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Multiple readings of the mining landscape in Lavreotiki (SE Attica, Greece)

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Readers of poetry see the factory-village, and the railway,
and fancy that the poetry of the landscape is broken up by these;
for these works of art are not yet consecrated in their reading;
but the poet sees them fall within the great Order
not less than the beehive, or the spider's geometrical web.
(R.W. Emerson, Essay I, 1844)

Abstract

From the widespread mineral exploitation of the past to the protected territory of the Sounion National Park in the present, the region of Lavreotiki has diachronically been at the centre of human activities and experiences. Nowadays, the landscape of the region, as defined by hills, valleys and the coastline at the SE of Attica, includes a variety of land uses, such as settlements (with prevailing traditional or contemporary styles), isolated properties (legal or illegal, inland or by the coast), agricultural lands (mainly vineyards and olive groves), uninhabited areas, roads, pathways and other transport routes, industrial units, tourist complexes, geological formations, archaeological and historical sites and landmarks, protected forest and shrub areas. However, the connecting element between them all has always been the large multi-metallic ore deposits found underground - their exploitation has shaped the landscape diachronically in a multitude of ways. This paper aims to explore the multiple facets of the landscape, interpret its characteristics as part of the diachronic heritage of the region and discuss its potential as an 'off the beaten track' place to visit.

Keywords: *Lavreotiki, landscape, geology, mining, archaeology, heritage*

Περίληψη

Από την ευρεία εκμετάλλευση των μεταλλευμάτων του παρελθόντος μέχρι την προστατευόμενη έκταση του Εθνικού Δρυμού Σουνίου του παρόντος, η περιοχή της Λαυρεωτικής έχει διαχρονικά συσχετιστεί με τον υπόγειο πλούτο της και αποτέλεσε κέντρο ανθρώπινων δραστηριοτήτων και παρεμβάσεων ήδη από τη Νεολιθική Εποχή. Στις μέρες μας, το τοπίο της, όπως διαμορφώνεται από λόφους, κοιλάδες και την ακτογραμμή της ΝΑ Αττικής, περιλαμβάνει μια πληθώρα χρήσεων γης, όπως οικισμούς (παραδοσιακούς ή σύγχρονους), μεμονωμένες κατοικίες (νόμιμες ή αυθαίρετες, στα παράλια ή στην ενδοχώρα), αγροκτήματα και αγροτικές εκτάσεις (κυρίως αμπελώνες και ελαιώνες), ακατοίκητες εκτάσεις, δρόμους και μονοπάτια, βιομηχανικές μονάδες, τουριστικά καταλύματα, γεωλογικούς σχηματισμούς, αρχαιολογικές και ιστορικές θέσεις και μνημεία, ερειπιώνες, δασώσεις περιοχές και φρυγανότοπους. Το στοιχείο που συνδέει όλα αυτά τα διαφορετικά περιβάλλοντα ήταν από παλιά τα μεταλλοφόρα κοιτάσματα της περιοχής, που στάθηκαν πόλος έλξης για τον άνθρωπο (από την Προϊστορική εποχή ως τα Κλασικά χρόνια και ξανά από το 1865 ως τη δεκαετία του 1970 κατά τον 20ο αιώνα). Η εκμετάλλευση τους καθόρισε το τοπίο με πολλαπλούς τρόπους, αφήνοντας βαθιά ίχνη. Αυτή η ανακοίνωση έχει ως στόχο να εξερευνήσει τις πολλές και διαφορετικές πτυχές του τοπίου της Λαυρεωτικής, να ερμηνεύσει τα χαρακτηριστικά του ως αναπόσπαστο κομμάτι της πολιτιστικής κληρονομιάς της περιοχής και να συζητήσει τις δυνατότητες ανάπτυξης μιας περιοχής που αποτελεί «ένα καλά κρυμμένο μυστικό της Αττικής».

Λέξεις κλειδιά: *Λαυρεωτική, τοπίο, γεωλογία, ορυχεία, αρχαιολογία, κληρονομιά*

1. Introduction

Landscape means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors. By accepting this rather straightforward definition, as proposed by the European Landscape Convention that took place in Florence in 2000[i], one perhaps overlooks the ambiguity and pluralism of the term as has been expressed repeatedly by various scholars[ii], but at the same time keeps the essence of it, that is the dialogue between the natural and the anthropogenic under the scrutiny of the observer. The study of any landscape requires the synergy of geography, history, architecture, archaeology, geology, philosophy, ethnography and quite possibly a few other academic fields, indicating a concept that is interdisciplinary and flexible. It can be seen as mere scenery for human living but also as the most decisive element that dictates human actions and adaptation mechanisms and, at the same time, is shaped by them. The concepts of memory, identity, social order and transformation are particularly relevant to the understanding of landscapes as neither exclusively natural nor totally cultural (Knapp and Ashmore, 1999).

The region of Lavreotiki (c. 200 km^2) is situated at the SE tip of Attica (Greece) and has been diachronically associated with the exploitation of the rich mineral resources found in the substratum. Mining and metallurgy are inherently labor-intensive and complex enterprises, that require a supply region, transport systems (roads, harbors, railways), capital, manufacturers and distributors of equipment, political arrangements, laws and regulations, and, of course, a community of people that would take on the laborious task (Pfaffenberger, 1998). This list of prerequisites is relevant for both ancient and modern times, with some necessary adjustments, and determines the success and longevity of the mines. However, there comes a time when the natural resources are exhausted, all primary extractive work stops and we are left with a scarred landscape. Without human intervention, nature begins to dominate again encompassing all the structures in it and transforming them into monuments. The landscape itself becomes a monument, with a unique identity that reveals the technological, industrial, economic and social history of the place (Belavilas and Papastefanaki, 2009).

The landscape of Lavreotiki is not just attractive or static scenery, but it presents great and contrasting diversity. A variety of land uses can be identified, including residential areas, industrial zones, agricultural areas, archaeological and historic sites, forests and shrub lands, all of them often overlooking the sea on the horizon. Therefore, Lavreotiki is, in reality, composed of a multitude of micro-regions shaped by human activity over thousands of years, a process still dynamically at work today[iii]. The cultural landscape

includes natural and anthropogenic components with both material and symbolic values embedded in memory and subject to multiple readings (Hatjimichalis, 2010; Terkenli, 1996). The historical traces on the landscape can actually be perceived as a palimpsest where the various cultural elements are interconnected in such ways that it is sometimes difficult to differentiate and interpret (Doukellis, 2009; Kapetanios, 2013). This paper focuses on Lavreotiki, and particularly the Sounion National Park, as a mining district whose landscape has been shaped by the mining and metallurgical activities of the past, in an attempt to associate the existing mining remains with the present and the future of the region.

2. Geological background

The substratum of Lavreotiki is rich in metal-bearing ores and, once this reality was recognized, the region hosted numerous mining expeditions, operations and permanent installations. Nowadays the mines have been abandoned but their entrances are visible in the landscape, a mere reflection of the extensive underground network of galleries, together with other mine facilities and mining processing wastes (Figure 1). In this chapter the distinctive geology and mineralogy of Lavreotiki is summarily discussed.

Fig. 1: Mine entrance at the Sounion National Park.

Lavreotiki forms part of the metamorphic Attic-Cycladic Massif. There are two systems of strata present, the autochthon system and the overthrust phyllite nappe. The autochthon system consists of marbles, dolomites and schists and is over 1000 metres thick. It generally consists of alternating marbles and schists of varying thickness, usually subdivided into three horizons, (a) the lower marble, (b) the Kaisariani mica-schists and (c) the upper marble. Above the autochthon system lies the overthrust plane that includes phyllites, marbles, quartzite, prasinites and serpentine (Marinos and Petrascheck, 1956). As a rule, the minerals are to be found in the form of veins or lenses in the contact zones between the four aforementioned layers. Thus, there are three contacts or horizons: the first (uppermost and closest to the surface, sometimes exposed due to weathering), the second (intermediate) and the third (lowest). The ore veins follow the complexity and irregularity of the rock layers, so they are not horizontal and vary in thickness (Marinos and Petrascheck, 1956). The oldest mining exploitation that took place in Lavrio, dated at least to the beginning of the 3rd millennium BC, started from the surface contact exposed at the foot of Velatouri hill (Spitaels, 1984; Nazou, 2013). In classical times, however, the miners were able to reach and exploit the third, deepest and richest contact, having developed a better understanding of the geology of the region, and possessing greater manpower, advanced technological means and great organization derived from the city-state of Athens (Kakavoyannis, 2005).

In respect of minerals, approximately 600 have been identified in Lavreotiki, not all of them metallic, and some of the metallic ones not in exploitable amounts. In general, the exploitable ores fall into two main categories: they are either mixed sulphide Pb-Zn-Fe-Cu ores (often oxidised, forming extensive accumulations of secondary minerals) or Fe-Mn ores (Janikian, 2009). All of them were exploited in the distant or recent past. The most significant ones in antiquity were those containing argentiferous lead, that is galena (lead sulphide) and cerussite (lead carbonate), the two of them often found associated or mixed (Marinos and Petrascheck 1956; Kakavoyannis, 2005). In addition, copper and iron ores were mined, the former mainly in the Bronze Age and the latter later in antiquity (Kakavoyannis, 2005).

The remarkable geology of Lavreotiki is visible in a number of geosites that have been recently described by the Institute of Geology and Mineral Exploration (Janikian, 2009) as part of the Geotrails in Greece series of the Institute. The geological landscape of Lavreotiki includes impressive sights like Chaos (a karstic-type formation) and also numerous locations where one can witness the tectonic and petrological history of the region (Figure 2).

Fig. 2: Chaos, a karstic-type geosite.

Lavreotiki can be considered as a 'geological museum' and has attracted the interest of many geological institutions and universities over the years that have resulted in specialised studies and scientific expeditions. It has also attracted collectors of minerals who often 'plunder' the region for mineral specimens that they afterwards circulate in relevant markets disregarding any notion of geo-conservation (D. Morin, pers. comm., 12-19 May). The authorities need to intervene and develop control mechanisms, because the basically 'no restriction' policy prevailing today may have devastating results in the future.

3. The archaeological landscape

The landscape of Lavreotiki includes two of the most emblematic monuments of Attica: the temple of Poseidon at Sounion, overlooking the dramatic seascape of the Aegean, and the ancient theatre at Thorikos, with its characteristic elongated orchestra (for a review of the excavation history of Sounion and Thorikos, see Saliora-Oikonomakou, 2004 and Dermatis and Manthos, 2010, respectively). The most prominent prehistoric monuments in the landscape are the 5 Mycenaean tombs of distinctive typology situated on Velatouri hill at Thorikos (Laffineur, 2010). Furthermore, numerous other antiquities

dot the landscape, excavated or unexcavated, revealing rich layers of historicity (Figures 3 and 4; Saliora-Oikonomakou, 2004; Apostolopoulou-Kakavoyanni, 2008; Kapetanios, 2013). This is not a typical landscape with ruins, however, as will become apparent in the next paragraphs.

Fig. 3: Velatouri hill in the background, the theatre of Thorikos in middle ground and ore washery n. 4 in the foreground.

Lavreotiki was probably an attractive terrain for its first inhabitants, being a low hill area with small streams and small plains in between and situated by the sea with a coastline providing safe harbors. The first traces of habitation are dated to the Paleolithic period as shown by the excavations conducted at Kitsos cave near Kamariza led by N. Lambert between the years 1968-1975 (Lambert, 1981). The cave was settled intermittently until the Neolithic period and its inhabitants do not appear to be isolated during the later stages of the Neolithic, as they got hold of obsidian from Melos, flint-stone tools probably from central Greece and millstones most likely from Aegina. They probably even used native copper found locally, as the discovery of a single pin from a Final Neolithic level indicates. There is additional archaeological evidence for a number

of other Neolithic sites in the region, most notably Thorikos (Apostolopoulou-Kakavoyanni, 2008).

Fig. 4: Temple of Demeter and Kore at Thorikos.

However, if we need to isolate one element as the most decisive feature of Lavreotiki, it would have to be its metal-rich geology, as described in the previous chapter - this is the asset that regularly drew prospectors and settlers into the area throughout antiquity. The first traces of metal exploitation go back to the Final Neolithic and the Early Bronze Age. The most notable site is the cave-like mine 3 at Thorikos, where the Belgian excavations in the 1970s brought to light pottery dating to these periods as well as bone tools and tool marks on the walls (Spitaels, 1984). However, the securely dated deposits in the mine are Early Helladic II and it is perhaps wiser to place the beginnings of exploitation at that period (Nazou, 2013). Also, worth-mentioning is the discovery of litharge fragments at Mokriza in Keratea (Kapetanios, 2013) and especially at Lambrika in Koropi, all dating within the early stages of the Early Helladic, which indicate silver-producing workings in locations close to Lavreotiki (Kakavoyanni, 2005).

The archaeological evidence for the exploitation of metal ores in the Middle and Late Bronze Age is sporadic and consists of a litharge fragment found in a 16th c. BC house and a possible tuyere of approximately the same time period, both from Thorikos (Papadimitriou, forthcoming). Moreover, mine 3 has also yielded a deposit of Late Helladic IIIC sherds, indicating some mining activity at the site (Apostolopoulou-Kakavoyanni, 2008). Nevertheless, there is adequate indirect evidence coming from Archaeometry that indicates systematic exploitation of the mineral resources in the Bronze Age not just for extracting lead and silver but also copper. This evidence comes from lead isotope analysis, a method that compares the lead isotope signature of the Lavrio ores to that of lead, silver and copper objects. Lead isotope analysis has been applied to a large number of samples coming from Bronze Age metal artifacts from the Aegean and has led to the following conclusions: (1) as far as lead is concerned, Lavrio was the predominant source for the Aegean, particularly in the Late Bronze Age, (2) as far as silver is concerned, a small number of Bronze Age silver artifacts can be positively attributed to Lavrio and (3) many of the copper-based samples analyzed seem to be consistent with the Lavrio lead isotope field, which means that Lavrio should be considered as a copper source of some significance for the Late Bronze Age, among a few other possibilities (Gale, Kayafa and Stos-Gale, 2009; Stos-Gale, 2014).

For the subsequent archaeological periods, up to Classical times, the archaeological evidence for local mining and metallurgy is also scanty. For example, pieces of litharge have been discovered in a large room at Thorikos from the 9th c. BC, while lead isotope analysis has shown that several Archaic lead votive figurines from the sanctuary of Artemis Orthia in Laconia are consistent with Lavrio ores (Gill and Vickers, 2001; Coldstream, 2003). Given that most physical evidence for mining and metallurgical activities has been wiped out by later operations, it can be suggested, based on common sense rather than solid proof, that the exploitation was probably continuous with periods of intensity and periods of decline due to the variability of the ore body.

From the Classical period onwards, Lavreotiki becomes the main provider of silver and lead for the city-state of Athens, and the literary sources provide us even with a date: 483 BC is the year that the Athenians struck a rich vein of silver-bearing lead ore having discovered the so-called third contact at Maronia (Aristotle, *Constitution of the Athenians*, XXII, 7, as mentioned by Gill and Vickers, 2001). As a result, Lavrio is defined as the mining region par excellence for Athens, particularly for the 5th and 4th c. BC, with ample remains still visible today. The landscape is full of features that confirm the extensive exploitation of galena and cerussite in order to extract silver and lead in antiquity. These include mine shafts and galleries, vertical pits of great depth,

ore washeries and water reservoirs, a few furnaces, quarries, towers and also residential quarters, farmsteads, tombs, shrines (for example, dedicated to Asklepius, Dionysus and Hygeia) and a theatre that testify to a permanent population (for a review of the archaeological evidence, see Photos-Jones and Ellis Jones, 1994; Saliora-Oikonomakou, 2004; Apostolopoulou-Kakavoyanni, 2008; Kapetanios, 2013; Kakavoyannis and Koursoumis, 2013). However, the most impressive and common monuments among them are the ore washeries, the majority being rectangular and flat but with many variations in plan. When the Athenians were faced with the problem of poor metal ores they developed an innovative technique in order to enrich the ore and at the same time re-circulate the water required for the process, given that the region receives limited rainfall, namely the ore washeries and their adjacent water tanks and channels. This is a prominent and repetitive feature throughout Lavreotiki, about 55 of them have been explored and a couple of hundred more are found scattered in the landscape but fairly close to one another (Rehren et al, 2002; Tsaimou and Frangiskos , 2008). In fact, next to the systematically - excavated sites at the Sounion National Park (e.g. '*Asklepiako*', excavated by Conophagos in 1977-8 and published in 1980, Agrileza, excavated by Ellis Jones in the years 1977-1983; Photos-Jones and Ellis Jones, 1994) and Souriza, excavated by Kakavoyannis and the Greek Archaeological Service in the 1980s), there is a land full of ancient ruins, sometimes hidden by vegetation, testifying to the blending of land uses, from the residential to the industrial and the agricultural (Kapetanios, 2013). Taking into account the wide distribution in the landscape of the ancient remains, mining in the 5th and 4th c. BC can be viewed as exploitation on an industrial scale, in the sense that the general application of an exploitation concept in a regional context, such as this, bore significant effects on society, the natural environment and the landscape (Stöllner, 2008). The main environmental consequences in this case were the obliteration of the forests which provided fuel for the furnaces, the random disposal of slags and tailings which formed enormous heaps poisonous for the soil, and the ultimate exhaustion of the ore deposits.

The decline of Lavrio as a mining district is attested by Strabo in *Geographica* (IX.1.23) in the 1st c. BC: "*The silver mines in Attica were originally valuable but now have failed. Moreover, those who worked them, when the mining yielded only meagre returns, melted again the old refuse, or dross, and were still able to extract from it pure silver, since the workmen of earlier times had been unskilful in heating the ore in furnaces*" (Anguilano, 2012, 33). Similarly but more laconically, Pausanias in the 2nd c. AD refers to Lavrio as the place where the Athenians once had silver mines (Description of Greece, book 1, I. 1). For a long period there were probably only itinerant ore collectors or smiths operating occasionally in the region dealing with the re-washing of

relatively rich tailings and/or the re-smelting of slags left behind by their predecessors (Rehren et al. 2002; Kapetanios, 2013). After the 6th c. AD, the region appears to be abandoned. According to Ch. Kontogeorgopoulou (2011), the place-names Lavrio and Lavreotiki were probably used in Byzantine times, but there is no mention in the literary sources of any metal exploitation. In any case it can be presumed that any possible inhabitants were not living there because of the mines but in spite of them.

4. The historical landscape

After a long hiatus that lasted more than one millennium, mining and metallurgy were revived during the 19th c. AD, first through the exploitation of ancient waste materials and a little later with new mining operations (Marinos and Petrascheck, 1956). The old glory of the Athenian silver mines combined with the advanced technical realities of the 19th c. drew new prospectors to the area who seized the opportunity.

The ancient mining and metallurgical by-products were of three kinds: (1) mounds of poor ores or ores unworkable by the ancient metallurgists, like sphalerite and smithsonite (altogether called "*εκβολάδες*") left behind usually near the galleries (2) the ancient tailings ("*πλυνίτες*") accumulated near the washeries after the enrichment process and (3) the slags ("*σκωρίες*") which were the by-products of smelting and formed enormous heaps (Conophagos, 1980; Dermatis, 2006). In the 19th c. it was estimated that the ancient slagheaps totalled about 1500000 tons, while the rest of the residues were estimated to be several million tons (Conophagos, 1980). All the ancient by-products were thoroughly re-worked in the 19th c. and are now wiped out.

The most significant player at the time was the French Mining Company, which, after a few changes in its ownership, finally closed in the 1980s, having exhausted the viable mineral potential of Lavreotiki (Conophagos, 1980; Dermatis, 2006). Its counterpart was a Greek company (*Lavrion Metallurgical Company*) which mainly exploited the ancient spoil-heaps and stopped working in the first quarter of the 20th c. (Conophagos, 1980; Dermatis, 2006). The French company led mining operations mainly in Kamariza and Plaka. At the beginning, they were following closely and expanding the ancient mine galleries and pits thus destroying many of the ancient workshops in the hope of finding useful materials. It is regrettable that no-one thought of documenting what was removed in this process, so a great deal of evidence about ancient technology is now lost (Conophagos, 1980).

The French Mining Company worked the mines in the hinterland of Lavreotiki but its industrial quarters were situated next to the modern town of Lavrio. Nowadays, the old installations have been considered worth-preserving and have been given new life: about 40% of the old buildings have been restored, the soils have been decontaminated and the old French Mining Company complex has become an ambitious Technological and Cultural Park[iv]. The monumental landscape of the industrial complex cannot help but evoke some sort of nostalgia of times past, as it is within the aims of the park to preserve the historical identity and the collective memory of the place. It also functions as a repository of technological knowledge. At the same time, new research and entrepreneurship are promoted with an eye to the future (Panagopoulos, 2008).

The landscape of Lavreotiki has been drastically transformed in the 19th and 20th c. First, Lavrio as a company town was founded on account of the French Mining Company. Second, the town and its outskirts were given a profoundly industrial character, but with distinct housing units for the workers and the engineers (Belavilas, 2012). Third, the first industrial railway network in Greece was established in the region, connecting the company headquarters with the mining villages and also Lavrio with Athens (Dermatis, 2006). Fourth, the re-processing of ancient waste heaps, the re-opening of ancient mines and the incidental destruction of ancient furnaces and other surface installations led to the obliteration of a great deal of evidence regarding ancient mining and metallurgy (Photos-Jones and Ellis Jones, 1994). Fifth, the natural environment of Lavreotiki was degraded, mainly due to the disposal of mostly solid wastes in the swamps and coasts of the region. Sixth, the landscape of what is now Sounion National Park was marked with extended and continuous networks of underground mine galleries, various types of auxiliary installations which are now mostly derelict, and enormous heaps of mining debris (Figures 5 and 6). The latter forms an intriguing paradigm: the mining ruins of the past two centuries are intertwined with the ancient mining ruins – in other words, ruins within ruins that constitute two of the basic temporal components of the Lavreotiki palimpsest.

Fig. 5: Ruin of a mining installation at the Sounion National Park.

Fig. 6: Waste heap at the Sounion National Park.

5. The natural landscape

The natural environment of Lavreotiki has been an enabling force of human activities. Its favorable geographic location, its mild geomorphology and climate, coupled with its rich multi-metallic ore deposits have been decisive factors in attracting settlers throughout the millennia. The landscape, therefore, can be viewed as a continuous record of human activity, where man and nature interact. Sometimes, this relationship leaned towards the use and abuse of the natural resources and the landscape, while in other times nature prevailed. Therefore, what can be perceived as stability in one's lifetime falls in reality within the constant framework of change in the larger scale of time.

After the decline of intensive mining in the years after WWII, the landscape became forested again (Photos-Jones and Ellis Jones, 1994). As a result, a considerable part of Lavreotiki was named in 1974 as the Sounion National Park[v]. It is the smallest National Park in Greece, extending over a region of c. 3500 ha, 750 of them defined as core, and the remaining 2750 as periphery. Most of the forest is covered by Aleppo pines (*Pinus halepensis*), while a great variety of shrubs and wildflowers is to be found, some of them protected by CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), like the orchids. The fauna of the park consists of various reptiles, mammals such as hedgehogs, hares, foxes, weasels and badgers, and many bird species, most of them migratory, that use the park as stopover (Vallianatou, 2012). The decision to declare the Sounion National Park was probably inspired, given the historical importance of the region and also that Attica is densely populated and needs open spaces and forests. However, the fact that the park is still without a managing body that could handle its protection more efficiently and the fact that its borders are from time to time disputed, speaks volumes about a hazy bureaucratic environment that could surrender to various pressures and *faits accomplish.* For example, 1985, 1993, 2000 and 2012 are marked as years of great wildfires that did not leave the park unscathed (see the WWF report published in 2012 by Korakaki, Kordopatis and Kazanis). Further potential threats include: urban expansion and deforestation, visitor - use impacts, inappropriate recreational activities, hunting and herding, unauthorized collection of minerals, rocks and even ancient artifacts, unauthorized dumping of litter or other materials (Gray, 2004). All of the above have been recorded in the Sounion National Park, which, however, without being totally pristine, has managed up to now to somehow absorb them. It is undeniable that the natural landscape of Lavreotiki has not been produced by the forces of nature alone, but has been altered and shaped by human activities, recording our 'cultural warts and blemishes' but also our 'cultural glories' (Lewis 1979, 12).

6. The landscape in education

Lavreotiki is an interesting and generally pleasant field of exploration in environmental and cultural education, being in accordance with modern considerations of diffusing knowledge beyond specialists to the general public opting for a future of sustainable development[vi].

The Environmental Education Centre at Lavrio[vii] is an offshoot of public formal education in Greece. Approximately 50 such centres are working throughout Greece, educating students and training teachers on topics related to their particular locality. It is a place-based education, in the sense that it uses local examples in order to promote environmental and social responsibility (Papadimitriou, 2012). The students who more efficiently visit the center range from kindergarten to college level and they can participate in a number of educational programs that normally last 3-5 hours. Furthermore, the centre organizes seminars for the professional training of teachers, as well as workshops and other environmental actions that promote sustainable development for the benefit of the local community. Depending on the age of the students, different educational tools and different aspects of the history and environment of Lavrio are used. Lavreotiki is considered as an ideal setting for raising environmental and cultural awareness, because it provides useful case studies for a number of issues on sustainable development. In addition, the region is still largely unknown to the students and teachers who visit the centre, so their primary reaction and surprise is an interesting starting point of the programs.

The educational programmes of the centre include topics related to the flora and fauna of the Sounion National Park, to the history of ancient mining and metallurgy and the technological chaîne opératoire involved, to recent mining history and its impact on environment and society, to the geology of Lavreotiki and the concept of geodiversity, to human interventions in the Sounion National Park and the concept of protected areas, to various aspects of contemporary life in Lavrio and to local history. In all cases, the aim is to use the most modern approaches to teaching by offering first hand experiences to the students and by visiting with them specific outdoor locations where they may watch, walk, observe, think, discover, recognize, connect, imagine, discuss, play, hear, feel, react, visualise, immerse… Contact with the landscape has an impact on students of all ages and constitutes a different kind of learning, based more on optical connections and problem solving and less on the transmission of information.

7. The landscape palimpsest as cultural capital

The series of human impacts at Lavreotiki forms a mosaic of vulnerable monuments, mostly in ruins, and authentic landscapes. In the previous chapters of this paper I have attempted to demonstrate that the multiple facets of the landscape can be read in different ways, stressing the geological, mining, historical, archaeological and natural features found in it, and that at the end they all reflect a cultural landscape of great interest and vitality. The inevitable question concerns the future of such an intriguing yet often overlooked terrain.

The experience of a cultural landscape is regarded as a process of personal observation: one must first examine visually the landscape, and then identify its individual features, stand by and reflect on it, watch it again, try to interpret it and wonder about it (Terkenli, 1996). When visiting Sounion National Park for the first time, one is faced with an unfamiliar, complex, unpredictable and often dangerous territory: monuments of various ages in ruins can be seen, as well as mine entrances that look like gaping holes, abrupt vertical pits, intensely colored rocks (mostly iron oxides, in shades of red and yellow), geological features (like '*Chaos*'), quarried surfaces, heaps of stones, abandoned and derelict buildings, chapels, etc (Figures 7 and 8).

Fig. 7: Mine entrance at the Sounion National Park.

Fig. 8: Quarried surface and marble debris at the Sounion National Park.

At times, one will come across large fenced areas, which denote antiquities properly excavated, usually well-preserved, but also artificially withdrawn from the landscape and often inaccessible (Figure 9).

Fig. 9: The archaeological site of Souriza within the Sounion National Park, in the background the village of Kamariza can be discerned.

It is not a so-called 'picturesque' landscape, as almost everything in it implies the dark side of harsh human labor[viii]. All these features are located within the confines of a National Park, whose vegetation sometimes underlines the beauty of the landscape and at others obscures the individual manmade features found in it. Repeat visits may reveal the details of the landscape and lessen the original bewilderment, leading to a feeling and sensibility for the place, still far removed from the strictly conditioned experience that is usually saved for tourists in most organized sites and parks[ix]. The 'truth' of the place lies mostly on the imagination. A good sense of understanding, however, cannot be achieved without a basic knowledge of what the widespread remains represent and their historical context – and the only place that one would find such information is the Archaeological Museum in town. In other words, if we accept the axiom that '*any landscape is composed not only of what lies before our eyes but what lies within our heads*'[x], it is necessary to offer to the visitor some basic tools for reading the landscape in situ, in order to make the experience more meaningful and ultimately to promote public appreciation and protection.

As mineral deposits are not renewable, there is little hope (or concern) at present that Lavreotiki will be used for its mineral resources in the near future. In this post-mining era, Lavrio and its surrounding area is perceived as a region with enhanced cultural capital and it seems imperative to exploit this potential in a sustainable way. Many interested parties in the past have postulated this (to mention just a few: Tsaimou and Frangiskos, 2008; Birraux, 2008; Panagopoulos, 2008; Korka, 2009). In this context, attempts have been made to include Lavreotiki in the European and UNESCO Global Geoparks network (2009) [xi] and the UNESCO World Heritage sites (2003, 2014)[xii], but so far without success because the necessary criteria set by UNESCO were not met in their entirety. Given that thousands of tourists visit the proximate Temple of Poseidon at Sounio every year (Figure 10), Lavreotiki is still a best kept secret in Attica (or the last frontier, as proposed by Agriantoni et al. in 2011) practically known only to the *cognoscenti*. It is a place where the visitor still acts as an explorer. Can Lavreotiki escape this fate, is it desirable to escape it, and at what cost? The answer should be affirmative, bringing together and engaging all relevant authorities and the local communities with their often conflicting views and interests. In fact, it is only a matter of time before the Lavreotiki experience becomes normalised, as tourism[xiii] is at the forefront of any thought about development. It should, however, be a well-planned, non-intrusive and balanced kind of development that would underline the features that make the region special, namely the close relationship between geology, landscape and cultural heritage, and would provide meaningful interpretations of the complex past, beyond the stereotypes of tourism.

Fig. 10: The temple of Podeidon as seen from the Sounion National Park.

8. Conclusions

This paper has attempted to demonstrate the characteristic features of the Lavreotiki landscape, most of which are associated with mining and the exploitation of underground metal resources. Human presence has been attested for a long period of time, with a starting point in the end of the 4th millennium BC, leaving a complex network of traces on the surface, i.e. mining shafts and pits, metallurgical workshops and installations, heaps of by-products and miners' settlements. The majority of these structures are located within the confines of the Sounion National Park which makes an ideal backdrop for all these ruins and at the same time preserves their authenticity and integrity. The complex cumulative record of the work of nature and humans, which is connected to Meinig's (1979) historical reading of the landscape, puts an emphasis on the industrial past of the region. The technological and industrial aspects of past civilizations and past times are often overlooked or even treated as marginal, both by scholars and the public: it is all too often that people focus more on monuments ignoring what made them possible in terms of raw materials and revenues. The case of Lavreotiki has been characteristic of this attitude but at the same time seems to be challenging this notion. Lavreotiki is on the verge of 'being discovered' and it is crucial to this paper that its 'discovery', followed by its future exploitation as a major heritage site, would highlight the multiple readings of this exciting landscape.

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[i] See, http://conventions.coe.int/Treaty/EN/Treaties/Html/176. htm (last access: 6-1-2015).

[ii] See, for instance, Terkenli (1996), Knapp and Ashmore (1999), Doukellis (2009), Hatjimichalis (2010) and Vavouranakis (2012) for lengthy discussions about the evolution of the term and its multiple aspects.

[iii] See Agriantoni et al (2011) about current land uses and residential developments.

[iv] For more information, see http://www.ltp.ntua.gr/lavrion_park

[v] Published in: ΦΕΚ 80/A/1974.

[vi] See: UNESCO's definitions of environmental education and education for sustainable development (last access 21/3/2015).

[vii] For a comprehensive account on the educational programs of the Environmental Education Centre at Lavrio, see: http://kpe-lavriou.att.sch.gr/programs.php (last access 11/3/2015)

[viii] Tens of kilometres of underground mines in a state of disuse are found in Lavreotiki. The subterranean experience of the miners, who worked in confined places of reduced visibility and air supply, is beyond the scope of this paper and requires further study.

[ix] For an interesting account on mining districts that have chosen to capitalise on their mining heritage by encouraging tourism, see: Pretes (2002).

[x] As stated by the American geographer D.W. Meinig (1979).

[xi]See: http://old.igme.gr/Lavreotiki_Geopark_Application_Dossier.pdf (last access 11/3/2015).

[xii] In fact, Lavreotiki belongs to the tentative list. See, http://whc.unesco.org/en/tentativelists/5857/ (last access 11/3/2015).

[xiii] For a balanced discussion on the ethics of converting archaeological sites into tourist attractions and the typology of tourism related to antiquities and landscapes (e.g. cultural tourism, eco-tourism, adventure tourism, archaeological tourism etc), see: Díaz-Andreu, 2013.