D digital model of the Nandru cave

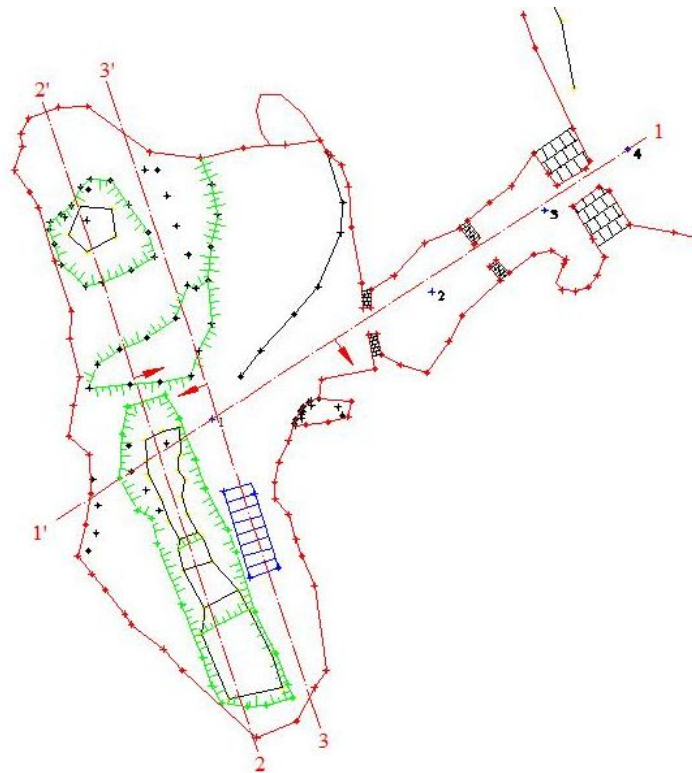


Fig. 7. Manner to achieve the vertical sections through the 3D model

Finally, vertical sections has been made through the main parts of the cave (see figure 7) as shown in figures 8, 9 and 10.

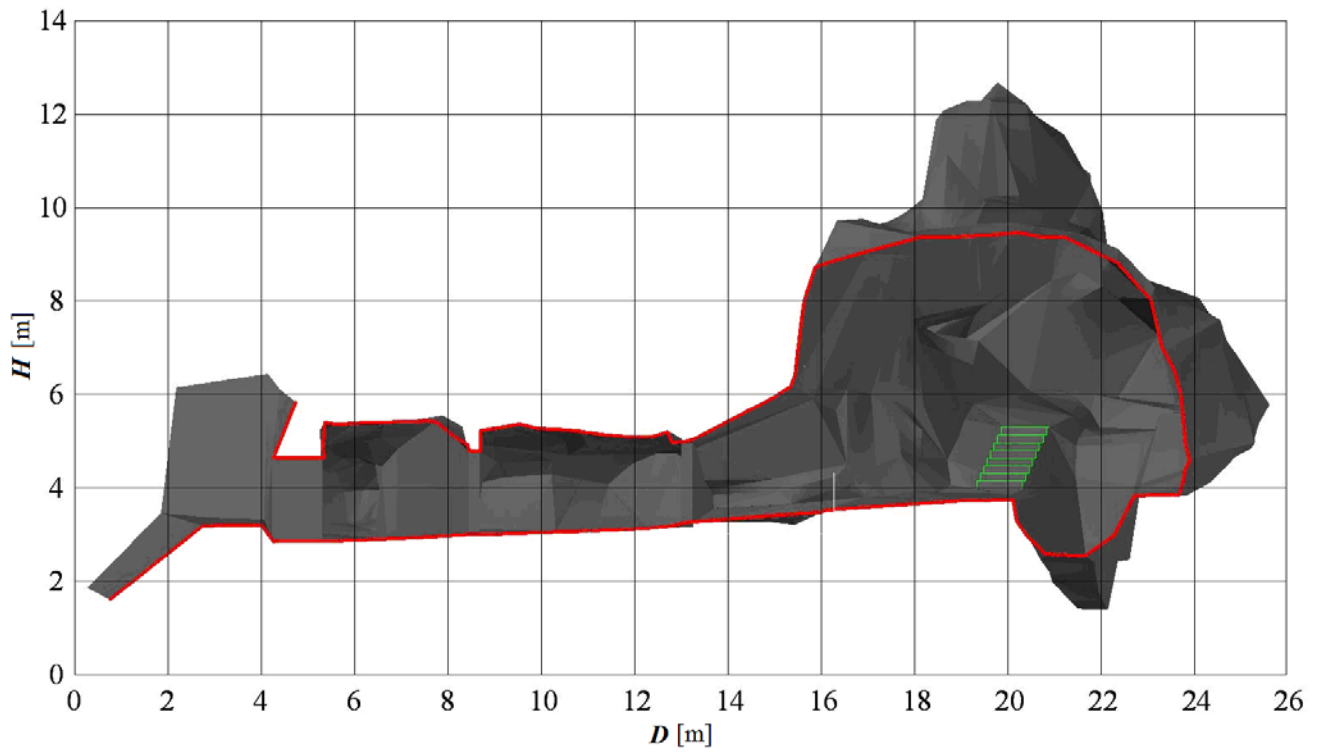


Fig. 8. Vertical section 1-1`

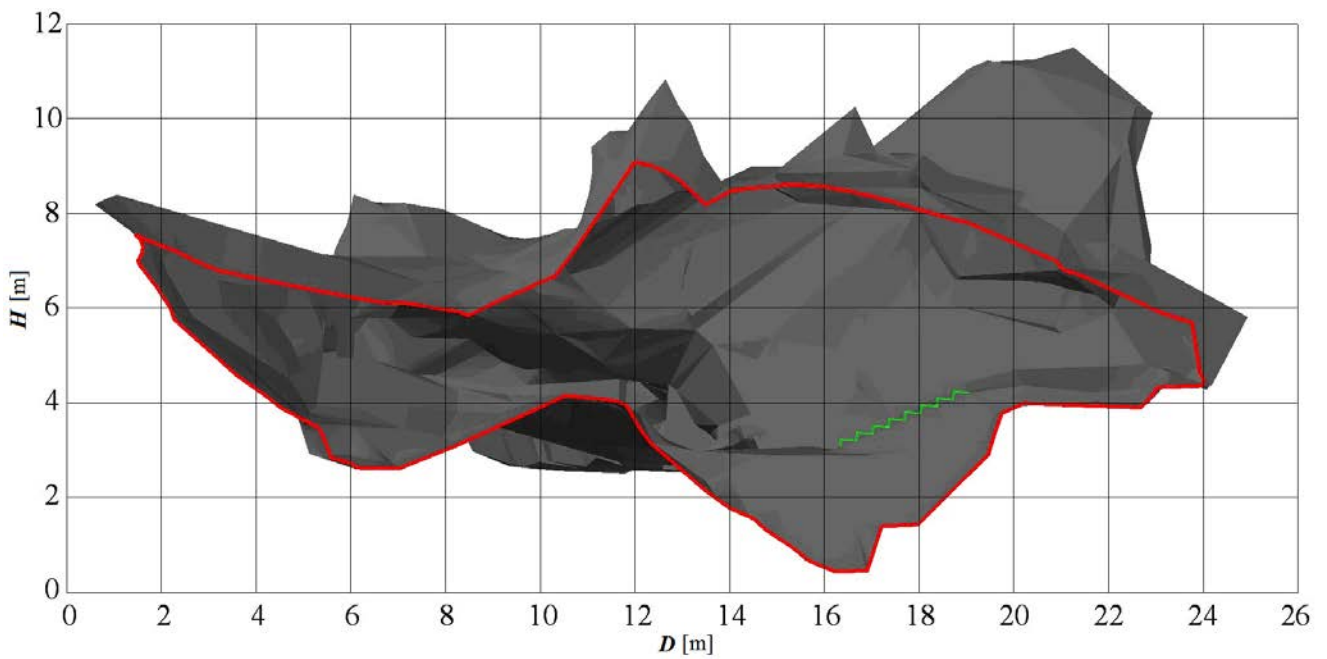


Fig. 9. Vertical section 2`-2

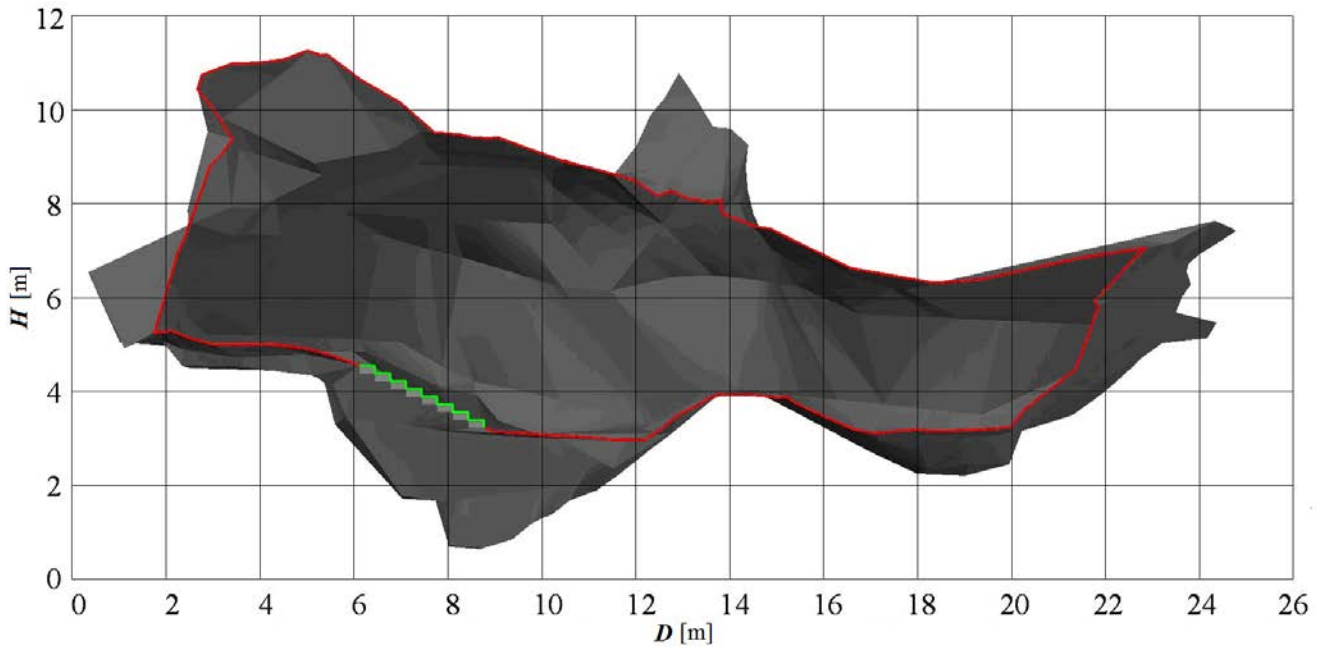


Fig. 10. Vertical section 3-3`

In this vertical sections can be seen much better the outline contour of the cavity.

In figure 10 is represented a 3D view inside the Nandru cave.

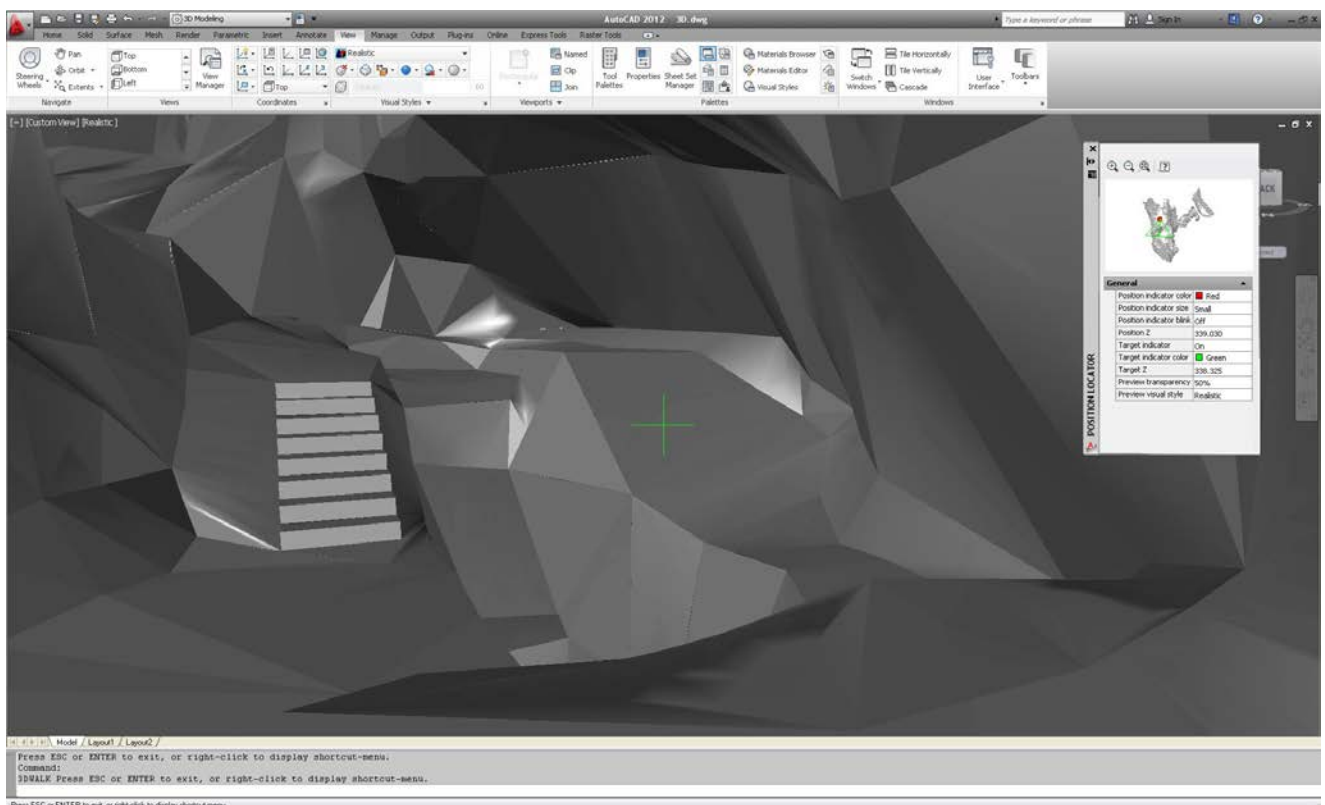


Fig. 11. 3D view inside the Nandru cave

4 Conclusions

The Nandru cave is an archaeological objective with particular importance, being archaeologically researched since XIX century. Inside the cave was

discovered significant archaeological material that led to the conclusion that this cave was inhabited since the Paleolithic period.

Being an important archaeological site here were conducted numerous excavations (unfortunately many of them were made by amateurs), traces of which are still visible today.

From the desire of implementation of this objective in a tourist circuit (achieving of a prehistoric village) emerged the need to survey this cave and the realization of a 3D model of it.

To achieve this objective the measurements were made using a Leica GPS receiver, SR20 model (to determine the coordinates of the starting points) and a total station capable to measure distances without prism. The 3D model was performed using the AutoCAD Civil 3D 2012 software.

Finally, for a better visualization of the cavity contour, vertical sections were made through the most important areas (a vertical section through all three chambers and two vertical sections in the main chamber).

In the future the cave will be arranged as a prehistoric house.

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