



Virtual simulation of chimney shaft of Valdeazogues

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Abstract

Purpose:

Virtual simulation of mineral-metallurgical fence of Valdeazogues in Almadenejos (Ciudad Real) dedicated to cinnabar exploitation for getting mercury. It was demolished when the open pit mine of el Entredicho was open.

Method:

The method used for the research was historic-logic and inductive-deductive for the virtual simulation. The employed materials were: spoken sources, documentary sources, cartographic sources and graphic sources. The hardware used was a 64-bit computer, and the software: Auto-CAD 2010, 3D Studio, Corel Draw and Corel Photo Paint x3.

Result:

The Wall fences of Valdeazogues was compound with one baritel, two pair of aludel furnaze, gunpowder store, sentaduría house with engineering and assistants accommodation places, one patio and stables. The models obtained in the research do not differ from the ones that are acquainted and have been left as inheritances, perhaps the showiest in the baritel of Sta. Cristina due to its cylindrical shape with reinforcements for its support and its conical cover.

Discussion & Conclusion:

The Almadén Mine was declared as World Heritage in June 30th, 2012 by UNESCO. The declaration doesn't include Almadenejos Heritage, of which the mine and metallurgy were important part of the history of the mercury. We would like to recover that heritage to be included in Almadén World Heritage.

1 Introduction

The current technology allows us to recreate scenarios simulating the reality to project something that still is not made or to see what has already gone.

The simulation as virtual environment offers a perception of the gone elements (machines, buildings, constructions, and so on) getting an empathic implication through the generation of an artificial model that would represent how this element that left being real was. For this reason, the patrimonial recovering of these elements uses the virtual simulation as methodology to solve the challenges that has its knowledge with 3D representations, mixing them with scenes and virtual worlds.

1.1 The object of the research

The research work what is exposed is centered in the knowledge creation of chimney shaft de *buitrones*¹ de Valdeazogues placed in the southeast and 3,5 km of Almadenejos (Ciudad Real), what disappears in the opening of the open pit mine of *El Entredicho* in 1978,

¹ It was an environment closed by 2,5 meters stone wall (to have the control of the mercury and avoid the robs) from a mining-metallurgical facility.

to realize a virtual simulation of the same, with the object that this population be part of the Almadén world heritage.



Fig. 1 Demolition of Valdeazogue fence

1.2 Historical backgrounds

Almadenejos means "small mine" or "small Almadén" in Spanish, and owes its origin to the discovery of the "Conception"² mine, placed under the town, which was discovered in 1699 and closed 1800.

² After called as 'old one' mine de la Concepcion to make out from the 'new one' with the same name discovered in the Gilbreros' hill.

Almadenejos distance from Almadén is 12 km in the southwest of the Ciudad Real province in Castilla La Mancha region.



Fig. 2 Situation Map



Fig. 3 Location Map

It was a mine exploded by the Romanians and there were authors said, because of the wealthy that the mine gave, that it could be the mine that Plinio el Viejo³ was talking about (XXXIII 118), showing its importance with the following words: "... There are enough reasons to believe that Valdeazogues is one of those that the Romanians took off cinnabar, main and more productive. It seems that we can conclude what Plinio told us, who ensures that to Rome any other cinnabar was given besides the Spanish one, taking off from the mines in the sisaponenes region which the appreciates a lot, particularly the one what was from the name of 'Sisapo', what was its capital... in the Valdeazogues river side and two and a half leagues from Almadén is placed the actual mine what preserves that name and of what the age is ignored, the Sisaponenses mine what Plinio refers, wealthy in productions and in consequence wanted from the Romanians..."[1].

This reference to Valdeazogues could cause confusion and refer to an old mine of "El Entredicho⁴ de Valdeazogues" too, because where the cinnabar was extracted what arrived Rome could be any of those mines or even both of them. After, with the opening of the open pit mine was demonstrated that both mines operated in the same mine site, making true the references given by Plinio el Viejo. What was not certain is that in any moment of the history those

³ Gayo Plinio Cecilio the second (23-79 b.C.).

⁴ The old mine of el Entredicho, also denominated as el entredicho register, 3,5 km far from Almadenejos (Ciudad Real) towards to Orient and next mine of Valdeazogues, was discovered in 1771 [7] and closed in August 1860 [8].

mines were joined in the depth because the opening of the open pit one did not allow the determination.

1.3 Basic information

The bibliographic information about the description of this fence of buitrones (mining-metallurgical character) is very low and limited. The evolution of the mine during the Independence War and after was abandoned until the public money could make some invests in 1825 [1]. Other consulted sources were: two pictures with details about Santa Cristina's baritel [2], bridge before it was destroyed [3], descriptions of Valdeazogues mine [4], [5] and [6]. Related to the baritel the information was taken with the only one what left in the San Carlos's⁵ baritel in Almadenejos that belongs to the new mine of the Concepción and the plane of the machines house of San Teodoro in Almadén.

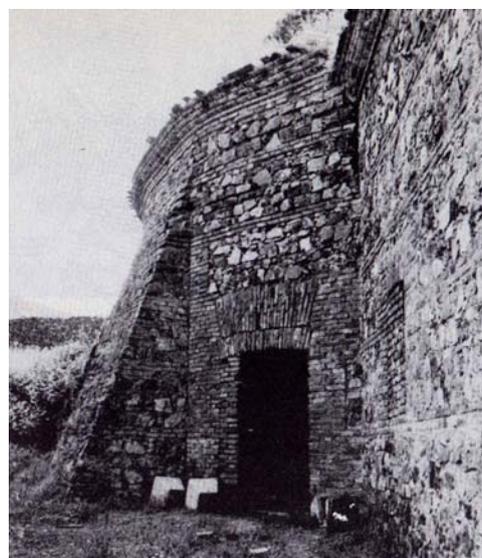


Fig. 4 Detail of Santa Cristina's baritel

Related with the metallurgical technology that was in buitrones fences there were aludeles⁶ furnaces that were executed in pairs to preserve the heat better in the furnace. The builds in this place were an evolution from the one invented in Perú. This technology has been studied well by different authors [5], [7], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19] y [20].

2 Materials and methods

Now we will describe how the Valdeazogues fence mining-metallurgical virtual simulation research has been carried out.

2.1 Materials

The materials used were classified as: oral sources, documentary sources, cartographical sources and graphical sources.

⁵ Has been declared BIC with monument category in 1992.

⁶ Also known as Bustamantes's ovens, because they were brought by Juan Alonso Bustamante in 1645, from Huancavelica (Peru) to Spain and of which the inventor was Spanish Lope de Saavedra Barba in 1635 [21].

The oral sources were consulted in the beginning of the research and they were done by the habitants of Almadenejos, old people, who were miners getting a general composition of the distribution of what the mining-metallurgical place had before its demolition.

The documentary sources helped completing the few known information. The contented description of the mining-metallurgical place since its opening until its closing were the main reason of the Archivo Histórico Nacional research (AHN) and Almaden's foundation "Francisco Javier de Villegas" mainly.

The first cartography that makes reference to the mine and Valeazogues fences is an orographic map in 1838 about Almadén and Almadenejos [22], as well as the topographic map of Almadén of the years 1889, 1953, etc..., but in none of them shown the content and the distribution of the mining elements that were in the fence of buitrones. This limitation was overcome thanks to the aerial photograph⁷ of the zone taken by the Americans in 1956.



Fig.5 Orographic Map of Almaden and Almadenejos 1838

There were the graphic sources compound by the two photos of the fence found in the Instituto Geológico y Minero de España (IGME) [24] and the other is from Sanz [25] which told us how it used to be. The last one has the view of the bridge that had the access from Almadenejos and crossing the river Valdeazogues.



Fig. 6 General view of buitrones fence

2.2 Methods

The methodologies used to create the virtual simulation of buitrones fence were the following:

- Research and gather historical documentation about this subject.

- Research and gather oral sources: miners who knew the places, ex mayor, and old settlers from the area.
- Research and gather documentary sources.
- Research and gather graphical and cartographical sources (planes, pictures, aerial photos, and so on) which can give us information about how it was before.
- Compare the obtained information with other sources that includes other similar elements to what it wants to virtualize.
- Determination of the historical moment of the virtualization, determining if the elements that were in the place changed over time.
- Study the information obtained to come to determinate how was about the objectives data and some and how could be when the necessary information was not found. In this phase they created a lot of sketches from some parts.
- 2D modeling
- 3D modeling.
- Creation and usage of the textures. In most cases they have been created a texture that were the most possible real starting from similar elements in Almadenejos.
- Study the illumination and shadows.
- Creation of the render with some photographical change to have more reality.

2.3 Equipment

The virtual simulation was made using 64 bits computer with the software AutoCAD v.10, 3D Studio, Corel Draw and Corel Paint X3.

3 Results

The historical investigation showed us that the mineral-metallurgical fence of Valdeazogues was compound by a baritel (Santa Cristina) which was covering the main well of the mine, two pair of aludel furnace (named Sta. Isabel and Sta. Cristina and San Anselmo and Santiago), a store of powder, the bridge⁸ which was crossing the Valdeazogue river and a sentaduria⁹ house, where the engineers and assistants accommodated, with a big patio and some barns for mules and oxen.

Thanks to the aerial photograph of American flight of 1956, we could figure out the distribution in plant of the fence, conforming the historical dates, except the sentaduria which did not appear.

⁸ It is known by the people as minetas bridge.

⁹ Place is dedicated to the sentador (similar to accountant) who took all notes to leave a written record of everything and give all the data to the contador of the mine.

⁷ Frame 7074. Source: EIMIA [23].



Fig. 7 Areal Photo. American flight 1956

For the design of the baritel, the idea was originated from the aerial photograph and was designed the winc which was a structure (made from beam, scissors, levers, and so on, also from wood) and a vertical axis which was having a cylindrical tambour called “*bombo*” on its top, divided into two parts, in those, normally esparto grass, hemp, was being rolled up with a series of cranks “*el tiro*” or “*cintero*”, passing through two pulleys. At the end of the both extremes of the rope they hang up wooden barrel of extraction or a basket that they go up or go down.

Usually they have mules to move the winch. They were attached to the fork or “*volea*” and they turn and turn on the platform or floor of the baritel or winch. With this movement the material go up or down depending on the way in one or other sense. [26]

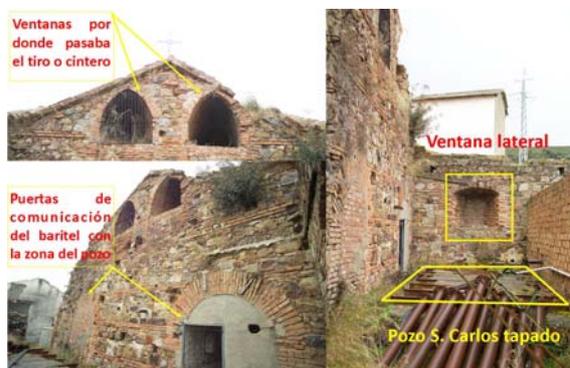


Fig. 8 San Carlos baritel at Almadenejos

The aludeles furnace were buildings of the same epoch than the others at buitrones fence of Almadenejos and the unique pair¹⁰ that the are rehabilitated at buitrones fences of San Teodoro in Almadén.

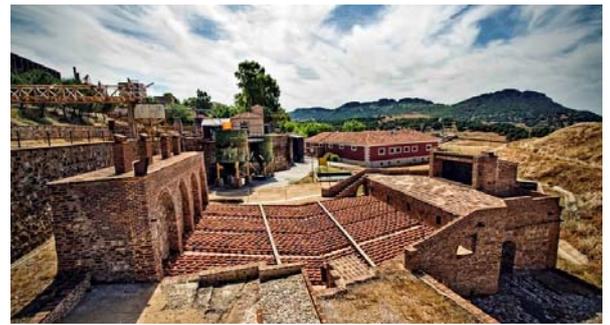


Fig. 9 Couple of aludel furnace in Almadén

We have a photograph of the Valdeazogue bridge before it was destroyed in 1982 [3].



Fig. 10 Minetas de Valdeazogue bridge

The epoch of the virtual simulation was determinate when there were more diversity of elements, in 1852, when in the fence there were a baritel, only one couple of furnace (Santa Isabel and Santa Cristina), the gunpowder store and the sentaduria house (it was also housing, offices, with patio and stables).

The design was made with the historical information and with the support of similar models that allowed to measure the dimensions [27].

¹⁰ It was declared BIC, with monument category in 1992.

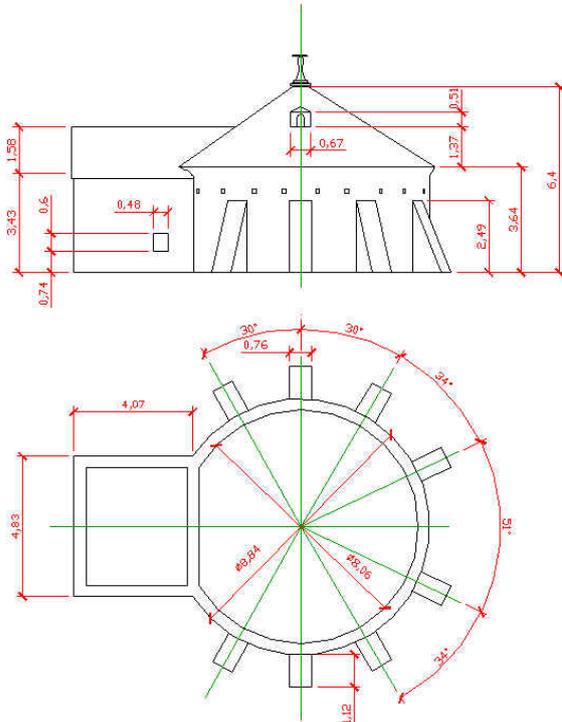


Fig. 11 Floor and elevation of Santa Cristina's baritel

As an example, the conceptual 3D representation of the baritel, shown at Fig.12.

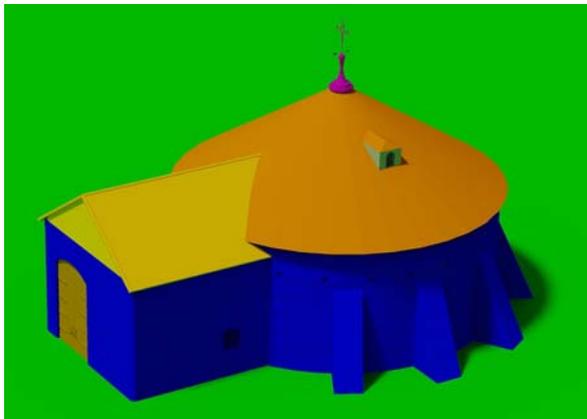


Fig. 12 Conceptual picture of Santa Cristina's baritel

In order to get that figure modeled in 3D animation, a texture of an image was applied to a solid or a mesh. For this we worked with mosaics and the majority have been created from similar elements of the same epoch that we found in Almadenejos [27].



Fig. 13 The texture created from a photograph

The final render of Santa Cristina's baritel is shown at Fig. 14.



Fig. 14 Rendering Santa Cristina's baritel

The design of the constructive solution of the winch was based on the baritel of San Carlos in Almadenejos that even if it lacks winch it made its design possible. It involved a square formed by pieces of timber embedded in the walls and leant in wood beams built-in on side and cantilever for another one. In order to endure tensions the pieces of timber were shored up in the angles with pieces of timber to 45 for their reinforcement and in every one of the unions positioned themselves metallic cruciform flat strips of steel to fix them among themselves avoiding displacements for the efforts that can come true during your functioning [27].



Fig. 15 Detail of rendering of pulleys and well

The aludeles furnace where the cinnabar was processed for getting the mercury or azogue, once it was rendered is shown at Fig.16.



Fig. 16 Rendering of a couple of aludeles furnace

The gunpowder arsenal, with a simple roof, that contained the gunpowder used in the mine, which was the simplest element and it was based on a similar element of the fence of buitrones in Almadenejos.



Fig. 17 Rendering of gunpowder arsenal

The last element of vital importance, that their information and data were acquainted, was the bridge to access to the fence. It allowed the communication with other parts of La Mancha region (Fontanosas, Abenojar, Almodovar del Campo, Puertollano and Ciudad Real) [28].



Fig.18 Rendering of minetas bridge

4 Conclusion & Discussion

The importance of the mines of Almadén, where Almadenejos is one of them, consisted in the high value of the mercury since the discovery of the method of patio by Bartolomé de Medina in 1555, for obtaining the gold and silver from deposits with ores of low law that could not be obtained by means of foundry.

This fence was a part of the lost industrial and mine heritage, origin of the historic mining of the mercury (more of 2.000 years of uninterrupted exploitation) once its closedown was obliged by environmental aspects. The mines of Almadén was listed as one of the World Heritage sites for its importance in the transference of knowledge in relation to mining and metallurgy of mercury, on June 30th, 2012. In this declaration of heritage is not included mineral-metallurgist heritage located in Almadenejos. We want to show it to achieve its rehabilitation and in that it being able to add up this worldwide recognition.

Thanks to this study and to the techniques of virtual simulation has been able to determine with a high level of approximation how was the fence of Buitrones of Valdeazogues. The Techniques used and the used equipment has been the adequate to obtain the established objectives.

The house of the sentaduría didn't appear in the image of the frame 7074 of the American flight (1956) because in 1861 the well had sunk. It justified the mine was closed and it affected directly one house. That house got cracked and the demolition was needed in another historic unknown moment [8].

In the virtual simulation, the sentaduria's house was interpreted. It was known for its use due to the historic descriptions but the lack of data about its distribution, its exact placement inside the fence buitrones and we are proposing a possible placement that fulfills several requirements at the same time: Being protected by the outer wall of the fence, the control of the Western door, having the height lowered than ovens and west of them avoiding the smokes of metallurgy, far away from the gunpowder arsenal as well as of the well of the mine [29] and [30].

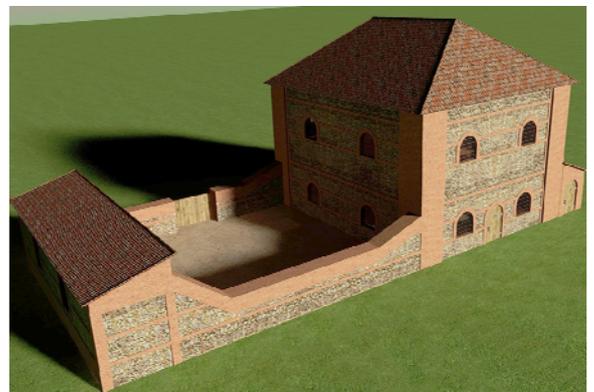


Fig. 19 Rendering proposed of the House of the sentaduría, engineers, assistants, patio and stables

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