

THE ALMADÉN MINING PARK: an example of both recreational, educative, scientific, environmental and territorial approach for revitalizing a closed down mining basin.

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ABSTRACT: Mining in the Almaden mercury basin (Ciudad Real area, Castilla-La Mancha province) stopped in 2001 and its smelter in 2003. Basing upon their huge historical and cultural significance, a program of touristical revalorization was launched in 2002 by the state-owned mining company and by the Almaden-Francisco Javier de Villegas Foundation. Its 9 millions euros funding mainly came from the Spanish state (80 %) and from Europe (FEDER funds, 15 %). The operations of environmental remediation were granted of another 9 millions Euros. The underground and surface installations have thus been transformed into a mining park, inaugurated on January 16th, 2008. The results provide a showcase of the technical and economic aspects of operations which aim both at : contributing to growth in closed mining areas; helping to reduce the decline in population by offering job opportunities; make possible the growth of tourism in territories that in the past had lost their attraction as a tourist destination because of mining and metallurgy and of the nature of the commodity exploited (mercury here).

KEYWORDS: Almadén, mercury, mines, mining heritage.

RESUME : L'extraction dans les mines du bassin mercuriel d'Almaden a cessé en 2001 et la fonderie en 2003. En raison de leur énorme signification historique et culturelle, un programme de revalorisation touristique a été lancé en 2002 par la compagnie minière d'état et par la Fondation Almaden-Francisco Javier de Villegas. Sa dotation de 9 millions d'euros a été fournie principalement par l'Etat Espagnol (80 %) et par l'Europe (fonds FEDER, 15 %). Les opérations de réhabilitation environnementale ont reçu une dotation de 9 millions d'euros séparée. Les installations de surface et souterraines ont ainsi été transformées en un parc minier, inauguré le 16 janvier 2008. Les résultats fournissent un exemple méthodologique de grande utilité sur les aspects techniques et économiques des opérations qui visent à la fois : à contribuer à la croissance dans les zones minières arrêtées ; aider à

réduire l'exode de la population en créant des emplois ; rendre possible le développement du tourisme dans des territoires qui, dans le passé, avaient perdu leur attraction comme destination touristique en raison de l'activité minière et métallurgique et de la nature de la substance exploitée (le mercure, ici).

MOTS-CLEFS : Almaden, mercure, mines, patrimoine minier.

1. Introduction : a worldclass deposit and an intriguing metal

Mercury is a metal with intriguing properties. Liquid under current conditions, it excited the curiosity of the Alchemists. The major mining basin of the Planet for this metal is located around Almadén city (Ciudad Real district, province of Castilla La Mancha). It comprises several mines (Hernandez *in* Féraud ed., 2005): Almaden (286,350 t metal produced), El Entredicho (12,075 t), La Concepcion Nueva (6,382 t), Las Cuevas (5,175 t), La Concepcion Vieja (3,105 t) and contains still deep-seated reserves (among which El Nuevo Entredicho for 5,175 t).

"This is the richest mine for the state, the most instructive in their labour and the oldest that is know in the world". Thus William Bowles, an Irish scientist, described the Almadén mine in 1775 in his book "Introduction to the natural history and physical geography of Spain". Nature was very generous with Almadén when, around 400 million years ago, it generated in its entrails the largest reservoir of mercury in the Earth. In figures, of the 22 million bottles of mercury (a flask containing 34.5 kg of metal) consumed over the history of Mankind, one third (9,225,000 flasks) comes from the Almadén mining basin (i.e. 319,000 t metal).

Some authors believe that Cervantes was thinking of Almadén when he wrote about the Barataria Insula of his book "Don Quixote".

But unfortunately, all deposits, even the largest ones, come to an end. For different reasons (economics, environment, global change) Almadén was not to be an exception. However, we should feel privileged because the 2,000 years' life span of this mining basin has let to us a great heritage concerning both historical, social, societal, scientific and technological aspects, particularly concerning mining and metallurgy of mercury.

Mercury, the "flowing mercury", the "azogue" of the alchemists, is one the most intriguing metals known by Humanity. Almaden is the biggest mining basin and the largest mine of this metal in the World. Since the discovery of silver amalgamation by mercury, Almadén has taken a huge significance in the history of the economic development of the Spanish empire, as the major starting point of the so-called "Royal route of mercury" towards Americas and towards the mines of the New World. It was subject of conflicts by prominent faces of History : Charles Quint, the Függer, the Rothschild. It inspired the Alexander Calder's Almadén mercury fountain, a unique work of art that was exhibited together with the Picasso's "Guernica" in the Universal Exhibition of Paris in 1937 and is now hosted in the Joachim Miro's museum in Barcelona. Therefore, all the "alchemical" components were gathered to make Almadén one of the sites of major mining heritage in the World.

Nonetheless, the game, set and match were not won yet. When market prices decline and difficulties come, mining companies usually cannot offer the luxury and fantasy of culture.

2. The beginnings

The idea of revalorizing abandoned mining basins by opening secured mining sites to tourist visits and by creating recreational and educational museums has been in operation for several decades in Europe, as in Rammelsberg (Germany), Příbram (Czech Republic), Sardinia etc.... In Spain as well, are now renowned several old mining sites opened to tourism. Each year, new projects enter feasibility: Las Médulas (Leon), Cercs (Barcelona), El Entrego (Asturias), Cardona (Barcelona), Rio Tinto (Huelva), etc.

The collapse of mining industry in Spain, similar to what has occurred in many other countries in Western Europe, resulted in the creation in 1995 of the Spanish Society for the Protection of the Geological and mining Heritage, in Madrid. The first annual conference of this association was organised in October 1996 in the Almadén School of Mines, by Luis Mansilla Plaza, director of the School, and Roberto C. Fernandez Barba, of the University of Castilla-La Mancha. For that circumstance, the school was transferred, from its original historical palace in the city centre, down to a new building which is located on the old foundations of the royal penal jail for the convicts employed in mining. In the School of Mines was as well inaugurated the Historical Museum “Francisco Pablo Holgado” which contains collections of objects and minerals from the Almaden mine.

In the mid-90's, was also raised, as a lobbying movement, an association of Almadén citizens concerned about the preservation of their historic monuments, among which 15 buildings and mine facilities. The Board of Communities of Castilla-La Mancha, for his part, ranked several buildings as of industrial archaeological and cultural interest and requiring a high level of a protection. Among them were the old distillation kilns (“aludeles”) of Almadén and Almadenejos smelters, and the building hosting the horse moved winch of the San Carlos shaft in the Nueva Concepcion mine, both dating from the 18th century.

The privately owned tourism society of Almadén’s district tried to launch the commercial exploitation of these resources, but the lack of support from various institutions prevented it from fulfilling its goal.

At present there are so many projects for revalorising the heritage, that it seems that after a few years there will be no mining district in Spain that will not have its own museum or Mining Park. These projects are granted of consideration from both the public and the authorities, as far as they promote the defence and preservation of heritage and they consider the remnants of Spanish mining as a new economic resource within areas today in decline that have serious problems of industrialization.

3. Geographical and economic context

Almaden is a small city which, at the peak of mining, has had 10,000 inhabitants and now fluctuates from 7,000 to 6,000. It is located 300 km South of Madrid, in the autonomous community of Castilla-La Mancha, close to the border of the communities of Extremadura and Andalucía, in the North of Sierra Morena. The landscape is closely linked which geology, dominated by elongated hilltops culminating at 500 m above sea level. They are made of

quartzite layers Ordovician-Silurian in age, intercalated between thick black schists that make flat narrow plains, according to a Variscan age folding phase of successive anticlines and synclines.

Economy is (except mining) mostly depending from breeding sheep, local-scale agriculture, olive oil and hunting tourism. Mining started at least during the Roman Empire. Due to the strategic importance of mercury for the beneficiation of silver ores in Bolivia and Mexico, Almaden was continuously a state-owned mine, ruled by the ministry of Finance. The last operating company was named MAYASA (Minas de Almadén y Arrayanes S.A.). When mercury prices began to decline in the 70's, mining declined as well. The Almaden mine properly speaking, which was the last still operated in the basin, closed at the beginning of this century : mining operation in 2001 and the metallurgical plant (which was still benefiting the stockpiled ore of Almaden, La Cuevas and El Entredicho mines) in 2003. The last production still in operation (recycling of mercury from the European rejects from chlorine and soda industry) will stop in 2011 according to the European Union's decision to stop production and exports of this banned metal.

4. Start of the adventure

During the 90's, when the economic signals had turned definitely red, the directorate of Almaden mines started to encourage the preservation of the heritage of the mine. Nonetheless, mining and regional exploration were still going on. Numerous high level publications and PhD of purely geological interest came out, with sometimes the collaboration of foreign universities, improving the knowledge of the ore controls (these works will not be quoted in the references below).

The scientists of the geological and drilling department of MAYASA started to forecast what artefacts warranted protection and might possibly feed a later valorisation. A small building inside the mining compound was devoted to the storage and exhibition of the oldest or most precious relics of the mine as well as the mineralogical collections of reference. Some publications were printed by the State in order to make the public (and the authorities concerned) acknowledged of the wonderful history of the mine and its heritage, among which those by Gonzalez Tascon and Perez (1990) and Hernandez (1995a). The geological department surveyed the feasibility of preserving the upper mine levels of Almaden mine and started collecting all the old plans and tools available.

In May 2002, whilst numerous miners were still available on the site, an agreement was signed between Sociedad Estatal de Participaciones Industriales (SEPI, created in 1995), which belongs to the Ministry of Economy and Finance and had become the final owner of the mine, and MAYASA Unions UGT, CCOO and SICMA. This agreement envisaged the allocation of funds for the Foundation Almadén-Francisco Javier de Villegas, created in late 1999.

The work plan was basically to carry out the necessary initiatives to redevelop the historic resources of the mines (documentaries, mining, metallurgical, etc....) for both a future tourist use and research. The investment committed to this end until March 2006 amounted to about 9 million euros.

For the drafting of the Master Plan for this project, MAYASA convened a restricted competition that was won by the company Quality Group competing with seven other candidates. The company cited delivered the memory of the Master Plan in late February

2003 and the overall development of the work then began. Its ultimate aim was to convert all the historical facilities of MAYASA into a cultural exploitation, through their adaptation to public visits. In addition, there would be various cultural activities related to the history and technique of mining and metallurgy of mercury. Various companies of the SEPI group were involved, the directorate of MAYASA, and, together, ENUSA and its subsidiaries EMGRISA, SADIM (HUNOSA), TRAGSA, INFOINVEST and SEPIDES.

5. Restoration of historical buildings and shafts

5.1. *The San Rafael royal hospital of the miners and the archives*

The visitors are sensitised to the impacts of mercury on health. It is a building of significant size outside the mining and metallurgical compound. It was founded in 1752 by the superintendent Francisco Javier Villegas, whose name was given to the Foundation. Moreover, it is a magnificent example of synergy, as the funds needed for its construction came from the sale of houses attached to the Almadén's bullring and the benefit of bullfighting shows. It is one of the first hospitals in Spain which had a structure for professional cares and can be considered as an achievement of the ideals of the movement of the eighteenth century medicine. The building was declared a cultural heritage in 1992. The works to restore it represented an investment of approximately 2.5 million euros and were co-financed at 50/50 by the Fundacion Caja Madrid and MAYASA.



Figure 1. Restoration of the hospital of the miners

In July 2003 were settled in this building the historical archives of the Mines of Almadén, the headquarters of the Foundation and a museum devoted to recreate the hospital activity and the life and customs of the miners. The documentary archives of MAYASA came mainly from the period between 1936 and today. However, there are also documents of the 18th, 19th and early 20th century funds. The files are grouped into five sections: Old Fund, Board of Directors (1916-1981), (1981-2002) MAYASA, Library collection and mapping. The latter contains some 5,000 drawings and maps valuable for the study of mining and metallurgy of mercury. The preservation of these maps and documents is also absolutely necessary for hazard forecasting, future monitoring of the site and understanding any disorder that could occur on the surface or within the hydrogeological plumbing system of the site in depth.

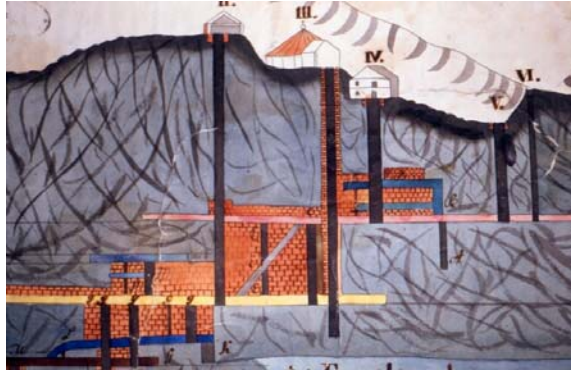


Figure 2. Mining profile dating from the 19th century

5.2. Cerco San Teodoro.

With this name is known the area where the shafts of the mine are located, except the San Joaquin shaft located in the metallurgical compound. The highlighted items are the shaft and the machine of San Aquilino, the former hospice of mines, in the basement of which is a wonderful storage facility dug into rock, that miners call "the San Teodoro tavern", workshops and the compressor room dating from 1923, and the San Teodoro shaft. The San Aquilino shaft is probably the oldest preserved, because a description of the mine dating from 1543 refers to the existence of a vertical shaft known as "The Crane" 30 fathoms deep. The San Teodoro shaft was built in the mid-eighteenth century to exploit the Castle mine, which had been discovered in 1698.

5.3. The interior of the mine

The plant 1^a of Almadén mine at -50 m from the surface allows the observation of various mining techniques of the sixteenth to nineteenth centuries. The visitors, well equipped with helmets and electric lamps, are guided in small groups of 10 to 15 persons, with all the guarantees of security. Special attention was paid to ventilation of these galleries in order to prevent any contamination of the visitors by mercury bearing gazes. They walk in various galleries around the San Aquilino shaft (in places where were the entrances to the mine of the Függer's bankers of the sixteenth and seventeenth centuries, places where nobody had been able to return after the fire of 1755), in the adit Socavon del Pozo (mid-17th) operated by vertical stopes with wood supports (late eighteenth century). They visit the "baritel San Andres", one of the most outstanding items of the mining park. It consists of a horse moved blind shaft machinery made of timber, hosted within an impressive, tall and large dome-shaped stope covered with brick walls. They walk in the adit Socavón of the Castle mine (still used at the beginning of the 20th century), etc. On the other hand, since some of these old galleries are dug in the rock and in the ore, they can make various geological observations : a magnificent gallery wall covered with ripple marks carved in the surface of the quartzite layers, volcanic breccia, vertical dip of the layers, the red cinnabar, the black schists etc.

Looking at the ceiling of the San Andres shaft, the visitors have an impressive outlook of a special technique launched by the mine director Diego of Larrañaga from the year 1800, the "mampostería" (masonry supporting). Instead of using wooden timbering, he had tall, wide and thick brick arches built to support the host rocks after having extracted the vertical cinnabar layers.



Figure 3. Supporting technique of Diego de Larranaga

The visitors are thus sensitised to the technologies and difficulties of mining, as well as to volcanism, sand sedimentation in the sea 400 millions years ago, and plate tectonics which made the layers of the sea floor vertical. They follow the paths of the convicts (mostly political convicts) who were conducted every morning from their jail to the stopes, through this long blind tunnel so that none could escape, and whose life was very short.

5.4. The “Cerro de Buitrones” : from Alchemy to the “Royal Route of mercury”

This is another kea-point of the mining park. The visitors may observe the metallurgical evolution, in a space museum designed for this purpose, such as visiting on-site kilns and Pacific furnaces.

In 1633 Lope Saavedra Barba invented in the mercury mine of Huancavelica (Peru) kilns "aludeles", which were introduced in Almadén in 1646 by Juan Alonso Bustamante, which are called “Bustamante ovens”. The ore was placed inside the kiln without being entered into pots, but distributed in several layers according to sizes and qualities. Once the oven was loaded and closed, the fire was introduced to burn the “fuel” (wood first and then coal), which produced mercury vapour, passing through holes and coming out through several clay pipes. Each pipe was formed by various containers attached to each other (aludeles), which had a hole in their bottom, so that the mercury first condensed and then poured out through the holes in a ditch where it was collected. Before proceeding to a new loading of ore, the aludeles were disjoined for recovering the mercury drops retained on their walls. Only 32 rows of 40 aludeles are preserved but they make an outstanding impression to the visitor.



Figures 4 and 5. The ovens of Bustamante

These kilns were used till 1928. In 1954, new ovens of the Pacific, Herreshof type were settled, using propane fuel. They can be visited as well. In the same area has been settled a museum devoted to all the aspects of mercury.



Figure 6. In the museum of mercury

5.5. The Royal Route of Mercury

The compound in which all these ovens are settled is surrounded by a long, square masonry wall, crosscut by a huge, impressive portal made of bricks and stone. That was the starting point of the famous “Royal Route of Mercury”, by which started the carriages transporting mercury to the harbour of Seville. The door that the visitors can see is that of Charles IV built in 1795.

In November 2006, the authorities of Almaden (foundation, municipality, university, province), the ministry of Culture of Spain and the School of Mines and Polytechnic University of Madrid organised together with UNESCO’s International Committee for Monuments and Sites (ICOMOS) a great congress devoted to the valorisation of the Royal Mercury Route, from Almaden up to Idria (in Slovenia, which was the second mercury mine in the World and has highlighted its mining heritage as well) and up to Mexico, Peru and Bolivia. Almaden was ranked by the committee as a key point of this route and the possibility of its raise up to the World Heritage classification of UNESCO was seriously discussed.

5.6. Other localities of interest in the mining park

In Almaden city can be seen the impressive old Academy of Mines, the intriguing front door of the House of the Inquisitor, the San Miguel chapel, and the famous bullring, the “Plaza de Toros” which has now been transformed into an hotel. This hexagonal bullring was the first of Spain and goes back to the middle of 18th. Nonetheless, the city does not host all the curiosities of the Almaden mining park. Many other sites of great interest are scattered all around, in a 10 km distance, such as the prehistoric cinnabar paintings of Rock of the Virgin formerly described by the Abbé Breuil, the metallurgical facilities and monumental door of Almadenejos, both dating from the 18th century, and the cute “barritel” San Carlos dating from the end of the 18th century. In Almagro old city can be visited the palace of the Függer’s family and an open-space theatre (Corral de Comedia) dating from the end of the 16th and from the 17th century.

Concerning the older remnants, the various mercury mines of the Almadén basin have not given all their archaeological resources yet. Very little is attested concerning mining in the Roman times. The mining relics of the Arabic occupation which goes back to the Middle Ages are numerous, close to the Almadén village (Huerta del Rey) and in another valley close to Almadén, at Las Savecas (Hernandez 1995b). These relics have been very little studied yet and provide to the scientists a great field of discoveries.

6. The environmental remediation

The environmental remediation was also a large part of the actions developed in Almadén. It focused on the mining and metallurgical compound, on the dumps, tailings and slags. Its approximate cost was 8.5 million euros. The main area had received, over the centuries, dumps, tailings and slags up to a level close to 3.5 million tons, covering an area of more than nine hectares, with a maximum height of 60 metres. Starting in October 2005, the environmental restoration work has included the earth moving of more than half a million cubic metres, incorporating a soil layer 30 cm thick. The implementation of a sealing system comprising four blankets of various plastic barriers prevents the penetration of water into the dumps. A drainage system was settled, as well as the spreading of 145,000 cubic metres of soil over the plastic sheets prior to restoring the vegetation cover. A plan of environmental

monitoring with inspections of the site has been settled for a 50 years duration, in order to react at any disorder in due time.

7. Budget and economical impacts expected

The total budget for the Almadén mining park until now (works will be pursued in Almadén and Almadenejos) is about 9 millions euros. Besides, another 9 M€ was devoted to the environmental restoration. All the funds came from the State and Europe, nothing from de Region or the City. The funds of the State came from SEPI. The funds of Europe came of FEDER funds (for regional development). The parts are : SEPI 80% ; Europe 15€; others 5%.

From their beginning in 2002, most of the works have been contracted with companies specialized in civil works, museums, etc., but the management has been insured by Minas de Almadén with the collaboration of Fundación Almadén. Now, there are twelve people of Minas de Almadén working in the mining park as guides and for maintenance, but the most important impact is the number of indirect employments in restoration and hotels in Almadén. There are currently six restaurants, five hotels, and rural houses in Almadén. A total of 20,000 visitors is expected for 2008, one third of them resting one night in Almadén.

Among the projects still pending, the creation in Almadén of a scientific research centre devoted to mercury is under discussion. That would write the last page expected to raise Almadén mining park to the best examples of mining heritage revalorisation.

8. Conclusion

Almadén mining park is an outstanding example of the profitability expected from such educational and recreational centres, which go far beyond economy and tourism but attain the education to ecocitizenship and to the true values of mankind. Together with the mines and quarries still in production, such mining parks enable the public to picture the importance the extractive industry, essential to man's activities, had for each civilization over the centuries, and its consequences. The "flowers of the mine," natural crystals of various ores, fascinate us all. Mining heritage is a subject of continuing interest, springing afresh with each generation, attracting the scientific and academic sphere and the general public, the media, territorial communities and the authorities. Museums and other educative and informative initiatives are springing up. Through the memory perpetuated by these sites, their historical, economic and human significance, they incite visitors to recollect their roots. Thanks to their approach, both recreational and educative, they contribute to land management, especially its tourist aspect. Lastly, they reform certain bonds – societal, environmental and territorial – amongst the generations and with land planners, particularly like Almadén in the great mining basins now closed down, where a substantial conversion effort has been accomplished. The "mine of yesteryear," with its varied forms, has become a "mine for always": a destination for Sunday excursions, a spot for cultural visits, scientific research, intense interest or even physical exertion, as well as an element in land-use planning.

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