

OLD MINES AND INDUSTRIAL TOURISM: THE CASE OF AN ANCIENT MINING GALLERY IN LAVRION, GREECE

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Abstract: The mining sector is one of the most important economic sectors in the world. Metals, fossil fuel and industrial minerals are essential to every country's economy supporting its growth and development. However, when mines close due to mineral resources exhaustion, environmental concerns, economic or political reasons the impact on the local economies and communities is very hard. Reusing old mine sites and turning them into tourist attractions can help revitalize these communities and boost their economies. Mining tourism is part of industrial tourism, a trend that has been growing significantly in the last three or four decades. Old mines are recognized as having significant potential for industrial tourism as they offer visitors a chance to see and get to know mining tools, equipment and technologies, minerals and rocks, etc. This has resulted in former mine sites being used as museums/educational centers (Britannia Mine Museum, British Columbia), visitor attractions (e.g. Wieliczka Salt Mine, Poland), recreational areas (Zip World, Wales) and even underground theme parks (Salina Turda, Romania). The paper describes the undergoing project of restoring and repurposing of an ancient mining gallery in Lavrion, Greece. The underground mining gallery has evidence of mining activities that span over more than 5,000 years as it was used both by ancient Greeks and contemporary miners in the 19th century to mine the silver ores in the area. The mining gallery will attract visitors and will provide both informative and educational material and activities related to the mining methods, the geology and history of the area.

Keywords: closed mines, mining tourism, ancient mine gallery restoration

1. INTRODUCTION

The global mining industry is a crucial component of modern society, supplying the raw materials that are indispensable for infrastructure, technology, digital transformation and energy transition. Global mining production is driven by the escalating demand for "critical minerals" – notably lithium, cobalt, and rare earth elements – which are vital for electric vehicle batteries, renewable energy technologies (solar panels, wind turbines), and advanced electronics. While traditional commodities like coal face a declining trajectory in some regions due to decarbonization efforts, overall demand for mined resources is projected to continue its upward trend, particularly for those essential to the green economy (OECD, 2019).

The mining industry is also very important for the economy. Its value is estimated at approximately \$2.26 trillion in 2024, expecting to experience further growth, with projections suggesting it could reach around \$3.0 trillion by 2029. Furthermore, the mining sector contributes to direct and indirect employment worldwide. The coal industry accounts for approximately 8.4 million jobs globally. Within the European Union, the mining and quarrying sector employed around 371,000 individuals in 2022. The future prospects of the mining industry are dependent on both significant opportunities and challenges, such as the demand in critical minerals and energy transition, the digitization and automation of mining operations, sustainability and Environmental, Social, and Governance (ESG) targets as well as geopolitical factors (Herrera Herbert, 2022).

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Without doubt, the mining sector is very important, nevertheless, mining activity usually expands in a rather short period of time. After a mine is closed either because the ore deposit has exhausted or for various economic, technological and even political reasons there remains a significant industrial infrastructure. It may not be able to serve its original purpose but it bears a significant potential that could be exploited. Many mining sites are valuable as industrial monuments, carrying an important legacy and are seen as a testament for miners and mining communities. In this context the concept of industrial tourism has emerged in the last decades (Edwards and Coi, 1996). Industrial tourism is a growing trend that focuses on the adaptive reuse of unused industrial sites, with closed mines emerging as particularly popular attractions. Mining tourism highlights the historical, geological, and cultural significance of former mining sites and creates immersive visitor experiences. Closed underground mines offer a unique window into the industrial heritage of a region, allowing tourists to explore adits, shafts, and machinery that once powered local economies. By transforming disused tunnels and facilities into safe, engaging attractions, regions can both preserve mining heritage and stimulate post-industrial economic regeneration. Sites of former mining activity offer a blend of historical authenticity, technological heritage and socio-economic narratives, transforming places of past labor and resource extraction into spaces for public engagement and education (Guo et al., 2024; Xie et al., 2020; Chazi et al., 2021). One key parameter lies in providing visitors with an immersive, "behind-the-scenes" experience that transcends traditional museum exhibits, allowing for a tangible connection to industrial processes, the challenging lives of miners, and the profound impact of industry on local communities and landscapes. Furthermore, the conversion of closed mines into tourist destinations often serves as a vital strategy for post-industrial regeneration, offering new economic opportunities and helping regions overcome the socio-economic repercussions of mine closures by creating new jobs, supporting local businesses and improving vital infrastructure in these areas. Moreover, mining tourism can have positive effects regarding the protection of historic structures, the preservation of mining culture and history and the establishment of partnerships with schools and universities developing educational material and creating research opportunities (Morea et al., 2016). Among the many successful examples of transforming abandoned mines into thriving tourist operations are the Wieliczka salt mine in Poland (Fig. 1), the Salina Turda salt mine in Romania (Fig. 2) and the Zollverein Coal Mine Industrial Complex in Germany (Fig. 3).



Figure 1. The St. Kinga's Chapel in the Wieliczka salt mine, Poland (source: <https://whc.unesco.org/en/list/32> Accessed 05/07/2025)



Figure 2. View of the Rudolf Mine in Salina Turda underground theme park (source: <https://www.salinatorda.eu/en/locatie/rudolf-mine/> Accessed 05/07/2025)



Figure 3. Aerial view of the Zollverein XII Coal Mine Industrial Complex, which has been inscribed on the UNESCO World Heritage List (source: <https://whc.unesco.org/en/list/975/> Accessed 05/07/2025)

These examples illustrate the diverse approaches to mine repurposing, ranging from historical preservation and educational tours to extreme sports venues and cultural centers. Their success lies in their ability to offer compelling narratives, unique experiences, and often, significant economic contributions to their respective regions.

The paper presents the steps in order to repurpose an ancient mining gallery in the Lavrion Technological Park in Greece. The underground mining works span across almost 5,000 years of mining history in the area as parts of the mining gallery are the remains of the mining works of ancient Greece, while the most recent sections represent the last phase of mining activity in the area across the 19th and 20th centuries. The paper analyzes the main methodological approach, the questions that need to be answered, the challenges, the risks and the future plans.

2. METHODOLOGICAL APPROACH FOR RESTORING OLD MINE GALLERIES

The process of turning former mining sites into safe facilities that attract tourists involves many challenges and requires careful design. Mines are designed to serve a heavy industrial activity and not to welcome visitors or the general public. The lifespan of underground mining works is short as they are not indent to and the safety factors are kept at a minimum to boost economic output. There are many risks associated with closed mines such as aged and deteriorating infrastructure, roof instability, rock collapse oxidation of metal support elements, etc. In addition, one cannot exclude that the underground space has its own unique characteristics, like lack of lighting, poor ventilation, confined spaces, orientation difficulties and usually water inflow or even flooding. In some underground mines it is possible for pollutants or hazardous material to be present, a condition that further complicates restoration and reuse plans (Guo et al., 2024).

The key actions for the successful repurposing of old underground mine facilities are linked to safety, environmental concerns, authenticity and history, exhibition/educational material and visitor accommodation infrastructure:

- Control and safety requirements: Stability of galleries, ventilation, lighting, fire safety, access - emergency exits and compliance with legislation
- Environmental Concerns Risk: Acid mine drainage, heavy metal leaching. Mitigation: Water treatment systems, sealed waste piles, ongoing environmental monitoring
- Respect for authenticity and history: preserving the historical and aesthetic identity of the site while enhancing it. Risk: Over-theming can undermine historical authenticity. Mitigation: Engage heritage experts, maintain original structures, interpret rather than alter
- Adaptation to the modern visitor experience: interactivity, digital applications (e.g. VR/AR), thematic guided tours.
- Development of educational/exhibition material: Creation of signage, multimedia, mock-ups and guides explaining the operation of the mine.
- Visitor accommodation infrastructures: Installation of parking, toilets, refreshment facilities, ticket offices, etc.

3. THE CASE OF THE ANCIENT MINING GALLERY AT LAVRION TECHNOLOGICAL AND CUTLURAL PARK

3.1. Mining activity in Lavrion through history

The Lavrion area has a very long history in mining activity. There is evidence from archaeological data that mining started in the area as early as 3200 BC (Morin and Delpech, 2018). Research has brought to light ancient ore washing facilities, ancient smelting installations and ancient underground mining works (Conofagos, 1980; Voudouris et al., 2021). The ancient Greeks used slaves to mine the silver ores in the area, contributing to the wealth and strength of the city of Athens. The discovery of higher grade, third contact mineralization around Kamariza area, dated at 483 BC, marked a change in the mining history of Lavrion. It favored more continuous and large scale mining and processing operations (Ross et al., 2023).

Modern metallurgy and mining at Lavrion started at 1864 with the exploitation and the resmelting of the ancient slag heaps (Morin and Delpech, 2018; Markouli, 2019). There were two mining companies, “The Metallurgical Company of Lavrio” (1873–1927) and the “French Mining Company of Lavrio” (1875–1981, FMCL) in the area. Both the Hellenic and French companies have been the essential supporting factors of Lavrio area's development in that new period of the industrialization of Greece. The 1867 workers' settlement was finally developed into a 10.000 inhabitants' town in the beginning of this century. The two companies constructed urban infrastructures, such as schools, churches, a small hospital and port facilities, in order to facilitate their operations and attract

working population. The Hellenic Company is associated with the use, for the first time in Greece, of electricity, the telephone and other technological innovations. Those included the construction of the Attikos railway (1882-1885), thus connecting Lavrion to Athens. Operations ceased permanently in 1989 as a result of the broader de-industrialization all over Greece (<https://en.ltcp.ntua.gr/history/>).

3.2. The Lavrion Technological and Cultural Park

The Lavrion Technological and Cultural Park (LTCP) was founded in 1992 in the facilities of the old French Mining Company of Lavrion (Compagnie Française des Mines du Laurium), at the initiative of the National Technical University of Athens (NTUA), aiming to host and promote research and business activities. In the following years after the closure, NTUA set out an ambitious project to transform the former industrial site into a Technological Cultural Park and Museum of Technology (<https://en.ltcp.ntua.gr/history/>).

Today, the Park occupies a space of 60,78 acres, which includes 41 building units of a total area of 25,000 m², and constitutes a protected national monument by the Ministry of Culture. The LTCP's facilities include industrial, laboratory and professional premises of high aesthetic and architectural value, most of which were built during the period 1875-1940. The site used to host industrial activity until 1988. During the 120 years of the industrial complex operation, it has been subjected to various transformations, renovations and additions, in order to line up with the demands of each technological evolution. Until now, 19,76 acres of facilities and several buildings have been restored, highlighting the LTCP as a unique monument of industrial archaeology and architecture. The industrial buildings have been reconstructed, combining the evaluation of the historical forms with contemporary functionality and house a variety of new and innovative businesses, NTUA's laboratories, as well as cultural and educational institutions. With the support of the local community, the LTCP contributed to the rebirth of the industrial facilities and their operation as a cradle for the development and the implementation of innovative products and activities of technological, educational and cultural content (<https://en.ltcp.ntua.gr/history/>).

3.3. The restoration of LTCP's ancient mining gallery into a tourist attraction

The ancient mining gallery is located on the southern edge of the LTCP. Miners around 1875 followed the ancient galleries that existed in the area in search of mineralization and orebody. There was therefore the excavation of the main original chamber and, subsequently, the extension of the adit further south towards the area of the Kyprianos settlement. After the ore deposit was exhausted, the underground space was used as a storage area for explosives (Fig. 4).

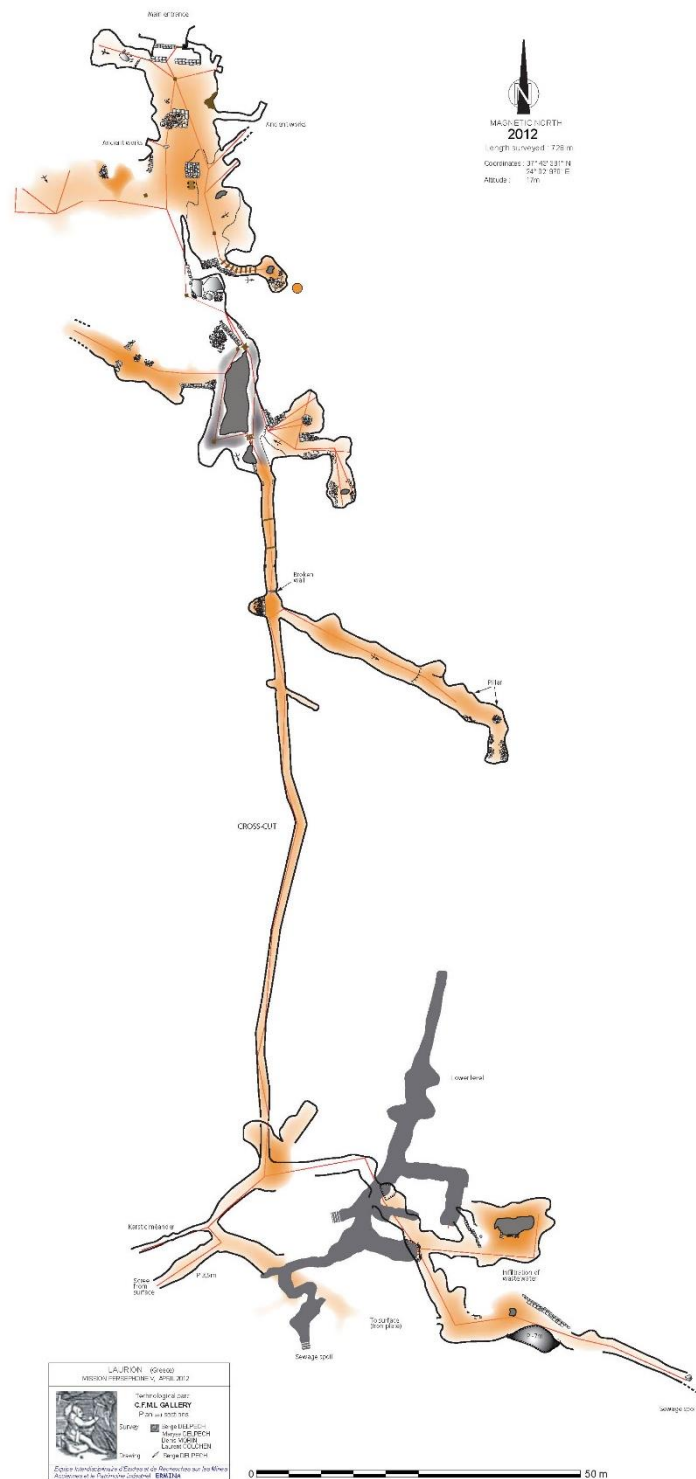


Figure 4. Map of the ancient mining gallery in Lavrio TCP (source: Delpech et al., 2012)

The ancient gallery can be divided into three sections:

- Section 1. Entrance (Fig. 5): The Entrance area is the main area of interest of the Historic lodge. Within this area there are and developed ancient galleries, exploitation areas, artificial stone pillars, and most importantly there is a significant widening of the cross-section (~12 m), which may facilitate visitors to the site. In addition, a key element is that there is direct access through the entrance/exit to the site. There are stability issues with the roof in this area.

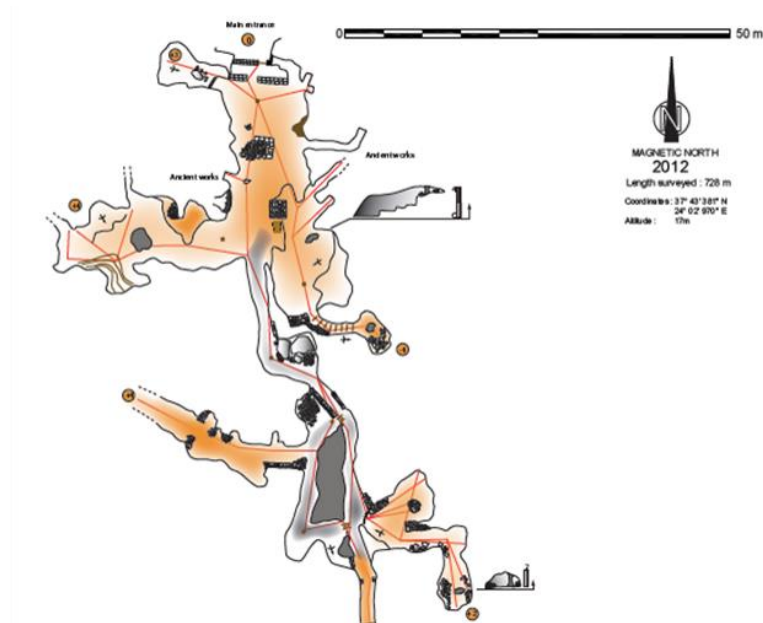


Figure 5. Section 1 of the ancient gallery. The entrance to the underground space, the artificial stone pillar and ancient mining works are depicted.

- Section 2. Gallery area (Fig. 6): The gallery area is the central part of the site and consists of the gallery (rectangular/petal-shaped cross-section, 1.5-2.0x2.0m in size), approximately 75-80 m long, extending south of the entrance area. In this area there is a local widening to the east, for ore exploitation, 4-5 m wide. The adit has been drilled mainly within the upper marble and does not show any stability problems.

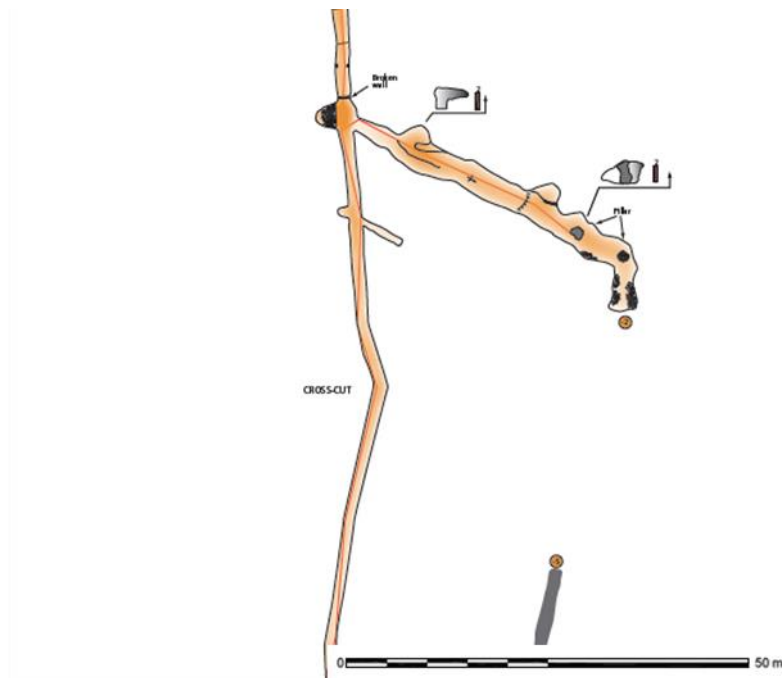


Figure 6. Section 2 of the ancient gallery. The central part consists of an adit of rectangular cross-section, roughly 1.5-2.0x2.0m in size and around 80 m long.

- Section 3. Kyprianos area (Fig. 7): This section concerns the terminal part of the gallery that runs below the Kyprianos area. There are older adits or mining stopes and access is difficult. In addition,

the area is underneath houses and roads and as a result there is inflow of rainwater and sewage. This section is not considered to be of interest for development.

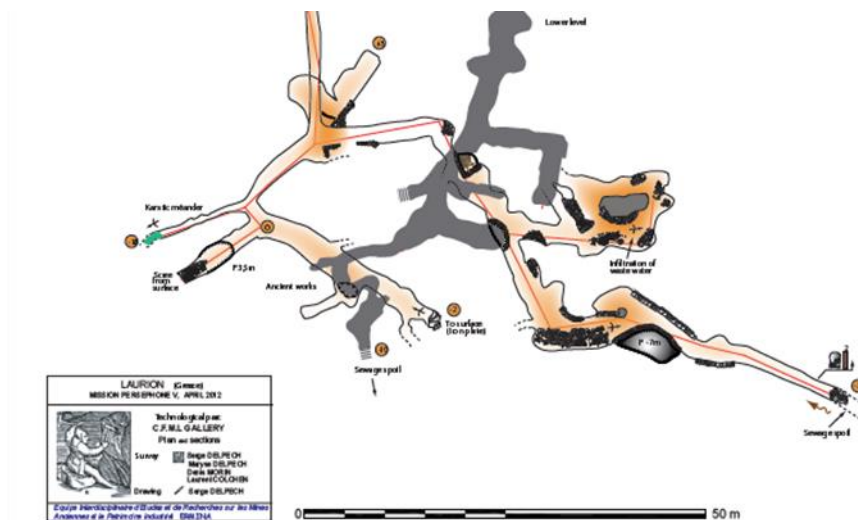


Figure 7. Section 3 of the ancient gallery. Most of this part is developed beneath the Kyprianos urban settlement.

In the past there have been some attempts to restore this ancient mining gallery. In 1998, the effort was mainly aimed at improving the safety conditions. To this end, the roof and rock wedges were reinforced using wooden supports. Timber sets were installed along the main gallery and the artificial stone pillar was restored. In addition, access to the edges of the underground rooms (mainly the eastern side) was prohibited for safety reasons.

For the design of the restoration of the ancient mining gallery in the LTCP, the following objectives were considered:

- Ensure the stability of the central area
- Ensure a second access/safety exit
- Ensure appropriate air quality (air supply, humidity control)

There are some challenges or restrictions in this direction. There are mainly linked with the physical limitations of equipment access, the preservation of site form/image using “historic methods/materials”, the limitation in finding, nowadays, skilled personnel familiar with old mining or support techniques and certain legal restrictions on use of areas outside the premises of the LTCP.

As far as the stability of the underground space is concerned, the required work includes conducting extensive and detailed geological mapping and geotechnical measurements of the underground rock mass. Additionally, installation of monitoring instrumentation is deemed necessary in order to examine the behavior of critical underground areas. Another critical component of the design is the analysis of key failure mechanisms of roof, wedges and pillars. Moreover, the development of a calibrated geotechnical simulation that can evaluate the behavior of the underground space and finally the installation of specific support elements that will enhance the stability and safety of the underground space.

With regards to the improvements in the underground gallery and improving public safety, the focus is on improving the entrance area by increasing the cross-section. Furthermore, the excavation of a second access tunnel would vastly improve ventilation and safety and is considered a priority. Finally, the repurposing of this ancient mining gallery into a tourism attraction requires the installation of an appropriate flooring system for easy public movement and appropriate signage, safety lighting, etc.

Regarding the support measures, the underground area of the ancient mining gallery is generally characterized as stable, with only local instability issues at the roof. It is expected that the main stability problems would be related to gravitational failures. Therefore, we suggest using passive support (timber and artificial stone pillars) that are in line with the techniques of the past and respect the historic character of the site. The possibility of using modern materials such as steel or concrete can also be considered, granted that these materials would be used as e.g. the core for artificial pillars and then broken stone material will be used to shape them in an aged form. The use of roof bolts is considered necessary for certain cases.

The excavation of a second access/exit tunnel is of critical importance for the project. It is proposed to develop the second access tunnel at the south-western boundary of the entrance area, inside the LTCP premises. The access tunnel would be approximately 30-35 m long and would facilitate the ventilation of the underground space, thus

improving air quality for visitors and also meet the safety requirements for having two exits in any underground mine.

4. CONCLUSIONS

In recent decades, industrial tourism has emerged as a significant cultural and economic trend. It has gained momentum as a tool for cultural preservation and regional revitalization, particularly in areas marked by industrial decline. This form of tourism, particularly in post-industrial and post-mining regions, transforms inactive industrial and mining facilities into cultural landmarks, thus creating both educational and recreational value. The Lavrion area in Attica, Greece, with its rich mining legacy dating back to antiquity, serves as a compelling case study in this evolving trend. The Lavrion Technological and Cultural Park has been creating remarkable actions and synergies, hence steadily and decisively contributing to the promotion of the distinctive history of the wider region of Lavreotiki. Furthermore, LTCP is an important hub of innovation in the region of Attica, a milestone for the development and evolution of the area of Lavrio. The various scientific, research and educational activities that are hosted in the Lavrion TCP coupled with the multitude of cultural events and happenings have been an important pillar for the revitalization and economic development of the area in the post-mining era.

The restoration of the ancient mining gallery of the Lavrion TCP is an integral reference point of the history of the French Company of Lavrion Mines complex and of Lavrion in general. The necessary studies and the corresponding works for the restoration of its structural stability, safety and functionality should be carried out immediately so that it can find a new use as an emblematic tourist landmark of the area. The restoration can serve as a pilot project that can be used as a tourist attraction in the region. The restoration and transformation of the LTCP's ancient mining gallery into a tourist attraction exemplifies this shift, demonstrating how heritage conservation can coexist with sustainable economic regeneration. By repurposing mining infrastructure for public engagement, can contribute to the revitalization of communities that have historically depended on extractive industries. The introduction of guided tours, interpretive exhibitions, and interactive experiences not only preserves local identity and memory but also generates employment and supports the diversification of the regional economy. Moreover, the integration of mining tourism within broader heritage and eco-tourism networks opens new directions for sustainable development, building upon the area's historical significance and natural beauty. The future prospects of industrial tourism in Lavrion present opportunities towards interdisciplinary collaboration, community engagement and increased international visibility making the Lavrion area a model for innovative heritage-driven development.

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