

# Mine closure in Ouro Preto: the remnants of the 18th century gold rush and the tourism as an economic opportunity

<http://dx.doi.org/10.1590/0370-44672018720131>

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## Abstract

Mine closure is the set of all activities that follow the end of the productive phase of a mine, characterizing itself as the process of returning an area transformed by mining into a new condition of sustainability, considering the potential future and the best possible reclamation of the area impacted. However, such an understanding was not conceivable during the Colonial Period, a time when gold mining took place in the Ouro Preto Hill, among others, and nearly 200 years after the end of the gold rush, negative and positive impacts are revealed by the human interaction and the urban occupation on those mined areas. Through both geographic information data of eighteenth-century mining traces and a socioeconomic study involving six tourist gold mines, this article describes how overcoming paradigms involving underground mines have resulted in business opportunities, setting a success example of Mine Closure and future use of the area, showing an alternative way to handle the current abandoned mines.

**Keywords:** mine closure, gold mines, eighteenth-century, gold rush, Ouro Preto.

## 1. Introduction

The region of Ouro Preto was the scene of an intense gold rush in the 18<sup>th</sup> century and testimonies of this activity can still be found today. These testimonies, located in the Ouro Preto Hill, have great archaeological and tourist potential. The 18<sup>th</sup> Century Gold Rush occurred throughout the flanks of the Mariana Anticline and its hinge zone (Ouro Preto Hill, Antônio Pereira Hill and Passagem de Mariana Hill, respectively). The Ouro Preto Hill, object of this article, is the Southwestern flank of the Mariana Anticline and the mine remnants are spread over an inhabited part of the town, public and private properties. Currently, 8 underground mines are part of the Ouro Preto tourist itinerary. However, this is an insignificant figure considering the estimated more than 300 abandoned underground mines that can be found in the region (Laccourt, 1937; Lima and Miranda, 1996; Sobreira and Fonseca, 2001; Sobreira *et al.*, 2005).

The discovery of this gold-rich region dates back to the end of the 17<sup>th</sup> century, when Bandeirantes conducted

expeditions in Brazilian territory, and found alluvial gold in the region of Ouro Preto, initiating the so called gold rush. First extracted from the mineralized alluviums, gold was later extracted from riverbanks and hillsides, and in a final phase gold was extracted from the quartz veins in underground mines. By the end of the 18<sup>th</sup> century a sharp drop in gold production was experienced as a consequence of the predatory mining installed (Eschwege, 1944).

After almost 200 years of the gold mining, Ouro Preto preserves the marks of the mining activities developed in riverbeds, on the hills or underground (Lima *et al.* 2017; Sobreira and Fonseca, 2001). Today, such testimonies are confused with the landscape and pass unnoticed by most people. Along the 5 km stretch of part of the Serra de Ouro Preto, numerous remnants of gold mining can be found. These include underground and open pit mines, aqueducts, water dams, gold mud dams, locally called *mundéos*, and shafts for ventilation, miners access and ore extraction. In addition, these orphan mine sites comprise an interesting area of study

for Mine Closure issues including post-mining use, mine site reclamation, and the environmental and socioeconomic aspects in the long-term.

These ancient gold mines resulted in negative and positive environmental and socioeconomic impacts in Ouro Preto. The negatives are mainly related to areas of subsidence, abandoned structures (such as shafts that impose risk to the people and domestic animals) and contamination of water or alteration of the water quality. On the other hand, the touristic exploration of abandoned underground mines purposes has been a beneficial economic activity for the current landowners, where these mines are located, being today a considerable source of employment and income for the population.

This article describes the *status quo* of the cataloging process of these mining sites and their characteristics in the Ouro Preto Hill noting that the solution given to the underground mines by some locals reveals that the current negative impacts can be reasonably mitigated considering all current mine closure precepts .

## 2. Methodology

### 2.1 Cataloguing process of the vestiges of the mining of century XVIII

The cataloguing process of mining traces of the eighteenth century is not recent: several academic studies have sought to characterize the ancient mines and locate them in space as a way of understanding

the old local mining process and its consequences for society and the environment. In the current database, the oldest records date back to Laccourt (1937), followed by Lima *et al.* (1995) and Cavalcanti *et al.* (1996), and

year after year more information has been generated and made available. Figure 1 presents the methodological flowchart followed by the authors in order to collect new data regarding the ancient gold mines.

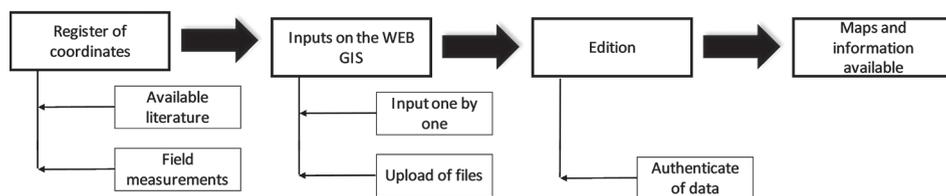


Figure 1  
Flow chart demonstrating the data cataloguing process.

The organization of geographic information in a single environment is, therefore, a natural consequence of the numerous records on ancient mines, ruins, wells, aqueducts and ore reservoirs (known as *mundéos*). Currently, the Web Geographic Information System (Web-GIS) consists of 176 records, of which 109 correspond to independent entries of underground mines.

In order to maintain consistency between the records, the data, from the field survey or the available literature,

are classified and must provide sufficient information to fill out the form of their category, as shown in Tables 1 and 2. In the next step, all records are included in a free geographic information system, such as Google My Maps<sup>®</sup> or ESRI ArcGIS Online<sup>®</sup>, which make it possible to view the records on upgraded maps or satellite images, as well as offer functionalities of geoprocessing. That is, thanks to available geotechnology, it is possible to create customized cartographic products, such as the maps

presented herein.

The methodology adopted herein is applicable to several areas of public domain that need low-cost analyses of a considerable amount of geographic information. The implementation of economic mappings in cities, universities and other public agencies has become a recurring resource due to the advantageous cost-benefit ratio. A key to its effective implementation is usability (ease of use and adaptability for mobile devices) without the need for extensive training.

Characteristics	Options	Description
Type	(1) Mine entrance	It is the location of the entrance to an ancient gold mine.
Name	Alphanumeric padding	Popular name or name created for the mine.
Owner	(1) Public (2) Private	Type of owner who has rights over the area.
Current Usage	(1) None (2) Water collection (3) Tourism (4) Other	Main utility given to the mine by the community around them.
Access	(1) Free (2) Obstructed (3) No access	About the condition of access to mine interior.
Urban area	(1) Yes (2) No	If it is within urban area.
Detail map	(1) Yes (2) No	If there is mapping of underground chambers.
Geology	(1) BIF* (2) BIF* and quartzite (3) Quartzite (4) Quartzites and schists (5) Other	About the predominant geological formation within the mine.
Risk	(1) Low (2) Medium (3) High	About the geotechnical condition of the mine.
Landslide zone	(1) Yes (2) No	If there is an area of collapse observed inside the mine.
Extension	(1) Less than 10m (2) From 10 to 50m (3) Greater than 50m	About the extent of the main mine access.
Water catchment	(1) Yes (2) No	If there is water abstraction from the mine for consumption.
Presence of sewage	(1) Yes (2) No	If there is presence of sewage in its entrance or interior.
Presence of bats	(1) Yes (2) No	If there are bats inside the mine.
Comments	Alphanumeric padding	Any other information about the place.

Table 1  
Form for underground mines.

\*BIF = Banded Iron Formation

Characteristics	Options	Description
Type	(1) Ruins (2) Ventilation well (3) Aqueducts (4) Mundéos (5) Water Reservoirs (6) Subsidies	Type of remnant related to ancient gold mines.
Name	Alphanumeric padding	Popular name or name created for the remainder.
Owner	(1) Public (2) Private	Type of owner who has rights over the area.
Urban area	(1) Yes (2) No	If it is within urban area.
Comments	Alphanumeric padding	Any other information about the place.

Table 2  
Form for other types of  
structures or traces of mining.

The approach to the remnants from the eighteenth-century in Ouro Preto is not unique, as the cataloging process aims to record broad information about them, according to Tables 1 and 2. This information associated with the records are spatialized occurrences that can guide the research of

hydrogeology, industrial archeology, risk mitigation, among others. The focus of the current study is to identify the underground mines that are used as a tourist route; that is, as a source of income for the population. Thus, from filters applied to the WebGIS (Type: "Mine entrance" and Current Use:

"Tourism"), it is possible to identify the 8 tourist mines located into urban network of Ouro Preto and handle this group as an object of study. The location of these 8 tourist mines near to downtown is unquestionable evidence that urban occupation developed over the old mining areas of the eighteenth-

century. This fact is reinforced by new queries to the WebGIS and especially

when all the remnants are presented on the satellite images.

## 2.2 Geoprocessing of the mine sites and ruins

The geographic database displayed on the My Maps (Google My Maps, 2018) or ArcGIS Online (Arcgis Online, 2018) is hosted in "cloud computing" and through the web address, it is possible to view the georeferenced points, as well as the form information associated with the record. Database storage capacity, tools available

for analysis (such as filters, buffers, area calculations) and information security are limited by the free services offered by the GIS platform.

By accessing the electronic address associated to My Maps or ArcGIS Online, all records are displayed on screen, as shown in Figure 2. An information bal-

loon is triggered by a mouse click at the registered point, showing a picture of the location (if any) and features acquired in the field (Figure 3). The research project maintains the records of the old mines both on Google© and ESRI© geographic information system, both free for academic purposes provided the sources are quoted.

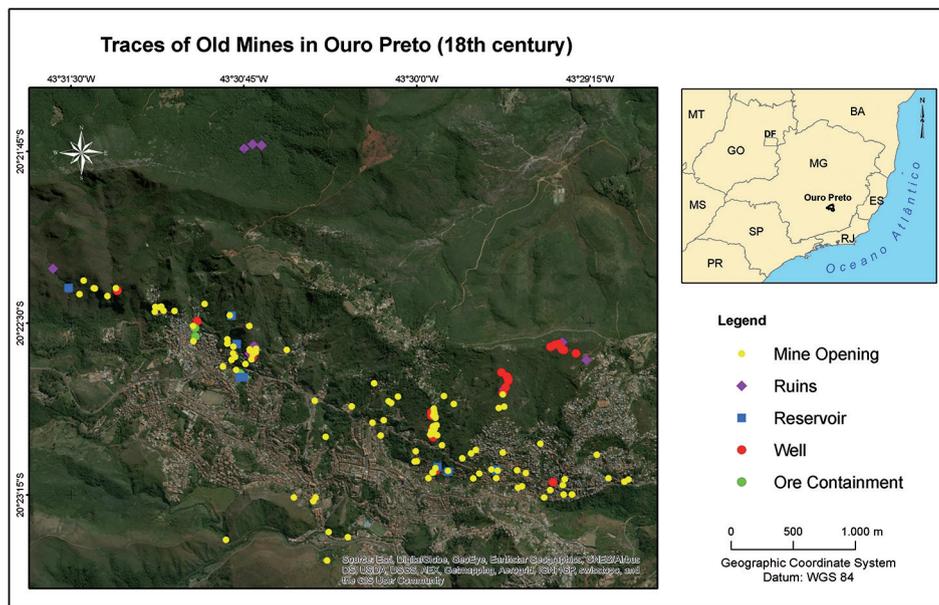


Figure 2 Visualization of the location of part of the 165 records of eighteenth-century mining traces in the Ouro Preto Hill, generated by ArcGIS Online.

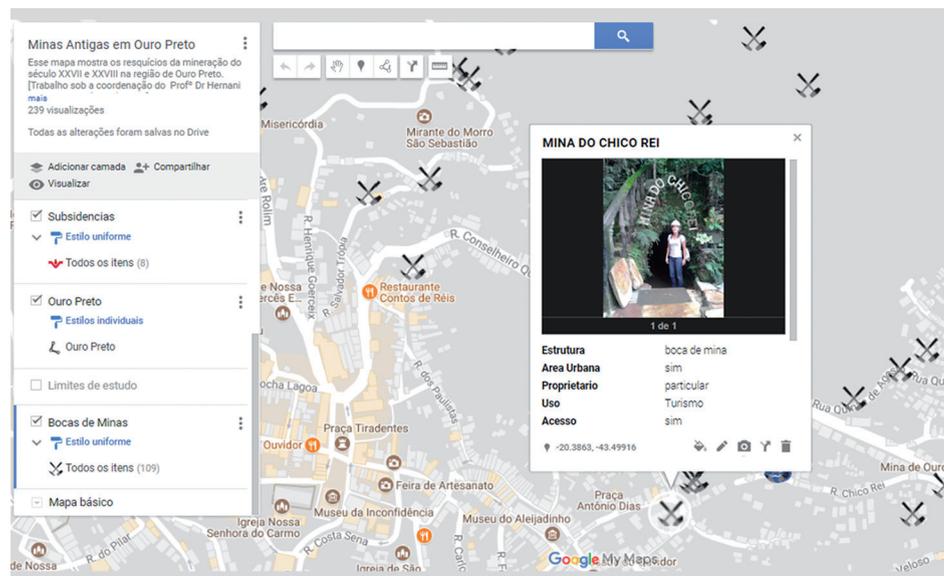


Figure 3 Visualization of the information about the Chico Rei Mine, generated by My Maps.

Customizing WebGIS is possible because of Application Programming Interfaces (APIs). API is a set of instructions and programming standards for accessing an Internet-

based software application. An API resembles software as a service, in the sense that WebGIS designers do not have to start from scratch each time they write a program: features such

as coordinate centering on the screen, zoom level, search box, satellite imagery, among others, can be used for the production of digital maps (Laudares and Abreu, 2013).

## 2.3 The Mine Closure in Ouro Preto

One of the fundamental premises of the Mine Closure is to determine the

best possible reclamation of the area impacted by mining to the community

that was most affected by the process. Formerly Vila Rica, now the city of

Ouro Preto, was declared a World Heritage Site by UNESCO on September 5, 1980, being the first Brazilian Cultural Heritage inscribed on the World Heritage List. Therefore, it is natural to consider mining closure proposals geared to tourism, by establishing a connection with the vocation of the region, making them more attractive, feasible and close to the reality of the citizens of Ouro Preto.

Although only 8 of the 109 underground mines are not a representative sample of the database, they reveal the transformative social potential of using old mines as tourist routes. By private initiatives and with the support of the Mining Engineering and the Geology Departments of the School of Mines at the Federal University of Ouro Preto (UFOP), these mines have been restored

and surveyed in order to consolidate themselves as tourist attractions and as the main source of income for those who explore them for a living.

Additionally, the Department of Tourism, Industry and Commerce of Ouro Preto provides a free guide with information about the ancient Gold Mines that can be visited in the region. In its most recent pamphlet "Old Mines: Preserved History", the mines of Santa Rita, Chico Rei, Jeje, Du Veloso and Felipe dos Santos are presented to tourists that visit the town. Generally, such mines are passed from generation to generation of a family since they lie within the limits of a private property.

The main entrances to the sited underground mines are commonly located on private properties, espe-

cially in the poor neighborhoods of the city which are on the slopes of the Ouro Preto Hill, a place that has notoriously developed numerous open pit and underground mines. However, such a symbol was easily related to an insignia of regret and torture, an unpleasant memory of the times of the existence of slavery in Brazil, and many residents obstructed the entrances for security reasons or hid them for representing hard times for the black people. Such a paradigm, however, has been overcome, and several holders of underground mine entrances have seen such mines as an economic opportunity. The tourist exploitation of these mines has re-signified the strong stigma of suffering and slave labour resulting from the gold mining in the Brazilian colonial period.

### 3. Discussion of results

In Ouro Preto, an ancient gold mine does not become a touristic one overnight. As the interest in tourism exploration is relatively recent, the owner of an ancient mine site is the one who owns the mine within the limits of his property and therefore can decide whether or not to invest in a new business.

Once the decision to set up a tourist mine is positive, the owner must secure an operating permit, conditional upon compliance with various requirements imposed by the public prosecu-

tor's office of the town, such as the fire-fighters department certificate of safety of the site for tourism exploration purposes.

The Mining Engineering Department of UFOP has assisted these mine site owners in preparing the documents and technical reports to obtain the licenses for tourist purposes. A touristic mine must be lit throughout its course; underground openings must be stable and safe, demonstrated by a geomechanical hazard map prepared by a competent

person; it must have a topographic map at its portal, fire extinguishers, sufficient signage in areas of instability or drainage and take any other intervention necessary to ensure a safe environment for visitation. The most well-known tourist mines have obtained reports of mine engineers attesting to the stability of the excavations and maps made by the Speleological Society (SEE, 2018) of the School of Mines of the Federal University of Ouro Preto. Figure 4 shows a map produced by the SEE.

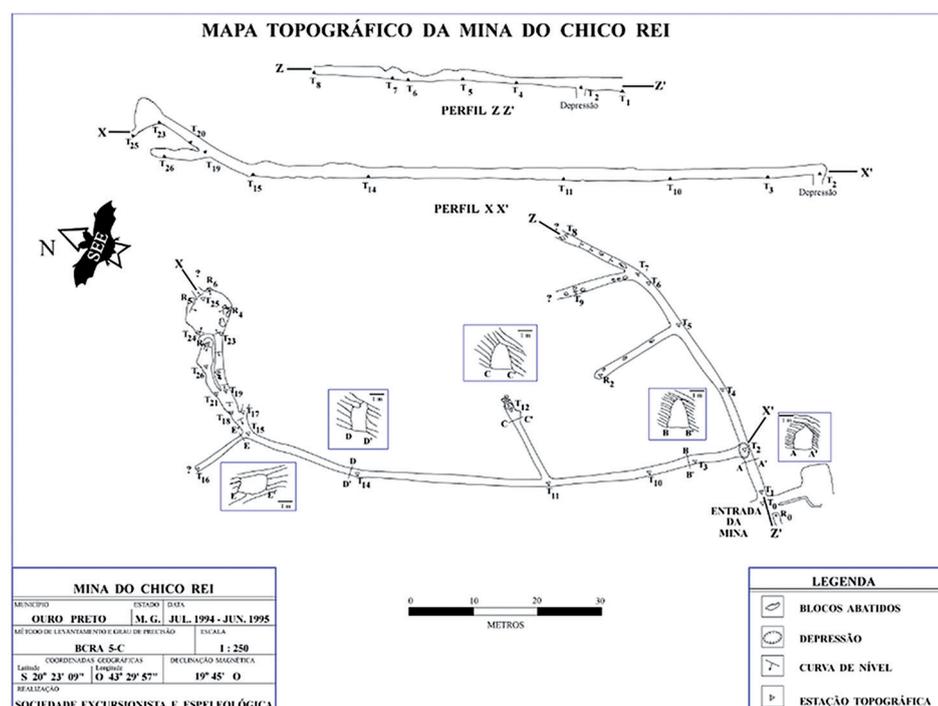


Figure 4  
Topographic map  
of the Chico Rei Mine, produced by the SEE.  
Source: Chico Rei Mine.

The 8 underground mines classified as tourist in the database are inserted in the urban area of Ouro Preto, as shown in Figure 5. It is interesting to note that part of the city developed over the old mining

areas, as shown by the small portion of the identified tourist mines, so it is reasonable to think that there are more underground excavations. Only in this small area to the east of the Du Veloso Mine and west of the

Santa Rita Mine, the database records the existence of exactly 81 underground mines, of which 52 are located in public properties in a state of total abandonment (Arcgis Online, 2018; Google My Maps, 2018).

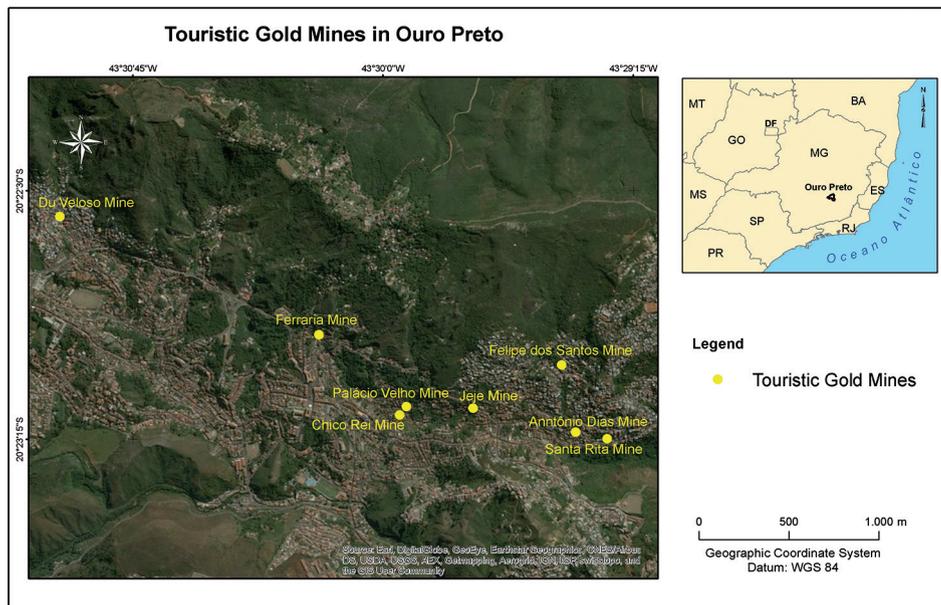


Figure 5 Highlights for the location of 8 tourist mines through ArcGIS Online.

Table 3 shows the survey of the average monthly revenues generated by 6 of these tourism enterprises, at current

values. Ferrara Mine and Antônio Dias Mine were not part of the socioeconomic study because they are enterprises that are

open seasonally for visitors. Even mines with lower billings are characterized as profitable deals for their dealers.

Tourist Mine	Year of inauguration	Visitors per month	Direct jobs	Revenue (R\$)
Chico Rei	Prior to 1990	1,183	3	11,830.00
Jêje	2012	1,350	6	13,500.00
Santa Rita	2012	953	3	9,530.00
Felipe dos Santos	2014	620	3	6,200.00
Du Veloso	2015	1,390	8	13,900.00
Palácio Velho	2016	930	5	9,300.00
<b>TOTAL</b>		<b>6.426</b>	<b>28</b>	<b>64,260.00</b>
			Ticket price	25.00
			Per capita income	2,295.00

Table 3 Economic data from Ouro Preto tourist mines in 2017.

The year of inauguration and the number of direct jobs were raised through an interview addressed to the owner of the mine. The business model of all 6 mines is similar: people work at the reception, guides are prepared to contextualize tourists, mining history is discussed and a visit is made to the underground mine with the owner. Other people work outside the mine, in attracting tourists in more distant places. All listed tourist mines are financially controlled by one or two people.

The number of visits per month was estimated from the Visitor Book kept at the reception of all 6 mines and is voluntarily signed by the people who visit them. In these Visitor Books, which are also very common in museums, visitors provide the

name, place of residence and date of the visit. A simple average was made considering the number of signatures of the months of 2017 and, therefore, the number of visitors per month was reached. This work did not estimate the number of people who visit the tourist mines and do not sign the Visitor Book.

The monthly revenue is the product of the average number of visits per month and the price of the ticket paid by the tourist. In general, the mines practice varying prices for students, adults and groups of people, which can vary from R\$ 5.00 to R\$ 30.00, in current values. However, a single value, equal to R\$ 25.00 was considered, since it was the average price indicated by the owners of the tourist

mines. It is interesting to note that mines have prices controlled by supply and demand and, therefore, it is reasonable to assume that the average ticket price is similar amongst the mines. True revenue was not revealed through the interviews and could not even be estimated through the Visitor Book, which does not identify the price paid by the tourist.

Thus, it was estimated that the revenue of the 6 tourist mines together is R\$ 64,260.00 on a monthly basis. Considering the 28 direct jobs involved, the gross per capita income is equal to R\$ 2,295.00. It should be noted that, although some mines correspond to family business, they are independent organizations with their own hierarchy

and contrast in wage values.

According to data from the Brazilian Institute of Geography and Statistics (IBGE Cidades, 2018), in 2015, the average monthly wage in Ouro

Preto was 3.3 minimum wages, equivalent to R\$ 2,600.00. However, 35% of the population had a monthly nominal per capita income of less than 0.5 of the minimum wage. In other words,

more than a third of the population lived with approximately R\$ 400.00 monthly per person, characterizing the remarkable economic stratification between social classes.

#### 4. Conclusion

The mining of the eighteenth century is the object of study of different lines of research such as History, Industrial Archeology, Hydrogeology, Geography, Mining Engineering, Geology, among others. The remnants of mining, represented by still preserved and effective structures, result in positive and negative impacts that must be managed by the Government, since such excavations belong, in the light of the current Brazilian Mining Code, to the Union. This does not mean the present owners of tourist mines should hand over their enterprises to the Government, but rather that they should be protected. The Mine Closure, still under legal development in Brazil, seeks to integrate the com-

munity with the legacy left by mining, and therefore, all archaeological sites should have a correct destination and negative impacts, mitigated.

The private initiative of few owners has shown that the tourist exploration of underground mines is a means of social ascension in a city that clearly preserves stratified economic structures. The monthly per *capita* income of employees of underground mines is R\$ 2,295.00, contrasting with the monthly R\$ 400.00 per capita of 35% of population of Ouro Preto, indicated by IBGE.

Moreover, because it is a considerable source of income for the population, the strong stigma of slavery is softened

without being forgotten. In an event in the History of the Old Republic of Brazil, Prime Minister Rui Barbosa ordered the burning of all documents that registered the slave regime, under the excuse that such vouchers would be a shame for the incipient Republic. The loss of these documents is an incalculable loss to the Brazilian History, which, for the time being, could be mitigated by the preservation of the remaining physical mining structures.

The great tourist potential still preserved in underground mines located in public properties reveals a great economic opportunity in which the Government or the Union could promote for the citizens of Ouro Preto.

#### Acknowledgements

The authors thank CNPq and CAPES for supporting this research

and UFOP for granting the doctoral scholarship.

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Received: 27 August 2018 - Accepted: 7 November 2018.

